Université d'Auvergne Clermont-Ferrand 1
École d'Économie – Centre d'Études et de Recherches sur le Développement International (CERDI)
École Doctorale des Sciences Économiques, Juridiques et de Gestion

Financement soutenable de la santé pour le progrès vers la couverture universelle en santé dans les pays à revenus faible et Intermédiaire

Sustainable health financing for progress towards universal health coverage in low- and middle-income countries

Thèse Nouveau Régime
Présentée et soutenue publiquement le 22 décembre 2017
Pour l'obtention du titre de Docteur ès Sciences Économiques

Par Palingwindé Yann TAPSOBA

Sous la direction de
Mme Martine AUDIBERT
M. le Professeur Jacky MATHONNAT

Membres du Jury

M. Fouzi MOURJI	Professeur à l'Université Hassan II	Rapporteur
M. Bruno VENTELOU	Directeur de recherche, AMSE-GREQAM	Rapporteur
Mme Elodie DJEMAI	Maître de conférences à l'Université Paris-Dauphine	Suffragant
Mme Martine AUDIBERT	Directrice de Recherches au CNRS (CERDI)	Directrice
M. Jacky MATHONNAT	Professeur à l'université d'Auvergne (CERDI)	Directeur

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Résumé: Les pays à revenus faible et intermédiaire se sont engagés depuis de nombreuses années à améliorer la santé de leur population. Le défi actuel de ces pays, inscrit dans les Objectifs de développement durable, est d'atteindre une couverture universelle en santé pour l'ensemble de leur population. Par conséquent différentes politiques ont été implémentées dans l'optique de promouvoir dans ces pays, un financement soutenable des systèmes de santé ; cela en raison de l'insuffisance des ressources allouées pour répondre aux multiples besoins de santé des populations. De ce fait, il apparait souhaitable et surtout fondamental pour les décideurs politiques de comprendre et de connaitre les différentes stratégies qui permettraient de renforcer la soutenabilité du financement de la santé dans les pays à revenus faible et intermédiaire. L'une des solutions envisageables pour les pays serait d'améliorer l'efficience des dépenses de santé et de contrer les différents facteurs susceptibles d'augmenter inutilement ou de réduire le niveau de ces dépenses de santé. Dans l'optique d'apporter une contribution face à cette préoccupation, cette thèse, organisée autour de quatre chapitres, se propose d'explorer respectivement dans les deux premiers, les déterminants de l'efficience et du niveau des dépenses de santé dans les pays à revenus faible et intermédiaire. Dans le premier chapitre, il est question d'analyser l'effet de l'ouverture commerciale sur l'efficience des dépenses de santé. Le second chapitre étudie l'effet de la pollution de l'air sur les dépenses de santé. Au sein de la composition des dépenses de santé, il s'avère que les paiements directs contribuent à appauvrir les ménages. Toutefois, parmi les pays à revenus faible et intermédiaire, la région d'Afrique Sub-saharienne demeure la plus pauvre et fait face à des performances sanitaires déplorables, probablement occasionnées par la contribution assez élevée des paiements directs dans le financement de la santé. Ainsi, une nécessité s'impose pour ces pays de réduire progressivement la part des paiements directs dans le financement de la santé et de promouvoir le financement prépayé de la santé. De ce fait, nous choisissons pour les deux derniers chapitres de cette thèse de nous focaliser uniquement sur les pays de l'Afrique au sud du Sahara. Le troisième chapitre s'intéresse au rôle que joue le financement prépayé de la santé sur l'état de santé des ménages. Dans ce chapitre, nous testons l'effet des dépenses prépayées de santé sur des indicateurs de santé à savoir le taux de mortalité infanto-juvénile et le ratio de la mortalité maternelle. Quant au quatrième chapitre, il a pour objectif d'analyser les déterminants des dépenses prépayées de santé, en se focalisant plus particulièrement sur l'instabilité politique qui ne cesse de déstabiliser ces pays depuis ces dernières années.

Mots clés : efficience technique, financement soutenable de la santé, ouverture commerciale, pollution de l'air, instabilité politique, analyse des frontières partielles, modèles de régressions fractionnelles, moindres carrés généralisés, GMM efficient.

Abstract: Low- and middle-income countries have committed for many years to improve health of their population. The current challenge of these countries, registered in the Sustainable Development Goals, is to achieve universal health coverage for the whole of their population. Various policies have been consequently implemented to promote in countries, sustainable financing of health systems; given the shortfall in resources allocated to meet with the multiple health needs of population. Hence, it is advisable and mostly fundamental for policy-makers to understand and to know the different strategies which would allow the reinforcement of sustainability in health financing in low- and middle-income countries. One of conceivable solutions for countries would be to enhance the efficiency of health expenditures and to counter the different factors likely to uselessly increase or to reduce the level of heath expenditures. To address this concern, this thesis, articulated around four chapters, proposes in the two firsts to respectively explore the determinants of efficiency and health expenditures 'level in low- and middle-income countries. The first chapter analyzes the effect of trade openness on the efficiency of health expenditures. The second chapter investigates air pollution effect on health expenditures. Within the composition of health expenditures; it appears that the out-of-pocket payments lead to impoverish households. Among low- and middle-income countries, Sub-Saharan African region remains the poorest and experiences deplorable health performances, probably due to the high contribution of out-of-pocket payments to health financing. Thereby, it is necessary for these countries to progressively reduce the share of out-of-pocket payments and to promote the prepayment schemes in health financing. Hence, for the two last chapters, we only focus on Sub-Saharan African countries. The third chapter is interested to the role that plays prepayment health financing on health status of households. In this chapter, we test the effect of prepayment health expenditures on health indicators such as the under-five mortality rate and the maternal mortality ratio. As far as the fourth chapter, it sets the goal to analyze the determinants of prepayment health expenditures, by particularly focusing on political instability which imperils these countries since the last years.

Keywords: technical efficiency, sustainable health financing, trade openness, air pollution, political instability, partial frontier analysis, fractional regression models, feasible generalized least squares, efficient GMM.

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General Introduction

Over the thirty last years, health has been placed at the heart of priorities in the implementation of fight policies against poverty. Indeed, health improvement intends to insure a social justice.

The poorest are generally the most sickness people in the sense that they cannot access to healthcare quality. Their worsen health status contributes to exacerbate their level of poverty and consequently to jeopardize their well-being.

This major issue has led governments and international institutions during the Millennium Declaration for Development in 2000 to coordinate their actions to insure a better health for the individuals, mostly in low- and middle-income countries. They intended to achieve the following goals: reduce child mortality by two thirds and maternal mortality by three quarters and to fight against diseases such as HIV/aids, malaria and tuberculosis. Despite the noteworthy improvement of health in low- and middle-income countries, the major part of these countries has not achieved the Millennium Development Goals for health (MGDs)[1].One of main impediments met has been the shortfall in financial resources compared to numerous health needs of population. This constraint has aroused the emergence of new wave of researches based on the sustainability of health financing in low- and middle-income countries. The main goal of these researches is to find strategies which would allow a sustainable, equitable and efficient financing of health systems in these countries which constitutes an actual challenge for these last ones. Three main approaches have been successively used to finance health in low- and middle-income countries: the free healthcare, the cost-sharing systems and the insurance schemes (Audibert et al., 2004).

1. Evolution of health financing policies in low- and middle-income countries: three used approaches

Before the implementation of free healthcare, more specifically during the 1960s, health financing essentially focused on the vertical programs targeted on the fight against the infectious diseases which at this time constituted the main cause of deaths. These diseases were majorly due to the unhealthy lifestyle and some cultural practices likely to damage health status of people. The vertical programs were mainly financed by foreign sponsors given the shortfall in health resources at nationally. The external financing was conditioned by rules which not fostered the functioning and the organization of national institutions intervening in health sector. Furthermore, vertical programs had not been able to solve all health problems about which countries were faced up. Despite these vertical programs, the access to health facilities and the quality of healthcare were reduced. Moreover, health supply was unequally distributed with medical deserts in the rural areas. This deplorable situation has induced governments during the conference of Alma-Ata in 1978 to reflect about strategies which could be implemented to meet with health needs of population.

1.1 The conference of Alma-Ata: free healthcare

During this conference, governments have defined a policy of primary healthcare for which the goal were to promote the free of primary healthcare; in view of financial capacity of countries; which appears fundamental for health improvement in low- and middle-income countries. This goal could be achieved only under the following conditions: insuring a sufficient and sustainable budget allocation in favour of primary healthcare and promoting the good management of these budgetary funds allocated to health to meet with the needs of patients (Letourmy, 2008). However, the economic crisis of 1980s has adversely affected the public financing of countries.

[1]See the Millennium Development Goals Report 2015,
http://www.un.org/millenniumgoals/2015_MDG_Report/pdf/MDG%202015%20rev%20(July%201).pdf

The social sectors such as education and health were the most touched by the crisis. The economic shock has reduced the volume of public resources allocated to health which remained insufficient even before this event. This crisis has resulted in: an increase in inequalities in the coverage of healthcare which was unfavourable for the poorest, a lack of essential generic drugs and qualified medical staff and a generalization of unofficial payments leading not only to a virtual free but also to a decrease in access to healthcare for people, mostly the poorest. It has consequently resulted in a deterioration of health status in general fashion which has induced governments to establish through the Initiative of Bamako a system of participation by the users to the purchase of drugs in 1987 and to general financing of healthcare in 1994.

1.2 The initiative of Bamako: the cost-sharing

This initiative had four major goals (WHO, 1999b): the reinforcement of management and financing mechanisms at locally, the promotion of community participation in health financing, the implementation of permanent sources of health financing and the reinforcement in the provision, the management and the use of essential generic drugs. The finality of three first goals was to counter the shortfall in public health resources, to lighten the financial hardship of states to insure an efficient allocation of resources based on the most priority needs and to promote an adequate financing of healthcare units. The last goal intended to reduce the cost of healthcare without impeding the payment capacity of users given the low elasticity of demand against the price of essential goods such as healthcare (Chabot, 1988). The common expected consequence of all goals was to induce healthcare providers to deliver quality healthcare to meet with patients' expectations. The guiding principles of Bamako initiative are (WHO, 1999b; Mc Pake; 1992):

- Government must allow all communities to access to activities of primary healthcare;

- The decision-making based on primary healthcare at the level of health district must be decentralized at locally;

- The financial management must be decentralized to allow for the concerned communities to manage the resources locally produced;

- The relative principles to community financing of health services must be applied at all health system levels;

- The concept of essential drugs must be included in the national health policies based on the primary healthcare;

- The strategies such as exemptions and subsidies must be accounted for to secure the access to health for the most disadvantaged social classes;

- Intermediary goals must be clearly defined and indicators must be computed to measure the progress of this initiative.

The implementation of Bamako initiative has been jeopardized by factors that have undermined the process of health enhancement. This strategy has been implemented in a context of poverty, mostly for informal sector and rural individuals. This situation impeded the capacity of population to participate to healthcare financing. Then, the cost-sharing has aroused a disengagement of states in health financing which has increased and decreased respectively the cost and the demand of healthcare. Furthermore, the definition of guiding principles of this initiative has not accounted for the non-financial factors limiting the access to healthcare, mostly for the poorest. There are for example transportation barriers (transport costs between the place of residence and health facilities) which are often substantial in developing countries (Attanayake et al., 2000; Nahar and Costello, 1998) and which jeopardize the access to and the use of healthcare (Gage, 2007; Tsawe and

Susuman, 2014). Health centres are often away from the place of people residence (Silal et al., 2012). In this way, the use of healthcare requires a travelling which is costly and not reachable for some people.

This situation has induced the policy-makers to think another approach which would allow a better sustainable health financing. It needed to find a mechanism by which the individuals could access to quality healthcare without experience a deterioration of their well-being. This new dynamic has led the actors in the 1990s to orient their reflections on health financing based on insurance schemes.

1.3 The development of health insurance schemes

Health insurance sets the goal to share the risk of disease through cross-subsidization systems. Through health insurance schemes, any person who have subscribed to health insurance could profit of healthcare in case of disease episode. In case of absence of disease episode, the insurance premium directly paid by this individual (for the private insurances) or paid by community (for the community insurance), will serve to finance healthcare of individual who needs to be treated. Through health insurance schemes, the least sick people finance healthcare for the most sick which needs more to care.

The reflection about health insurance has articulated around three approaches, mostly in low- and middle-income countries. The first one has started before 1990s. It consisted to reinforce the package of insurances services dedicated to formal (official) sector. This insurance system was based on two main models: the compulsory health insurance and the private and voluntary health insurance. These traditional mechanisms could not be applied to informal (non-official) sector on account of traceability problem of resources in this sector. It needed to find a method which would allow this category of persons to participate to health insurance schemes. At the early 1990s, two kinds of health insurance schemes have been implemented: the Mutual Health Organization and Health Micro-Insurance. Compared to national health insurance schemes, Health Micro-Insurance can be defined as an independent company which proposes small-scale services. These services consist to repay the fees of healthcare provided health-delivers to patients which have been enrolled by this Micro-Insurance. This insurance scheme has been designed for the most vulnerable social classes (Dror and Jacquier, 1999). The Mutual Health Organization constitutes a group of individuals which pool their resources also called the dues to counter health risk likely to imperil the members of their family. They are generally based on five main principles such as: the non-profitability, the solidarity, the volunteering, democracy and the independence (Letourmy and Pavy-Letourmy, 2005). Over time, most specifically in the 2000s, health insurance systems started to be financed in part by the states, the foreign sponsors and the non-profit institutions serving households such as the Non-Governmental Organizations (NGOs). This new approach of health financing sets a goal to achieve universal health coverage, mostly in low- and middle-income countries.

2. Focus on universal health coverage: a new perspective for a better health of population in low- and middle-income countries

Since the 58th session of world health assembly in 2005, the member states, more specifically low- and middle-income countries have committed to promote universal health coverage to improve health status of their population. Based on the World Health report, 2010 (World Health Organization, 2010), universal health coverage can be defined as a strategic framework which would allow all people and communities to use promotive, preventive, curative, rehabilitative and palliative health services they need, of sufficient quality to be effective, while also ensuring that the

use of these services does not expose the users to financial hardships. In addition to this institutional definition, universal health coverage can be regarded as the expected result of performance of health systems for which the main goal is to offer qualitative health services to populations per their needs, by avoiding that the use of healthcare leads to financial hardship likely to impoverish the individuals (Boerma et al., 2014). This definition can be understood as the following fashion: any person in the need must be able to benefit from qualitative health services without incur the risk to become poor or to exacerbate its level of poverty after the use of healthcare at the point of services.

The final goal of universal health coverage is to improve health status of population. Two intermediate goals are defined. The first one sets to increase the access to and the use of qualitative healthcare. This access notion includes five components (Penchansky and Thomas, 1981): the acceptability defined as the consent of patient to receive healthcare, the sufficient availability of human and physical resources used in the production of healthcare, the geographical accessibility to health facilities, the financial affordability of healthcare which refers to the costs of these healthcare, the effective organization in the process of healthcare provision to meet with the needs of patients. Based on the study of Wyszewianski, (2002), it is necessary and essential to simultaneously respect these five principles to enhance the use of healthcare. The second intermediate goal is to protect the users against the financial risks caused by the out-of-pocket payments. The out-of-pocket payments refer to any direct outlay by households, including gratuities and in-kind payments, to health practitioners and suppliers of pharmaceutical, therapeutic appliances and other goods and services for which the primary intent is to contribute to the restoration or the enhancement of individuals 'health status. In general, the out-of-pocket payments result in catastrophic health expenditures[2] leading to impoverish the populations (Xu et al., 2003; Wagstaff and Van Doorslaer, 2003; Van Doorslaer et al., 2006). On this subject, the World Health report 2010 has shown that every year, around 150 millions of people face up to financial catastrophe, whereas 100 million pass under poverty line.

There is not a standard directive to achieve these two intermediate goals of universal health coverage. The approaches used to implement universal health coverage remain different per countries. However, it remains unanimous that the major part of countries combines various mechanisms to achieve universal health coverage. These are the compulsory, voluntary, public, private or community health insurance and the national health systems. These mechanisms are generally financed by prepayment health expenditures that include the set of resources pooled to finance healthcare. Excluding the out-of-pocket payments, these health expenditures are composed of central government health expenditures financed in part by external resources for health, the social security funds, health expenditures from private health insurance schemes and NGOs health expenditures.

The progress of universal health coverage accounts for three dimensions (Figure 1) such as:

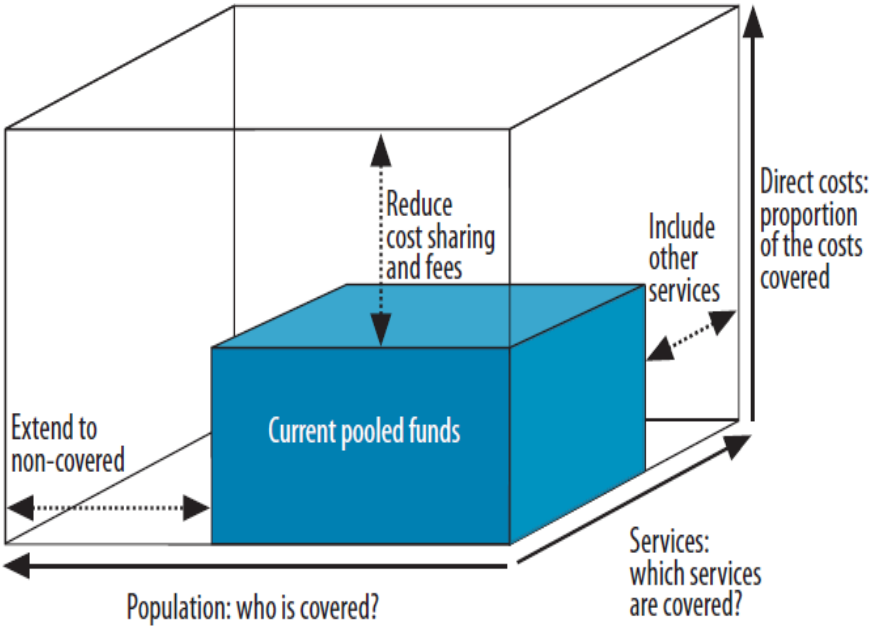
- The covered population: The programs entering in the framework of universal health coverage prioritize the poor and the vulnerable that need the most to healthcare but cannot access to them due to the shortfall in this resources;

[2] The financial catastrophe is defined as different ways per the studies. Based on the study of the Xu et al., (2003), the financial health catastrophe occurs in the case where health expenditures of the households exceed 40% of their income remaining after subsistence needs have been met. Based on the World Health Organization (WHO), there is financial health hardship when households spend 50% or more of their non-food expenditures on healthcare.

- The kind of covered healthcare: in general, the priority is given to primary healthcare which are the least costly but less accessible to individuals, given their poverty situation.

- The proportion of costs covered by health expenditures excluding the out-of-pocket payments: The costs coverage can be partial or total according that the financing system is contributory or not. In the contributory schemes, the users participate at different proportions per country. The contribution of users to health financing sets the goal to limit the unnecessary over consumption of healthcare and to avoid opportunistic behaviours. That has been the case of Medical assistance scheme to economically impoverished peoples (RAMED), implemented in 2008 in the framework of universal health coverage in Morocco (Tazi, 2013).

Figure 1: Three dimensions to consider when moving towards universal health coverage



Source: World Health report, 2010.

3. Why insure sustainable health financing to progress towards universal health coverage in low- and middle-income countries?

In low- and middle-income countries, the financial viability of health programs and policies remains an impediment for the progress towards universal health coverage. This constraint comes from the shortfall in health resources, the limited allocation and the low the efficiency in the management of these health expenditures.

3.1 The level of health expenditures is low, whereas the share of out-of-pocket payments in health financing remains non-negligible

In the framework of health financing in low- and middle-income countries, recommendations have been given by the international organizations such as the World Health Organizations but also by empirical works. The goal of recommendations is to promote the progress towards universal health coverage and health improvement. On this subject, the macroeconomic and health commission of World Health Organization (Sachs, 2002) suggests that the minimum amount of total health expenditures required to provide a basket of essential goods and services for the population is 34 USD per person. Concerning the fiscal effort for health, by the Chatham House report 2014 and McIntyre et al., (2017) recommend that government health expenditures per capita and as

percentage of GDP should be at least 86 USD and 5% respectively to progress towards universal health coverage and to ensure a access to primary healthcare services. Then, during the conference of Abuja, African countries have committed to allocate at least 15% of these total government expenditures to health sector. Furthermore, to counter the impoverishment effect of out-of-pocket payments, it is also convenient to reduce much possible their share in total health expenditures. The Chatham House report (2014) suggests that the out-of-pocket payments should be less than 20% of total health expenditures.

Our analyses on a sample of 149 low- and middle-income countries over the period 2000-2014, based on the Global Health Expenditures (GHE) database[3] (WHO, health statistics, 2014) reveal that effort have been made to respect these recommendations. Between 2000 and 2014, total health expenditures per capita have increased in all income-groups, passing from 19.82 USD to 39.99 USD and from 196.5 USD to 321.23 USD[4] respectively for low- and middle-income countries. Countries have achieved in 2014 the threshold proposed by the macroeconomic and health commissions of World Health Organization. These amounts remain low compared to high-income countries which have also experienced an increase in total health expenditures per capita passing from 1773.81 USD in 2000 to 3102.24 USD in 2014.

In addition to total health expenditures, government expenditures on health per capita and as percentage of GDP have also increased over time. Between 2000 and 2014 government health expenditures per capita are passed from 8.51 USD to 15.11 USD and from 119.59 USD to 201.28 USD respectively in low- and middle-income countries. Government health expenditures as share of GDP are passed from 2.01% to 2.47% in low-income countries and from 3.56% to 3.91% in middle income countries. It consequently appears that low-income countries have not respect the recommendations of McIntyre et al., (2017). Middle-income countries have not also achieved the minimum threshold of government health expenditures as percentage of GDP to progress towards universal health coverage. They have gone over the minimum amount of government health expenditures necessary to insure a suitable access to primary healthcare services. Nevertheless, this amount remains largely lower than the one of high-income countries estimated around 1281.3 USD in 2000 and 2294.23 USD in 2014.

In view of analysis, it appears that despite the performances achieved in health financing, the resources for health remains insufficient to cover health needs of individuals. Moreover, budget prioritization towards health remains low compared to the threshold recommended by the World Health Organization. In countries, government health expenditures as percentage of total government expenditures have not exceeded 12.5% between 2000 and 2014 (Graphic 1)[5]. Over the period, middle-income countries have experienced a slight increase in budget prioritization towards health. In upper-middle-income countries, government health expenditures as share of total public expenditures are approximately passed from 11.12% to 12.25% between 2000 and 2014. This percentage was approximately 9.25% in 2000 in lower middle-income countries but it has not exceeded 10% in 2014. In low-income countries, budget prioritization for health is passed from 9.25% in 2000 to approximately 11.37% in 2007. Since 2007, this percentage has decreased until approximately 10% in 2014.

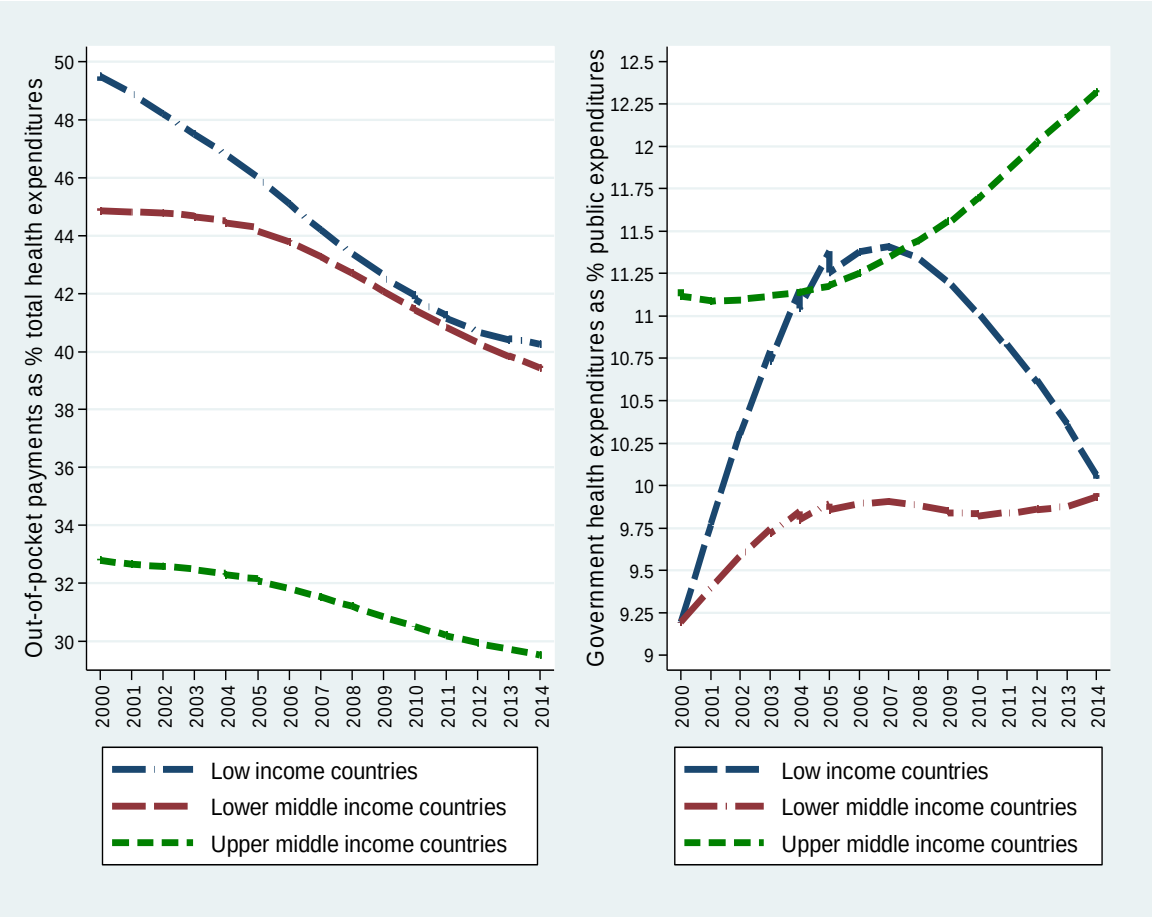
[3]http://apps.who.int/nha/database/Select/Indicators/en.

[4]We do not know whether the threshold for total health expenditures and government health expenditures in per capita was estimated in current or constant USD. We make the analysis with the current USD.

[5]For the moment, there is no a consensus on the threshold of budget prioritization toward health. However, given that a threshold (15%) has been given for African countries, we choose the same for the other ones.

As far as the out-of-pocket payments, their contribution to health financing has decreased in all income-groups; mostly in low-and lower middle-income countries. In upper middle-income countries, the out-of-pocket payments as share of total health expenditures are approximately passed from 33% in 2000 to a value inferior to 30% in 2014. In low-and lower middle-income countries; this percentage is respectively passed from 49.5% and 45% in 2000 to an approximate value of 40%[6]. Despite the observed decreasing trend in the out-of-pocket payments as percentage of total health expenditures, their value remains nonetheless non-negligible and greater than the threshold of 20% suggested by the Chatham House report 2014.

Graphic 1: Time trend of budget prioritization towards health in low- and middle-income countries (2000-2014)



Source: Author, using Government Health Expenditures (GHE) database.

3.2 The limited allocation and the low efficiency in the management of health expenditures

In the context of expenditures, the efficiency can be viewed in two ways (Farell, 1957). There are the allocative the efficiency and the technical efficiency. In the perspective health expenditures management, the allocative the efficiency can be defined as the ability of Decision-Making Units (DMUs) to combine the outputs or the inputs to respectively maximize their production (income) and minimize their costs. The DMUs refer to entities which use input(s) and a technology to produce output(s). Here, DMUs refer to health systems of countries which set the goal to produce

[6]The analyses on budget prioritization for health and the contribution of the out-of the-pocket payments to health financing have been also made by Barroy et al., (2017) and Mathonnat et al., (2016). These works find the same results of our investigations.

health outcomes (outputs) through, among other things, health funds/expenditures (inputs). In this way, the allocative the efficiency allows health systems to adequately allocate health expenditures per the most priority health needs of population to improve health status. It allows checking whether expenditures allocated to health are higher because the higher prices are chosen (choice of specialty care drugs instead of generic drugs for example). Concerning the technical efficiency, also called managerial efficient or the efficiency-x (Leibenstein, 1978; Jacobs and al., 2006), its first definition has been provided by Debreu (1951), Koopmans (1951) and Farell (1957). It is defined as the optimal management of a production technology allowing a DMU to achieve better performance in terms of output production, or input use. Here, health systems will be considered as technically efficient in the case where their maximize their health outcomes in view of existing level of used health expenditures or to produce the same level of health outcomes with fewer health expenditures.

The estimation of allocative the efficiency requires getting information about the price of produced output(s) and or input(s). Given that health expenditures the efficiency are investigated on the basis of national data at country-level, it is impossible to get information about the price by country of inputs (medical staff, medical equipment) used in the process of health outcomes' production. The use of health expenditures as factor of health outcomes' production already accounts of value of health inputs. However, even if the value or the price of health inputs can be accounted for, the second challenge in the estimation of allocative the efficiency is to express the results in value; a fact is impossible for health status expressed in physical terms and for which it is difficult to assign a price. However, in the approach of technical efficiency, the results are expressed in physical terms. That induced the analyses on the efficiency of health expenditures to essentially focus on its technical component instead of its allocative one.

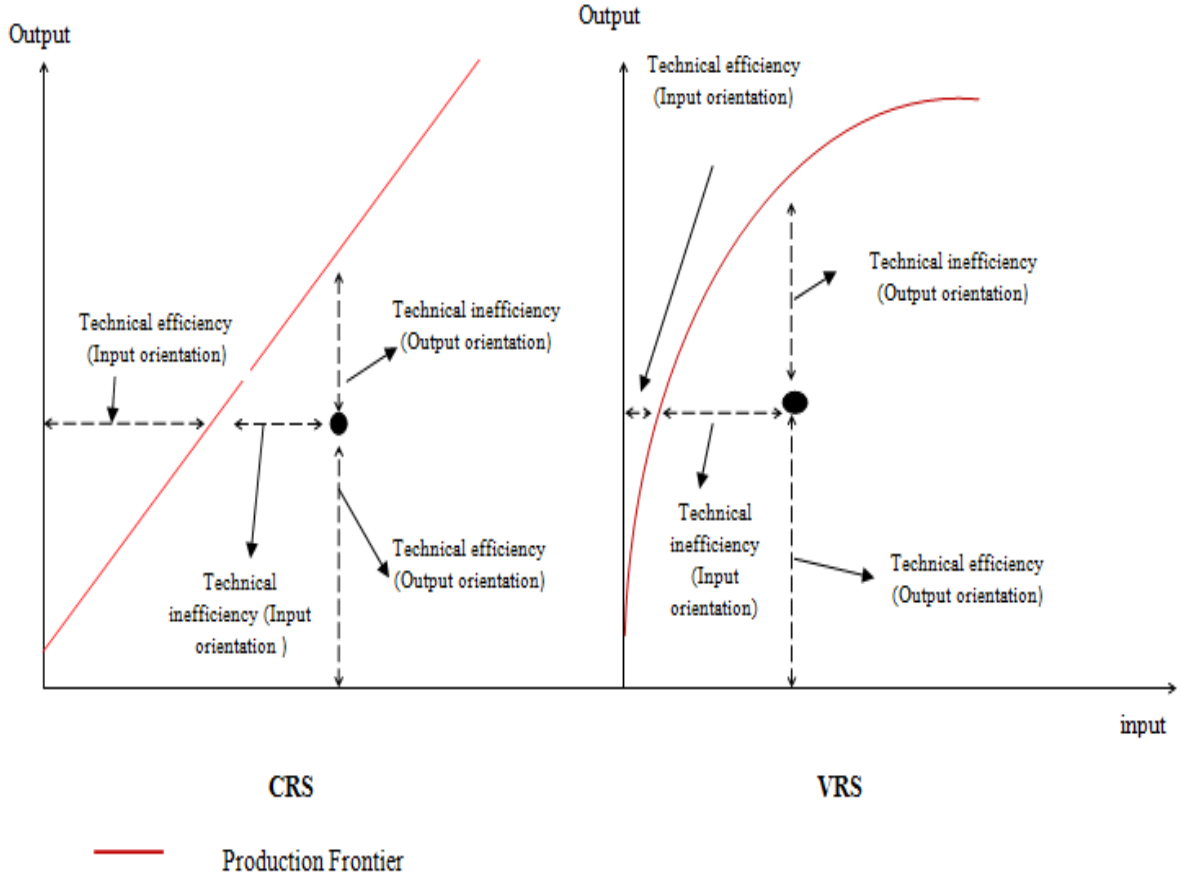
Generally, the technical efficiency is assessed by defining a production frontier[7], approximating the technology of production, in below which are situated the least efficient DMUs. The most efficient DMUs compose the production frontier (Figure 2). The technical efficiency is estimated in two different ways. It can be estimated in terms of output orientation supposing the possibility for the DMUs to produce more output(s) in view of existing level of input(s). Through the output orientation, the level of output(s) produced by each DMU is compared to the maximum level of output(s) which is produced by the most efficient DMU(s) (best practices). The technical efficiency can be also estimated in input orientation. The use of input orientation implies that the DMUs could produce the same level of output(s) with fewer input(s). Through the input orientation, the level of input(s) used by each DMU is compared to the minimal level of resource(s) used by the most efficient DMU(s) to produce the output(s).

Furthermore, the assessment of technical efficiency requires making some assumptions about the production process. There are two kinds of assumption such as the Constant Returns-to-Scale (CRS) and the Variable Returns-to-Scale (VRS). The first one assumes that the increase in used input(s) by X% should allow increasing the quantity of output(s) produced by DMUs in the same proportions (Charnes et al., 1978). Based on CRS assumption, the relation between the output(s) and the input(s) is linear. With this assumption, the efficiency scores in output orientation coincide with the input-oriented efficiency scores (Fare and Lovell, 1978). In contrary, the VRS assumption supposes that the relationship between the output(s) and the inputs(s) is convex (Banker et al., 1984). It means that the increase in inputs by X% should result in a less (in decreasing returns-to-scale) or more (in increasing returns-to-scale) proportionally increases in outputs. The technical

[7]It is also possible to investigate the efficiency of the health programs by analyzing their ratio cost/result. This method is different from the one of the production frontiers.

efficiency estimated with VRS includes two components, such as the pure technical efficiency and the scale efficiency which considers the influence of size production of DMUs on their productivity. Compared to CRS, the output-oriented scores differ from the input-oriented scores in the case where the VRS assumption is considered.

Figure 2: Graphical representation of efficiency measurement



Source: Author, adapted from Pélissier (2012).

Health expenditures are unequally allocated in low- and middle-income countries. Based on benefit incidence analysis carried out by Filmer (2004) and Gwatkin (2005), public health expenditures are generally allocated in favour of richest instead of poorest. This misallocation results in inequalities in the access to and the use of healthcare. Hence, health resources, mostly from public sources, might be allocated in favour of healthcare more consumed by the poorest. This allocation would allow the achievement of goals targeted by health systems by reducing the inequality in the access to and the use of healthcare. Furthermore, it would allow avoiding the wastage in the management of health expenditures that remains deplorable in low- and middle-income countries. Based on the WHO report 2010 "health systems financing the path to universal coverage[8]", 20% to 40% of total health expenditures are wasted. This wastage can be explained by the shortfall in technical efficiency in the use of health resources. The technical efficiency is a necessary condition allowing countries to reinforce the allocation of health expenditures and to accordingly reduce the wastage in their use.

[8]See chapter 4, page. 67.

Several authors showed effectively that many of low- and middle-income countries wasted their financial resources as they could achieve health performances with health expenditures fewer than those they spent. For example, Herrera and Pang (2005), using an input orientation and working on 140 developing countries, found that developing countries would have been able to achieve the same performances in terms of life expectancy, and immunization coverage against measles and DPT (Diphtheria-Pertussis-Tetanus) by saving 13% to 16% of these total health expenditures. Dukhan (2010) working on a sample of 103 low- and middle-income countries also concluded that those countries with their same level of infant survival, of maternal survival and tuberculosis prevalence, would have been able to save respectively 67%, 60% and 71% of health expenditures.

Other authors, adopting the output orientation, will reinforce the precedent results by showing the inefficiency of health expenditures in those countries. Their results argued that countries could further enhance health status without increase their health expenditures. For example, Herrera and Pang (2005) found that countries could increase the life expectancy of people and the immunization coverage rate against measles and DPT from 7% to 8% with the same used level of public and private health expenditures. Compared to Herrera and Pang (2005), Jayasuriya and Wodon (2003) carried out their study on a lower sample including 76 developing countries. They found that with the same level of health expenditures, countries could increase the life expectancy by 15%. Mathonnat (2010) focused his investigation on 86 low-and lower middle-income countries. By accounting for the density and the literacy of population, he sheds light the possibility for countries to increase the child survival respectively by 41% and 32% in view of existing level of public health expenditures. Regarding separately countries of East and South Asia and Pacific, Middle East and North Africa and Sub-Sahara, he estimated that countries could respectively increase the child survival by 48%, 15% and 39% without reduce their public health expenditures. Dukhan (2010) found that in 28 low- and middle-income countries, it is possible to reduce under-five mortality, maternal mortality and tuberculosis prevalence by 11% with the same level of health expenditures.

4 The thesis: context, research questions and structure

In view of arguments established above, it is fundamental for sustainable health financing in low- and middle-income countries to increase the efficiency of health expenditures and to reduce the wastage in their use. Furthermore, countries need to counter the factors which uselessly increase or decrease the volume of health expenditures, mostly their prepayment component taken in general fashion and which is likely to enhance health status. It is consequently important for the policy-makers to identify the determinants which explain the low the efficiency of health expenditures. Furthermore, it is also important to find strategies which would allow for these countries to save more resources for health. In addition low- and middle-income countries tend to promote the decrease in share of out-of-pocket payments in health financing given their adverse effect on poverty which impedes health status. In view of this observation, it is well to know whether prepayment health financing effectively allows health improvement and to explore the eventual factors likely to reinforce the effectiveness of health financing from prepayment sources in the process of health enhancement. Then, it is also essential to know how health expenditures coming from the prepayment schemes could be increased or to identify the factors likely to jeopardize their increase.

To contribute to the literature on sustainable health financing in low- and middle-income countries, we attempt in this thesis to address the following questions:

- How can we increase the efficiency of health expenditures in low- and middle-income countries?

- How can we counter the useless increase in health expenditures in low- and middle-income countries?

- Do prepayment health financing be effective for health improvement in low- and middle-income countries? What can we reinforce this effectiveness?

- What does explain the low level of health expenditures from prepayment sources in low- and middle-income countries? How can we increase them?

The thesis is organized around four chapters that set the goal to respectively reply to four research questions asked above.

Chapter 1, ***"Determinants of technical efficiency of health expenditures in low- and middle-income countries: focus on trade openness"***. The research on the efficiency of health expenditures has developed since the 2000s. This literature has focused on the assessment of technical efficiency of health expenditures and the investigation about the factors likely to explain this efficiency. On this subject, these last years have been described as the era of globalization in the world which has resulted in an interconnection of economic systems but also in strong waves of trade openness for low- and middle-income countries. Trade openness has allowed countries to import goods and services for which the consumption has affected health status of population. Furthermore, trade openness has resulted in a structural and cyclical shift of economic tissues that have also affected health of people. In this way, it is important to investigate the eventual effect of trade openness on the efficiency of health expenditures defined in this context as the capacity of countries to produce better health outcomes in view of existing level of health expenditures that they use. The first chapter pursues the goal to estimate the technical efficiency of health expenditures and to test trade openness effect on this efficiency by using a sample of low- and middle-income countries. Generally, there are two approaches to estimate the determinants of technical efficiency scores. The first one is a parametric approach based on the Stochastic Frontier Analysis (SFA) that uses a composed error model to estimate in one stage, both the efficiency scores and their determinants. SFA uses econometric tools to estimate a production function by explaining the output(s) on the input(s). The residual term of econometric model comprises two components such as a random error and an inefficiency term. The inefficiency term is transformed into an efficiency term which is explained on its determinants (Battese and Coelli, 1995). The second approach is a non-parametric one that constraints to estimate the determinants of efficiency in two steps. In the first step the technical efficiency scores are estimated through several methods which are the DEA (Data Envelopment Analysis) and the FDH (Free Disposal Hull). In the second step, the technical efficiency scores are explained by their determinants through econometric tools. Each of both approaches presents advantages but also limits/constraints. Firstly, the parametric approach imposes specific assumptions about the form of production frontier. Its use needs to well-know and to be consistent with the production technology. However, the non-parametric one does not make assumptions about the form of production frontier. In this approach, the production frontier is defined on the basis of existing data. Secondly the potential random shocks are accounted in the parametric approach whereas they are not taken into account in the non-parametric approach. Thirdly, compared to the parametric approach, the measurement methods of efficiency used in the non-parametric one are less and more sensitive respectively to the size of sample and to the dimensionality of study and the presence of outliers. Fourthly, in the non-parametric approach, it is possible to use multi-outputs and/or multi-inputs in the efficiency assessment whereas that is not possible in the parametric one. In view of comparison, it appears that for the moment, the process of production cannot be rigorously modelled in health sector. It would be consequently challenged to theoretically define the frontier of production in health expenditures efficiency

analysis. Furthermore, in this chapter a multi-outputs/multi-inputs model will be used to assess the technical efficiency scores. Hence, the non-parametric approach in two steps is more adapted here. A new method, called the partial frontier analysis is used to estimate the technical efficiency scores by addressing the limits of traditional methods, mostly of DEA. Next the determinants of efficiency scores are estimated through the Fractional Regression Models that have not been yet used for the moment in the analyses about technical efficiency of health expenditures.

Chapter 2, ***"Air pollution and health Expenditures in low and-middle-income countries: what should we learn?"*** In addition to the need for low- and middle-income countries to improve health outcomes with their existing health expenditures, it is also a priority for these last ones to avoid the useless use of these expenditures. In other words, it is fundamental for these countries to find strategies which would allow them to save funds for health. The world has experienced and continues to experience a persistent environmental degradation mostly due to air pollution. Even if environmental degradation, most especially air pollution comes the most from developed countries, low- and middle-income countries are the most vulnerable because they depend on resources which are sensitive to the degradation of environment (Adger et al., 2003; Mirza, 2003), most specifically to air pollution. These are for example the resources coming from agriculture and fisheries. In addition to agriculture and fisheries, environmental degradation, in particular air pollution is also likely to affect health sector. Air pollution appears as a factor leading to diseases which are costly for health systems in these countries. In this way, it would result in a useless increase in health expenditures in low- and middle-income countries. Hence, the decrease in air pollution would allow for countries to save funds for health. To confirm this assumption, the second chapter proposes to investigate the effects of air pollution on the level of health expenditures in low- and middle-income countries. We firstly test direct effects of air pollution on health expenditures. Then, we suggest in this chapter to secondly investigate eventual factors likely to affect air pollution effect on health expenditures. We focus on external resources for health and economic vulnerability of countries. Whether air pollution potentially increases health expenditures, the allocation of foreign resources for health could serve to counter health costs of air pollution. However, the strong economic vulnerability of countries could be an impediment which would undermine the capacity of these countries to face up health cost of air pollution. We consequently test conditional effects between air pollution and external resources for health and between air pollution and economic vulnerability on health expenditures. In the remainder of chapter, we identify the agent(s) intervening in health financing which support the most health cost of air pollution in low- and middle-income countries. That could shed light the policy-makers in the implementation of health policies. We thirdly test the effect of air pollution on the composition of health expenditures.

Chapter 3, ***"The role of prepayment health financing for health improvement in Sub-Saharan African countries"***. In addition to the improvement of efficiency and the wastage in the use of health expenditures, the policy-makers and international organizations recommend in the framework of universal health coverage to increase prepayment health expenditures in low- and middle-income countries and to reduce the share of out-of-pocket payments in health financing. Among low-and middle income countries, Sub-Saharan African region remains one in which the individuals are the sickest. In 2015, this region recorded the highest incidence rate of malaria estimated around 246 per 1,000 persons at risks, representing for approximately 90% of all cases and deaths globally. In this region and for the same year, 1 child in 12 dies before achieving their fifth birthday followed by South Asia where 1 in 19 dies before age five. The highest stunting prevalence in children has been also observed in Sub-Saharan Africa (38%), followed by South-East Asia (WHO health statistics, 2016). According to joint report 2015 between WHO, UNICEF, UNFPA, World Bank and United Nations Population Division, Sub-Saharan Africa accounted for

roughly 66% of the global maternal deaths in 2015 followed by South Asia. In addition to be the sickest, Sub-Saharan African population is the poorest. According to the United Nations report 2015 on the MGDs, the region experienced in 2015 the highest levels of poverty, where approximately 41% of individuals living with less than 1.25 dollars a day, followed by South Asia (17%). This poverty and low health performance in Sub-Saharan African region would be due to the out-of-pocket payments for which the contribution to health financing is high (Mathonnat, 2010) and was estimated around 34.6% in 2013 (WHO health statistics, 2016). Sub-Saharan African countries need to increase their prepayment health expenditures to improve health status of people, specifically the most vulnerable such as children and pregnant women. Hence, it is important for the policy-makers to know whether in these countries, prepayment health financing has effectively enhanced health status. The third chapter firstly proposes to test the effect of prepayment health expenditures on health status measured here by the under-five mortality rate and the maternal mortality ratio. In addition to their potential effect on health status, it would be also interesting for Sub-Saharan African countries to find sustainable policies that could reinforce the improvement effect (negative and significant effect) of prepayment health expenditures on the mentioned mortality indicators. On this subject, we focus on international remittances and financial development which appear to be factors reducing poverty of households and consequently promoting the enhancement of health status. In this way, we secondly test whether the effect of prepayment health expenditures on mortality indicators is greater or no in countries receiving more international remittances and/or experiencing a more financial development.

Chapter 4, ***"Political instability: a major concern for prepayment health financing in Sub-Saharan African countries".*** Given the advantages based on prepayment health financing for health improvement in low- and middle-income countries, mostly in Sub-Saharan African countries, it is important to explore the strategies likely to increase prepayment health expenditures or to understand why their level remains low in these countries. Regarding Sub-Saharan African countries and since these last years, they have experienced some events of political instability which have jeopardized the better functioning of their economic system. This shock has also impeded the performance of health systems and it has consequently and adversely affected the mobilization of prepayment resources for health. We accordingly propose in the fourth chapter of thesis to investigate the effect of political instability on prepayment health expenditures in Sub-Saharan African countries. The first goal of chapter is to check whether political instability is a cause which explains the low level of prepayment health expenditures in Sub-Saharan African countries. In addition, we also explore the potential channels through which the political instability could affect prepayment health expenditures in these countries. However, countries maintain cooperation with international community which has sometimes tended to intervene in countries experiencing political instability events. International community generally accompanies these countries in the process of conflicts resolution. In this way, the cooperation between Sub-Saharan African countries and international community could reduce the eventual adverse effect of political instability on prepayment health financing. To confirm this assumption, we thirdly test whether the effect of political instability on prepayment health expenditures is low or not in countries maintaining more of cooperation with international community.

Each chapter comprises an introduction, a theoretical analysis presenting a selective literature review, a description of used concepts and a discussion about potential channels of transmissions which explain the various studied links, an empirical investigation, a brief conclusion and a last part consecrated to annexes. Subsequent to these four chapters, we propose a general conclusion and policy implications/recommendations followed from the limits of study, the future researches and bibliographic references.

Chapter 1: Determinants of technical efficiency of health expenditures in low- and middle-income countries: focus on trade openness

1. Introduction

The efficiency of health expenditures remains a key issue for sustainable health financing which sets the goal to insure a better health status of population in low- and middle-income countries. In this way, it is necessary to examine the factors which are likely to affect this efficiency of health expenditures. The literature has analyzed the determinants of technical efficiency of health expenditures. From this literature, five main kinds of determinants are identified: factors referring to the structure of health financing, political and institutional environment, the socio-economic context, the demographic profile and ethnic diversity (Alexander et al., 2003; Greene, 2004, Herrera and Pang, 2005; Dukhan, 2010, Hsu, 2013; Yogo, 2015,a).

In addition to them, we suggest that trade openness is an important factor likely to influence the technical efficiency of health expenditures. During the past years, low- and middle-income countries have experienced a more solid integration to the international trade which has served a stimulator affecting health outcomes (Owen and Wu, 2007; Levine and Rothman, 2006) without influencing the level of health expenditures (Avelino et al., 2005). In this way, trade openness is likely to affect the technical efficiency of health expenditures in low- and middle-income countries by influencing the level of health outcomes produced by their health systems in view of existing level of health expenditures.

The present chapter proposes to examine the effect of trade openness on the technical efficiency of health expenditures. It attempts to address the following questions: Does trade openness significantly affect the technical efficiency of health expenditures? In case of significant effect, what is the direction of this effect? The chapter sets as specific goals to firstly assess the technical efficiency of health expenditures through scores and then to estimate the determinants of these scores by particularly focusing on trade openness.

The rest of chapter is organized as follows: the Section 2 is devoted to presenting the channels through which trade openness is likely to affect the technical efficiency of health expenditures. Then, the Section 3 mentions the methodology framework including the method and the econometric models respectively used to assess the technical efficiency scores and to analyze their determinants. In the Section 4, we present and discuss the results. The Section 5 is consecrated to the robustness checks, whereas the Section 6 focuses on the sensitivity analysis of these results. Finally, in the Section 7, we draw conclusion followed of annexes in the Section 8.

2. Trade openness and the technical efficiency of health expenditures: what are their links?

Trade openness or the development of trade exchanges could be defined as a situation by which the imports or/and exports of goods and services in a given country experience a general increasing trend. The effect of trade openness on the technical efficiency of health expenditures can be regrouped into two categories which are: the direct and the indirect effects.

2.1 Direct effects of trade openness on the technical efficiency of health expenditures

There are several channels through which trade openness could directly affect the technical efficiency of health expenditures. We have selected four main factors.

2.1.1 Imports of medical and pharmaceutical products and medical technologies

Through trade openness, low- and middle-income countries import new drugs and medical technologies, generally produced in developed countries, and which contribute to improve the quality of healthcare and to reinforce the process of health outcomes production. These imported products would allow for countries not only to diagnose but also to treat the diseases specifically the non-communicable diseases. The imports of pharmaceutical products and medical technologies serve to improve health outcomes (Papageorgiou et al., 2007) and more specifically, help to reduce the deaths and the mortality rates in low- and middle-income countries. Accordingly, the imports of this kind of goods have most likely increased the performance of health systems and the technical efficiency of health expenditures.

2.1.2 Access to better health knowledge through the imports of Information and Communication Technologies (ICTs)

In addition to pharmaceutical products and to medical technologies, low- and middle-income countries also import ICTs likely to affect the efficiency of health expenditures in two ways. Firstly, they bring new health knowledge allowing people to adopt preventive behaviours to avoid many diseases. These imported ICTs (televisions, computers, and phones) would allow for the individuals to be aware of risk of factors leading to several diseases like for example, obesity, cancers and other non-communicable diseases. For example, the televisions could bring educational messages for health: reduce the consumption of sugar and fats and avoid the sedentary lifestyle. In this way, the imports of ICTs would help decrease the spread of diseases, particularly non-communicable illnesses. In this case, these technologies will improve health outcomes, most especially; they will reduce the morbidity in view of existing health expenditures, and then improve the technical efficiency of health expenditures. However, this argument concerns the urban populations and not yet the rural people in low-income countries.

2.1.3 Vulgarisation of unhealthy messages through the imports of Information and Communication Technologies (ICTs)

Through the imported ICTs, most particularly the television, the unhealthy messages, through the advertising, are conveyed. They promote the consumption of new industrial low cost foods (bad oils, sugar beverages such as Fanta and Coca Cola, sugar, confectioneries, chocolate, fast food….) and locomotion goods which are majorly imported from developed countries. These products reduce health outcomes in view of existing level of health expenditures. Accordingly, they could jeopardize the enhancement of technical efficiency of health expenditures. The imported industrial low cost foods are generally high in calories. Their consumption fosters the overweight/obesity (Philipson and Posner, 2003a; Popkin, 2001; Mendez and Popkin, 2004; Popkin and Gordon-Larsen, 2004; Popkin et al., 2012; Goryakin et al., 2015) that constitutes a risk factor to emergence of non-communicable diseases (Mendez et al., 2004) such as diabetes, high blood pressure, and cardiovascular diseases. Hence, they would impede the improvement of technical efficiency of health expenditures.

2.1.4 Imports of locomotion goods

Regarding the imported locomotion goods, they are likely to induce the populations to less practice physical activities and to spend lower energy; a fact which is likely to increase the prevalence of overweight/obesity. Furthermore, these imported locomotion goods have developed road traffic

accidents that were the ninth cause of death in 2011(Mathonnat and Thuilliez, 2014). These deaths have increased the mortality rate of population. Hence, by reducing health outcomes in view of existing health funds, the imports of goods locomotion are factors which are likely to reduce the technical efficiency of health expenditures.

2.2 Indirect effects of trade openness on the efficiency of health expenditures

The effect of trade openness on the technical efficiency of health expenditures depends on health policies and priorities in countries. In this way, the channels that link trade openness to health expenditures efficiency would depend on considered health indicators. Two factors have been identified as main channels through which trade openness would affect the technical efficiency of health expenditures. These are environmental degradation and income.

2.2.1 The channel passing from environmental degradation

Two mixed effects are suspected. Firstly, trade openness generally tends to increase the industrial production and consequently the one of unhealthy substances through greenhouse gases emissions that lead to grow up air pollution (Halicioglu, 2009; Al-Mulali and Ozturk, 2015; Li et al., 2015).The increase in air pollution would increase the prevalence of non-communicable diseases. The combustion of gases related to air pollution produces PCA (Polycyclic Atomic Compounds) and nitro-PCA such as PAH (Polycyclic Atomic hydrocarbons) and nitrated-PAH. These carcinogenic and mutagenic particles are likely to generate oxidization and damages on human DNA and to lead the appearance of non-communicable diseases such as the respiratory (pneumonia, asthma, reactive airways diseases, and chronic obstructive pulmonary diseases), the chronic (lung cancer) and the cardiovascular diseases (Lewtas, 2007; Jacobson, 2008; Truckner, 2009; Brunekreef and Holgate, 2002). Accordingly, it is possible that the increase in prevalence of non-communicable diseases results in added mortality rate without influencing health expenditures. In this way, the technical efficiency of health expenditures would experience a decline.

However, with time, trade openness will boost economic growth (Devereux and Lapham, 1994; Andersen and Babula; 2008; Aghion and Howitt, 2008) through the comparative specializations and the technology transfers (Ben David and Loewy, 1998; Harrison, 1996). It will also generate an environmental degradation which might induce the authorities to take actions such as technological innovations to internalize environmental externalities. These measures would lead to a reduction of air pollution and consequently of prevalence and maybe of mortality caused by the non - communicable diseases. In this way, the technical efficiency could increase.

2.2.2 The channel passing from income

For this channel, mixed and complex effects can also be expected. The effect of trade openness on income depends on the kind of traded goods and services and it also depends on the class of population affected by the development of trade exchanges. Based on the Stolper-Samuelson (SS) theorem (Deardorff and Stern, 1994) in Heckscher-Ohlin (HO) model, trade in primary goods is likely to increase the real return of factors which are relatively more abundant. In low- and middle-income countries, the low-skilled workers are more abundant. In this way, trade in primary goods would increase employment of low-skilled workers thus generating more income for them. Through this channel, the development of trade exchanges could positively affect the income of an important part of population; a fact which could affect the level of GDP. On this subject, the literature points out the effect of increasing income (GDP) on some health indicators, particularly on obesity (Popkin et al., 1995) which is a risk factor fostering the emergence of non-communicable diseases. The increase in income would result in nutritional/dietary shifts and in lifestyle changes. With more income, the individuals, mostly the low-income earners, tend to

consume more calorific foods and are more likely to adopt risky behaviours that lead to overweight/obesity and non-communicable diseases which increases in turn the risk of deaths. In this way, it appears that the increase in income would be associated with a high prevalence of obesity (Mendez et al., 2004) and to an increased number of deaths caused by the non-communicable diseases. Hence it is possible that the potential growth of income caused by trade in primary goods reduces the technical efficiency of health expenditures by increasing the prevalence of overweight/obesity and non-communicable diseases and maybe of deaths caused by these diseases.

Regarding trade in secondary goods such as the manufactured products; their production necessitates using more skilled workers that are less abundant in low- and middle-income countries. Hence, whether trade of this kind of goods would increase the income of skilled workers, its effect on the overall income of population would be low or nonexistent. Consequently, through this assumption, the increase in trade flows of secondary products (manufactures) would not significantly affect the technical efficiency of health expenditures.

2.2.3 Other aspects to account for

The effect of trade openness on the technical efficiency, passing by income and environment degradation, is likely to be cumulative. The potential income chocks and air pollution caused by the development of trade exchanges could have lagged effects on health of children and adults. These effects would pass by the "Foetal Origins Hypothesis" stipulating that the conditions in which the foetus grows are likely to influence health status of individuals during their childhood and even in adult age (Audibert, 2015; Mathonnat, 2012).

Concerning the income, it is likely to result in an increase in income of households, particularly of skilled workers. This increasing income could lead these populations to follow unhealthy nutritional diets likely to degrade their health status. These unhealthy nutritional diets could particularly harm health not only of pregnant women but also that of their foetus. These could result in malnutrition.

Regarding environmental degradation, in presence of polluted air, pregnant women and their foetus are in contact with unhealthy particles likely to harm them. The malnutrition of foetuses caused by the nutritional shifts and unhealthy particles with which they have been in contact would increase the risk to be obese and to develop chronic and non-communicable diseases in childhood or even in adult age (Bhalotra and Rawlings, 2009; Almond and Currie, 2011). Through these channels, the potential adverse effect of trade openness on health (obesity, non-communicable) and consequently on the technical efficiency of health expenditures is likely to increase over time.

3. Methodology and databases

As mentioned in the general introduction, a two-stage approach considering the non-parametric approach is used to test the effect of trade openness on the technical efficiency of health expenditures.

3.1 Estimating the technical efficiency of health expenditures

Among the methods used in analyzing the non-parametric approach to estimate the technical efficiency scores and their determinants, DEA is the most used method (Alexander et al., 2003; Herrera and Pang, 2005; Dukhan, 2010; Hsu, 2013; Yogo, 2015, a). It estimates the technical efficiency scores, bounded between 0 and 1, by comparing health systems of countries located on the production frontier (efficient countries) to the others which are below the production frontier (inefficient countries). The efficient and inefficient countries respectively have the technical

efficiency scores equal to 1 and comprise in the interval]0; 1[. Given the sensitivity of this method to the dimensionality of study and to the outliers in the sample, it imposes the most efficient countries to be located on the production frontier. Among them, there are some superefficient countries (outliers) which should be situated above the production frontier. Accordingly, the presence of outliers may distort the production frontier and produce biased scores for countries which are compared to them.

In this way, the partial frontier analysis has been developed. Comparatively to DEA, it allows for countries to be above the production frontier and to consequently have the technical efficiency scores greater than 1.

There are two approaches of estimation in partial frontier analysis: order-m (Cazals et al., 2002; Daraio and Simar, 2007); and order-alpha (Aragon et al., 2005). The estimation of order-m scores consists of first simulating n times subsamples of m DMUs (countries). The subsamples are composed of DMUs producing at the most (in output orientation) or at the least (in input orientation) the same levels of output(s) in the sample (Petitfour et al., 2015). Then, for each DMU, n efficiency scores are assessed through a frontier production estimated on each simulated subsample. The other-m scores are computed by calculating the mean of scores derived for all simulations. Regarding the order-alpha scores, they are estimated with the same logic of order-m approach. The only difference between these approaches relies in the selection way of simulated subsamples. The order-alpha scores are assessed by comparing the output(s)of each DMU to the level of output(s) produced by (1-α) *100 % of DMUs using at most (in output orientation) or at least (in input orientation) the same levels of input(s).

Among the two approaches developed in partial frontier analysis, our option will be for the order-m because once the order-alpha frontiers break down; they become less resistant to outliers than the order-m frontiers (Daouia and Gijbels, 2011). Concerning the value of parameter m, we follow the criterion established by Daraio and Simar (2007) that propose to retain the value of m for which the decrease in super-efficient observations becomes stable (constant). We retain the value of m=30. The order-alpha approach is used in a sensitivity analysis to check the robustness of results got with the order-m approach.

Furthermore, we assess the technical efficiency scores in output orientation for two main reasons. Firstly, trade openness influences the technical efficiency of health expenditures by affecting the level of health outcomes (outputs) in view of existing level of health expenditures. Secondly, health expenditures are insufficient in low- and middle-income countries. It would be difficult for these countries to reduce their level of health expenditures, even if results would show that some countries use more inputs that they would have to use taking into account their outcomes.

We also assume the variables returns-to-scale (VRS) because in health sector, the relationship between the outputs and the inputs is nonlinear. In low- and middle-income countries, institutional constraints and information asymmetries prevent health market from being competitive. They constrain countries to produce health outcomes with different proportions of health expenditures.

In the literature, two kinds of health indicators are used to assess the technical efficiency of health expenditures in low- and middle-income countries. The first one refers to simple measures which includes mortality, and morbidity indicators and the life expectancy at birth. Among mortality indicators, there are for example the infant mortality rate (Alexander et al., 2003; Gupta and Verhoeven, 2001), the under-five mortality rate (Dukhan, 2010, Mathonnat, 2010), the maternal mortality ratio (Dukhan, 2010) and the adult and infant deaths caused by HIV/aids (Zanakis et al., 2007). The morbidity indicators used in the literature are the prevalence of HIV/aids in adult

population (Zanakis et al., 2007) and the prevalence of tuberculosis (Dukhan, 2010). The variable of life expectancy at birth is used by Gupta and Verhoeven (2001), and Jayasuriya and Wodon (2003). The second group of indicators refers to multidimensional indicators such as the Disability Adjusted Life Expectancy (DALE) also called Health Adjusted Life Expectancy (HALE) [9] used by Alexander et al., (2003); Herrera and Pang, (2005); Evans et al., (2001); Grigoli and Kapsoli, (2013) and the composite index computed by Tandon et al., (2001) and including the dispersion of child survival rate, the responsiveness of healthcare systems, the inequities in responsiveness and the fairness of financial contribution.

We consider here a multi-outputs/multi-input model. In contrary to the traditional outputs used in the literature, we depart from two outputs which are not used for the moment. These two outputs are used per the presented channels through with trade openness is likely to affect the technical efficiency of health expenditures. The first output is obesity prevalence (Obesity) indicating the percentage of people for which the body mass index (BMI) (weight-to-height ratio) is greater than or equal to 30. The second output is the crude deaths rate caused by the non -communicable diseases[10] (Deaths). It measures the number of deaths caused by the non -communicable diseases per 1,000 individuals (See the data source of variables in subsection 3.5).

Generally, the use of decreasing outputs also called reversed outputs, such as the deaths rates, the incidence or the prevalence rates of diseases, needs to reverse them because health system sets the goal to produce a good health instead of a death or a disease. In the literature, two ways are used to reverse the decreasing outputs. The first method proposed by Lewis and Sexton (2004) uses the following formula: $1+Max(X_i)-X_i$ where X_i is the decreasing outputs and $Max(X_i)$ means the maximum value of X_i. In addition, Dukhan (2010) proposes another formula which is: $100-(X_i/(1+Max(X_i)))$. However, the use of these approaches leads to reduce the variability of outputs between DMUs. Given that the partial frontier analysis consists of comparing the DMUs, the reduction of outputs' variability would result in artificial output-oriented technical efficiency scores. The findings would not be realistic given the heterogeneity of sample. There is another approach which consists of using the following transformation: $1/X_i$. This method leads to the same trend of others but only in the case where the indicators having a high upper bound. The most relevant examples of this kind of indicators are: the maternal mortality ratio and tuberculosis incidence/prevalence respectively expressed as per 100,000 live births and 100,000 people. Here, the indicator with the greatest theoretical upper bound is the deaths rate caused by the non -communicable diseases: per 1,000 individuals. This upper bound is largely low than the examples of indicators mentioned above. Consequently, the use of last approach of inversion would be the most relevant.

The inputs variables used in the analysis are public health expenditures per capita in USD PPP (Purchasing Power Parity[11]) (Public_Exp) and private health expenditures per capita in USD PPP (Private_Exp) which are calculated by deducting public health expenditures per capita in USD PPP from total health expenditures per capita in PPP USD.

[9] The health adjusted life expectancy estimates the number of the healthy years an individual is expected to live at birth by subtracting the year of the ill health (weighted per the severity) from overall the life expectancy (Grigoli and Kapsoli, 2013)

[10] It has been more rigorous to depart from the prevalence of the non-communicable diseases but the information about this variable is not available.

[11] Purchasing power parity conversion factor is the number of the units of the a country's currency required to buy the same amounts of the goods and services in the domestic market as US dollar would buy in the United States (World Development Indicators database).

3.2 Estimating the effect of trade openness on the technical efficiency of health expenditures

3.2.1 Empirical strategy

In the literature, two controversial approaches are used to analyze the determinants of technical efficiency in the second-stage of non-parametric method. The first one is the conventionalist approach that regards the scores as a real measure of true technical efficiency. This approach has been developed by Simar and Wilson (2007; 2008). They propose a several step estimation involving the use of truncated Tobit model and two re-sampling (double bootstrapping) approach.

The second one, the instrumentalist approach regards the scores as a descriptive measure of true technical efficiency. It is more relevant to depart from the instrumentalist method because technical efficiency scores estimate the performance of each DMU compared to the observed best practices. Hence, the estimated scores are more a descriptive proxy of efficiency than a real measure.

In the instrumentalist approach, two traditional models are generally used: the linear model such as the OLS and the censored Tobit (Hoff, 2007; Dukhan, 2010; Yogo, 2015,a). They are specified differently per the nature of efficiency scores regarded by each of them. In the Tobit model, the efficiency scores are censored, whereas in the use of OLS, the censorship of scores is artificial. However, the use of these both models would be biased. Given that the estimation of technical efficiency results from a process of comparison between DMUs, the estimated values of technical efficiency scores are linked to each other, producing a serial correlation (heteroskedasticity) bias in the second-stage econometric model (Simar and Wilson, 2007).

Furthermore, each of traditional models used in the instrumentalist approach presents some specific limits. In the OLS model, the predicted values of technical efficiency scores may lie outside the unit interval]0, 1]. Moreover, the estimated marginal effects of determinants are not compatible with the bounded nature of efficiency scores.

Regarding the Tobit model, there are two different groups, the two-limit Tobit model and the one-limit Tobit model (Hoff, 2007). In the first one, the dependent variable is censored in left (with lower bound) and in right (with upper bound). In the second one, the dependent variable is censored in left or in right. In efficiency analysis, the use of two-limit Tobit model assumes that the efficiency scores are censored in the interval [0, 1]. This assumption is based on the fact that the likelihood to have null efficiency scores is non-zero. In practice, the efficiency scores of zero are not observed. In addition, the use of two limit Tobit model with limits at zero and unity coincides with the use of an one-limit Tobit model with scores comprise in the interval$]-\infty, 1]$ (Ramalho et al., 2010). This one-limit Tobit supposes the possibility to have negative technical efficiency scores. This hypothesis is not compatible with the real bounded nature of technical efficiency scores.

Some authors such as Pélissier (2012) suggest to transform the technical efficiency scores (TE) as follows: Log (1/TE). This transformation results in a new variable approximating the inefficiency instead of efficiency. Given the maximum value of TE estimated at 1, the values of this new variable will range in the interval $[0, +\infty[$. Next, a one-limit Tobit model with lower bound at 0 is used to analyze the determinants of inefficiency. This method does not deal with the serial correlation bias mentioned above. It is necessary to find a better model regarding the instrumentalist approach.

Fractional Regression Models (FRMs) are introduced by Papke and Wooldridge (1993) and developed by Ramalho et al., (2010). Unlike Tobit and OLS models, the use of FRMs does not need to make assumptions about the conditional distribution of efficiency scores and the serial

correlation patterns (Ramalho et al., 2010). Furthermore, by using a Quasi-Maximum Likelihood (QML) estimator, the dependent variable (the technical efficiency scores) equally distributed over the whole interval]0, 1]. In other words, the use of FRMs requires non-zero efficiency scores which must not be greater than 1. These models are mostly compatible with the bounded nature of technical efficiency scores.

There are two kinds of FRMs: the one-part and the two-part regression models. The one-part regression model estimates the effects of covariates (determinants) common to both efficient and inefficient DMUs. The two-part regression model estimates different partial effects for efficient and inefficient DMUs. The choice between these two kinds of model depends on the proportion of efficient DMUs in the sample. When the proportion of efficient DMUs is low, the use of two-part regression model is not relevant.

Furthermore, the FRMs are estimated by considering a set of link functions such as the logistic link function, the probit link function, the cauchit link function (cauchit), the log-log link function and the complementary log-log link function (cLog-log)[12].

We adopt for the second-stage, the FRMs which will allow estimating the determinants of technical efficiency scores (order-m). Before, we removed from the same the superefficient countries for which the score is greater than 1. Moreover, the proportion of efficient countries will be calculated to choose the better model among the two approaches of FRMs. Regarding the link functions associated with the FRMs, we shall select the most relevant through the p-tests which will be presented in greater details later in the work.

3.2.2 Explanatory variables

Our variable of interest is the trade openness rate (Trade). It refers to the sum of imports and exports of goods and services as percentage of GDP. In addition to trade variable, some key control variables are selected : urbanization measuring the percentage in the total population of individuals living in urban areas, the old dependency ratio approximating the percentage in the total population of elderly people aged 65 and above, the mean duration in secondary education, external resources for health, an index of governance effectiveness, an indicator approximating the similarity in merchandise trade structures, GDP per capita and CO2 emissions.

Urbanization (Urban): a mixed effect of this variable is expected. In some cases, urbanization could be a factor likely to positively affect the technical efficiency of health expenditures by improving health status in general view. With urbanization, health demand moves closer to health supply including skilled medical staff and health facilities that are more available in urban areas. Hence, the migration of population towards the urban areas would foster the access to healthcare and avoid the deaths caused by diseases. Concerning the non-communicable diseases, it appears that the medical equipment used for the treatment of these diseases is sophisticated and more available in urban areas. This treatment is very costly not only for governments but also for households. Moreover, the rural households that move towards urban areas are generally poor. In this way, despite the availability of health supply in the urban zones, the rural migrant households may not have access to treatment, especially that for non-communicable diseases. In this case urbanization will not significantly affect the technical efficiency of health expenditures. Nevertheless, in the case where the treatment for the non-communicable diseases is totally of partially free for people, the access will be enhanced. Accordingly, in this context, urbanization

[12]The logit, probit, cauchit, log-log and cLog-log link functions are respectively based on the standard logistic
distribution, the standard normal distribution, the Cauchy distribution, the logarithm distribution and the Gumbel distribution (Ramalho et al., 2010).

will increase the access to healthcare and avoid the deaths caused by the non-communicable diseases. It will increase the technical efficiency of health expenditures. The first expected effect of urbanization on the technical efficiency of health expenditures is positive, but could be potentially non-significant. The second potential effect is negative. It is possible that urbanization negatively affects the technical efficiency of health expenditures by increasing the prevalence of obesity and mortality caused by the non-communicable diseases. In the major part of countries, compared to rural populations, the urban residents generally consume foods with greater proportions of saturated fats (Popkin et al., 1995) which are more available in urban areas. In this way, the increase in urbanization could result in an increase in overweight/obesity prevalence and maybe in deaths caused by the non-communicable diseases which result in some cases from obesity. Hence, by this argument, urbanization could reduce the technical efficiency of health expenditures.

Old dependency ratio: is included into the model for the simple reason that the elderly suffers more and die from the non-communicable diseases such as diabetes, renal failure and the cardiovascular diseases. Hence, the increase in size of elderly people would be associated with an increase in mortality caused by the non-communicable diseases. It would consequently result in a reduction of technical efficiency of health expenditures.

Duration of secondary education (Education): refers to the average number of years in secondary school for country 'population, excluding years spent repeating individuals' grades. This variable is chosen because among the educational indicators, it is more provided. It controls for the fact that education improves health status of people in low- and middle-income countries (Alves and Belluzo, 2005; Bidani and Ravaillion, 1997; Hanmer et al., 2003) in view of existing health funds. Hence, it constitutes a factor increasing the technical efficiency of health expenditures (Alexander et al., 2003; Hsu, 2013 and Dukhan, 2010). Particularly, a better level of education would allow reducing the risk of obesity and non-communicable diseases. The individuals with higher educational levels, compared to those with low educational attainment, are more likely to follow dietary recommendations and to adopt adequate behaviours to reduce the risk of obesity and non-communicable diseases (Popkin and al., 1995) and to avoid the deaths caused by them. In this way, the improvement of education would increase the technical efficiency of health expenditures.

External resources for health in USD PPP per capita (Ext_Fin): constitute one of key determinants that negatively affect the technical efficiency of health expenditures (Dukhan, 2010). This adverse effect comes from two assumptions such as the fungibility of foreign aid earmarked to health and the soft budget constraint. The fungibility supposes that the external resources previously dedicated to health sector are partially or totally allocated to other sectors (Van Der Gaag and Stimac, 2008). The budget constraint stipulates that the permanence of foreign aid flow tends to reduce the performance of governments (Kornai et al., 2003). These two factors could induce governments to reallocate health domestic funds to other sectors (Gottret and Scheiber, 2006). In this way, external resources for health wouldn't affect or would reduce health outcomes, most especially obesity prevalence and the deaths caused by the non-communicable diseases. Hence, a negative effect on the technical efficiency of health expenditures could be expected. This adverse effect might be not significant, more precisely in the case whether the external resources are not allocated in favour of fight against obesity and non-communicable diseases. On this subject, the goal of study is to check whether the volume of external resources for health affects the technical efficiency of health expenditures. External resources for health per capita in USD PPP are consequently used. They refer to the sum of resources channelled towards health by all non-resident institutional units that enter into transactions with resident units or have other economic links with residents units, explicitly labelled for health or not, to be used as mean of payments of

health goods and services or as investment in capital goods by financing agents in government or private sectors. They include donations and loans, in cash and in-kind resources.

Government effectiveness index (Governance): controls for the positive effect of best institutional quality on the performance of health systems. Ranged from -2.5 to 2.5, it is defined as the perception of quality of public and civil services, the quality of policy formulation and implementation, the degree of government's independence from political pressures and the credibility of its commitment to such policies. We expect a positive effect of this variable on the technical efficiency scores.

Index of similarity in merchandise trade structure (Simi_Trade): controls for the disparities in trade structure between countries. Countries do not have the same trade structure. This heterogeneity can influence the average effect of trade openness on the technical efficiency scores. Let consider for example two groups of countries for which trade structures are mainly and respectively based on exchanges of healthy and unhealthy goods. Countries specialized in trade of healthy goods will produce better health outcomes and will be consequently more efficient than the ones that focus their trade exchanges on unhealthy goods. Hence, it is important to control for this potential driver of health expenditures efficiency. The indicator measures the degree of trade structure similarity of a country compared to another. It approximates bilateral flows indicating whether the structure of exports or imports by product of two economies is similar or not. It is calculated as follow:
It is calculated as follow:

$S_{ijk} = 1 - \frac{1}{2}\sum_i |h_{ij} - h_{ik}|$, where:

- S_{ijk}:Indicator of structure similarity in merchandise exports or imports
- h_{ij}: Share in total merchandise exports or imports of product "*i*" of country or country group "*j*".
- h_{ik}: Share in total merchandise exports or imports of product "*i*" of country or country group "*k*".

This indicator is ranged from 0 to 1. The value closer to 1 reveals a greater similarity of exports or imports structure between two countries. We firstly extract the two following indexes: the similarity in exports structure and the similarity in imports structure. These indexes are calculated for all merchandises. Then, for each country, we calculate the average of these indexes of similarity compared to the other countries of sample. Thirdly, we calculate for each country the similarity in trade structure which is the mean of two indexes.

GDP per capita in USD PPP per capita (GDP): can be regarded as a key determinant of technical efficiency of health expenditures (Herrera and Pang, 2005; Greene, 2004). We have shown above that the increase in income would increase the risk of obesity and non-communicable diseases through a nutritional/dietary shift and a lifestyles change that it could produce. Hence, it is likely to negatively affect the technical efficiency scores. The use of this variable requires checking its correlation with the other explanatory variables, particularly trade openness variable. As trade variable is expressed as percentage of GDP, it could be correlated with GDP variable expressed into USD PPP per capita; a fact could result in a multi-collinearity bias. This bias could inhibit the significance of coefficients associated with GDP per capita or to the trade openness rate in the econometric model. We test the correlation between the two variables and find a low correlation

(0.1867). Consequently GDP per capita and the trade openness rate can be jointly included in the same model.

CO2 emissions in metric tons per capita (CO2): this variable approximates the environment degradation which, we have seen above, constitutes a factor fostering the emergence of non-communicable diseases. Hence the increasing of CO2 emissions would be more likely to positively affect the number of deaths caused by the non- communicable diseases. It could consequently reduce the technical efficiency scores.

Among the mentioned control variables, GDP per capita is correlated with urbanization (0.6959) and with CO2 emissions variables (0.7193). To deal with multi-collinearity bias likely to slant the results, we propose to test three specifications presented in Table 1.1. In the first one, we include all explanatory variables, exception made for GDP per capita and CO2 emissions variable which are separately included respectively in the second (after removing urbanization variable) and the third specifications.

Table 1.1: Tested specifications in the Fractional Regression Models

Dependent variable: order m-scores		Specifications (Models)		
		(1)	(2)	(3)
Control variables	Trade	*	*	*
	Urban	*		*
	Old dependency	*	*	*
	Education	*	*	*
	Ext_Fin	*	*	*
	Governance	*	*	*
	Simi_Trade	*	*	*
	GDP		*	
	CO2			*

Source: Author.

3.3 Description of sample

Our sample includes 89 low- and middle-income countries of which twenty-four low-income countries, thirty-five lower middle-income countries and twenty-eight upper middle-income countries[13]. Per the regional repartition of World Bank, the sample is composed of ten countries of East Asia and Pacific, nine countries of Europe and Central Asia, nineteen countries of Latin America and Caribbean, eight countries of Middle East and North Africa (MENA), five countries of South Asia and thirty-eight countries of Sub-Saharan Africa. Data are available over the period 1995-2012. The analysis of efficiency over a long period does not provide rigorous information. The economic situation has experienced a significant evolution in many countries during the period. Furthermore, the expenditures on health can vary from one year to another for various

[13]Per the World Bank classification, low-income countries are these for which GNI per capita is $1,045or less. Lower middle-income countries have GNI per capita which is between $1,046 and $4,125 whereas the GNI per capita of upper middle-income countries is between $4,126 and $12,275.

causes without getting changes health systems. Hence, it would be challenged to compare the performances of health systems realized on eighteen years. It would not be relevant to work on annual data. The temporal dimension has been divided up into three sub-periods of six years: 1995-2000; 2001-2006 and 2007-2012. The sub-periods of six years have been chosen because the outputs slowly vary over time. Then, three frontiers of production have been built on the basis of average of outputs and inputs calculated on each sub-period. This strategy allows dealing with the cyclic fluctuations of these variables used in the estimation of technical efficiency sores. In our database, each country is associated with one efficiency score for each sub-period. In addition, like the outputs and the inputs, the mean of explanatory variables (determinants) is also calculated by country on each sub-period to estimate the FRMs.

3.4 Identification issues

The most suspected source of endogeneity is the reverse causality between some explanatory variables and the technical efficiency scores. The first variable which is concerned is the trade openness rate. Despite the potential effect of trade on the performance of health systems, a better efficiency of health expenditures could intensify trade flows by reducing obesity prevalence and the deaths rate caused by the non-communicable diseases in view of used health expenditures. The reduction of these health indicators is likely to boost economic growth.On this subject, the literature points out that health status is a determinant of income and its growth (Bloom and al., 2004, 2009; Acemoglu and Johnson, 2007, 2014; Ashraf and al., 2008). This literature essentially refers to life expectancy as health indicator.

Concerning our used outputs, they could also affect the income and its growth. The reduction of obesity prevalence and deaths caused by the non-communicable diseases may increase the labour productivity which is a factor fostering economic growth. Generally obesity and non-communicable diseases appear with the change in the behaviour of individuals leading to unhealthy lifestyle. The people that are more concerned in this case are the young and adult productive individuals that contribute the most to economic activity. For example, in Africa, cancers coming from domestic pollution more concern the females, generally young, which are constraint to cook with wood charcoal in non aerated zones. In this way, it is possible that the increase in technical efficiency of health expenditures through the reduction of obesity prevalence and deaths caused by the non-communicable diseases affects the level and the growth of income likely to increase trade exchanges flows.

In addition to the trade openness rate, control variables in the model are likely to be affect by the outputs used in the estimation of technical efficiency scores. These are: GDP per capita, the duration in secondary schooling, and external resources for health. Concerning GDP per capita, its endogeneity would be explained by the adverse effect of used outputs (non-reversed) on the income (see the last paragraph). Concerning the educational variable, the increase in used outputs, more specifically obesity prevalence may result in people invalidity which is likely to adversely affect the duration in secondary schooling. Concerning health aid, the level of health outcomes such as the outputs, particularly the deaths due to non-communicable diseases, could constitute a signal that could induce the foreign sponsors to increase their health aid flows.

It is necessary to deal with the endogeneity of mentioned variables. For the moment, the FRMs (Fractional Regression Models) aren't specified to make instrumentation estimations. Hence, the endogeneity of mentioned explanatory variables is dealt by using their one-period lagged value. This strategy even if less robust than classical instrumentation procedures has also the benefit to account for the assumption attesting that the endogenous explanatory variables, more specifically the trade openness rate, don't immediately affect the technical efficiency of health expenditures.

Furthermore, we also introduce the one-period lag of urbanization and old dependency ratio for the same reason that their effect on the technical efficiency of health expenditures is not immediate.

3.5 Data and descriptive statistics

The variables used are retrieved from five databases. The deaths caused by the non-communicable diseases and the prevalence of obesity come from the Global Burden of Disease (GBD) database[1415]. Total health expenditures per capita, public health expenditures per capita and external resources for health per capita come from the Global Health Expenditures (GHE) database. The following variables such as the trade openness rate, GDP per capita, the percentage of urban population, the percentage of population aged 65 and above, the duration of secondary education and CO2 emissions are retrieved from the World Development Indicators (WDI) database[16]. The index of government effectiveness comes from the Worldwide Governance Indicators (WGI) database[17] and the index of similarity in trade structure is provided by the UNCTDSTAT database[18].

The descriptive statistics of data are provided in Table1.2. GDP per capita is associated with an order of magnitude which is greater than the estimated values of technical efficiency scores (bounded between 0 and 1 after excluding the outliers). This gap could result in biases in the estimation of coefficient associated with GDP per capita. Consequently, GDP per capita is transformed into logarithm to reduce its order of magnitude.

[14] http://ghdx.healthdata.org/record/global-burden-disease-study-2015-gbd-2015-life-expectancy-all-cause-and-cause-specific

[15] http://www.healthdata.org/data-visualization/overweight-and-obesity-viz

[16] http://databank.worldbank.org/data/reports.aspx?source=world-development-indicators&preview=on.

[17] http://databank.worldbank.org/data/reports.aspx?source=worldwide-governance-indicators

[18] http://unctadstat.unctad.org/wds/ReportFolders/reportFolders.aspx?sCS_ChosenLang=en

Table 1.2: Descriptive statistics (1995-2012)

Variables	Definitions	Period 1 (1995-2000)					Period 2 (2001-2006)					Period 3 (2007-2012)				
		Mean	Std. Dev.	Min	Max	Obs	Mean	Std. Dev.	Min	Max	Obs	Mean	Std. Dev.	Min	Max	Obs
Deaths	Deaths rate caused by the non -communicable diseases (per 1,000 people)	7.831	3.997	3.766	26.45	89	8.033	4.296	3.723	28.285	89	8.318	4.511	3.503	27.435	89
Obesity	Obesity prevalence rate (%)	10.464	6.302	1.346	38.661	89	11.406	6.601	1.541	39.741	89	12.212	6.874	1.744	40.853	89
Public_Exp	Public health expenditures per capita (PPP USD)	93.101	98.39	2.073	396.589	89	128.764	135.630	4.286	735.984	89	204.728	248.889	11.811	1769.151	89
Private_Exp	Private health expenditures per capita (PPP USD)	89.850	102.256	4.956	754.633	89	122.202	112.191	10.544	594.293	89	173.179	157.109	16.949	712.621	89
Trade	The trade openness rate (%)	72.934	38.515	1.698	207.579	89	80.116	40.047	0.566	202.287	89	82.412	36.365	24.283	226.873	86
Urban	Percentage of urban population (%)	42.176	18.838	7.726	85.513	89	44.371	19.132	9.030	86.408	89	46.649	19.395	10.517	87.123	89
Old dependency	Percentage population aged 65 and above	4.449	2.191	1.815	13.689	89	4.791	2.585	2.048	15.349	89	5.040	2.734	2.281	15.941	89
Education	Duration of secondary education (years)	6.249	0.731	4	8	89	6.223	0.776	4	8	89	6.258	0.788	4	8	89
Ext_Fin	External resources for health per capita (PPP USD)	8.677	14.897	0.638	132.034	83	11.660	10.595	0.575	55.480	88	20.193	19.274	0.603	94.457	88
Governance	Governance effectiveness index	-0.497	0.529	-1.9	0.862	89	-0.528	0.521	-1.551	1.125	89	-0.531	0.542	-1.572	1.094	89
Simi_Trade	Index of similarity in trade structure	0.413	0.045	0.217	0.502	87	0.397	0.042	0.200	0.506	88	0.399	0.038	0.227	0.469	89
Log. GDP	GDP per capita (PPP USD)	8.073	0.883	6.203	9.886	89	8.211	0.890	6.515	9.769	89	8.399	0.936	6.554	9.962	89
CO2	Co2 emission (metric tons per capita)	1.508	1.930	0.016	8.991	89	1.574	2.010	0.025	10.538	89	1.804	2.357	0.023	13.647	89

Source: Author 'calculation using the GBD, the GHE, the WDI, the WGI and the UNCTADSTAT databases. Note: Std.Dev: Standard Deviation. Obs: observations.

4. Results

4.1 Efficiency analysis

We first identify the superefficient countries and remove them from the sample (Table 1.3) because they are likely to distort the production frontier (Petitfour et al., 2015). These countries provide the efficiency scores greater than the unit (order-m>1). Then, we analyze the statistical trend of average efficiency scores not only in the global sample but also by income-group and by region. Based on the findings (Table 1.4), we find that the efficiency scores have varied from 67.8% (for the first sub-period) to 63.2% (for the third sub-period). These scores involve that countries could averagely increase their health outcomes in terms of obesity and deaths caused by the non-communicable diseases from 32.2% (for the first sub-period) to 36.8% (for the third sub-period) in view of existing level of public and private health expenditures that they use.

Table 1.3: List of superefficient countries by sub-period (1995-2012)

Periods	1995-2000	2001-2006	2007-2012
Superefficient countries	Burkina Faso, Cambodia, Chad, Eritrea, Gambia, Kenya, Madagascar, Nepal, Tanzania, Togo, Uganda, Vietnam.	Burkina Faso, Chad, Kenya, Nepal, Rwanda, Tanzania, Uganda, Vietnam.	Bangladesh, Botswana, Cambodia, Kenya, Malawi, Nepal, Rwanda, Vietnam.

Source: Author 'calculation using the GBD, and the GHE databases.

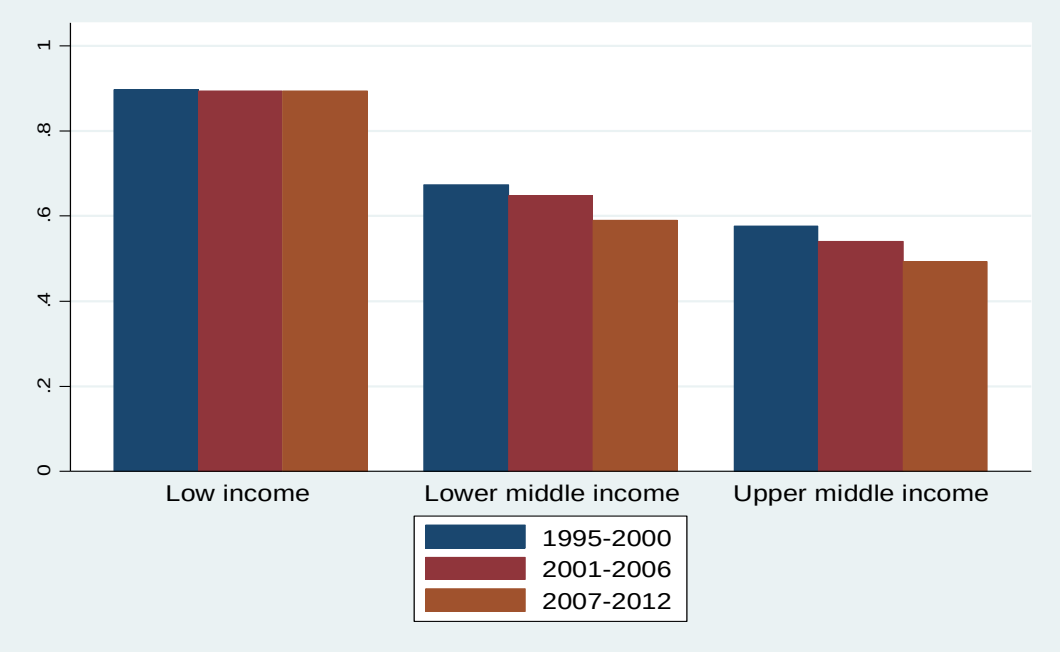
Table 1.4: Descriptive statistics of technical efficiency and inefficiency scores of health expenditures (1995-2012)

Periods	The efficiency scores				Mean of inefficiency scores
	Mean	Std. Dev.	Min	Max	
1995-2000	0.678	0.218	0.203	1	0.322
2001-2006	0.661	0.223	0.198	1	0.339
2007-2012	0.632	0.223	0.190	1	0.368

Source: Author 'calculation using the GBD, and the GHE databases.

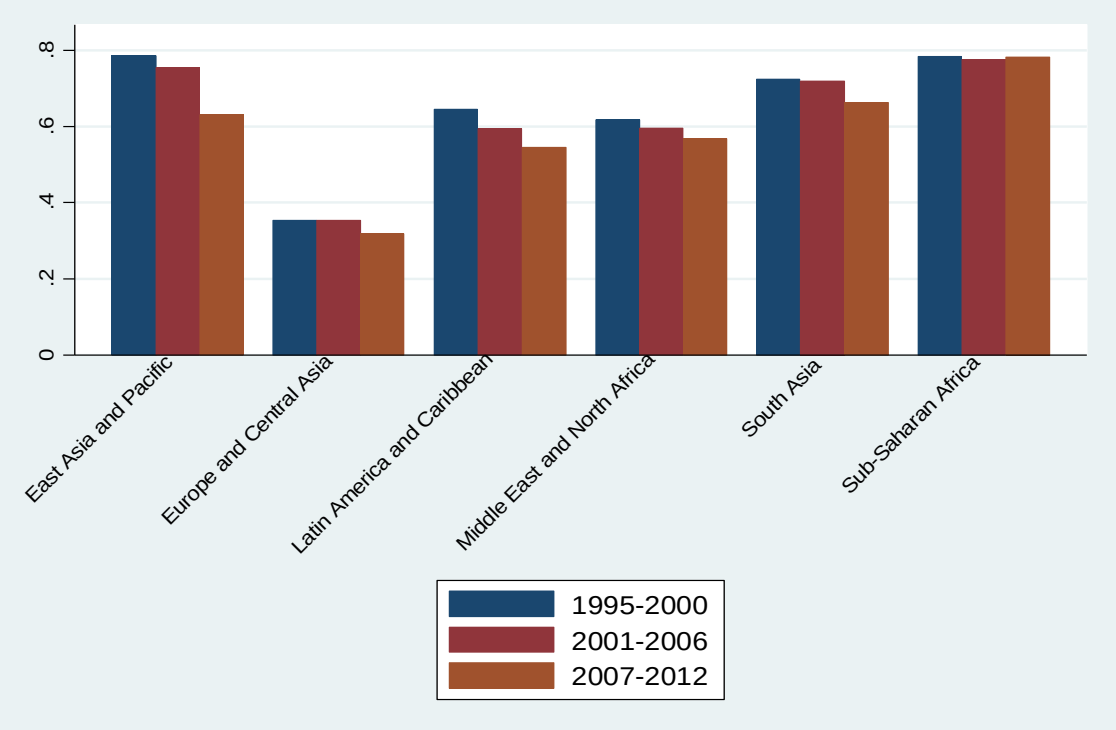
Furthermore, a global decreasing trend in average of efficiency scores has been observed in the overall sample (Table 1. 4). The same trend is observed for all income-groups and regions, exception made for low-income and Sub-Saharan African countries (Graphics 1.1 and 1.2). The result globally shows that obesity prevalence and the deaths rate caused by the non-communicable diseases have averagely increased over time.

Graphic 1.1: Time trend of average technical efficiency scores by income-group (1995-2012)



Source: Author using the GBD, and the GHE databases.

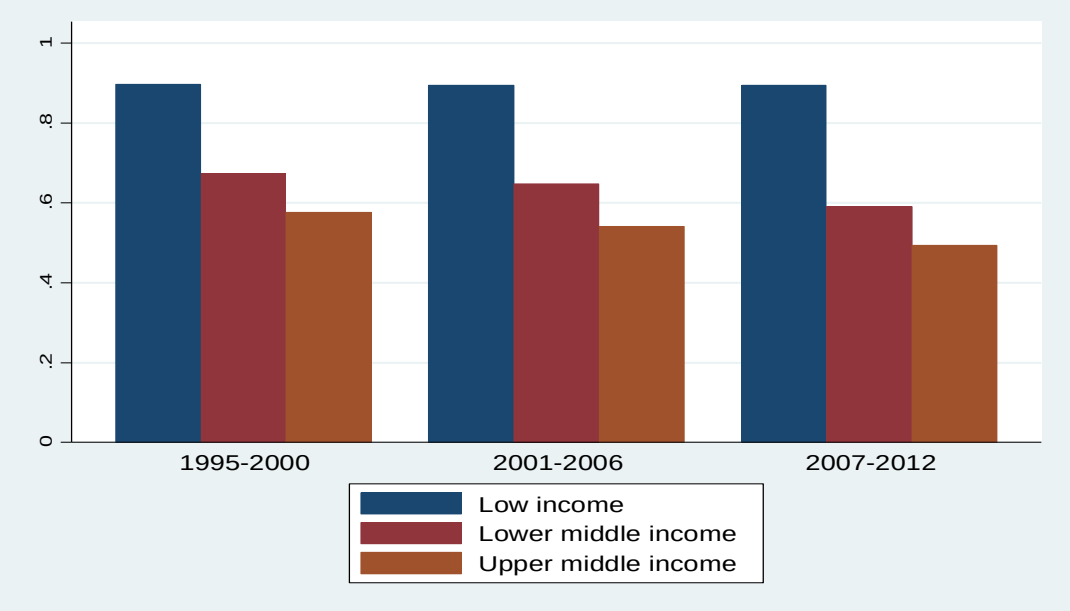
Graphic 1.2: Time trend of average technical efficiency scores by region (1995-2012)



Source: Author using the GBD, and the GHE databases.

Through the average rankings by income-group, we find that low-income countries are more efficient than lower and the upper-middle income countries (Graphic 1.3). Compared to middle income countries, low-income countries experience lower levels of obesity and deaths caused by non-communicable diseases (Annex 1.1).Given the use of output-oriented model in the technical efficiency estimations, countries with low levels of outputs and consequently with high levels of reversed outputs will be the most efficient and vice versa.

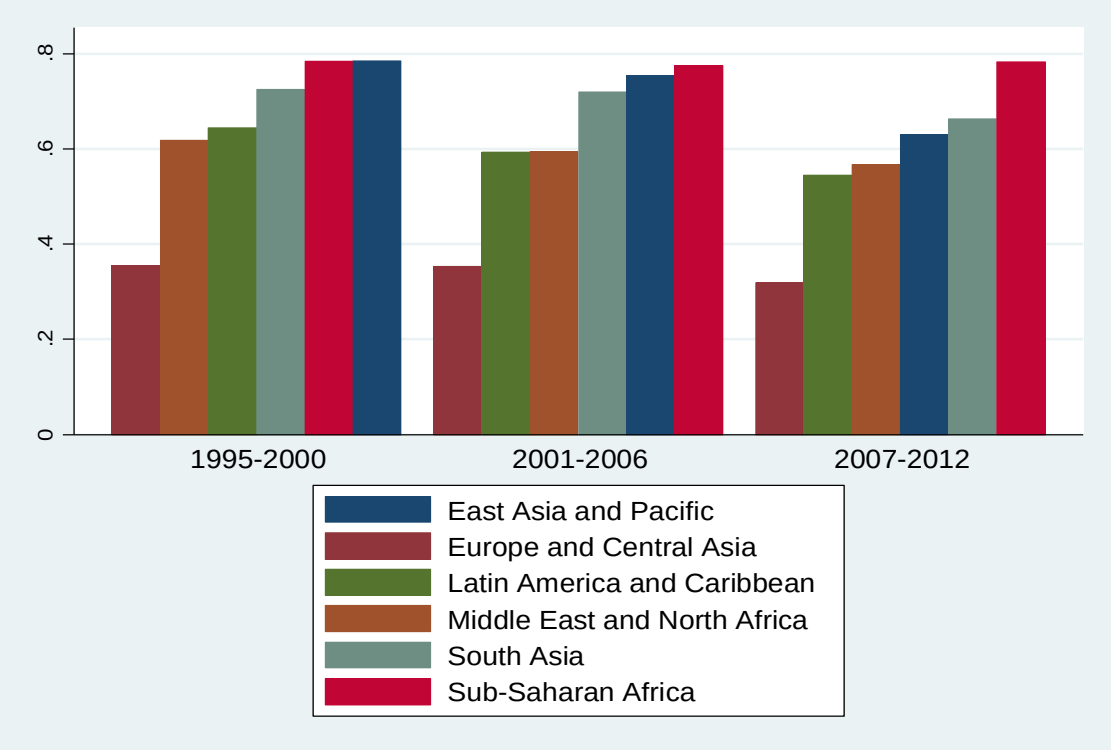
Graphic 1.3: Average technical efficiency scores by income-group and by sub-period (1995-2012)



Source: Author using the GBD, and the GHE databases.

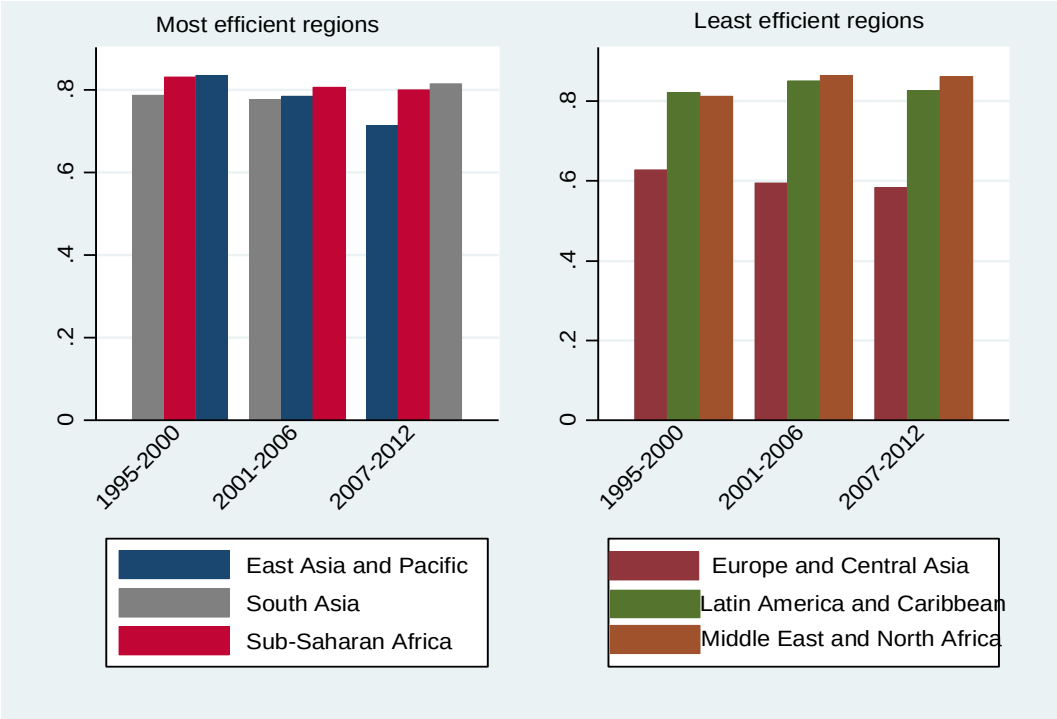
Concerning the average rankings by region, two groups are identified: the least efficient regions including Europe and Central Asia, Latin America and Caribbean and Middle East and North Africa and the most efficient regions encompassing Sub-Saharan Africa, South Asia and East Asia and Pacific (Graphic 1.4). These findings are explained by the higher level of outputs, particularly of obesity prevalence in the least efficient regions compared to the most efficient regions (Annex 1.2). These results could also come from the fact that obesity and non-communicable diseases constitute problems of public health in the least efficient regions compared to the most efficient regions. We consequently re-estimate the average technical efficiency scores by sub-period on each group of regions (Graphic 1.5). In the group of most efficient regions, we find low differences between the regions. However, South Asia and East Asia and Pacific have been slightly less efficient than the others respectively for the first and the third sub-periods. Sub-Saharan African countries have been slightly more efficient than the others at the second sub-period. In the group of least efficient regions, the differences are more perceptible. Countries of Europe and Central Asia have been less efficient than countries of Middle East and North Africa and Latin America and Caribbean which have approximately the same the efficiency scores. However, Latin American and Caribbean countries have slightly less efficient (for the second and the third sub-periods) and more efficient (for the first sub-period) than Middle East and North African countries.

Graphic 1.4: Average technical efficiency scores by region and by sub-period (1995-2012)



Source: Author using the GBD and the GHE databases.

Graphic 1.5: Average efficiency scores by group of regions and by sub-period group (1995-2012)



Source: Author using the GBD and the GHE databases.

In view of these results, it has been more interesting to estimate the FRMs not only on the global sample but also on each group of regions. However, the insufficient number of observations by group of regions (52 and 37 respectively for the most and the least efficient groups of regions) would not

allow us to get rigorous estimations. We have compared the efficiency scores on the global sample to the ones estimated on each group of regions through correlation and Spearman rank coefficients (Table 1.5) These coefficients have respectively the goal to test the correlation between the technical efficiency scores and their ranking. Significantly estimated around the unit, these coefficients reveal that the rankings provided by the efficiency scores estimated on the groups of regions are approximately the same than the ones assessed on the global sample. Moreover, they show that the compared scores are much correlated. In this way, the estimations of FRMs on the global sample would approximately bring the same results comparatively to the case where these FRMs were estimated on each group of regions by using sufficient observations. In this way, for the second-stage regressions, we focus on the global sample.

Table 1.5: Comparison between the technical efficiency scores on the global sample and each group of regions (1995-2012)

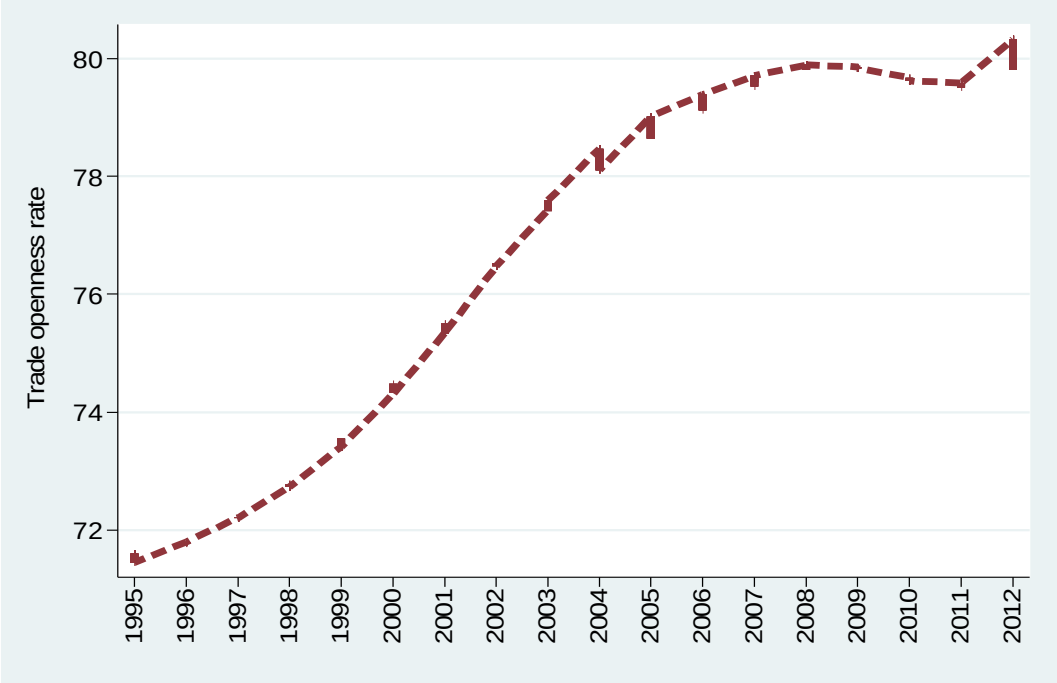
The most efficient regions Sub-Saharan Africa, East Asia and Pacific and South Asia			The least efficient regions: Europe and Central Asia, Latin America and Caribbean and Middle East and North Africa		
Periods	Spearman Rank coefficients	Correlation coefficients	Periods	Spearman Rank coefficients	Correlation coefficients
1995-2000	0.9994***	0.9995***	1995-2000	0.8460***	0.8640***
2001-2006	0.9955***	0.9997***	2001-2006	0.9081***	0.9117***
2007-2012	0.9998***	0.9998***	2007-2012	0.9394***	0.9288***

Source: Author 'calculation. Note: *** $p < 0.01$.

4.2 Descriptive analysis of trade openness

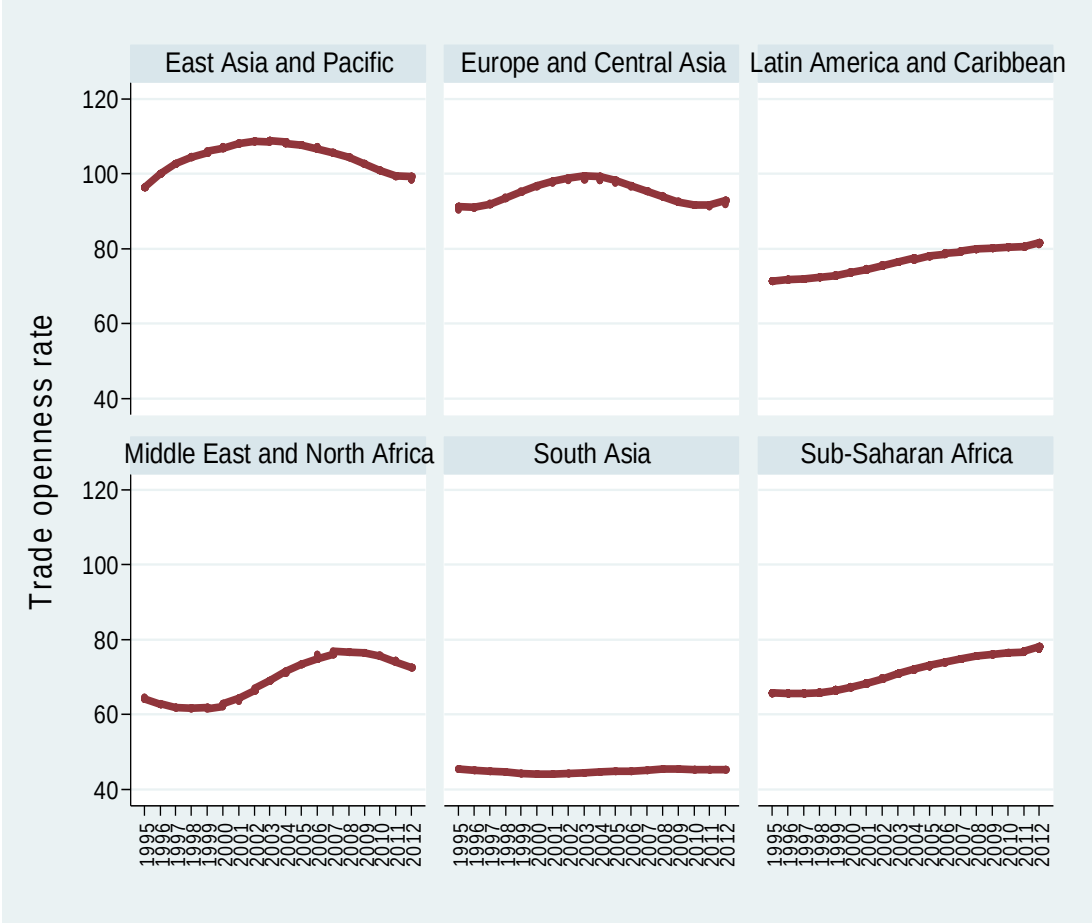
Here we analyze the time trend of trade openness in the global sample but also by region and income-group. For all countries and each region and income-group, the mean of trade openness rate has been calculated by year. We find that trade openness has increased between 1995 and 2012 in low-and middle-income countries (Graphic 1.6). It has increased in Sub-Saharan Africa, Latin America and Caribbean and Middle East and North Africa. In Europe and Central Asia and East Asia and Pacific it has increased between 1995 and 2002 and has decreased since the 2003s. In South Asia the trade openness rate has stagnated and has been the lowest comparatively to the other regions (Graphic 1.7). In addition, Graphic 1.8 reveals a global increasing trend in trade openness in all income-groups. Low-income countries have experienced the lowest trade openness rate but the highest increase in this indicator. In lower and upper-middle income countries, trade openness has decreased respectively since the 2005s and the 2008s.

Graphic 1.6: Time trend of trade openness rate in low-and middle-income countries (1995-2012)



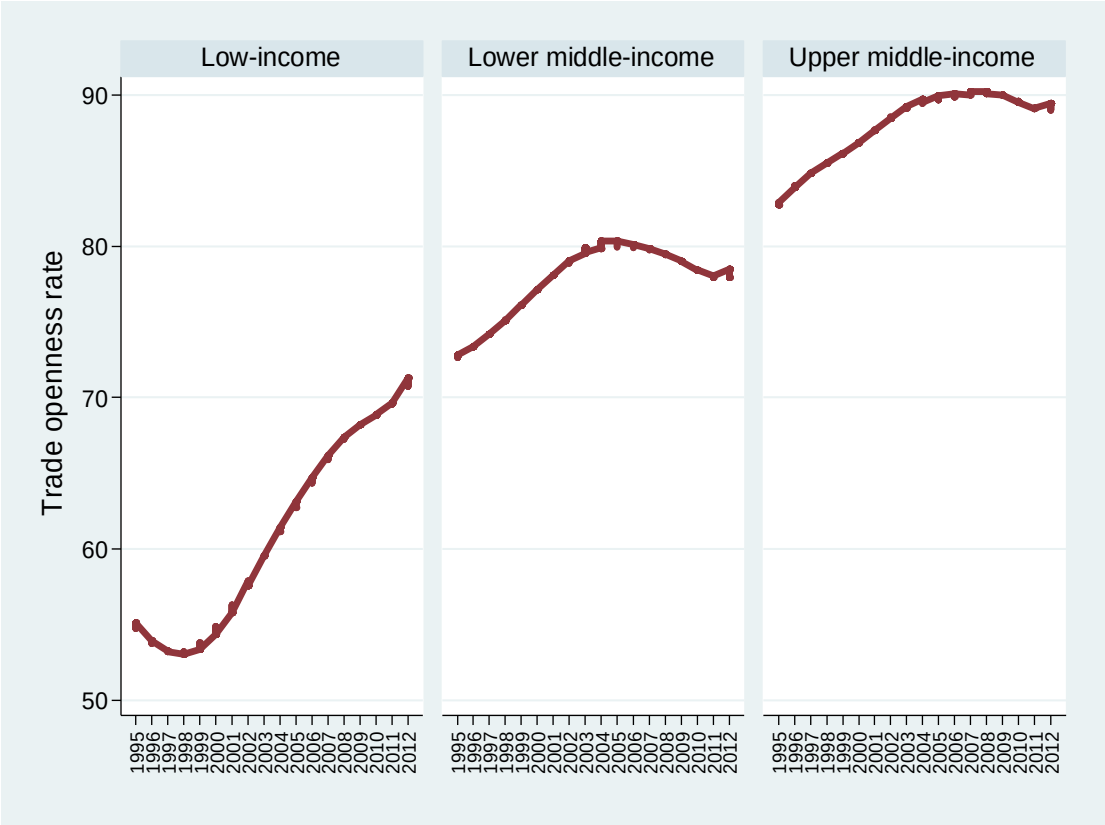
Source: Author using the WDI database.

Graphic 1.7: Time trend of trade openness rate by region (1995-2012)



Source: Author using the WDI database.

Graphic 1.8: Time trend of trade openness rate by income-group (1995-2012)



Source: Author using the WDI database.

4.3 The Role of trade openness on health expenditures efficiency

4.3.1 Preliminary tests

The use of FRMs (Fractional Regression Models) in the second step needs to calculate for each period the percentage of efficient countries which compose the production frontier (order-m=1). This proportion will allow us to choose between the one-part and the two-part regression models. We get the following values for this proportion: 11.23%, 12.36% and 8.99% respectively for the first, the second and the third periods. For each period, the number of efficient countries is not sufficient to use the two-part regression model. Furthermore, we do not find a justification attesting the presence of different partial effects of trade openness on the efficient and the inefficient countries. We choose the one-part regression model.

The effect of trade openness on the technical efficiency scores is estimated in pooling data on each studied period. Before estimating the effect, we firstly use the p-tests to select the most relevant link function associated with our FRMs. The p-tests consist of first estimating the FRMs with all existing link functions. Then, each specification (link function) is compared to the others through LM tests. For example, we take two link functions X and Y which must be compared. In the first LM test, the null and the alternative hypotheses respectively mean that X and Y are more relevant. In the second one the null and alternative hypotheses respectively mean that Y and X are more relevant. For all tests, a significant LM statistic means that the null hypothesis can be rejected, whereas a non-significant LM statistic results in a rejection of null hypothesis. Based on the example taken on both link functions X and Y, four kinds of results presented in Table 2.6, are possible.

Table 1.6: Potential results of p-tests in the Fractional Regression Models

Fist LM test		Second LM test		Final interpretations
Null hypothesis: H0: X		Null hypothesis: H0: Y		
Alternative hypothesis: HA: Y		Alternative hypothesis: HA: X		
Intermediate interpretations	LM statistic	Intermediate interpretations	LM statistic	
X rejects Y	Non-significant	Y does not reject X	Significant	X is preferred to Y
X does not reject Y	Significant	Y rejects X	Non-significant	Y is preferred to X
X rejects Y	Non-significant	Y rejects X	Non-significant	X and Y are equivalent
Y does not reject Y	Significant	X does not reject Y	Significant	

Source: Author.

Among the two link functions, the most preferred will be the one which will be relevant in both LM tests. In other words, the most preferred link function will reject the other without being rejected by it. For example, the link function X will be preferred to Y or will reject Y without being rejected by it in the case where the null hypothesis is not rejected in the first LM test (non- significant LM statistic) and is rejected in the second LM test (significant LM statistic). Among the five link functions proposed for the estimations of FRMs, the most relevant will be one which rejects the others without being rejected by them.

We made the p-tests for the two kinds of regression. The first one refers to the effect of the trade openness rate at the second period on the technical efficiency scores at the third period. In the second one, the technical efficiency scores of second period are explained on the trade openness rate of first period. Table 1.7 reports the LM statistics related to these p-tests.

Table 1.7: Specification tests (p-tests) in the Fractional Regression Models

Fist regression: effect of trade openness at second period on the efficiency scores at third period						
		Null hypothesis (H0)				
		Probit	Logit	Log-Log	Clog-log	Cauchit
Alternative hypothesis (H1)	Probit	-	3.922**	13.468***	6.967***	7.478***
	Logit	2.953*	-	12.635***	6.888***	6.971***
	Log-Log	9.714***	9.148***	-	6.901***	0.492
	Clog-log	10.319***	11.001***	14.023***	-	12.419***
	Cauchit	1.191	1.513	3.249*	4.376***	-
Second regression: effect of trade openness at first period on the efficiency scores at second period						
		Null hypothesis (H0)				
		Probit	Logit	Log-Log	Clog-log	Cauchit
Alternative hypothesis (H1)	Probit	-	2.215	9.264***	4.383**	6.386***
	Logit	1.477	-	7.378**	4.463**	6.213**
	Log-Log	6.603***	5.554***	-	4.446**	1.152
	Clog-log	6.862**	7.833**	9.531**	-	9.238***
	Cauchit	1.043	1.535	1.178	3.127***	-

Source: Author 'calculation. Note: ***p< 0.01; **p<0.05; *p< 0.1.

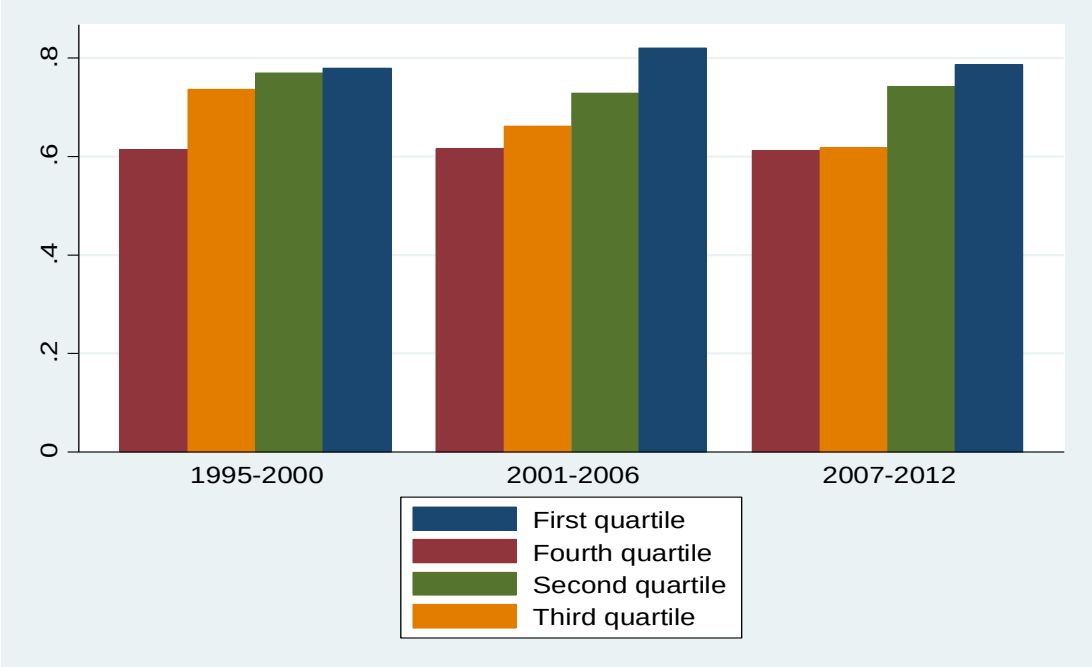
Based on the results, it appears that some link functions that are equivalent. These are: probit and logit, probit and log-log, probit and clog-log, logit and log-log, logit and clog-log, log-log and clog-log and cauchit and clog-log. Hence, it is not possible to choose between these link functions. Given the high number of equivalent link functions, we propose to eliminate ones which are less preferred by one or two link functions. For the first kind of regression, we find that cauchit is preferred to log-log. We consequently eliminate this log-log link function. Then, we observe that for the two kinds of regression, the probit and the logit are preferred to cauchit. Hence we also eliminate cauchit and we keep the following link functions: the probit, the logit and the clog log. We present the results based on the probit link function. The findings referred to the other retained link functions will be presented in the remainder of paper, particularly in the sensitivity analysis.

4.3.2 The effect of trade openness on the technical efficiency of health expenditures

- Descriptive analysis of statistical relationship between trade openness and the technical efficiency of health expenditures

Before performing the regressions, we statistically analyze the relationship between the trade openness rate and the technical efficiency scores. For each sub-period, we divide up the sample into four quartiles calculated on the base of trade openness rate values. Then we calculate the average efficiency by quartile. It appears that the upper quartiles record the least scores comparatively to the lower quartiles (Graphic 1.9). This observation reveals a negative correlation between trade openness and the technical efficiency of health expenditures. This relationship remains more perceptible on the second sub-period (2001-2006).

Graphic 1.9: Average efficiency score per countries trade openness rate (1995-2012)



Source: Author using the GBD and the GHE databases.

- Evidences on trade openness effect on the technical efficiency of health expenditures

Table 1.8 reports the baseline results related to the estimated effect of trade openness at the first and the second sub-periods on the technical efficiency scores respectively estimated at the second and the third sub-periods. In this table, the marginal effects of explanatory variables are presented. After control for income and the other explanatory variables, we find that trade openness leads to significantly reduce the technical efficiency of health expenditures. It seems that trade openness

increases obesity prevalence and the deaths caused by the non-communicable diseases in view of existing public and private expenditures on health. This effect remains low, varying from 0.001 to 0.002 per the specification.

Furthermore, we globally find that the duration of secondary education, government effectiveness, external resources for health and the similarity in merchandise trade structure do not significantly affect the technical efficiency scores. The non-significant effect associated with external resources for health variable shows that the allocation of external resources health aid does not benefit to the fight against obesity and non-communicable diseases; a finding that is explained again by the fact that this fight does not constitute a public health priority for the major part of studied countries.GDP per capita, CO2 emissions, the old dependency ratio and urbanization contribute in reducing the technical efficiency of health expenditures by increasing obesity prevalence and the deaths caused by the non-communicable diseases in view of existing public and private health expenditures.

Table 1.8: Baseline results of estimated effect of the trade openness rate on the technical efficiency scores by using the probit link function (1995-2012)

Dependent variable: Order-m score at the third sub-period (multi-outputs/multi-inputs)				Dependent variable: Order-m score at the second sub-period (multi-outputs/multi-inputs)			
Covariates	(1)	(2)	(3)	Covariates	(1)	(2)	(3)
$Trade_{period2}$	-0.002***	-0.001***	-0.001***	$Trade_{period1}$	-0.001***	-0.001**	-0.001**
	(0.000)	(0.000)	(0.000)		(0.000)	(0.000)	(0.000)
$Urban_{period2}$	-0.004***		-0.003***	$Urban_{period1}$	-0.002*		-0.001
	(0.001)		(0.001)		(0.001)		(0.001)
Old $dependency_{period2}$	-0.040***	-0.038***	-0.038***	Old $dependency_{period1}$	-0.059***	-0.054***	-0.054***
	(0.006)	(0.006)	(0.007)		(0.007)	(0.007)	(0.009)
$Education_{period2}$	0.012	0.005	0.016	$Education_{period1}$	0.009	-0.001	0.015
	(0.020)	(0.017)	(0.019)		(0.021)	(0.021)	(0.020)
$Ext\_Fin_{period2}$	-0.0003	-0.002**	-0.001	$Ext\_Fin_{period1}$	-0.001	-0.001	-0.001
	(0.001)	(0.001)	(0.001)		(0.000)	(0.000)	(0.000)
$Governance_{period3}$	-0.036	0.039	-0.023	$Governance_{period2}$	-0.033	0.032	-0.008
	(0.034)	(0.034)	(0.036)		(0.039)	(0.038)	(0.036)
$Simi.Trade_{period3}$	-0.564	-0.165	-0.470	$Simi.Trade_{period2}$	-0.790*	-0.562	-0.710
	(0.416)	(0.389)	(0.409)		(0.429)	(0.415)	(0.436)
$Log.GDP_{period2}$		-0.123***		$Log.GDP_{period1}$		-0.101***	
		(0.020)				(0.023)	
$CO2_{period3}$			-0.012***	$CO2_{period2}$			-0.026***
			(0.005)				(0.007)
Observations	80	80	80	Observations	74	74	74
R^2	0.668	0.7102	0.6859	R^2	0.6011	0.6453	0.6499

Note: Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

5. Robustness checks

5.1 Removing atypical countries on the sample

The regressions have shown that trade openness leads to significantly reduce the technical efficiency of health expenditures. This effect could be only explained by the presence of atypical countries with very high values of the trade openness rate. Here, we check whether there are atypical countries in the distribution of the trade openness rate and whether they influence the results. The distribution of trade openness is analyzed through a box-plots analysis (Graphic 1.10).

Graphic 1.10: Box-plot analysis of the trade openness rate

Source: Author using the WDI database.

For the first sub-period, two atypical countries such as Guyana and Malaysia have been identified. Their trade openness rate is greater than 200%. For the second sub-period, graphic 1.4 reveals four countries which have distinguished themselves from the others: Guyana, Lesotho, Malaysia and Swaziland. They presented the trade openness rates greater than 175%. After the identification of atypical countries, the FRMs (Fractional Regression Models) are re-estimated without these last ones to check whether they influence the raised effect of trade openness (Table 1.9). We find that the coefficient associated with trade openness remains negative, significant and low (estimated from 0.001 to 0.002 per the specification). The estimated effects associated with the control variables remain robust when the outliers are removed from the regressions.

Table 1.9: Baseline results of estimated effect of the trade openness rate on the technical efficiency scores by using the probit link function in the sample excluding atypical countries with high the trade openness rate (1995-2012)

Dependent variable: Order-m score at the third sub-period (multi-outputs/multi-inputs); (Trade_period2<150%)				Dependent variable: Order-m score at the second sub-period (multi-outputs/multi-inputs); (Trade_period2<200%)			
Covariates	(1)	(2)	(3)	Covariates	(1)	(2)	(3)
$Trade_{period2}$	-0.002***	-0.002***	-0.002***	$Trade_{period1}$	-0.001**	-0.001	-0.001**
	(0.001)	(0.001)	(0.001)		(0.001)	(0.001)	(0.001)
$Urban_{period2}$	-0.004***	-0.002*	-0.004***	$Urban_{period1}$	-0.002**	0.001	-0.001
	(0.001)	(0.001)	(0.001)		(0.001)	(0.001)	(0.001)
Old $dependency_{period2}$	-0.033***	-0.031***	-0.031***	Old $dependency_{period1}$	-0.055***	-0.053***	-0.048***
	(0.006)	(0.006)	(0.006)		(0.007)	(0.008)	(0.008)
$Education_{period2}$	-0.010	-0.013	-0.006	$Education_{period1}$	-0.006	-0.016	-0.003
	(0.019)	(0.017)	(0.018)		(0.021)	(0.021)	(0.019)
$Ext\_Fin_{period2}$	0.000	-0.001	-0.000	$Ext\_Fin_{period1}$	-0.001	-0.001	-0.000
	(0.001)	(0.001)	(0.001)		(0.000)	(0.000)	(0.000)
$Governance_{period3}$	-0.056*	0.005	-0.045	$Governance_{period2}$	-0.051	0.015	-0.029
	(0.031)	(0.035)	(0.032)		(0.041)	(0.039)	(0.037)
$Simi.Trade_{period3}$	-0.169	-0.027	-0.083	$Simi.Trade_{period2}$	-0.608	-0.327	-0.472
	(0.474)	(0.465)	(0.460)		(0.442)	(0.425)	(0.444)
$Log.GDP_{period2}$		-0.096***		$Log.GDP_{period1}$		-0.116***	
		(0.031)				(0.031)	
$CO2_{period3}$			-0.014***	$CO2_{period2}$			-0.029***
			(0.005)				(0.007)
Observations	75	75	75	Observations	72	72	72
R^2	0.6991	0.7286	0.7206	R^2	0.6048	0.6541	0.6662

Note: Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1, the results are based on probit link function.

5.2 Trade openness and the technical efficiency of health expenditures: using single-output/multi-inputs models in the estimation of efficiency scores

Here, the order-m scores are re-estimated by using single-output/multi-inputs models. Here, the goal is to check whether each of used outputs is effectively affected by trade openness. Two kinds of technical efficiency scores are assessed. For both kinds, public and private health expenditures in USD PPP per capita are used as inputs. For the first and the second ones, the reverse of obesity prevalence rate and the reverse of deaths caused by the non-communicable diseases are respectively used as output. The technical efficiency scores are estimated in output orientation by assuming the VRS assumption. After, estimating the scores, the outliers (superefficient countries) are removed from the sample. Then the scores are explained on their determinants. For the second-stage estimations we

follow the same methodology (FRMs, specifications and link functions). Tables 1.10 and 1.11 respectively report the results based on the determinants of single-output/multi-inputs efficiency scores.

Table 1.10: Baseline results of estimated effect of the trade openness rate on the technical efficiency scores assessed by regarding the reverse of obesity prevalence as output (1995-2012)

Dependent variable: Order-m score at the third period (single-output/multi-input)				Dependent variable: Order-m score at the second period (single-output/multi-input)			
Covariates	(1)	(2)	(3)	Covariates	(1)	(2)	(3)
$Trade_{period2}$	-0.002***	-0.001**	-0.002***	$Trade_{period1}$	-0.001***	-0.0003	-0.001**
	(0.000)	(0.001)	(0.001)		(0.000)	(0.000)	(0.000)
$Urban_{period2}$	-0.007***		-0.007***	$Urban_{period1}$	-0.007***		-0.006***
	(0.001)		(0.001)		(0.001)		(0.001)
Old $dependency_{period2}$	-0.004	-0.009	-0.003	Old $dependency_{period1}$	-0.023***	-0.023***	-0.019**
	(0.007)	(0.007)	(0.007)		(0.009)	(0.008)	(0.009)
$Education_{period2}$	0.055*	0.051*	0.057*	$Education_{period1}$	0.057**	0.041	0.060**
	(0.029)	(0.027)	(0.029)		(0.026)	(0.027)	(0.027)
$Ext\_Fin_{period2}$	-0.0001	-0.003*	-0.0004	$Ext\_fin_{period1}$	0.001	0.0004	0.001
	(0.002)	(0.002)	(0.002)		(0.001)	(0.001)	(0.001)
$Governance_{period3}$	-0.051	0.054	-0.044	$Governance_{period2}$	-0.075*	0.028	-0.063
	(0.038)	(0.046)	(0.039)		(0.045)	(0.041)	(0.047)
$Simi.Trade_{period3}$	-0.331	0.192	-0.285	$Simi.Trade_{period2}$	-1.020	-0.430	-0.988
	(0.505)	(0.596)	(0.503)		(0.681)	(0.545)	(0.687)
Log. $GDP_{period2}$		-0.187***		Log. $GDP_{period2}$		-0.202***	
		(0.024)				(0.028)	
$CO2_{period3}$			-0.008	$CO2_{period2}$			-0.018
			(0.006)				(0.012)
Observations	85	85	85	Observations	79	79	79
R^2	0.6019	0.5763	0.6053	R^2	0.5193	0.60	0.5305

Note: Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1; the results are based on probit link function.

In the regressions based on the technical efficiency scores using obesity prevalence as output, the trade openness rate globally enters with negative coefficients varying from 0.001 to 0.002. The result attests that trade openness contributes in increasing obesity prevalence (let remember that the outputs are reversed in the assessment of efficiency scores) in view of existing private and public health expenditures. Furthermore, it appears that urbanization, the old dependency ratio and GDP per capita also reduce the technical efficiency scores. The effect associated with the old dependency ratio remains significant only on the scores assessed at the second sub-period. In the major part of tested specifications, we find non-significant effects for the external resources for health, government effectiveness, CO2 emissions and the similarity in merchandise trade structure. Moreover, it appears that the duration of secondary education is a factor enhancing the technical efficiency in the process of

fight against obesity. In other words, the duration of secondary education leads to reduce obesity prevalence in view of existing public and private expenditures on health.

Table 1.11: Baseline results of estimated effect of the trade openness rate on the technical efficiency scores assessed by regarding the reverse of deaths rate caused by the non- communicable diseases as output (1995-2012)

Dependent variable: Order-m score at the third period (single-output/multi-input)				Dependent variable: Order-m score at the second period (single-output/multi-input)			
Covariates	(1)	(2)	(3)	Covariates	(1)	(2)	(3)
$Trade_{period2}$	-0.001***	-0.001**	-0.001***	$Trade_{period1}$	-0.001**	-0.001*	-0.001*
	(0.000)	(0.000)	(0.000)		(0.000)	(0.000)	(0.000)
$Urban_{period2}$	-0.002*		-0.001	$Urban_{period1}$	-0.00006		0.001
	(0.001)		(0.001)		(0.001)		(0.001)
Old $dependency_{period2}$	-0.051***	-0.044***	-0.049***	Old $dependency_{period1}$	-0.070***	-0.058***	-0.065***
	(0.007)	(0.006)	(0.008)		(0.008)	(0.007)	(0.009)
$Education_{period2}$	-0.002	-0.012	0.002	$Education_{period1}$	0.002	-0.009	0.009
	(0.021)	(0.019)	(0.021)		(0.020)	(0.021)	(0.020)
$Ext\_Fin_{period2}$	-0.0003	-0.002**	-0.0004	$Ext\_Fin_{period1}$	-0.001**	-0.001	-0.001
	(0.001)	(0.001)	(0.001)		(0.001)	(0.000)	(0.000)
$Governance_{period3}$	-0.056	0.020	-0.042	$Governance_{period2}$	-0.047	0.025	-0.019
	(0.038)	(0.037)	(0.039)		(0.041)	(0.040)	(0.039)
$Simi.Trade_{period3}$	-0.074	0.376	0.014	$Simi.Trade_{period2}$	-0.282	-0.136	-0.202
	(0.515)	(0.458)	(0.503)		(0.474)	(0.452)	(0.484)
Log. $GDP_{period2}$		-0.108***		Log. $GDP_{period1}$		-0.087***	
		(0.020)				(0.022)	
$CO2_{period3}$			-0.013**	$CO2_{period2}$			-0.029***
			(0.005)				(0.007)
Observations	86	86	86	Observations	78	78	78
R^2	0.6360	0.6930	0.65	R^2	0.5785	0.6245	0.6303

Note: Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1; the results are based on probit link function.

For the technical efficiency scores estimated on the basis of deaths caused by the non-communicable diseases, we find that the coefficients associated with the trade openness rate remains significant, negative but also stable (0.001). They confirm that trade openness also increases the deaths rate due to the non-communicable diseases in view of existing public and private health expenditures. It appears that the effect of trade openness on the technical efficiency estimated in Table 1.8 remains robust even if the single-output/multi-inputs efficiency scores are used as dependent variables. In addition, we globally observe that urbanization, the educational variable, government effectiveness index, the

degree of similarity in merchandise trade structure and external resources for health do not significantly affect the technical efficiency scores. The old dependency ratio, GDP per capita and CO2 emissions contribute in increasing the deaths occasioned by the non-communicable diseases in view of public and private health expenditures.

5.3 Testing the effect of trade composition on the technical efficiency of health expenditures

Evidences show that trade openness reduces the technical efficiency of health expenditures. Here we test the effect of trade composition on this efficiency. The goal in the subsection is to check whether the modification in trade structure would affect the technical efficiency of health expenditures. In the remainder of this subsection, we shall present the various trade composition variables that have been retained and the channels through with they could potentially affect the efficiency scores. Next, we shall describe the constitution of FRMs (Fractional Regressions Models) which will be used to test the effects. Thereafter, the results will be discussed.

5.3.1 Trade composition variables

Four indicators are selected on the base on transmissions channels explained above in the section 2. They are retrieved from two databases such as WDI and UNCTAD.

Imports of fuels as percentage of merchandises imports (Fuel Imp, source: WDI database): it is likely to have mixed effects on the technical efficiency such as measured in the study. This first channel potentially passes through air pollution. The imported fuels are generally intended to be consumed. Hence, an increase in fuels imported would expand air pollution, particularly the emissions of greenhouse gases such as for example CO2 emissions that impede the technical efficiency of health expenditures (based on evidences) by mostly increasing the deaths caused by the non-communicable diseases. The second channel is based on the consumption of industrial foods locally produced. The imported fuels are used for the production of goods and services, particularly of industrially processed foods which constitute a risk factor of obesity. In this way, the increase in fuels imports could increase obesity prevalence and consequently reduce the technical efficiency of health expenditures. Here, we have chosen to use the imports of fuels instead of exports because air pollution caused by the fuels mostly comes from their local use. Hence, the variable of fuel imports is more rigorous that their exports. The fuels comprise the commodities of third section of Standard International Trade Classification (SITC), revision 3 (mineral fuels).

Imports of ICTs as percentage of total goods imports (ICT_Imp, source: WDI database): We have highlighted above that the ICTs imports could affect the technical efficiency of health expenditures in two ways. They could allow for the individuals to adopt preventive measures to avoid obesity and non-communicable diseases. Through the advertisings encouraging the consumption of unhealthy products, they could also induce the individuals to change their life style; a fact could lead to obesity and non-communicable diseases. To clarify these hypotheses, we empirically test here the effect of ICTs imports on the technical efficiency. The ICTs refers to computers and peripheral equipment's, communication equipment's, consumer electronic equipment's, electronic components and other information and technology goods (miscellaneous).

Exports of primary commodities as percentage of total products exports (Com_Exp, source: UNCTAD database): approximates trade in primary goods. We have shown above that this kind of trade is likely to reduce the technical efficiency of health expenditures by increasing obesity and deaths caused by the non-communicable diseases (see subsection 2.2.2). Indeed, trade in primary goods is likely to increases income by modifying the income inequalities in favour of the low-skilled workers that remain the poorest. The increase in income would result in nutritional/dietary shifts and

in lifestyles; a fact would potentially increase obesity prevalence and the deaths rate caused by the non- communicable diseases. The primary products include the commodities of sections 0 (food and live animals), 1 (beverage and tobacco), 2 (crude materials, excluding fuels), 4 (animal and vegetable oils, fats and waxes) and 68 (non-ferrous metals) on the SITC, revision 3. Regarding these products, we have chosen to use the exports instead of imports because the local low-skilled labour is generally more used for the exports instead of imports.

Exports of manufactures as a percentage of merchandises exports (Manu_Exp, source: WDI): the potential effects of this variable are mitigated. We have mentioned above that trade of these products is likely to have a non- significant effect on the technical efficiency of health expenditures. However, there were eventual assumptions attesting negative effects of trade openness on the technical efficiency of health expenditures. Indeed, manufactured industries are generally pollutant. Hence, the intensification of trade in manufactured goods would result in air pollution that appears as a factor leading to non-communicable diseases. Through this channel it is likely to reduce the technical efficiency of health expenditures by increasing the deaths rate caused by the non-communicable diseases in view of used health expenditures. To understand and to clarify this controversy of ideas, we retain the exports instead of imports of these products because per assumptions evoked above, they are more relevant than imports. The exports of these products more represent a convincing channel of transmission through which trade in secondary goods, specifically in manufactures, would affect the technical efficiency of health expenditures. The manufactures comprise the fifth (chemicals), the sixth (basic manufactures), the seventh (machinery and transport equipment's) and the eighth (miscellaneous manufactured) sections of SITC, revision 3.

5.3.2 Empirical model for the tested effect of trade composition on the technical efficiency of health expenditures

In the following estimates, the effect of each trade composition variables is separately tested. The models including the variables of imports composition (fuels imports as percentage of merchandises imports and ICTs imports a percentage of total goods imports) are controlled by the index of similarity in merchandise imports structure (Simi_Imp); whereas the models using the variables of exports composition (primary commodities exports as percentage of total products exports and manufactures exports as share of merchandises exports) are controlled by the index of similarity in merchandise exports structure (Simi_Exp).

The starting control variables and the probit link function are used in the estimates of second-stage. Furthermore, trade composition variables are lagged to deal with any eventual endogeneity bias and to take into account the fact that their effect on the technical efficiency could take the time. We only present the regressions explaining the technical efficiency at the third period because some trade composition variables such as the imports of ICTs do not provide sufficient observations allowing making rigorous regressions on the technical efficiency scores at the second period. The regressions explaining the technical efficiency scores at the second period by trade composition variables, exception made for the ICTs imports are presented in Annexes1.3, 1.4 and 1.5. The baseline results based on the effect of imports and exports composition variables are respectively reported in Tables 1.12, 1.13, 1.14 and 1.15.

5.3.3 Evidences on the tested effect of trade composition on the technical efficiency of health expenditures

The estimations reveal that the fuels imports enter with negative coefficients which are significant in some cases (Table 1.12). The most significant coefficients have been identified in the regressions on the efficiency scores using as output the reverse of obesity prevalence. The result shows that the imports of fuels reduce the technical efficiency scores by mostly increasing obesity prevalence in view

of existing public and private health expenditures. This result is adequate with our hypothesis assuming that the imports fuels are likely to increase obesity and consequently to reduce the technical efficiency through the channel a more consumption of industrially processed foods by the individuals.

Through Table 1.13, we observe that the ICTs imports variable is associated with positive coefficients which are significant, mostly in the case where the technical efficiency scores are estimated on the basis of obesity prevalence. It increases the multi-outputs/multi-inputs efficiency scores in the second specification but it does not significantly affect the efficiency scores assessed on the basis of deaths rate caused by the non-communicable diseases. The finding highlights that the ICTs imports improve the technical efficiency scores by allowing countries to reduce the prevalence of obesity in view of private and public funds that are allocated to health systems.

The third result of this series of estimations majorly shows that the primary commodities exports have not a significant effect not only on the multi-outputs/multi-inputs scores but also on the single-output/multi-inputs ones (Table 1.14). The second variable of exports composition such as the manufactures exports appears with negative coefficients which are majorly significant on the efficiency scores assessed by using as output the reverse of deaths rate caused by the non-communicable diseases (Table 1.15). The exports of manufactures consequently lead to reduce the technical efficiency scores by mostly increasing the deaths rate caused by the non-communicable diseases in view of existing health expenditures from public and private sources. The estimated effects of trade composition variables, exception made for the ICTs imports remain globally robust when the technical efficiency scores at the second sub-period are used as dependent variables (Annexes 1.3, 1.4 and 1.5).

Table 1.12: Baseline results of estimated effect of fuels imports as percentage of merchandises imports on the technical efficiency scores estimated at the third sub-period by using the probit link function (1995-2012)

Dependent variable: Order-m score at the third sub-period									
Covariates	Multi-outputs/multi-inputs			Single-output/multi-inputs (reverse of obesity prevalence as output)			Single-output/multi-inputs (reverse of deaths caused by the non communicable diseases as output)		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
$Fuel\_Imp_{period2}$	-0.003	-0.006**	-0.003	-0.004*	-0.007**	-0.005*	-0.002	-0.005**	-0.002
	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)	(0.003)	(0.002)	(0.002)	(0.002)
$Urban_{period2}$	-0.003***		-0.003**	-0.008***		-0.007***	-0.001		-0.0005
	(0.001)		(0.001)	(0.001)		(0.001)	(0.001)		(0.001)
Old $dependency_{period2}$	-0.043***	-0.034***	-0.040***	-0.007	-0.004	-0.004	-0.058***	-0.041***	-0.055***
	(0.007)	(0.007)	(0.007)	(0.008)	(0.007)	(0.008)	(0.008)	(0.006)	(0.008)
$Education_{period2}$	0.030	0.023	0.035*	0.079**	0.067**	0.082**	0.020	0.008	0.025
	(0.022)	(0.018)	(0.021)	(0.033)	(0.027)	(0.033)	(0.020)	(0.019)	(0.020)
$Ext\_Fin_{period2}$	-0.002	-0.004***	-0.002*	-0.001	-0.004*	-0.001	-0.002	-0.003***	-0.002
	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)
$Governance_{period3}$	-0.068*	0.023	-0.049	-0.082*	0.027	-0.070	-0.077**	-0.001	-0.057
	(0.035)	(0.033)	(0.037)	(0.042)	(0.045)	(0.044)	(0.037)	(0.035)	(0.040)
$Simi.Imp_{period3}$	0.413	0.420	0.367	-0.351	-0.254	-0.381	0.703*	0.807**	0.670*
	(0.451)	(0.475)	(0.439)	(0.470)	(0.491)	(0.466)	(0.401)	(0.407)	(0.392)
Log. $GDP_{period2}$		-0.164***			-0.216***			-0.129***	
		(0.027)			(0.026)			(0.022)	
$CO2_{period3}$			-0.017***			-0.014**			-0.017***
			(0.005)			(0.006)			(0.006)
Observations	73	73	73	78	78	78	79	79	79
R^2	0.6177	0.7162	0.6504	0.5972	0.6451	0.6063	0.6158	0.7052	0.6391

Note: Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Table 1.13: Baseline results of estimated effect of ICTs imports as percentage of merchandises imports on the technical efficiency scores estimated at the third sub-period by using the probit link function (1995-2012)

Dependent variable: Order-m score at the third sub-period									
Covariates	Multi-outputs/multi-inputs			Single-output/multi-inputs (reverse of obesity prevalence as output)			Single-output/multi-inputs (reverse of deaths caused by the non communicable diseases as output)		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
$ICT\_Imp_{period2}$	0.005*	0.003	0.005*	0.007***	0.005**	0.007***	0.003	0.003	0.003
	(0.002)	(0.002)	(0.003)	(0.003)	(0.002)	(0.003)	(0.003)	(0.003)	(0.003)
$Urban_{period2}$	-0.004***		-0.003***	-0.008***		-0.008***	-0.001		-0.0001
	(0.001)		(0.001)	(0.001)		(0.001)	(0.001)		(0.001)
Old $dependency_{period2}$	-0.041***	-0.037***	-0.039***	-0.005	-0.006	-0.003	-0.057***	-0.043***	-0.054***
	(0.005)	(0.005)	(0.006)	(0.006)	(0.006)	(0.007)	(0.007)	(0.006)	(0.008)
$Education_{period2}$	0.030	0.011	0.034	0.080***	0.059**	0.083***	0.026	0.004	0.030
	(0.024)	(0.019)	(0.024)	(0.031)	(0.025)	(0.031)	(0.025)	(0.022)	(0.025)
$Ext\_Fin_{period2}$	-0.002	-0.004**	-0.002	-0.000	-0.004	-0.001	-0.001	-0.003*	-0.001
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
$Governance_{period3}$	-0.096***	0.002	-0.079**	-0.122***	-0.003	-0.110**	-0.097**	-0.019	-0.079*
	(0.036)	(0.033)	(0.038)	(0.046)	(0.051)	(0.045)	(0.041)	(0.039)	(0.043)
$Simi.Imp_{period3}$	0.450	0.304	0.407	-0.255	-0.305	-0.278	0.825*	0.825*	0.794*
	(0.514)	(0.494)	(0.494)	(0.499)	(0.547)	(0.491)	(0.491)	(0.485)	(0.477)
Log. $GDP_{period2}$		-0.158***			-0.214***			-0.122***	
		(0.023)			(0.023)			(0.024)	
$CO2_{period3}$			-0.017***			-0.013**			-0.016**
			(0.005)			(0.006)			(0.006)
Observations	69	69	69	74	74	74	75	75	75
R^2	0.6459	0.7321	0.6786	0.6221	0.6438	0.6278	0.6175	0.6945	0.6386

Note: Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Table 1.14: Baseline results of estimated effect of primary commodities exports as percentage of total products exports on the technical efficiency scores estimated at the third sub-period by using the probit link function (1995-2012)

Dependent variable: Order-m score at the third sub-period									
Covariates	Multi-outputs /multi-inputs			Single-output/multi-inputs (reverse of obesity prevalence as output)			Single-output/multi-inputs (reverse of deaths caused by the non communicable diseases as output)		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
$Com\_Exp_{period2}$	0.0002	-0.00006	0.0003	0.0002	0.00006	0.0004	0.001	0.001	0.001**
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
$Urban_{period2}$	-0.003***		-0.002**	-0.008***		-0.007***	-0.001		-0.001
	(0.001)		(0.001)	(0.001)		(0.001)	(0.001)		(0.001)
Old $dependency_{period2}$	-0.044***	-0.040***	-0.041***	-0.009	-0.011	-0.005	-0.052***	-0.043***	-0.048***
	(0.005)	(0.005)	(0.006)	(0.007)	(0.007)	(0.007)	(0.006)	(0.005)	(0.006)
$Education_{period2}$	0.014	0.010	0.018	0.057*	0.060**	0.059*	-0.002	-0.011	0.002
	(0.020)	(0.019)	(0.020)	(0.031)	(0.029)	(0.030)	(0.020)	(0.019)	(0.020)
$Ext\_Fin_{period2}$	-0.002	-0.003**	-0.002	-0.001	-0.003*	-0.002	-0.001	-0.002	-0.001
	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)
$Governance_{period3}$	-0.080***	0.003	-0.058*	-0.071	0.034	-0.054	-0.091***	-0.011	-0.067*
	(0.030)	(0.034)	(0.032)	(0.043)	(0.053)	(0.044)	(0.032)	(0.036)	(0.035)
$Simi.Exp_{period3}$	-0.575	-0.477	-0.467	-0.125	-0.221	-0.052	-0.170	0.053	-0.063
	(0.413)	(0.425)	(0.420)	(0.507)	(0.486)	(0.501)	(0.386)	(0.397)	(0.393)
$Log.GDP_{period2}$		-0.117***			-0.188***			-0.101***	
		(0.023)			(0.029)			(0.023)	
$CO2_{period3}$			-0.017***			-0.015**			-0.018***
			(0.005)			(0.006)			(0.007)
Observations	79	79	79	84	84	84	85	85	85
R^2	0.6285	0.6815	0.6703	0.5542	0.5318	0.5990	0.6067	0.6618	0.6338

Note: Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Table 1.15: Baseline results of estimated effect of manufactured exports as a percentage of merchandises exports on the technical efficiency scores estimated at the third sub-period by using the probit link function (1995-2012)

Dependent variable: Order-m score at the third sub-period									
Covariates	Multi-outputs /multi-inputs			Single-output/multi-inputs (reverse of obesity prevalence as output)			Single-output/multi-inputs (reverse of deaths caused by the non communicable diseases as output)		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
$Manu\_Exp_{period2}$	-0.001	-0.001	-0.001	0.001	0.002*	0.001	-0.002***	-0.002***	-0.002***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
$Urban_{period2}$	-0.003***		-0.002*	-0.007***		-0.007***	-0.001		-0.0003
	(0.001)		(0.001)	(0.001)		(0.001)	(0.001)		(0.001)
Old $dependency_{period2}$	-0.045***	-0.038***	-0.042***	-0.018***	-0.016***	-0.016**	-0.053***	-0.041***	-0.050***
	(0.005)	(0.005)	(0.006)	(0.007)	(0.006)	(0.007)	(0.006)	(0.005)	(0.006)
$Education_{period2}$	0.039*	0.030*	0.044**	0.083***	0.071***	0.084***	0.028	0.011	0.032
	(0.020)	(0.017)	(0.020)	(0.029)	(0.024)	(0.029)	(0.020)	(0.016)	(0.019)
$Ext\_Fin_{period2}$	-0.002	-0.003***	-0.002*	-0.00005	-0.002	-0.0003	-0.001	-0.003**	-0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)
$Governance_{period3}$	-0.055	0.036	-0.031	-0.077	0.013	-0.065	-0.038	0.048	-0.013
	(0.038)	(0.036)	(0.041)	(0.049)	(0.047)	(0.051)	(0.038)	(0.037)	(0.041)
$Simi.Exp_{period3}$	-0.884**	-0.913**	-0.834*	0.167	-0.064	0.187	-0.674*	-0.537	-0.611
	(0.445)	(0.436)	(0.432)	(0.496)	(0.435)	(0.489)	(0.403)	(0.382)	(0.392)
Log. $GDP_{period2}$		-0.133***			-0.191***			-0.114***	
		(0.023)			(0.025)			(0.021)	
$CO2_{period3}$			-0.017***			-0.011**			-0.018***
			(0.005)			(0.005)			(0.005)
Observations	72	72	72	77	77	77	78	78	78
R^2	0.6373	0.7255	0.6703	0.5960	0.6614	0.5990	0.6373	0.7178	0.6672

Note: Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

6. Sensitivity analysis

6.1 Sensitivity of results to the link function in the Fractional Regression Models

The goal of subsection is to test the sensitivity of evidences to the link function used in the regressions of second-stage. Per the p-tests performed above the text, we depart from two alternative link functions such as the logit and the clog-log. The three specifications used in the starting models are re-estimated by separately using the multi-outputs/multi-inputs and the single-output/multi-inputs efficiency scores as dependent variables. Tables 1.16 and 1.17 report the results based on the logit link function and the efficiency scores estimated respectively at the third and the second sub-periods. Tables 1.18 and 1.19 report the results based on the clog-log link function and the efficiency scores assessed at the third and the second sub-periods, respectively.

Table 1.16: Baseline results of estimated effect the trade openness rate on the technical efficiency scores estimated at the third sub-period by using the logit link function (1995-2012)

Dependent variable: Order-m score at the third sub-period									
Covariates	Multi-outputs /multi-inputs			Single-output/multi-inputs (reverse of obesity prevalence as output)			Single-output/multi-inputs (reverse of deaths caused by the non communicable diseases as output)		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
$Trade_{period2}$	-0.002***	-0.001***	-0.001***	-0.002***	-0.001**	-0.001**	-0.001***	-0.001**	-0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)
$Urban_{period2}$	-0.003***		-0.003***	-0.007***		-0.008***	-0.001*		-0.001
	(0.001)		(0.001)	(0.001)		(0.001)	(0.001)		(0.001)
Old $dependency_{period2}$	-0.041***	-0.039***	-0.039***	-0.004	-0.008	-0.001	-0.053***	-0.045***	-0.049***
	(0.007)	(0.006)	(0.007)	(0.008)	(0.008)	(0.007)	(0.008)	(0.006)	(0.007)
$Education_{period2}$	0.012	0.006	0.016	0.052*	0.049*	0.055*	-0.002	-0.011	-0.008
	(0.019)	(0.017)	(0.019)	(0.031)	(0.029)	(0.030)	(0.021)	(0.019)	(0.021)
$Ext\_Fin_{period2}$	-0.0004	-0.002**	-0.001	-0.000003	-0.003	-0.0003	-0.0002	-0.002**	-0.001
	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)
$Governance_{period3}$	-0.032	0.042	-0.018	-0.058	0.051	-0.056	-0.051	0.022	-0.033
	(0.035)	(0.034)	(0.037)	(0.040)	(0.049)	(0.040)	(0.039)	(0.038)	(0.039)
$Simi.Trade_{period3}$	-0.586	-0.211	-0.488	-0.256	0.294	-0.220	-0.079	0.355	0.089
	(0.403)	(0.380)	(0.396)	(0.512)	(0.585)	(0.507)	(0.508)	(0.452)	(0.506)
Log. $GDP_{period2}$		-0.120***			-0.187***			-0.104***	
		(0.019)			(0.024)			(0.019)	
$CO2_{period3}$			-0.012***			-0.009			-0.011**
			(0.005)			(0.006)			(0.006)
Observations	80	80	80	85	85	87	86	86	87
R^2	0.6671	0.7086	0.6856	0.6136	0.5874	0.6174	0.6370	0.6909	0.6512

Note: Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Table 1.17: Baseline results of estimated effect the trade openness rate on the technical efficiency scores estimated at the second sub-period by using the logit link function (1995-2012)

Dependent variable: Order-m score at the second sub-period									
Covariates	Multi-outputs /multi-inputs			Single-output/multi-inputs (reverse of obesity prevalence as output)			Single-output/multi-inputs (reverse of deaths caused by the non communicable diseases as output)		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
$Trade_{period1}$	-0.001***	-0.001**	-0.001**	-0.001**	-0.0003	-0.001**	-0.001**	-0.001*	-0.001**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)
$Urban_{period1}$	-0.002*		-0.001	-0.007***		-0.008***	0.00007		0.001
	(0.001)		(0.001)	(0.001)		(0.001)	(0.001)		(0.001)
Old $dependency_{period1}$	-0.059***	-0.054***	-0.055***	-0.025**	-0.023***	-0.008	-0.072***	-0.059***	-0.065***
	(0.008)	(0.007)	(0.008)	(0.010)	(0.008)	(0.012)	(0.008)	(0.007)	(0.009)
$Education_{period1}$	0.010	0.001	0.017	0.055**	0.037	0.058*	0.004	-0.007	0.009
	(0.021)	(0.022)	(0.020)	(0.027)	(0.030)	(0.030)	(0.020)	(0.021)	(0.022)
$Ext\_Fin_{period1}$	-0.001	-0.001	-0.001	0.001	0.001	0.001	-0.001**	-0.001	-0.001*
	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)
$Governance_{period2}$	-0.031	0.032	-0.003	-0.077	0.028	-0.048	-0.043	0.027	-0.004
	(0.039)	(0.038)	(0.036)	(0.047)	(0.044)	(0.050)	(0.041)	(0.039)	(0.041)
$Simi.Trade_{period2}$	-0.780*	-0.579	-0.693	-0.987	-0.374	-0.794	-0.262	-0.134	-0.019
	(0.432)	(0.426)	(0.438)	(0.683)	(0.557)	(0.733)	(0.470)	(0.454)	(0.505)
Log. $GDP_{period1}$		-0.097***			-0.205***			-0.084***	
		(0.023)			(0.028)			(0.021)	
$CO2_{period2}$			-0.027***			-0.020*			-0.028***
			(0.007)			(0.012)			(0.008)
Observations	74	74	74	79	79	82	78	78	82
R^2	0.5994	0.6422	0.6504	0.5259	0.6080	0.5415	0.5789	0.6222	0.6323

Note: Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Table 1.18: Baseline results of estimated effect the trade openness rate on the technical efficiency scores estimated at the third sub-period by using the clog-log link function (1995-2012)

Dependent variable: Order-m score at the third sub-period									
Covariates	Multi-outputs /multi-inputs			Single-output/multi-inputs (reverse of obesity prevalence as output)			Single-output/multi-inputs (reverse of deaths caused by the non communicable diseases as output)		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
$Trade_{period2}$	-0.002***	-0.001***	-0.001***	-0.002***	-0.001*	-0.002***	-0.001***	-0.001**	-0.001***
	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)
$Urban_{period2}$	-0.003***		-0.003***	-0.008***		-0.008***	-0.001		-0.001
	(0.001)		(0.001)	(0.001)		(0.001)	(0.001)		(0.001)
Old $dependency_{period2}$	-0.050***	-0.045***	-0.047***	-0.003	-0.007	-0.001	-0.065***	-0.052***	-0.062***
	(0.008)	(0.007)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.008)	(0.010)
$Education_{period2}$	0.011	0.001	0.014	0.055*	0.052*	0.055*	0.0002	-0.015	0.003
	(0.020)	(0.018)	(0.019)	(0.032)	(0.030)	(0.031)	(0.022)	(0.020)	(0.022)
$Ext\_Fin_{period2}$	-0.0003	-0.002*	-0.001	0.00002	-0.004	-0.0003	-0.0001	-0.002*	-0.001
	(0.001)	(0.001)	(0.001)	(0.002)	(0.003)	(0.002)	(0.001)	(0.001)	(0.001)
$Governance_{period3}$	-0.024	0.053	-0.006	-0.087*	0.037	-0.078*	-0.045	0.025	-0.027
	(0.037)	(0.036)	(0.037)	(0.046)	(0.057)	(0.047)	(0.043)	(0.041)	(0.044)
$Simi.Trade_{period3}$	-0.369	0.068	-0.259	-0.207	0.430	-0.147	0.104	0.576	0.212
	(0.469)	(0.407)	(0.462)	(0.572)	(0.621)	(0.568)	(0.573)	(0.485)	(0.563)
Log. $GDP_{period2}$		-0.123***			-0.198***			-0.108***	
		(0.021)			(0.025)			(0.022)	
$CO2_{period3}$			-0.015**			-0.011			-0.015**
			(0.006)			(0.009)			(0.007)
Observations	80	80	80	85	85	85	86	86	86
R^2	0.6903	0.7272	0.7096	0.6422	0.6160	0.6464	0.6637	0.7149	0.6782

Note: Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Table 1.19: Baseline results of estimated effect the trade openness rate on the technical efficiency scores estimated at the second sub-period by using the clog-log link function (1995-2012)

Dependent variable: Order-m score at the second sub-period									
Covariates	Multi-outputs /multi-inputs			Single-output/multi-inputs (reverse of obesity prevalence as output)			Single-output/multi-inputs (reverse of deaths caused by the non communicable diseases as output)		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
$Trade_{period1}$	-0.001***	-0.001**	-0.001**	-0.001***	-0.0002	-0.001**	-0.001**	-0.001*	-0.001**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)
$Urban_{period1}$	-0.002		-0.001	-0.007***		-0.006***	0.0002		0.001
	(0.001)		(0.001)	(0.001)		(0.001)	(0.001)		(0.001)
Old $dependency_{period1}$	-0.073***	-0.061***	-0.065***	-0.029**	-0.024**	-0.021*	-0.087***	-0.067***	-0.078***
	(0.009)	(0.009)	(0.010)	(0.012)	(0.010)	(0.012)	(0.010)	(0.009)	(0.010)
$Education_{period1}$	0.008	-0.005	0.012	0.056**	0.036	0.058**	0.004	-0.010	0.007
	(0.021)	(0.022)	(0.020)	(0.028)	(0.033)	(0.028)	(0.020)	(0.020)	(0.020)
$Ext\_Fin_{period1}$	-0.001	-0.001	-0.001	0.001	0.001	0.002	-0.001	-0.001	-0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)
$Governance_{period2}$	-0.028	0.035	0.004	-0.093*	0.011	-0.080	-0.041	0.025	-0.008
	(0.039)	(0.038)	(0.038)	(0.049)	(0.046)	(0.051)	(0.042)	(0.041)	(0.042)
$Simi.Trade_{period2}$	-0.703*	-0.449	-0.630	-1.097	-0.269	-1.041	-0.197	-0.049	-0.125
	(0.426)	(0.399)	(0.428)	(0.738)	(0.554)	(0.746)	(0.500)	(0.461)	(0.510)
Log. $GDP_{period1}$		-0.101***			-0.216***			-0.086***	
		(0.024)			(0.028)			(0.022)	
$CO2_{period2}$			-0.032***			-0.031			-0.035***
			(0.008)			(0.019)			(0.008)
Observations	74	74	74	79	79	79	78	78	78
R^2	0.6195	0.6604	0.6731	0.5436	0.6275	0.5635	0.6013	0.6406	0.6547

Note: Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

The findings reveal that the trade openness rate reduces one again the technical efficiency of health expenditures. It is globally associated with negative but low coefficients varying from 0.001 to 0.002 per the specification. It leads to jointly and separately increase obesity prevalence and the deaths rate caused by the non-communicable diseases in view of existing public and private health expenditures. We also find that GDP per capita contributes to reduce the technical efficiency estimated not only on the multi-outputs/multi-inputs model but also on the single-output/multi-inputs models. Globally, it appears that external resources for health, government effectiveness and the degree of similarity in merchandise trade structure do not significantly affect the three kinds of technical efficiency scores. CO2 emissions and the old dependency ratio lead to reduce the technical efficiency scores. More

precisely, they increase the deaths rate caused by the non-communicable diseases in view of public and private expenditures on health. CO2 emissions have not a significant effect on the efficiency scores assessed on the basis of obesity prevalence. The old dependency ratio reduces the scores assessed through obesity prevalence but only at the second sub-period. The duration of secondary education do not significantly affect the multi-outputs/multi-inputs efficiency scores. In the case where the outputs are separately used in the efficiency scores assessment, we find that the duration of secondary education increases the technical efficiency by reducing obesity prevalence in view of existing public and private health expenditures. Urbanization globally reduces the technical efficiency scores. More precisely, it has the effect to significantly increase only obesity prevalence in view of existing public and private expenditures on health. Evidences found in the starting investigations are not sensitive to the link function used in the second-stage of estimations.

6.2 Sensitivity of results to the value of m parameter in order-m frontier analysis

In the starting models, the order-m efficiency scores were estimated by using the value of m=30 for which the decrease in superefficient observations becomes stable (constant). For these estimates, the comparisons between countries are made n times in different subsamples of thirty countries approximately representing the 1/3 of global sample. Here, we vary the m value and check whether the results will remain stable. We choose a value of m=59 which is approximately equivalent to the 2/3 of global sample size. For this test, the order-m scores are re-estimated in output orientation by using multi-outputs/multi-inputs and single-output/multi-inputs models and by assuming the VRS assumption. Then, the superefficient countries are removed from the sample and the scores are explained on their determinants through the FRMs performed on the basis of probit link function.

Before making the regressions, the order-m scores assessed by using the two values of m are compared through correlation and Spearman rank coefficients (Table 1.20). These coefficients show that the compared efficiency scores are much correlated. Furthermore, we find that the rankings provided by the two-compared order-m scores remain approximately the same.

Table 1.20: Comparison between the order-m efficiency scores (m=30 and 59) (1995-2012)

Multi-outputs/multi-inputs		
Periods	Spearman Rank coefficients	Correlation coefficients
1995-2000	0.9961***	0.9985***
2001-2006	0.9977***	0.9993***
2007-2012	0.9984***	0.9986***
Single-output/multi-inputs (reverse of obesity prevalence as output)		
Periods	Spearman Rank coefficients	Correlation coefficients
1995-2000	0.9976***	0.9996***
2001-2006	0.9975***	0.9996***
2007-2012	0.9987***	0.9992***
Single-output/multi-inputs (reverse of deaths caused by the non- communicable diseases as output)		
Periods	Spearman Rank coefficients	Correlation coefficients
1995-2000	0.9972***	0.9988***
2001-2006	0.9982***	0.9993***
2007-2012	0.9989***	0.9992***

Source: Author 'calculation. Note: *** p< 0.01.

The second-stage regressions are reported in Tables 1.21 and 1.22 respectively focused on the efficiency scores at the third and the second sub-periods. We find that the results do not change when the other value of m is used. Regarding the trade openness rate, it enters with negative, significant

coefficients, going from 0.001 to 0.002. Hence, the starting estimated effects of trade openness on the technical efficiency of health expenditures are not sensitive to the value of m. The effects associated with the other determinants remain also robust and not sensitive to the m value.

Table 1.21: Baseline results of estimated effect of the trade openness rate on the technical efficiency scores estimated at the third sub-period on the basis of order-m frontier with m=59 and by using the probit link function (1995-2012)

Dependent variable: Order-m score (m=59) at the third sub-period									
Covariates	Multi-outputs /multi-inputs			Single-output/multi-inputs (reverse of obesity prevalence as output)			Single-output/multi-inputs (reverse of deaths caused by the non communicable diseases as output)		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
$Trade_{period2}$	-0.002***	-0.001***	-0.002***	-0.002***	-0.001*	-0.002***	-0.001***	-0.001**	-0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)
$Urban_{period2}$	-0.004***		-0.003***	-0.007***		-0.007***	-0.002**		-0.001
	(0.001)		(0.001)	(0.001)		(0.001)	(0.001)		(0.001)
Old $depedency_{period2}$	-0.039***	-0.037***	-0.038***	-0.005	-0.009	-0.003	-0.051***	-0.043***	-0.049***
	(0.007)	(0.006)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.006)	(0.008)
$Education_{period2}$	0.016	0.009	0.020	0.054*	0.050*	0.056*	0.001	-0.010	0.005
	(0.020)	(0.017)	(0.020)	(0.029)	(0.027)	(0.029)	(0.021)	(0.019)	(0.021)
$Ext\_Fin_{period2}$	0.00008	-0.002**	-0.0003	-0.0001	-0.003*	-0.0004	-0.000007	-0.002**	-0.0004
	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)
$Governance_{period3}$	-0.036	0.045	-0.022	-0.057	0.052	-0.049	-0.059	0.022	-0.045
	(0.035)	(0.034)	(0.036)	(0.038)	(0.046)	(0.039)	(0.039)	(0.037)	(0.040)
$Simi.Trade_{period3}$	-0.696*	-0.281	-0.606	-0.300	0.243	-0.249	-0.108	0.374	-0.018
	(0.414)	(0.389)	(0.407)	(0.504)	(0.587)	(0.501)	(0.521)	(0.453)	(0.509)
$Log\ .GDP_{period2}$		-0.134***			-0.190***			-0.116***	
		(0.019)			(0.024)			(0.020)	
$CO2_{period3}$			-0.012***			-0.009			-0.013**
			(0.005)			(0.006)			(0.005)
Observations	82	82	82	85	85	85	86	86	86
R^2	0.6835	0.7281	0.7003	0.6078	0.5881	0.6117	0.6392	0.7037	0.6532

Note: Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Table 1.22: Baseline results of estimated effect of the trade openness rate on the technical efficiency scores estimated at the second sub-period on the basis of order-m frontier with m=59 and by using the probit link function (1995-2012)

Dependent variable: Order-m score (m=59) at the second sub-period									
Covariates	Multi-outputs /multi-inputs			Single-output/multi-inputs (reverse of obesity prevalence as output)			Single-output/multi-inputs (reverse of deaths caused by the non communicable diseases as output)		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
$Trade_{period1}$	-0.001***	-0.001**	-0.001***	-0.001***	-0.0003	-0.001**	-0.001***	-0.001**	-0.001**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)
$Urban_{period1}$	-0.003***		-0.002**	-0.007***		-0.007***	-0.001		0.0001
	(0.001)		(0.001)	(0.001)		(0.001)	(0.001)		(0.001)
Old $dependency_{period1}$	-0.057***	-0.053***	-0.052***	-0.023**	-0.023***	-0.019*	-0.071***	-0.059***	-0.066***
	(0.008)	(0.007)	(0.009)	(0.009)	(0.008)	(0.010)	(0.009)	(0.007)	(0.009)
$Education_{period1}$	0.010	-0.000	0.016	0.051*	0.035	0.054*	0.010	-0.002	0.017
	(0.022)	(0.021)	(0.021)	(0.028)	(0.028)	(0.028)	(0.020)	(0.020)	(0.020)
$Ext\_Fin_{period1}$	-0.001	-0.001	-0.0004	0.001	0.0004	0.001	-0.001**	-0.001	-0.001
	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)
$Governance_{period2}$	-0.025	0.045	0.001	-0.076	0.036	-0.063	-0.041	0.037	-0.013
	(0.040)	(0.037)	(0.038)	(0.046)	(0.042)	(0.049)	(0.042)	(0.039)	(0.041)
$Simi.Trade_{period2}$	-0.521	-0.260	-0.447	-0.882	-0.268	-0.846	-0.139	0.034	-0.062
	(0.441)	(0.408)	(0.449)	(0.697)	(0.538)	(0.704)	(0.492)	(0.451)	(0.502)
Log. $GDP_{period1}$		-0.123***			-0.216***			-0.104***	
		(0.022)			(0.027)			(0.020)	
$CO2_{period2}$			-0.026***			-0.019			-0.029***
			(0.007)			(0.012)			(0.007)
Observations	79	79	79	80	80	80	81	81	81
R^2	0.6200	0.6703	0.6633	0.5398	0.6295	0.5513	0.5891	0.6494	0.6371

Note: Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

6.3 Sensitivity of results to an alternative measure of technical efficiency scores

In the present subsection, we have the purpose to use another method to estimate the technical efficiency scores to check whether the findings will remain unchanged. The multi-outputs/multi-inputs and the single-output/multi-inputs technical efficiency scores are re-estimated in output orientation by assuming the VRS assumption and by using the other approach of partial frontier analysis that is the order-alpha frontier. For this method, we also retain the value of α for which the decrease in superefficient observations becomes stable: α=0.97. After estimating the order-alpha efficiency scores, the superefficient countries (order-α >1) are removed from the sample. Then, the second-stage FRMs are estimated by focusing on the probit link function.

Before making the regressions, the order-α scores are compared to the order-m scores through correlation and Spearman rank coefficients. We find Spearman and correlation coefficients that are significantly estimated around the unit. It appears that the compared technical efficiency scores are not only much correlated but they also provide the same rankings (Table 1.23).

Table 1.23: Comparison between the order-m and the order-α efficiency scores (1995-2012)

Multi-outputs/multi-inputs		
Periods	Spearman Rank coefficients	Correlation coefficients
1995-2000	0.9861***	0.9966***
2001-2006	0.9943***	0.9984***
2007-2012	0.9956***	0.9971***
Single-output/multi-inputs (reverse of obesity prevalence as output)		
Periods	Spearman Rank coefficients	Correlation coefficients
1995-2000	0.9968***	0.9992 ***
2001-2006	0.9972***	0.9995***
2007-2012	0.9944***	0.9988***
Single-output/multi-inputs (reverse of deaths caused by the non- communicable diseases as output)		
Periods	Spearman Rank coefficients	Correlation coefficients
1995-2000	0.9940***	0.9967***
2001-2006	0.9958***	0.9977***
2007-2012	0.9944***	0.9964***

Source: Author 'calculation. Note: *** p< 0.01.

Tables 1.24 and 1.25 provide the baseline results of regressions focused on the technical efficiency scores respectively estimated at the third and the second sub-periods. They show that the coefficients associated with the trade openness rate do not change. They remain negative and significant; varying from 0.001 to 0.002 per the specification. Moreover, the other explanatory variables globally appear with their effect estimated in the regressions departing from the order-m technical efficiency scores. Evidences based on the estimated effects of technical efficiency 'determinants are robust and not sensitive to the use of order-alpha frontier analysis.

Table 1.24: Baseline results of estimated effect of the trade openness rate on the technical efficiency scores estimated at the third sub-period on the basis of order-alpha frontier and by using the probit link function (1995-2012)

Dependent variable: Order-alpha score at the third sub-period									
Covariates	Multi-outputs /multi-inputs			Single-output/multi-inputs (reverse of obesity prevalence as output)			Single-output/multi-inputs (reverse of deaths caused by the non communicable diseases as output)		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
$Trade_{period2}$	-0.002***	-0.001***	-0.002***	-0.001***	-0.001	-0.001**	-0.001***	-0.001**	-0.001***
	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)
$Urban_{period2}$	-0.004***		-0.004***	-0.008***		-0.008***	-0.002*		-0.001
	(0.001)		(0.001)	(0.001)		(0.001)	(0.001)		(0.001)
Old $dependency_{period2}$	-0.037***	-0.037***	-0.035***	-0.002	-0.008	-0.001	-0.050***	-0.044***	-0.049***
	(0.007)	(0.006)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.006)	(0.007)
$Education_{period2}$	0.009	0.003	0.013	0.053*	0.051*	0.055*	-0.012	-0.021	-0.008
	(0.020)	(0.017)	(0.020)	(0.030)	(0.027)	(0.030)	(0.021)	(0.019)	(0.021)
$Ext\_Fin_{period2}$	-0.0003	-0.002**	-0.001	-0.000	-0.003*	-0.0004	-0.001	-0.003**	-0.001
	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)
$Governance_{period3}$	-0.027	0.047	-0.016	-0.064*	0.045	-0.056	-0.046	0.023	-0.033
	(0.035)	(0.034)	(0.036)	(0.038)	(0.046)	(0.040)	(0.039)	(0.038)	(0.039)
$Simi.Trade_{period3}$	-0.691*	-0.311	-0.616	-0.271	0.270	-0.220	0.011	0.414	0.089
	(0.396)	(0.384)	(0.392)	(0.509)	(0.625)	(0.507)	(0.517)	(0.460)	(0.506)
Log. $GDP_{period2}$		-0.130***			-0.199***			-0.099***	
		(0.019)			(0.025)			(0.020)	
$CO2_{period3}$			-0.010**			-0.009			-0.011**
			(0.005)			(0.006)			(0.006)
Observations	86	86	86	87	87	87	87	87	87
R^2	0.6802	0.7062	0.6922	0.6023	0.5512	0.6057	0.6236	0.6698	0.6351

Note: Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Table 1.25: Baseline results of estimated effect of the trade openness rate on the technical efficiency scores estimated at the second sub-period on the basis of order-alpha frontier and by using the probit link function (1995-2012)

Dependent variable: Order-alpha score at the second sub-period									
Covariates	Multi-outputs /multi-inputs			Single-output/multi-inputs (reverse of obesity prevalence as output)			Single-output/multi-inputs (reverse of deaths caused by the non communicable diseases as output)		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
$Trade_{period1}$	-0.001***	-0.001**	-0.001***	-0.001***	-0.0002	-0.001**	-0.001***	-0.001**	-0.001**
	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)
$Urban_{period1}$	-0.004***		-0.003***	-0.009***		-0.008***	-0.001		0.0004
	(0.001)		(0.001)	(0.001)		(0.001)	(0.001)		(0.001)
Old $dependency_{period1}$	-0.052***	-0.051***	-0.047***	-0.013	-0.017*	-0.008	-0.070***	-0.059***	-0.065***
	(0.008)	(0.007)	(0.009)	(0.011)	(0.010)	(0.012)	(0.008)	(0.007)	(0.009)
$Education_{period1}$	0.009	-0.001	0.015	0.055*	0.040	0.058*	0.003	-0.008	0.009
	(0.023)	(0.022)	(0.022)	(0.029)	(0.030)	(0.030)	(0.022)	(0.022)	(0.022)
$Ext\_Fin_{period1}$	-0.001	-0.001*	-0.0004	0.001	0.000	0.001	-0.001**	-0.001	-0.001*
	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)
$Governance_{period2}$	-0.008	0.056	0.017	-0.061	0.054	-0.048	-0.032	0.036	-0.004
	(0.041)	(0.039)	(0.039)	(0.048)	(0.045)	(0.050)	(0.043)	(0.041)	(0.041)
$Simi.Trade_{period2}$	-0.528	-0.253	-0.452	-0.835	-0.118	-0.794	-0.095	0.047	-0.019
	(0.439)	(0.409)	(0.447)	(0.726)	(0.555)	(0.733)	(0.493)	(0.466)	(0.505)
Log. $GDP_{period1}$		-0.123***			-0.235***			-0.088***	
		(0.023)			(0.030)			(0.021)	
$CO2_{period2}$			-0.026***			-0.020*			-0.028***
			(0.008)			(0.012)			(0.008)
Observations	82	82	82	82	82	82	82	82	82
R^2	0.5918	0.6283	0.6355	0.5298	0.5833	0.5415	0.5703	0.6114	0.6166

Note: Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

7. Conclusion

The chapter has analyzed the effect of trade openness on the technical efficiency of health expenditures in 89 low- and middle-income countries. The technical efficiency scores are estimated through the partial frontier analysis, most precisely the order-m approach (m=30), over the period 1995-2012 subdivided into three sub-periods of six years such as 1995-2000, 2001-2006 and 2007-2012. A multi-outputs/multi-inputs model, and then single-output/multi-inputs models, including two reversed outputs (the reverse of obesity prevalence rate and the reverse of deaths rate caused by the non- communicable diseases) and two inputs (public and private health expenditures in USD PPP per capita) are used by looking at output orientation and by assuming variables returns-to-scale (VRS).

Then, in a second stage we use Fractional Regressions Models (FRMs) by looking at a probit link function to estimate trade openness effect on the technical efficiency scores. To go into the result in depth, we have also tested the effect of trade composition on the efficiency scores. Four variables approximating the imports and the exports composition were selected: the fuels imports as percentage of merchandises imports, the ICTs imports as percentage of total goods imports, the primary commodities exports as percentage of total products exports and the manufactures exports as percentage of merchandises exports.

In addition to trade variables, a set of other variables is also included in the FRMs: urbanization (the percentage in the total population of persons living in urban areas), the old dependency ratio (the percentage of elderly individuals aged 65 and above); the education measured here by the mean duration of secondary education, external resources for health in USD PPP per capita, governance approximated by government effectiveness index, the similitude in trade merchandise trade structure, GDP in USD PPP per capita and air pollution assessed by CO2 emissions in metric tons per capita.

Our investigations reveal the following evidences:

- Trade openness increases the technical efficiency of health expenditures. It contributes to increase obesity prevalence and the deaths caused by the non-communicable diseases in view of existing public and private health expenditures used by countries.

- Evidence remains also robust and not sensitive to the use of alternative link functions in FRMs (logit and clog-log), alternative value of m parameter (m=59) and alternative approach in technical efficiency assessment (order-alpha, α=0.97). It remains also robust when atypical countries are removed from the sample.

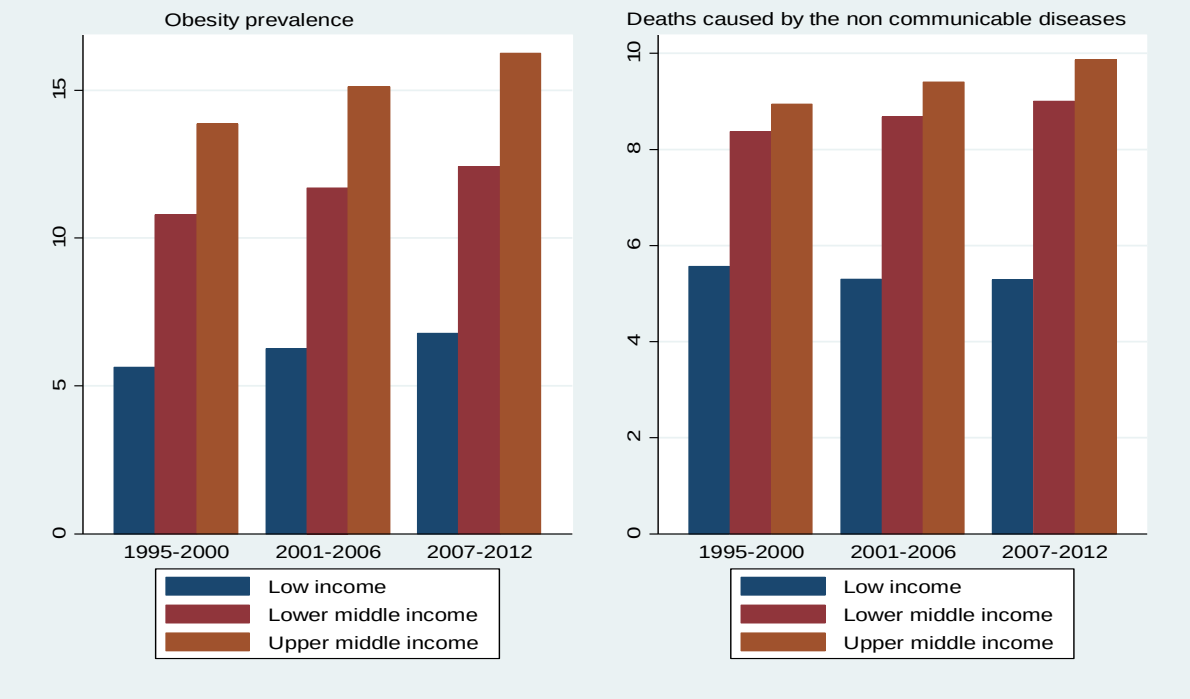
- The imports of fuels and the exports of manufactures contribute to reduce the technical efficiency of health expenditures by mostly increasing obesity prevalence and the deaths caused by non-communicable diseases respectively, in view of public and private health expenditures.

- The imports of ICTs lead to increase the technical efficiency of health expenditures by mostly reducing obesity prevalence in view of health expenditures from public and private sources.

- The primary commodities exports seem to have non-significant effect on the technical efficiency of health expenditures.

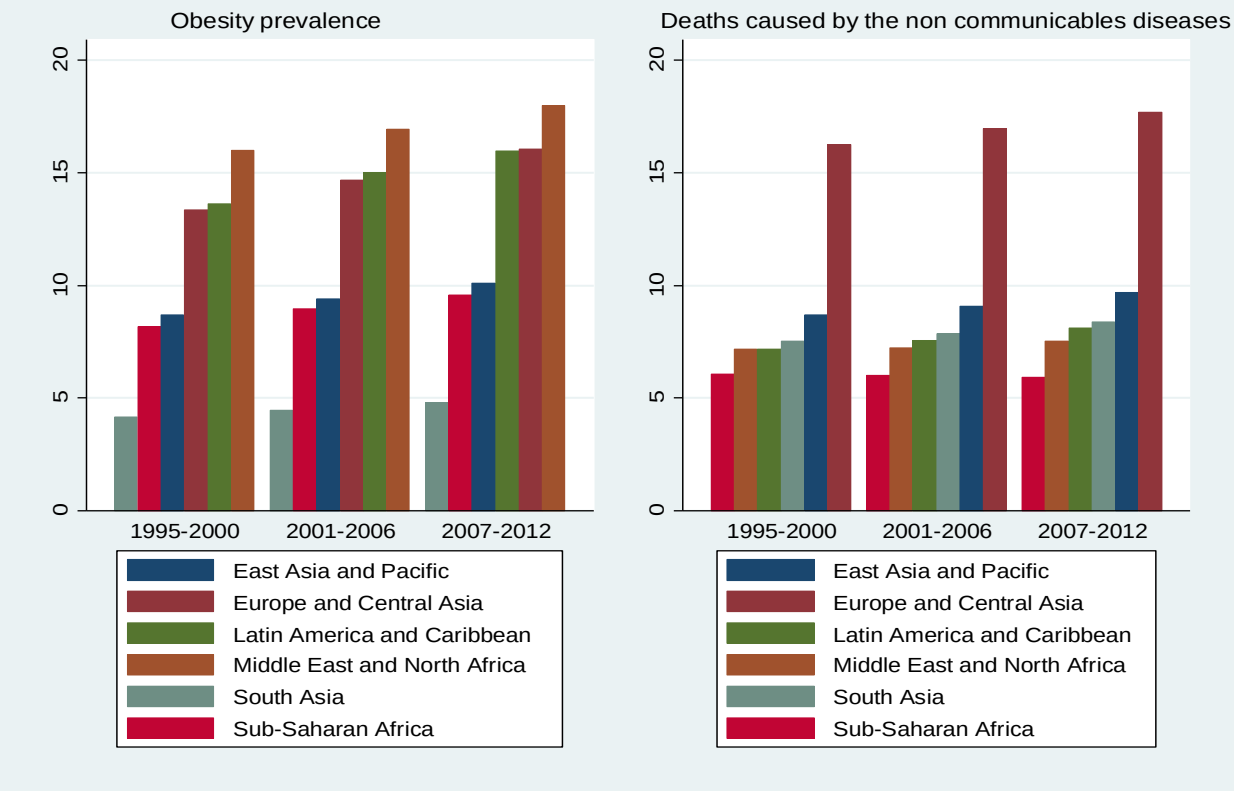
8. Annexes

Annex 1.1: Mean of obesity prevalence and deaths rate caused by the non communicable diseases by income-group by sub-period (1995-2012)



Source: Author using the GBD database.

Annex 1.2: Mean of obesity prevalence and deaths rate caused by the non communicable diseases by region and by sub-period (1995-2012)



Source: Author using the GBD database.

Annex 1.3: Baseline results of estimated effect of fuels imports as percentage of merchandises imports on the technical efficiency scores estimated at the second sub-period by using the probit link function (1995-2012)

Dependent variable: Order-m score at the second sub-period									
Covariates	Multi-outputs/multi-inputs			Single-output/multi-inputs (reverse of obesity prevalence as output)			Single-output/multi-inputs (reverse of deaths caused by the non-communicable diseases as output)		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
$Fuel\_Imp_{period1}$	-0.003	-0.009***	-0.004	-0.006**	-0.011***	-0.007**	-0.001	-0.006**	-0.002
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.002)	(0.003)	(0.002)
$Urban_{period1}$	-0.001		-0.0005	-0.007***		-0.007***	0.0004		0.001
	(0.001)		(0.001)	(0.001)		(0.001)	(0.001)		(0.001)
Old $dependency_{period1}$	-0.059***	-0.038***	-0.052***	-0.016	-0.005	-0.011	-0.074***	-0.049***	-0.067***
	(0.011)	(0.011)	(0.010)	(0.013)	(0.011)	(0.014)	(0.009)	(0.009)	(0.009)
$Education_{period1}$	0.025	0.016	0.030	0.079**	0.065***	0.083***	0.020	0.009	0.025
	(0.025)	(0.023)	(0.023)	(0.032)	(0.025)	(0.032)	(0.021)	(0.020)	(0.020)
$Ext\_Fin_{period1}$	-0.001**	-0.001	-0.001*	0.001	0.001	0.001	-0.001**	-0.001	-0.001*
	(0.001)	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)	(0.001)
$Governance_{period2}$	-0.085**	-0.004	-0.051	-0.117**	-0.015	-0.100**	-0.080*	-0.003	-0.045
	(0.042)	(0.038)	(0.042)	(0.047)	(0.040)	(0.049)	(0.044)	(0.040)	(0.043)
$Simi.Imp_{period2}$	-0.222	-0.199	-0.286	-0.871	-0.920*	-0.930*	0.343	0.335	0.276
	(0.437)	(0.506)	(0.418)	(0.554)	(0.501)	(0.546)	(0.345)	(0.415)	(0.333)
$Log.GDP_{period1}$		-0.150***			-0.231***			-0.113***	
		(0.027)			(0.027)			(0.026)	
$CO2_{period2}$			-0.029***			-0.021			-0.030***
			(0.007)			(0.013)			(0.007)
Observations	68	68	68	73	73	73	72	72	72
R^2	0.5801	0.6627	0.6379	0.5677	0.6796	0.5831	0.5756	0.6365	0.6297

Note: Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Annex 1.4: Baseline results of estimated effect of primary commodities exports as percentage of total products exports on the technical efficiency scores estimated at the second sub-period by using the probit link function (1995-2012)

Dependent variable: Order-m score at the second sub-period									
Covariates	Multi-outputs /multi-inputs			Single-output/multi-inputs (reverse of obesity prevalence as output)			Single-output/multi-inputs (reverse of deaths caused by the non communicable diseases as output)		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
$Com\_Exp_{period1}$	0.001	0.0004	0.001	-0.0002	-0.001	-0.0004	-0.001	-0.001*	-0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
$Urban_{period1}$	-0.001		-0.0002	-0.007***		-0.006***	0.0001		0.001
	(0.001)		(0.001)	(0.001)		(0.001)	(0.001)		(0.001)
Old $dependency_{period1}$	-0.064***	-0.055***	-0.058***	-0.031***	-0.025***	-0.024**	-0.073***	-0.057***	-0.067***
	(0.008)	(0.007)	(0.009)	(0.010)	(0.009)	(0.011)	(0.009)	(0.007)	(0.010)
$Education_{period1}$	0.024	0.010	0.027	0.060*	0.032	0.062**	0.019	0.007	0.023
	(0.023)	(0.024)	(0.022)	(0.031)	(0.030)	(0.031)	(0.020)	(0.020)	(0.019)
$Ext\_Fin_{period1}$	-0.001**	-0.001	-0.001*	0.0001	0.001	0.0004	-0.001*	-0.0003	-0.001*
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)
$Governance_{period2}$	-0.055	0.019	-0.024	-0.086	0.047	-0.063	-0.043	0.038	-0.002
	(0.038)	(0.038)	(0.039)	(0.055)	(0.043)	(0.057)	(0.046)	(0.044)	(0.047)
$Simi.Exp_{period2}$	-0.479	-0.407	-0.342	0.185	0.359	0.278	-0.075	-0.172	0.050
	(0.363)	(0.312)	(0.350)	(0.556)	(0.410)	(0.549)	(0.350)	(0.301)	(0.333)
$Log.\ GDP_{period1}$		-0.103***			-0.228***			-0.090***	
		(0.026)			(0.030)			(0.022)	
$CO2_{period2}$			-0.027***			-0.028**			-0.031***
			(0.007)			(0.013)			(0.008)
Observations	74	74	74	79	79	79	74	74	74
R^2	0.5759	0.6255	0.6270	0.4780	0.6210	0.5019	0.5701	0.6167	0.6264

Note: Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Annex 1.5: Baseline results of estimated effect of manufactures exports as percentage of merchandises exports on the technical efficiency scores estimated at the second sub-period by using the probit link function (1995-2012)

Dependent variable: Order-m score at the second sub-period									
Covariates	Multi-outputs /multi-inputs			Single-output/multi-inputs (reverse of obesity prevalence as output)			Single-output/multi-inputs (reverse of deaths caused by the non communicable diseases as output)		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
$Manu\_Exp_{period1}$	0.0004	0.0002	0.0004	0.002	0.002**	0.002	-0.001	-0.001*	-0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
$Urban_{period1}$	-0.001		0.000	-0.007***		-0.006***	0.0004		0.001
	(0.001)		(0.001)	(0.001)		(0.001)	(0.001)		(0.001)
Old $dependency_{period1}$	-0.067***	-0.056***	-0.062***	-0.038***	-0.036***	-0.034***	-0.073***	-0.057***	-0.067***
	(0.009)	(0.007)	(0.009)	(0.012)	(0.008)	(0.012)	(0.009)	(0.007)	(0.010)
$Education_{period1}$	0.026	0.015	0.029	0.062**	0.044	0.063**	0.019	0.007	0.023
	(0.024)	(0.024)	(0.023)	(0.031)	(0.029)	(0.031)	(0.020)	(0.020)	(0.019)
$Ext\_Fin_{period1}$	-0.001*	-0.000	-0.001	-0.0002	0.0001	-0.0001	-0.001*	-0.0003	-0.001*
	(0.001)	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)
$Governance_{period2}$	-0.077	0.004	-0.040	-0.091*	-0.009	-0.073	-0.043	0.038	-0.002
	(0.049)	(0.048)	(0.051)	(0.055)	(0.050)	(0.058)	(0.046)	(0.044)	(0.047)
$Simi.Exp_{period2}$	-0.297	-0.351	-0.177	0.792	0.724*	0.843*	-0.075	-0.172	0.050
	(0.369)	(0.323)	(0.362)	(0.504)	(0.419)	(0.502)	(0.350)	(0.301)	(0.333)
Log. $GDP_{period1}$		-0.101***			-0.191***			-0.090***	
		(0.025)			(0.028)			(0.022)	
$CO2_{period2}$			-0.028***			-0.018*			-0.031***
			(0.007)			(0.010)			(0.008)
Observations	70	70	70	74	74	74	74	74	74
R^2	0.6259	0.6284	0.5752	0.5631	0.6470	0.5724	0.5701	0.6167	0.6264

Note: Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Annex 1.6: Matrices of partial correlations by sub-period (1995-2012)

	Sub-period 1: 1995-2000													
	Trade	Fuel_Imp	ICT_Imp	Com_Exp	Manu_Exp	Urban	Old dependency	Education	Ext_Fin	GDP	CO2	Simi_Trade	Simi Imp	Simi_Exp
Trade	1													
Fuel_Imp	0.1154	1												
ICT_Imp	0.2792**	-0.3183**	1											
Com_Exp	-0.0094	0.0841	0.1854	1										
Manu_Exp	0.1817	-0.0618	0.3489***	-0.2271**	1									
Urban	0.0312	-0.0967	0.2385*	-0.0740	0.1189	1								
Old dependency	0.1369	0.3690***	-0.0261	-0.1625	0.2949***	0.4997***	1							
Education	-0.1162	0.2822**	-0.2259*	0.1008	0.0155	0.0140	0.2436**	1						
Ext_Fin	0.0098	-0.0944	-0.2240*	0.1335	-0.0203	0.1755	-0.0097	-0.0050	1					
GDP	0.2256**	-0.3637***	0.4122***	-0.0325	0.2562**	0.7071***	0.4092***	-0.0078	0.1319	1				
CO2	0.2018*	-0.0590	0.2740**	-0.0387	0.2231**	0.5352***	0.4912***	0.1153	0.1285	0.7352***	1			
Simi_Trade	-0.2146**	0.0017	-0.5740***	0.0961	-0.4626***	-0.0618	-0.0683	0.0728	0.3050**	-0.1403	-0.0949	1		
Simi Imp	-0.1995*	-0.0860	-0.4649***	0.1986*	-0.3527***	-0.0278	-0.0397	-0.1057	0.1114	-0.0035	-0.0652	0.7079***	1	
Simi_Exp	-0.1275	0.0549	-0.4282***	-0.0393	-0.3602***	-0.0626	-0.0613	0.1945*	0.3347**	-0.1941*	-0.0764	0.7876***	0.1223	1

Source: Author 'calculation using the GHE, the WDI, the UNCTAD and the WGI databases. Note: *** p<0.01, ** p<0.05, * p<0.1.

	Sub-period 2: 2001-2006													
	Trade	Fuel_Imp	ICT_Imp	Com_Exp	Manu_Exp	Urban	Old dependency	Education	Ext_Fin	GDP	CO2	Simi_Trade	Simi Imp	Simi_Exp
Trade	1													
Fuel_Imp	-0.0109	1												
ICT_Imp	0.2197**	-0.2287	1											
Com_Exp	-0.0541	0.1070	0.1736	1										
Manu_Exp	0.2602**	-0.0433	0.3402**	-0.1372	1									
Urban	0.0320	-0.0834	0.2268**	-0.0572	0.0767	1								
Old dependency	0.1294	0.2104	-0.0063	-0.1185	0.2842**	0.4972***	1							
Education	-0.1395	0.1708	-0.2677**	0.0702	0.0127	-0.0652	0.1552	1						
Ext_Fin	0.1195	-0.0310	-0.2332**	-0.0434	-0.2264**	-0.1349	-0.1878*	-0.2779***	1					
GDP	0.1683	-0.2915***	0.3788***	-0.0096	0.2181*	0.7127***	0.4315***	-0.0525	-0.2255**	1				
CO2	0.2043*	-0.0248	0.2087*	0.0256	0.1682	0.5250***	0.5012***	0.0599	-0.2075*	0.7352***	1			
Simi_Trade	-0.3506***	0.0306	-0.5800***	0.0077	-0.4950***	0.0049	0.0397	0.1188	0.1784*	-0.0341	0.0295	1		
Simi Imp	-0.3851***	0.0275	-0.5061***	0.1209	-0.3257**	0.0265	0.0689	-0.0984	0.2399**	0.0591	0.0119	0.7537***	1	
Simi_Exp	-0.1377	0.0205	-0.4077***	-0.1132	-0.4230***	-0.0195	-0.0102	0.2795**	0.0252	-0.1116	0.0324	0.7433***	0.1206	1

Source: Author 'calculation using the GHE, the WDI, the UNCTAD and the WGI databases. Note: *** p<0.01, ** p<0.05, * p<0.1.

	Sub-period 3: 2007-2012													
	Trade	Fuel_Imp	ICT_Imp	Com_Exp	Manu_Exp	Urban	Old dependency	Education	Ext_Fin	GDP	CO2	Simi_Trade	Simi Imp	Simi_Exp
Trade	1													
Fuel_Imp	0.0331	1												
ICT_Imp	0.0991	-0.1905*	1											
Com_Exp	-0.0956	0.1567	0.2155**	1										
Manu_Exp	0.2024	0.1379	0.2396**	-0.0003	1									
Urban	0.1241	-0.1052	0.2155*	0.0543	0.0475	1								
Old dependency	0.1491	0.1747	0.0598	-0.0689	0.3071***	0.5096***	1							
Education	-0.1220	0.0199	-0.2219**	0.0696	-0.0199	-0.0364	0.0929	1						
Ext_Fin	0.2110*	-0.0548	-0.2130*	-0.1214	-0.0175	-0.2923***	-0.3072***	-0.3365***	1					
GDP	0.1355	-0.2018*	0.3284***	0.0312	0.1599	0.7052***	0.4797***	-0.0363	-0.2876***	1				
CO2	0.1632	0.0011	0.1377	0.0420	0.0959	0.5108***	0.4960***	0.0685	-0.2720**	0.7352***	1			
Simi_Trade	-0.2916	0.0958	-0.3819***	0.0293	-0.5174***	0.0881	0.0330	0.1148	-0.1466	-0.0060	0.0353	1		
Simi Imp	-0.3718***	0.1752	-0.2381**	0.0970	-0.2220**	0.0464	0.0947	-0.1354	0.0283	0.0857	0.0283	0.7503***	1	
Simi_Exp	-0.0186	-0.0180	-0.3208***	-0.0652	-0.5162***	0.0810	-0.0567	0.3261***	-0.2525	-0.1057	0.0215	0.6677***	0.0088	1

Source: Author 'calculation using the GHE, the WDI, the UNCTAD and the WGI databases. Note: *** p<0.01, ** p<0.05, * p<0.1.

Annex 1.7: Descriptive statistics of trade composition variables and similitude indexes in imports and exports structures (1995-2012)

Sub-periods	Variables	Fuel_Imp	ICT_Imp	Com_Exp	Manu_Exp	Simi Imp	Simi_Exp
	Definitions	Fuels imports as percentage of merchandises imports	ICTs imports as percentage of merchandises imports	Primary commodities exports as percentage of total products exports	Manufactures exports as percentage of merchandise exports	Index of similitude in imports structure	Index of similitude in exports structure
1995-2000	Mean	13.682	6.808	47.206	36.121	0.509	0.317
	Std.Dev.	8.138	7.354	27.259	28.937	0.056	0.064
	Min	1.384	0.437	1.044	0.083	0.142	0.196
	Max	44.193	40.920	95.723	96.058	0.579	0.488
	Observations	82	71	89	83	87	87
2001-2006	Mean	15.270	6.463	40.490	36.746	0.502	0.293
	Std.Dev.	7.402	7.082	24.708	29.017	0.057	0.056
	Min	0.851	1.895	0.486	0.001	0.140	0.174
	Max	39.698	46.841	88.368	97.152	0.572	0.454
	Observations	82	81	89	81	88	88
2007-2012	Mean	17.219	5.775	39.416	35.488	0.514	0.285
	Std.Dev.	8.283	5.181	23.491	27.530	0.056	0.050
	Min	1.040	1.422	0.209	0.007	0.161	0.170
	Max	37.683	29.854	87.046	95.392	0.587	0.418
	Observations	81	80	88	81	89	89

Source: Author ‘calculation using the UNCTAD database. Note: Std.Dev: Standard Deviation

Annex 1. 8: Technical efficiency scores by country and for each sub-period (1995-2012)

Models	Multi-outputs/multi-inputs						Single-output/multi-inputs (using obesity prevalence as output)						Single-output/multi-inputs (using deaths rate caused by the non- communicable diseases as output)					
Methods	Order_m30			Order-α0.97			Order_m30			Order-α0.97			Order_m30			Order-α0.97		
Sub-periods	1995-2000	2001-2006	2007-2012	1995-2000	2001-2006	2007-2012	1995-2000	2001-2006	2007-2012	1995-2000	2001-2006	2007-2012	1995-2000	2001-2006	2007-2012	1995-2000	2001-2006	2007-2012
Algeria	0.786	0.718	0.680	0.813	0.749	0.697	0.120	0.140	0.126	0.122	0.127	0.125	0.774	0.717	0.664	0.813	0.749	0.697
Angola	0.706	0.745	0.784	0.701	0.736	0.777	0.219	0.160	0.170	0.218	0.153	0.153	0.707	0.689	0.720	0.701	0.661	0.681
Armenia	0.306	0.273	0.251	0.296	0.273	0.249	0.103	0.110	0.113	0.094	0.115	0.116	0.300	0.248	0.218	0.296	0.261	0.234
Azerbaijan	0.461	0.430	0.402	0.473	0.436	0.405	0.117	0.110	0.110	0.129	0.118	0.111	0.416	0.393	0.371	0.446	0.417	0.388
Bangladesh	0.999	1	1.001	0.999	1	1	0.999	1	1	0.999	1	1	0.754	0.679	0.497	0.754	0.679	0.497
Belarus	0.262	0.269	0.284	0.286	0.290	0.301	0.170	0.208	0.206	0.177	0.196	0.203	0.172	0.158	0.154	0.179	0.163	0.165
Belize	0.514	0.536	0.509	0.534	0.551	0.539	0.065	0.071	0.076	0.067	0.070	0.077	0.514	0.530	0.511	0.534	0.551	0.539
Benin	0.843	0.861	0.806	0.824	0.855	0.804	0.399	0.352	0.327	0.399	0.352	0.326	0.812	0.860	0.805	0.807	0.855	0.804
Bolivia	0.686	0.692	0.667	0.694	0.697	0.680	0.126	0.140	0.156	0.136	0.133	0.188	0.642	0.642	0.606	0.668	0.681	0.656
Botswana	0.990	0.963	1.067	1.023	0.992	1.018	0.138	0.151	0.158	0.139	0.144	0.155	0.988	0.948	1.073	1.023	0.992	1.018
Brazil	0.581	0.542	0.490	0.584	0.527	0.485	0.181	0.164	0.160	0.177	0.159	0.147	0.527	0.502	0.430	0.539	0.516	0.461
Burkina Faso	1.005	1.003	0.960	1	1	0.957	0.514	0.489	0.484	0.514	0.489	0.482	1.006	1.002	0.959	1	1	0.957
Burundi	1	1	1	1	1	1	1	1	1	1	1	1	0.760	0.871	0.828	0.760	0.871	0.828
Cabo Verde	0.628	0.610	0.560	0.621	0.602	0.547	0.275	0.293	0.292	0.275	0.291	0.285	0.611	0.606	0.502	0.609	0.602	0.476
Cambodia	1.024	0.986	1.061	1	0.973	1	1.027	0.983	1.051	1	0.973	1	0.633	0.482	0.414	0.632	0.478	0.411
Cameroon	0.701	0.665	0.676	0.698	0.660	0.673	0.177	0.162	0.224	0.169	0.154	0.222	0.687	0.666	0.677	0.683	0.660	0.673
Central Africa	1	1	1	1	1	1	0.693	1	1	0.693	1	1	0.688	1	1	0.688	1	1
Chad	1.023	1.001	1	1	1	1	0.673	0.680	0.838	0.671	0.679	0.838	1.004	1.001	1	1	1	1
Colombia	0.720	0.650	0.606	0.723	0.658	0.608	0.172	0.149	0.139	0.169	0.149	0.140	0.658	0.607	0.554	0.681	0.630	0.582
Costa Rica	0.651	0.624	0.587	0.669	0.649	0.610	0.093	0.105	0.112	0.094	0.102	0.107	0.651	0.614	0.547	0.669	0.639	0.589
Cote d'Ivoire	0.755	0.720	0.741	0.753	0.704	0.728	0.319	0.283	0.308	0.354	0.274	0.285	0.640	0.717	0.741	0.686	0.704	0.728
Cuba	0.354	0.342	0.311	0.346	0.346	0.318	0.147	0.103	0.118	0.145	0.098	0.140	0.353	0.314	0.282	0.346	0.331	0.304
Djibouti	0.744	0.677	0.613	0.740	0.670	0.603	0.234	0.235	0.175	0.234	0.234	0.155	0.744	0.673	0.550	0.740	0.670	0.525

Dominican	0.658	0.550	0.480	0.661	0.551	0.483	0.138	0.139	0.149	0.142	0.143	0.147	0.615	0.507	0.443	0.636	0.527	0.462
Ecuador	0.740	0.662	0.586	0.742	0.662	0.588	0.155	0.173	0.182	0.159	0.170	0.182	0.696	0.617	0.532	0.714	0.634	0.562
Egypt	0.393	0.375	0.358	0.403	0.387	0.373	0.060	0.060	0.062	0.059	0.059	0.062	0.393	0.372	0.355	0.403	0.387	0.373
El Salvador	0.670	0.604	0.518	0.683	0.594	0.522	0.134	0.123	0.123	0.133	0.120	0.121	0.628	0.566	0.477	0.669	0.581	0.500
Eritrea	1.013	1	1	1	1	1	0.752	0.814	1	0.749	0.814	1	0.930	0.977	1	0.922	0.977	1
Gabon	0.416	0.396	0.382	0.419	0.392	0.384	0.136	0.130	0.125	0.136	0.125	0.125	0.378	0.366	0.352	0.386	0.375	0.368
Gambia. The	1	0.919	0.844	1	0.917	0.843	0.240	0.269	0.253	0.240	0.269	0.252	1	0.918	0.844	1	0.917	0.843
Georgia	0.253	0.218	0.191	0.238	0.219	0.189	0.115	0.091	0.101	0.110	0.096	0.094	0.242	0.200	0.156	0.238	0.210	0.166
Ghana	0.812	0.736	0.666	0.799	0.728	0.662	0.423	0.374	0.338	0.420	0.373	0.332	0.806	0.733	0.666	0.799	0.728	0.662
Guatemala	0.914	0.827	0.770	0.916	0.838	0.778	0.188	0.185	0.187	0.198	0.188	0.188	0.847	0.779	0.704	0.881	0.802	0.744
Guinea	1	1	1	1	1	1	0.991	1	1	0.991	1	1	0.933	1	1	0.933	1	1
Guyana	0.373	0.360	0.377	0.364	0.354	0.385	0.141	0.151	0.128	0.140	0.149	0.152	0.369	0.329	0.342	0.364	0.318	0.369
Haiti	0.575	0.590	0.616	0.566	0.586	0.615	0.275	0.407	0.502	0.266	0.407	0.502	0.560	0.589	0.551	0.553	0.586	0.551
Honduras	0.686	0.620	0.580	0.698	0.626	0.588	0.166	0.146	0.140	0.178	0.153	0.142	0.624	0.570	0.535	0.658	0.599	0.562
India	0.619	0.687	0.806	0.598	0.660	0.785	0.494	0.533	0.628	0.484	0.525	0.565	0.470	0.470	0.444	0.466	0.465	0.436
Indonesia	0.828	0.685	0.582	0.802	0.698	0.616	0.413	0.381	0.333	0.374	0.371	0.316	0.582	0.503	0.450	0.554	0.534	0.484
Iran	0.630	0.640	0.677	0.667	0.655	0.720	0.103	0.113	0.119	0.103	0.111	0.113	0.629	0.636	0.679	0.667	0.655	0.720
Jamaica	0.431	0.406	0.401	0.436	0.407	0.402	0.124	0.114	0.117	0.124	0.114	0.115	0.391	0.375	0.367	0.402	0.390	0.385
Kazakhstan	0.273	0.267	0.283	0.264	0.253	0.296	0.121	0.117	0.116	0.120	0.113	0.108	0.237	0.236	0.252	0.243	0.242	0.272
Kenya	1.029	1.022	1.040	1	1	1	0.250	0.272	0.283	0.249	0.271	0.276	1.031	1.024	1.025	1	1	1
Kiribati	1	1	0.371	1	1	0.371	1	1	0.068	1	1	0.068	1	1	0.371	1	1	0.371
Lebanon	0.512	0.518	0.455	0.534	0.526	0.485	0.081	0.082	0.088	0.076	0.078	0.080	0.502	0.509	0.455	0.514	0.522	0.485
Lesotho	0.547	0.469	0.480	0.541	0.465	0.474	0.120	0.166	0.173	0.109	0.166	0.168	0.496	0.468	0.479	0.480	0.465	0.474
Liberia	1	1	0.842	1	1	0.842	0.357	1	0.221	0.357	1	0.221	1	1	0.842	1	1	0.842
Madagascar	1.006	0.874	0.875	1	0.870	0.874	0.795	0.871	0.874	0.794	0.870	0.874	0.684	0.743	0.692	0.682	0.742	0.692
Malawi	1	1	1	1	1	1	1	1	0.540	1	1	0.540	1	1	0.908	1	1	0.907
Malaysia	0.755	0.727	0.642	0.766	0.725	0.646	0.160	0.170	0.170	0.162	0.165	0.167	0.704	0.684	0.594	0.721	0.710	0.636
Mali	0.701	0.735	0.764	0.690	0.729	0.759	0.288	0.269	0.247	0.287	0.269	0.245	0.696	0.735	0.764	0.690	0.729	0.759
Mauritania	0.747	0.727	0.755	0.715	0.716	0.749	0.130	0.195	0.199	0.125	0.194	0.196	0.742	0.705	0.755	0.710	0.685	0.749
Mauritius	0.403	0.384	0.357	0.400	0.372	0.366	0.160	0.175	0.185	0.166	0.170	0.176	0.359	0.327	0.288	0.369	0.331	0.306

Mexico	0.677	0.622	0.536	0.692	0.639	0.570	0.095	0.095	0.096	0.096	0.090	0.090	0.674	0.618	0.540	0.690	0.639	0.570
Moldova	0.217	0.229	0.225	0.221	0.225	0.219	0.107	0.100	0.108	0.103	0.103	0.108	0.190	0.196	0.183	0.204	0.202	0.192
Mongolia	0.448	0.365	0.359	0.445	0.362	0.359	0.234	0.156	0.156	0.234	0.159	0.157	0.380	0.332	0.326	0.377	0.346	0.341
Morocco	0.657	0.617	0.575	0.675	0.613	0.583	0.100	0.106	0.113	0.111	0.112	0.116	0.632	0.576	0.527	0.675	0.611	0.562
Mozambique	1	1	1	1	1	1	1	0.814	0.572	1	0.814	0.572	1	1	1	1	1	1
Myanmar	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Namibia	0.683	0.607	0.640	0.687	0.605	0.638	0.194	0.175	0.189	0.198	0.172	0.180	0.625	0.558	0.591	0.648	0.578	0.611
Nepal	1.059	1.029	1.090	1	1	1	1.014	1.030	1.085	1	1	1	0.785	0.747	0.570	0.778	0.738	0.549
Nicaragua	0.838	0.730	0.642	0.883	0.762	0.683	0.108	0.122	0.127	0.116	0.116	0.117	0.840	0.727	0.637	0.883	0.762	0.683
Niger	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Pakistan	0.557	0.512	0.502	0.547	0.509	0.496	0.170	0.176	0.247	0.167	0.170	0.243	0.553	0.511	0.501	0.547	0.509	0.496
Panama	0.759	0.684	0.590	0.761	0.682	0.594	0.152	0.160	0.166	0.156	0.158	0.157	0.698	0.639	0.522	0.717	0.657	0.564
Papua New Guinea	0.713	0.604	0.899	0.713	0.604	0.899	0.713	0.604	0.899	0.713	0.604	0.899	0.499	0.516	0.718	0.499	0.516	0.718
Paraguay	0.731	0.611	0.508	0.748	0.630	0.525	0.080	0.083	0.091	0.081	0.083	0.091	0.728	0.614	0.501	0.748	0.630	0.525
Peru	0.821	0.809	0.738	0.808	0.804	0.735	0.135	0.141	0.145	0.140	0.142	0.145	0.777	0.780	0.693	0.808	0.804	0.724
Philippines	0.922	0.862	0.722	0.936	0.852	0.755	0.428	0.490	0.486	0.478	0.463	0.459	0.684	0.617	0.539	0.728	0.591	0.584
Rwanda	1	1.001	1.018	1	1	1	1	1	0.942	1	1	0.937	0.776	0.859	0.890	0.776	0.859	0.887
Senegal	0.823	0.745	0.798	0.818	0.730	0.794	0.204	0.198	0.191	0.203	0.198	0.189	0.824	0.731	0.800	0.818	0.720	0.794
Sierra Leone	0.667	0.690	0.683	0.654	0.686	0.679	0.230	0.246	0.371	0.223	0.232	0.367	0.661	0.693	0.683	0.654	0.686	0.679
South Africa	0.444	0.401	0.446	0.449	0.394	0.446	0.094	0.099	0.092	0.091	0.093	0.088	0.415	0.374	0.421	0.423	0.385	0.446
Sri Lanka	0.725	0.680	0.681	0.804	0.687	0.686	0.447	0.448	0.501	0.481	0.465	0.478	0.480	0.439	0.405	0.503	0.457	0.433
Sudan	0.616	0.652	0.674	0.610	0.644	0.683	0.153	0.147	0.161	0.142	0.142	0.151	0.615	0.653	0.613	0.610	0.644	0.659
Suriname	0.515	0.422	0.384	0.522	0.417	0.387	0.101	0.107	0.110	0.098	0.103	0.105	0.484	0.394	0.360	0.492	0.408	0.381
Swaziland	0.597	0.500	0.523	0.607	0.499	0.521	0.083	0.089	0.101	0.086	0.091	0.103	0.595	0.471	0.487	0.607	0.494	0.513
Tajikistan	0.722	0.831	0.601	0.721	0.831	0.597	0.449	0.473	0.247	0.449	0.473	0.244	0.721	0.748	0.600	0.721	0.748	0.597
Tanzania	1.006	1	0.968	1	1	0.965	0.332	0.327	0.318	0.332	0.327	0.315	1.007	1.002	0.967	1	1	0.965
Thailand	0.614	0.559	0.471	0.612	0.548	0.505	0.310	0.264	0.268	0.311	0.268	0.252	0.484	0.433	0.364	0.497	0.449	0.391
Togo	1.001	0.903	0.897	1	0.902	0.897	0.559	0.501	0.573	0.558	0.501	0.572	0.954	0.902	0.897	0.951	0.902	0.897
Tunisia	0.640	0.569	0.514	0.642	0.572	0.510	0.156	0.163	0.174	0.156	0.163	0.171	0.589	0.537	0.471	0.605	0.547	0.488

Uganda	1.002	1.008	0.993	1	1	0.987	0.726	0.500	0.561	0.725	0.491	0.513	0.927	0.878	0.887	0.925	0.865	0.876
Ukraine	0.203	0.198	0.190	0.203	0.193	0.193	0.104	0.106	0.112	0.103	0.105	0.110	0.155	0.141	0.145	0.160	0.147	0.149
Uzbekistan	0.491	0.467	0.442	0.501	0.458	0.452	0.139	0.153	0.163	0.135	0.147	0.154	0.442	0.425	0.399	0.472	0.411	0.432
Vietnam	1.089	1.071	1.081	1	1	1.133	1.071	1.081	1.111	1	1	1.133	0.462	0.428	0.415	0.456	0.407	0.445
Yemen	0.583	0.644	0.669	0.595	0.653	0.685	0.133	0.142	0.170	0.142	0.150	0.160	0.535	0.599	0.609	0.561	0.624	0.655
Zambia	0.937	0.857	0.864	0.919	0.847	0.857	0.196	0.190	0.208	0.183	0.181	0.189	0.848	0.795	0.781	0.815	0.761	0.746
Zimbabwe	0.949	0.883	0.839	0.932	0.870	0.835	0.228	0.245	0.399	0.213	0.219	0.397	0.871	0.806	0.838	0.827	0.781	0.835

Source: Author 'calculation using the GBD, and the GHE databases.

Annex 1.9: Technical efficiency scores (order-m, m=30) by country and for each sub-period based on the classification by group of regions (1995-2012)

Countries	Region codes	Multi-outputs/multi-inputs			Single-output/multi-inputs (using obesity prevalence as output)			Single-output/multi-inputs (using deaths rate caused by the non- communicable diseases as output)		
		1995-2000	2001-2006	2007-2012	1995-2000	2001-2006	2007-2012	1995-2000	2001-2006	2007-2012
Algeria	2	1.001	1	1.003	0.468	0.456	0.449	0.923	0.983	1.001
Angola	1	0.707	0.744	0.782	0.218	0.159	0.172	0.707	0.686	0.709
Armenia	2	0.534	0.466	0.448	0.436	0.420	0.404	0.503	0.415	0.358
Azerbaijan	2	0.758	0.701	0.592	0.486	0.431	0.392	0.758	0.664	0.523
Bangladesh	1	0.999	1	1.001	0.999	1	1.001	0.754	0.679	0.497
Belarus	2	0.670	0.752	0.754	0.670	0.747	0.758	0.203	0.204	0.222
Belize	2	0.609	0.726	0.790	0.256	0.259	0.268	0.612	0.729	0.790
Benin	1	0.836	0.859	0.805	0.399	0.352	0.328	0.811	0.861	0.805
Bolivia	2	0.938	1	1	0.511	0.471	0.771	0.939	1	1
Botswana	1	0.969	0.937	1.052	0.129	0.142	0.151	0.978	0.946	1.053
Brazil	2	0.899	0.851	0.795	0.703	0.635	0.593	0.618	0.631	0.629
Burkina Faso	1	1.007	1.001	0.959	0.514	0.489	0.486	1.004	1.003	0.960
Burundi	1	1	1	1	1	1	1	0.760	0.871	0.828
Cabo Verde	1	0.627	0.608	0.559	0.275	0.294	0.292	0.610	0.606	0.502

Cambodia	1	1.028	0.979	1.040	1.027	0.977	1.025	0.633	0.481	0.414
Cameroon	1	0.700	0.664	0.677	0.177	0.161	0.223	0.686	0.664	0.677
Central Africa	1	1	1	1	0.693	1	1	0.688	1	1
Chad	1	1.018	1.002	1	0.672	0.679	0.838	1.006	1.002	1
Colombia	2	0.868	0.943	0.893	0.668	0.549	0.502	0.778	0.826	0.837
Costa Rica	2	0.814	0.802	0.802	0.375	0.395	0.414	0.769	0.801	0.803
Cote d'Ivoire	1	0.757	0.720	0.739	0.322	0.284	0.304	0.637	0.713	0.738
Cuba	2	0.592	0.565	0.574	0.592	0.349	0.574	0.485	0.494	0.504
Djibouti	2	1	1	1	0.955	1	1	1	1	1
Dominican	2	0.741	0.851	0.849	0.547	0.536	0.526	0.722	0.697	0.679
Ecuador	2	0.826	1	0.970	0.607	0.625	0.662	0.809	0.947	0.764
Egypt	2	0.467	0.530	0.506	0.232	0.228	0.221	0.459	0.513	0.503
El Salvador	2	0.763	0.853	0.767	0.520	0.464	0.432	0.737	0.730	0.733
Eritrea	1	1.008	1	1	0.750	0.814	1	0.931	0.977	1
Gabon	1	0.406	0.387	0.378	0.126	0.121	0.119	0.368	0.361	0.345
Gambia. The	1	1	0.918	0.844	0.240	0.269	0.254	1	0.919	0.845
Georgia	2	0.644	0.374	0.327	0.644	0.350	0.327	0.405	0.334	0.253
Ghana	1	0.810	0.737	0.667	0.422	0.374	0.339	0.808	0.732	0.666
Guatemala	2	1.007	1.015	1.005	0.749	0.699	0.660	1.007	1.003	1.004
Guinea	1	1	1	1	0.991	1	1	0.933	1	1
Guyana	2	0.600	0.632	0.624	0.573	0.369	0.624	0.511	0.529	0.611
Haiti	2	1	1	1	1	1	1	0.942	1	1
Honduras	2	1	0.954	0.895	0.668	0.558	0.500	0.923	0.785	0.825
India	1	0.618	0.677	0.799	0.494	0.534	0.618	0.470	0.471	0.441
Indonesia	1	0.831	0.680	0.579	0.402	0.381	0.331	0.581	0.500	0.446
Iran	2	0.751	0.809	0.947	0.410	0.445	0.457	0.733	0.801	0.945
Jamaica	2	0.623	0.678	0.665	0.482	0.433	0.410	0.459	0.487	0.564
Kazakhstan	2	0.467	0.465	0.519	0.474	0.447	0.410	0.277	0.303	0.356
Kenya	1	1.032	1.017	1.039	0.251	0.271	0.281	1.027	1.026	1.022
Kiribati	1	1	1	0.371	1	1	0.068	1	1	0.371

Lebanon	2	0.605	0.652	0.639	0.314	0.324	0.318	0.590	0.651	0.638
Lesotho	1	0.548	0.470	0.479	0.116	0.166	0.173	0.493	0.468	0.478
Liberia	1	1	1	0.842	0.357	1	0.222	1	1	0.843
Madagascar	1	1.006	0.872	0.874	0.794	0.871	0.874	0.684	0.743	0.692
Malawi	1	1	1	1	1	1	0.540	1	1	0.908
Malaysia	1	0.742	0.711	0.634	0.149	0.157	0.168	0.679	0.670	0.579
Mali	1	0.701	0.734	0.764	0.288	0.269	0.248	0.696	0.736	0.763
Mauritania	1	0.744	0.730	0.756	0.130	0.195	0.199	0.744	0.704	0.753
Mauritius	1	0.395	0.374	0.347	0.158	0.165	0.175	0.353	0.318	0.279
Mexico	2	0.796	0.781	0.752	0.381	0.355	0.358	0.791	0.782	0.751
Moldova	2	0.372	0.375	0.390	0.373	0.377	0.391	0.286	0.265	0.282
Mongolia	1	0.449	0.364	0.358	0.234	0.152	0.152	0.380	0.332	0.319
Morocco	2	1	0.973	0.858	0.419	0.410	0.403	1	0.973	0.858
Mozambique	1	1	1	1	1	0.814	0.572	1	1	1
Myanmar	1	1	1	1	1	1	1	1	1	1
Namibia	1	0.675	0.599	0.629	0.185	0.162	0.177	0.614	0.555	0.576
Nepal	1	1.050	1.012	1.082	1.019	1.018	1.086	0.784	0.741	0.567
Nicaragua	2	1	1	1	0.436	0.412	0.407	1	1	1
Niger	1	1	1.001	1	1	1	1	1	1	1
Pakistan	1	0.559	0.511	0.499	0.170	0.174	0.246	0.553	0.511	0.501
Panama	2	0.866	0.983	0.866	0.621	0.605	0.607	0.820	0.826	0.769
Papua New Guinea	1	0.713	0.604	0.899	0.713	0.604	0.899	0.499	0.516	0.718
Paraguay	2	0.852	0.831	0.715	0.318	0.309	0.335	0.850	0.828	0.717
Peru	2	1.009	1.007	1.008	0.540	0.526	0.524	0.920	1.003	1.006
Philippines	1	0.923	0.864	0.721	0.426	0.487	0.480	0.680	0.614	0.549
Rwanda	1	1	1	1.013	1	1	0.944	0.776	0.859	0.892
Senegal	1	0.824	0.746	0.798	0.203	0.198	0.191	0.823	0.741	0.796
Sierra Leone	1	0.665	0.690	0.682	0.228	0.244	0.370	0.662	0.691	0.681
South Africa	1	0.436	0.388	0.440	0.083	0.089	0.087	0.401	0.365	0.413

Sri Lanka	1	0.716	0.675	0.685	0.434	0.444	0.499	0.474	0.437	0.401
Sudan	1	0.615	0.653	0.671	0.149	0.146	0.159	0.616	0.652	0.612
Suriname	2	0.605	0.561	0.574	0.405	0.408	0.406	0.565	0.499	0.500
Swaziland	1	0.577	0.499	0.519	0.080	0.088	0.101	0.579	0.471	0.478
Tajikistan	2	1	1	1	1	1	1	1	1	1
Tanzania	1	1.005	1.002	0.968	0.332	0.327	0.317	1.005	1.002	0.968
Thailand	1	0.610	0.555	0.464	0.290	0.258	0.268	0.470	0.434	0.362
Togo	1	1.002	0.904	0.897	0.558	0.502	0.573	0.953	0.905	0.897
Tunisia	2	0.819	0.967	0.942	0.634	0.633	0.635	0.688	0.687	0.685
Uganda	1	1.002	1.008	0.990	0.725	0.494	0.547	0.927	0.873	0.885
Ukraine	2	0.400	0.397	0.412	0.399	0.400	0.417	0.184	0.183	0.208
Uzbekistan	2	0.798	0.818	0.826	0.491	0.536	0.533	0.663	0.730	0.724
Vietnam	1	1.063	1.064	1.077	1.055	1.088	1.076	0.462	0.426	0.414
Yemen	2	0.867	0.995	1	0.533	0.546	0.555	0.787	0.995	1
Zambia	1	0.933	0.856	0.868	0.191	0.190	0.209	0.851	0.797	0.776
Zimbabwe	1	0.947	0.881	0.837	0.222	0.244	0.397	0.862	0.804	0.835

Source: Author ‘calculation using the GBD, and the GHE databases. Note: the region codes: 1 refers to countries of Sub-Saharan Africa, East Asia and Pacific and South Asia; 2 refers to countries of Europe and Central Asia, Latin America and Caribbean and Middle East and North Africa

Annex 1.10: Average technical efficiency scores estimated by sub-period for each region and income-group (1995-2012)

Models	Methods	Sub-periods	Low-and middle-income	Low income	Lower middle income	Upper middle income	East Asia and Pacific	Europe and Central Asia	Latin America and Caribbean	Middle East and North Africa	South Asia	Sub-Saharan Africa
Multi-outputs/multi-inputs	Order_m30	1995-2000	0.724	0.942	0.704	0.576	0.839	0.354	0.645	0.618	0.792	0.839
		2001-2006	0.693	0.924	0.669	0.540	0.786	0.354	0.594	0.595	0.782	0.813
		2007-2012	0.669	0.913	0.639	0.513	0.719	0.319	0.545	0.568	0.816	0.809
	Order-α0.97	1995-2000	0.723	0.934	0.702	0.583	0.827	0.356	0.651	0.634	0.790	0.834
		2001-2006	0.691	0.919	0.665	0.544	0.776	0.353	0.599	0.603	0.771	0.808
		2007-2012	0.670	0.907	0.641	0.521	0.728	0.322	0.555	0.582	0.793	0.804
Single-output/multi-inputs (using obesity prevalence as output)	Order_m30	1995-2000	0.345	0.620	0.336	0.139	0.636	0.158	0.139	0.123	0.625	0.434
		2001-2006	0.352	0.653	0.335	0.136	0.613	0.163	0.144	0.130	0.638	0.450
		2007-2012	0.340	0.622	0.323	0.138	0.554	0.142	0.151	0.128	0.692	0.430
	Order-α0.97	1995-2000	0.344	0.618	0.335	0.140	0.627	0.158	0.141	0.126	0.626	0.433
		2001-2006	0.349	0.649	0.331	0.133	0.600	0.163	0.142	0.129	0.632	0.446
		2007-2012	0.334	0.615	0.316	0.135	0.545	0.139	0.153	0.123	0.657	0.425
Single-output/multi-inputs (using deaths rate caused by the non- communicable diseases as output)	Order_m30	1995-2000	0.657	0.864	0.618	0.544	0.643	0.319	0.614	0.600	0.609	0.786
		2001-2006	0.636	0.883	0.584	0.506	0.599	0.305	0.566	0.578	0.569	0.786
		2007-2012	0.599	0.858	0.536	0.474	0.519	0.275	0.507	0.539	0.483	0.778
	Order-α0.97	1995-2000	0.664	0.859	0.625	0.559	0.646	0.329	0.633	0.622	0.610	0.783
		2001-2006	0.641	0.879	0.588	0.521	0.603	0.311	0.584	0.596	0.570	0.783
		2007-2012	0.610	0.855	0.547	0.495	0.538	0.288	0.536	0.563	0.482	0.775

Source: Author using the GBD, and the GHE databases.

Annex 1.11: Average technical efficiency scores (order-m, m=30) by sub-period for each group of regions (1995-2012)

Models	Sub-periods	Group 1: Sub-Saharan Africa, East Asia and Pacific and South Asia			Group 2: Europe and Central Asia, Latin America and Caribbean and Middle East and North Africa		
		Sub-Saharan Africa	East Asia and Pacific	South Asia	Europe and Central Asia	Latin America and Caribbean	Middle East and North Africa
Multi-outputs/multi-inputs	1995-2000	0.837	0.836	0.789	0.627	0.820	0.814
	2001-2006	0.811	0.782	0.775	0.594	0.852	0.866
	2007-2012	0.807	0.714	0.813	0.585	0.827	0.862
Single-output/multi-inputs (using obesity prevalence as output)	1995-2000	0.432	0.630	0.623	0.553	0.548	0.496
	2001-2006	0.448	0.610	0.634	0.523	0.498	0.505
	2007-2012	0.429	0.547	0.690	0.515	0.529	0.505
Single-output/multi-inputs (using deaths rate caused by the non-communicable diseases as output)	1995-2000	0.784	0.638	0.607	0.476	0.763	0.773
	2001-2006	0.785	0.597	0.568	0.455	0.780	0.825
	2007-2012	0.775	0.517	0.481	0.436	0.774	0.829

Source: Author using the GBD, and the GHE databases.

Chapter 2: Air pollution and health expenditures in low and-middle-income countries: what should we learn?

1. Introduction

To insure sustainable health financing, low- and middle-income countries need to reduce the wastage in the management of health expenditures and to find strategies which would allow them to save funds for health. Hence it is important to identify and to counter the factors which uselessly increase health expenditures.

A several number of low- and middle-income countries have experienced a rapid industrialization followed by an unplanned urbanization and an increase in population density (Fotourehchi, 2016). This structural transition has intensified both emissions and concentration of air pollution that have resulted in diseases for which the treatments are costly for their health system. In this way, air pollution is a factor that increases health expenditures. Consequently, the reduction of air pollution would allow for countries to save potential health funds which could be used to reinforce health financing.

On this subject, the literature has explored the effect of air pollution on health expenditures by controlling for several variables presented bellow in the subsection 2.2. Some studies have focused on the developed countries (Jerret et al., 2003; Narayan and Narayan, 2008), whereas others have recently worked on the developing countries (Mehrara et al., 2011; Chaabouni and Abdennadher, 2014; Chaabouni et al., 2016). The general trend of findings raised by these studies sheds light a positive effect of air pollution on health expenditures.

It is possible that this positive effect is due to some other factors. A matter of fact, in the context of health financing, low- and middle-income countries receive external support funds which are dedicated to the improvement of population 'health status. Their additional resources could allow for countries to counter health costs coming from air pollution. In this way, the positive of air pollution on health expenditures, supposed as positive could depend on the volume of foreign aid allocated to the financing of health systems.

Furthermore, the major part of low- and middle-income countries remains vulnerable to exogenous shocks such as the natural shocks (natural disasters including earthquakes or tsunamis), climatic shocks (droughts, floods of typhoons for example) and external or trade shocks (international commodity prices for example). This vulnerability reduces their economic growth (Chauvet and Guillaumont, 2003) and increases their macroeconomic instability, limiting their capacity to mobilize funds for health. In this way, it is probable that economic vulnerability of countries influences the positive effect of air pollution on health expenditures.

In addition, there are various agents who intervene in health financing in low- and middle-income countries. These are for example, households, central government, health insurance schemes and the NGOs (Non-Governmental Organizations). Air pollution could affect in different ways the budget of agents allocated to health financing. Hence, it would be also interesting for the policy-makers to identify the agents involved in health financing for which the budget is more affected by air pollution. This suggestion involves exploring the effect of air pollution on the composition and the structure of health expenditures.

On this subject, and to the best our knowledge, none of empirical studies have tested interactive effects on health expenditures of air pollution compared to other factors. Moreover there are not any works which focus on the effect of air pollution on the composition and the structure of health expenditures.

We contribute to the literature by addressing the following questions: Does air pollution affect the level of health expenditures in low- and middle-income countries? In case of significant effect, what is its direction? Do external resources for health and economic vulnerability influence the effect of air pollution on health expenditures in low- and middle-income countries? What is consequently the direction of this influence? What are the agents intervening in health financing for which the budget is more affected by air pollution? In this way, does air pollution modify the composition and the structure of health expenditures in low- and middle-income countries?

We firstly propose to empirically investigate the effect of air pollution on the amount of total health expenditures. Then, we test the interactive effect between air pollution and external resources for health and between air pollution and economic vulnerability on the total level of health expenditures. We also estimate the effect of air pollution on the composition and the structure of health expenditures.

The rest of chapter is arranged as follows: the Section 2 is devoted to the description of composition and the structure of health expenditures, the literature review and the potentials channels which not only link air pollution to health expenditures but also support the hypothesis that external resources for health and economic vulnerability influence the effect of air pollution on health expenditures. The section 3 outlines the empirical strategy to test our hypotheses. The results are discussed in the Section 4 and the Section 5 concludes. The Section 6 is dedicated to Annexes.

2. Theoretical framework

2.1 Composition and Structure of health expenditures

In the general introduction, we have briefly discussed the various components of health expenditures. Here, we present in details the composition and the structure of health expenditures. The structure of health expenditures can be viewed as the different levels (the amounts for example in per capita) of these specific components. However, the composition refers to the percentage of each specific component in total health expenditures. The different components of health expenditures are presented as following fashion.

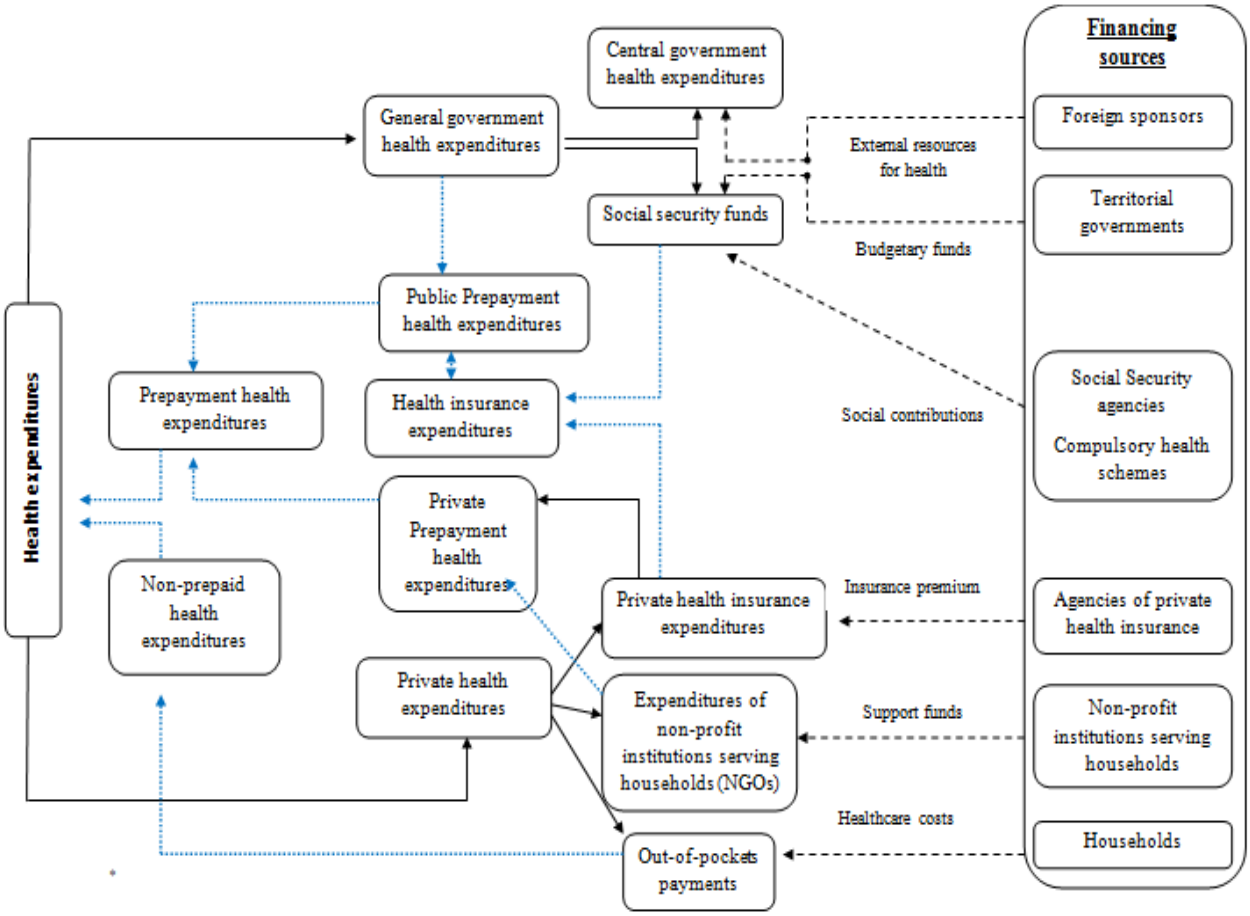
Generally, total health expenditures are composed of public (or government) and private health expenditures. Total public health expenditures include central government health expenditures and social security funds. Central government health expenditures are financed by territorial governments including central, federal (health ministry and other ministries), provincial, regional, state, municipal, local governments, and district authorities and by foreign sponsors, respectively through a part of budgetary (tax and non-tax revenue) and extra budgetary funds (external resources for health channelled through the budget of governments) (National Health Accounts, 2015) They include investment and functioning expenditures. Investment expenditures are used for the building construction and the rehabilitation, and the purchase of medical and non-medical equipments. The functioning expenditures are consecrated to the payment of salaries, hospital emoluments etc... (Atake, 2014). Regarding the social security funds, they are financed by the governmental social security schemes and other schemes of compulsory health insurance. They are financed through the social contributions and a part of budgetary funds. Any external donor funds channelled through these institutions are also included.

Total private expenditures on health include health expenditures financed by the non-profit institutions serving households like NGOs, the expenditures from private health insurances schemes and the out-of-pocket payments. The expenditures from private health insurances are financed by the insurance premiums. The out-of-pocket payments defined in the general introduction are directly financed by households.

Based on the WHO classification[19], the social security funds and the expenditures from private health insurances schemes form health insurance expenditures. Central government health expenditures, the social security funds, private health insurance expenditures and health expenditures from non-profit institutions serving households constitute prepayment health expenditures which have been also defined in the general introduction. They refer to the only component of total health expenditures which is not directly financed by households.

In view of discussion, three categorizations of health expenditures could be made. The first one consists of subdividing total health expenditures into public and private health expenditures. In the second one, total health expenditures could be split into two categories such as total prepayment health expenditures and non-prepayment health expenditures such as the out-of-pocket payments (Xu et al., 2011). The third categorization presents a more disaggregated fashion where, total health expenditures could be regrouped into four components such as central government health expenditures, health insurance expenditures, health expenditures from the non-profit institutions (NGOs) and out-of-pocket payments. Figure 2.1 summarizes the composition and the structure of health expenditures.

Figure 2.1: Composition and structure of total health expenditures



Source: Author.

2.2 Literature review

Issues on the environmental determinants of health expenditures are not well documented in the literature. We have only found five studies which empirically investigate the effect of environment quality on health expenditures. The two firsts have specifically focused on the developed countries. Jerret et al., (2003) have explored the effect of air pollution on health expenditures with cross sectional

[19] See the Global Health Expenditures database: http://apps.who.int/nha/database/Select/Indicators/en

data covering 49 towns of Ontario in Canada. After control for other variables (supply of physicians, the presence of teaching hospital(s) and age standardized mortality ratios adjusted from past health expenditures as a proxy of health needs), they find that the total emissions of toxic pollutants lead to increase health expenditures. They also stress that the increase in expenditures devoted towards defending environmental quality contributes to reduce the level of health expenditures. Narayan and Narayan (2008) have departed from Dynamic Ordinary Least Squares (DOLS) estimator to test short-run and long-run effects of air pollution on health expenditures by using panel-data based on eight OECD countries for the period 1980-1999. They measure air pollution by the emissions of carbon monoxide, the sulphur oxide and the nitrogen oxide. After control of income effect they find that the carbon monoxide emissions lead to an increase in health expenditures per capita in short and-long run. It also appears that the sulphur oxide emissions increase health expenditures per capita but their effect is only significant in the long-run, in which the effect of carbon monoxide emissions is greater than the sulphur oxide emissions. Regarding the nitrogen oxide emissions, they have not a statistically significant effect on health expenditures.

The two last studies have looked at developing countries. The first one is Mehrara et al. (2011). They have tested the effect of air pollution on health expenditures on a sample of 114 developing countries over the period 1995-2007. They depart from the DOLS (Dynamic Ordinary Least Squares) and the Error Correction Model (ECM) to estimate short-run and long-run effects. They also control for some aspects likely to affect the level of health expenditures. These are: GDP per capita, the energy intensity, the access to clean water and to improved sanitation. They find that CO2 emissions contribute in increase health expenditures in the short and long-run. The second one refers to the work of Chaabouni et al., (2016) that test the causal dynamic relationship between CO2 emissions, health expenditures and economic growth by using a dynamic panel estimator such as the GMM. They work on a sample of 51 low- and middle-income countries over the period 1995-2013 and control their econometric model for GDP per capita, the first lag of health expenditures and the size of ageing population. They stress that CO2 emissions raise health expenditures but the effect is unilateral.

The last identified paper from Chaabouni and Abdennadher (2014) considers the determinants of health expenditures in Tunisia over the period 1961-2008. They use the Autoregressive Distributed Lag (ARDL) to investigate the effect of environmental quality on the level of health expenditures per capita. They find that the nitrogen oxide emissions in kilos per capita lead to increase health expenditures. Despite these empirical evidences, it would be important to understand the theoretical channels that link air pollution to health expenditures.

2.3 Air pollution and health expenditures: theoretical arguments

The relationship between air pollution and health expenditures can be ambiguous. Air pollution would affect health expenditures through three main channels such as the increase in morbidity caused by chronic, non-communicable and mental diseases, the decrease in life expectancy at birth and the increase in economic growth.

2.3.1 The channel passing through the increase in morbidity caused by chronic non-communicable and mental diseases.

The exposure to air pollution particles appears to result in mental and non-communicable diseases. It increases the morbidity in cardiovascular diseases (Pope and Dockery, 2006; Chen et al., 2008; Brook et al., 2010). For example it increases blood pressure and results in arterial hypertension by provoking oxidative stress, systemic inflammation and autonomic nervous system imbalance that are likely to lead to endothelial dysfunction and vasoconstriction (Sanidas et al. 2017). Moreover, air pollution impedes the respiratory system and the lung development and function (Neidell, 2004; Pope et al., 2002; Portnov et al., 2009; Auerbach and Hernandez, 2012) which are likely to result in respiratory

diseases (Brunekreef and Holgate, 2002; Beatty and Shimshack, 2014). It is also likely to adversely affect the central nervous system (Block and Calderon-Garciduenas, 2009) and to consequently lead to a rising in the morbidity mental diseases.

The effects of air pollution on the emergence of these diseases could be explained on the one hand by the "Foetal Origins Hypothesis" which stipulates that the foetal exposure to unhealthy particles increases the risk to develop some chronic and non-communicable diseases in childhood and mostly in adult age (Bhalotra and Rawlings, 2013; Almond and Currie, 2011).

In view of arguments, air pollution is likely to increase the prevalence/incidence of chronic, non-communicable and mental diseases for which the treatment are generally costly for health systems. Indeed, the treatment of these diseases requires using sophisticated medical equipment and drugs for which the costs are high. Through this channel, air pollution would increase health expenditures.

2.3.2 The channel passing through the decrease in life expectancy and the increase in economic growth

The emergence of diseases caused by air pollution could result in deaths. The literature highlights an adverse effect of air pollution on infant mortality (Gangadharan and Valenzuela, 2001; Chay and Greenstone, 2003; Mukhopadhyay and Forssell, 2005; Jan Xu et al., 2009; Federman, 2010; Tanaka, 2010; Arceo-Gomez et al., 2012[20]), foetal mortality (Jayachandran, 2009) and on pregnancy outcomes (Lin et al., 2001; Portnov et al., 2009; Malmqvist et al., 2017). Hence, through the increase in deaths, air pollution would be a factor reducing the life expectancy (Fotourehchi, 2016; Wang et al., 2013).

The decrease in life expectancy occasioned by air pollution could affect health expenditures through the channel of economic growth. Normally the reduction in life expectancy is likely to decrease economic growth through a loss of productivity. Hence, the reduction of growth will reduce health expenditures. On this subject, the literature remains controversial about the empirical effect of life expectancy on economic growth. Some studies estimated a positive effect of life expectancy on economic growth whereas other ones found a non-significant effect. For Desbordes (2011), the life expectancy effect on economic growth is nonlinear and depends on the initial level of GDP. Focused on 47 countries at various levels of development over the period 1940-1980, the author showed that the effect of life expectancy on economic growth is negative for countries with low initial level of income and positive for the ones associated with high level.

In view of evidences, it is judicious to nuance the expected effect of air pollution on health expenditures passing by the channel of life expectancy and economic growth. The effect will be positive whether the reduction of life expectancy caused by air pollution increases economic growth which constitutes a factor fostering the increase in health expenditures (Chaabouni et al., 2016, Fan and Savedoff, 2014; Ayuba, 2014). In the case where, the reduction in life expectancy occasioned by air pollution reduces economic growth, health expenditures will decrease. However the both potential effects would be effective in the long-run. In case of a non-significant effect of life expectancy on economic growth, air pollution effect on health expenditures passing through this channel would be inhibited.

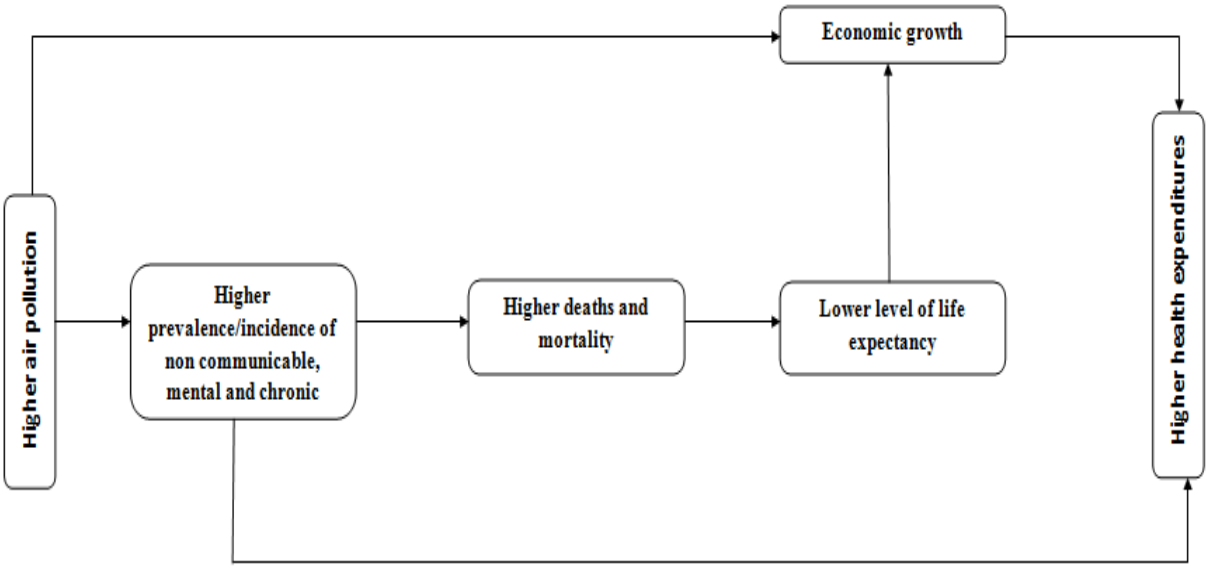
In addition, air pollution could directly affect economic growth which is likely to increase health expenditures. Generally, the emissions of pollutant particles come from the goods and services production. Hence, air pollution would be associated with an increase in economic activity and growth. Indeed, despite the tested effect of economic growth on CO2 emissions in the literature (Narayan and Narayan, 2010; Narayan et al., 2016), it is possible to expect some feedback effects

[20] For more information, the reader will be able to refer to Woodruff et al., (1997); Pereira et al., (1998); Abbey et al., (1999); and Loomis et al., (1999).

implying that CO2 emissions positively affect economic growth (Halicioglu, 2009; Ghosh, 2010; Chaabouni et al., 2016) that is likely to increase health expenditures.

In view of various scenarios through which air pollution is likely to affect health expenditures, the most probable effect is positive because the potential negative effects are mostly indirect and depends on many aspects. On this subject, the theoretical channels which link air pollution to health expenditures are summarized in Figure 2.2. Moreover, the positive effect of air pollution on health expenditures would depend on some factors discussed in the following subsection.

Figure 2.2: Various channels linking air pollution on health expenditures



Source: Author.

2.4 Air pollution and health expenditures: Do external resources for health aid and economic vulnerability make any difference?

2.4.1 External resources for health

The effect of air pollution on health expenditures could depend on the level of external resources allocated to health. The main goal of foreign health financing is to increase the quantity of resources devoted to health improvement. In this way, the increase in external resources for health should normally increase health expenditures. On this subject, Mishra and Newhouse (2007) have shown that a one USD increase in external resources for health increase public health expenditures by 1.5 USD. The results support the arguments attesting that external resources for health constitute additional funds for health financing. Other works in the literature stress that this argument is not effective. Some studies find that even if air pollution leads to increase health expenditures, the positive variation of these expenditures would be low in countries that receive more health aid. For example, Brun et al., (2012) have shown that for every one USD of external resources for health, public health expenditures increase by 0.20 USD. From this result, it appears that external resources for health are not totally additional to health expenditures. Other studies such as Devarajan et al., (1999); Farag et al., (2009); Lu et al., (2010), Dieleman et al., (2013) and Liang and Mirelman, (2014) estimate that the allocation of external resources for health induces governments to reduce their expenditures affected to health. They globally find that external resources for health contribute in reducing government health expenditures. Except Mishra and Newhouse (2007), the findings raised by the mentioned works could be explained by the assumption of health aid fungibility discussed above in the first chapter.

The conditional effect of air pollution on health expenditures depending on external resources for health ought to be clarified. In other words, the effect of air pollution on health expenditures would be dependent on the actual allocation of external aid earmarked to health sector but also on the propensity of countries to prioritize health in their agenda. In the case where health aid increases even partially health expenditures, the positive effect of air pollution on health expenditures will be lower in countries that receive more foreign aid. Comparatively to the others, these countries will have more health resources to counter the adverse effects of illnesses coming from air pollution. In the case where the allocation of external resources for health induces countries to reduce their health expenditures, the positive effect of air pollution will be higher in countries that receive more health aid.

2.4.2 Economic vulnerability

In addition to external resources for health, economic vulnerability of countries could also affect the effect of air pollution on health expenditures. Economic vulnerability can be defined as "the likelihood that a country's economic development could be hindered by unforeseen exogenous shocks (Guillaumont, 2009). Generally, the most vulnerable countries will tend to produce less economic growth and will experience macroeconomic instabilities. Through these channels, these countries will encounter difficulties in mobilizing resources for health. In this way, health expenditures in the most vulnerable countries will be lower comparatively to the others (the least vulnerable countries). In this case, the positive effect of air pollution on health expenditures would be higher in the most vulnerable countries. However, economic vulnerability could induce countries to invest in the social sectors such as, the one of health. This vulnerability could consequently encourage countries (the policy-makers) to increase their health expenditures. In this case, the increase in economic vulnerability would exacerbate the positive effect of air pollution on health expenditures.

3. Empirical strategy

3.1 Description of econometric model and used variables

The empirical effect of air pollution on health expenditures is tested by using an unbalanced panel-data model encompassing 99 low- and middle-income countries over the period 1995-2012. To get rigorous econometric results, it is important to control for the atypical and potential fluctuations of variables which will be used in the model. Furthermore non-stationarity problems could eventually arise over a long period. Hence, we propose to subdivide the time period into sub-periods and to calculate the mean of each variable on each sub-period. The choice of annual dimension (the number of years) by sub-period is also important. On this subject, the use of two years by sub-period is insufficient to control for the fluctuation of variables. We suggest using the minimum annual dimension which would be sufficient to account for the mentioned bias. Hence, we depart from six sub-periods of three years: 1995-1997, 1998-2000, 2001-2003, 2004-2006, 2007-2009, and 2010-2012.

Three specifications are tested. In the first one, we test the single effect of air pollution, economic vulnerability and external resources for health on health expenditures. In the second one, the interactive effect between air pollution and external resources for health is tested, whereas in the third specification, the interactive effect between air pollution and economic vulnerability is estimated.

In general, there exist two kinds of panel-data models: fixed effects model and random effects model. They account for time and cross-country unobserved heterogeneities but in different ways. In fixed effects model, the unobserved cross-country specificities are specified in determinist way and remain invariant over time. In contrast, the specification of random effects model assumes that the specificity of each country is random and depends on the time.

Random effects model is generally used in the context of randomization studies for which the goal is to estimate the effect of a treatment (for example the implementation of a policy) on a group of individuals (treatment group) compared to another (counterfactual). In this kind of study, the assignment of treatment is random. Hence based on Kennedy (2003), it would be more rigorous to use random effects model only in randomization studies.

Here the quantity of polluted air is not randomly fixed. Air pollution is generally caused by industrialization, urbanization (Ponce and Barido, 2014) and some other factors such as institutional quality (Abid, 2016) and the income inequalities (Combes et al., 2016). In this way, the specific characteristics of countries could be correlated to air pollution variable in the model whereas this assumption is rejected in the use of random effects model.

We firstly use a fixed effects model which would be biased in presence of heteroskedasticity and serial correlation of error term. The heteroskedasticity means that the standard deviation of error term is not constant: $(\omega_{it}) = \sigma_i$, whereas under the serial correlation assumption, the error terms is correlated over time:$E(\omega_{it}; \omega_{it'}) \neq 0$. These biases could distort the standard deviation of explanatory variables and consequently the level of significance of their associated coefficient. These assumptions are tested respectively to the Modified Wald test for groupwise heteroskedasticity in fixed effects models and to the Wooldridge test for serial correlation in panel-data models (Wooldridge, 2002). The null hypotheses for these tests respectively attest the presence of homoskedasticity of error terms and serial independence in their distribution. Their alternative hypotheses respectively suppose that there are heteroskedasticity and autocorrelation in the distribution of error terms. The Modified Wald test for groupwise heteroskedasticity and the Wooldridge test of serial correlation respectively provide chi2 and F statistics. In presence of homoskedasticity and serial independence structure, the p-values associated with statistics are greater than the maximal acceptable threshold estimated at 10%.
The statistical diagnostics reveal the presence of heteroskedasticity and serial correlation of error term in the econometric model (Annex 2.1). Hence, we propose to test the model by using Feasible Generalized Least Squares (FGLS) estimator (Fomby et al., 2012) which accounts for the fore mentioned biases. The data source of variables is presented in the subsection 3.3. Our FGLS regression model is specified through the following specifications:

$$Y_{it} = \alpha + \beta Pollution_{it} + \varphi Ext\_Fin_{it} + \gamma EVI_{it} + \sum_{k=1}^{n} \delta_k Z_{kit} + \varepsilon_{it} \qquad (1)$$

$$Y_{it} = \alpha + \beta Pollution_{it} + \varphi Ext\_Fin_{it} + \rho(Pollution_{it} * Ext\_Fin_{it}) + \gamma EVI_{it} + \sum_{k=1}^{n} \delta_k Z_{kit} + \varepsilon_{it} \qquad (2)$$

$$Y_{it} = \alpha + \beta Pollution_{it} + \varphi Ext\_Fin_{it} + \rho(Pollution_{it} * EVI_{it}) + \gamma EVI_{it} + \sum_{k=1}^{n} \delta_k Z_{kit} + \varepsilon_{it} \qquad (3)$$

Such as, $\varepsilon_{it} = \mu_i + v_{it}$

- Y_{it} refers to the variable of total health expenditures expressed in USD PPP per capita (Purchasing Power Parity (***THEPC***) for country "i" at the period "t". The use of this variable deserves to account for some aspects which could make the estimated results biased. Total health expenditures include external resources for health which is also used as explanatory variable. Hence, the estimation of coefficient associated with health aid variable would be biased in this case. By doing so, we calculate total health expenditures from domestic sources by retrieving external resources for health (including external resources for health passing through the budget of governments and the funds allocated by NGOs for health) from total health expenditures from overall sources.

- ε_{it} is the idiosyncratic disturbance. It includes the between-country error (μ_i) and the within-country error (v_{it}).$\alpha$is the intercept, whereas β; δ_k; φ; ρ and γ are the parameters which must be estimated.

- $Pollution_{it}$ is air pollution variable. We have chosen to work on air pollution because it constitutes the main source of environmental costs (Narayan and Narayan, 2008). This variable is approximated by the carbon dioxide (CO2) emissions assessed as metric tons per capita. The carbon dioxide emissions refer to those stemming from the burning of fossil fuels and the manufacture of cement. They include carbon dioxide produced during consumption of solid, liquid, and gas fuels and gas flaring.

- Ext_Fin_{it} refers to external resources for health expressed in USD PPP per capita used in the first chapter. Globally, this factor is likely to affect health expenditures in three ways. It would increase health expenditures in the case where the foreign funds for health are totally affected to health or are partially affected to the other sectors. In case of totally allocation of external resources for health the coefficient associated with this variable will be greater than 1. In case of partially affectation of external resources for health to the other sectors, the coefficient will be less than 1. The second potential effect is negative and attests that the allocation of external resources for health encourage countries to reduce their health expenditures in favour of other sectors. Thirdly, the external health resources could have non-significant effect on health expenditures whether they are totally allocated to other sectors.

- EVI_{it} is economic vulnerability index (EVI). It measures the structural vulnerability of countries, independently of current politic. It is the arithmetic mean of two sub-indexes assessing the magnitudes of shocks and the exposure of country to these shocks. The exposure sub-index is a weighted average of four indicators such as the smallness of population (50%), the remoteness from world markets (25%), the exports concentration (12.5%) and the share of agriculture, forestry and fishery in GDP (12.5%). The sub-index of shocks magnitude is a weighted average of three variables: the victims of natural disasters (25%), the instability in agricultural production (25%) and the instability in exports of goods and services (50%). Before constructing the EVI, all components of this index are normalized between 0 and 100 given the fact they are built on different kinds of primary data.

- Z_{kit} represents the "k (k going from 1 to n) control variables including the life expectancy at birth, the old dependency ratio and urbanization (used in the first chapter) tax revenue as percentage of GDP, the growth rate of GDP per capita, and a composite index assessing institutional quality.

Life expectancy at birth: it assesses the number of years a newborn infant would live in prevailing patterns of mortality at the time of its birth were to stay the same throughout its life. As discussed above the text, this variable is supposed to have mixed effect on health expenditures. It could positively affect health expenditures in the case where its positive variation concerns the most vulnerable people that use the most healthcare. However, a negative effect could be also expected in the case where they adversely affect economic growth (see section 2.6 of chapter).

Old dependency ratio: the literature has shown that the increase in percentage of elderly population leads to increase total health expenditures in low- and middle-income countries (Chaabouni and Abdennadher, 2014; Chaabouni et al., 2016). The increase in percentage of elderly population is financial costly for health systems. This category of people generally suffers from non-communicable diseases for which the treatment is costly for governments, and households. Hence, an increase in old dependency ratio would increase government health expenditures and the out-of-pocket payments. In addition to governments and households, the increase in size of elderly population could be also costly for the other entities in health systems. This category of persons is included in the group of most vulnerable populations, which are generally dependent on adult people .Hence, the high disease risks and the treatment costs of diseases affecting the elderly individuals could induce the adults to subscribe to health insurance contracts to avoid the payments of costly fees in case of disease events. That will allow them to transfer the financial risks of diseases to private health insurance companies.

The subscription to health insurance contracts would increase the activity of private insurance companies and accordingly the expenditures from these last ones. It is consequently possible to expect a positive effect of increase in old dependency ratio on health insurance expenditures. This assumption would be effective in the case where households have the "insurance culture" and whether they get income to finance health insurance contracts; a fact is not generally the case in low- and middle-income countries. Accordingly, the eventual effect of old dependency ratio on health insurance expenditures, more specifically on private health insurance expenditures, is less evident. It is more probable that government health expenditures and the out-of-pocket payments are affected by the old dependency ratio. Nevertheless, there are some assumptions attesting an eventual negative effect of old dependency ratio on health expenditures, more specifically on government health expenditures. The increase in size of elderly people could reduce the number of productive individuals which indirectly finance health systems through the domestic tax revenue and the social security funds. Hence, the decrease in productive workforce could result in a reduction in quantity of funds allocated to health sector. Consequently, it could reduce the level of government health expenditures. This potential negative effect would be only effective in the case where the growth of elderly people is greater than the young individuals that constitute a potential productive workforce.

Urbanization (Urban): its introduction is motivated by the fact that it affects not only CO2 emissions (Ponce and Barido, 2014) but also and mostly health expenditures. The effect of urbanization on health expenditures can be ambiguous. As discussed above in the first chapter, healthcare are generally more available in urban areas and they are more costly because health facilities in the urban zones more provide secondary and tertiary health services. Hence the increase in urban populations would increase the use of healthcare. Generally, the patients tend to bypass the primary level of health facilities and to directly go to the higher levels ones. Consequently it is probable that the growth of urban population would particularly increase the use of second and maybe tertiary healthcare. Given the high costs of that healthcare, it is possible that the increase in percentage of urban individuals leads to an increase in health expenditures. However, it could adversely affect health expenditures in the long-run through congestion effects. In fact, the concentration of individuals in the urban zones could result in economies of scale which will have the effect to reduce the unit costs of healthcare. Through this channel and in the long-run, urbanization is likely to reduce the level of health expenditures. Urbanization would also affect the components of health expenditures. On this subject Deaton (2013) stresses that urbanization could be favourable to the spread of pathogens and to unhealthy housing. It would consequently increase the burden of diseases as for example the cholera and would increase in this case health expenditures financed by households: the out-of-pocket payments. In addition, the migration of rural populations towards the urban areas would facilitate the pooling of health insurance contributions. It would arouse new subscriptions to health insurance contracts (Dukhan, 2010). In this case, urbanization would increase total health expenditures through the channel of health insurance expenditures.

Tax revenue as share of GDP (Tax): tax revenue mobilization is one of key determinants likely to affect the level of health expenditures. They serve as funds used by governments to finance health. Hence, an increase in tax revenue would result in an increasing in health expenditures. This potential effect would depend on government prioritization for health sector. This eventual effect will be higher in countries for which governments prioritize health in their agenda. In countries where health sector is less prioritized, the effect could be low or not significant. However, the taxation could reduce the disposal income of households and consequently their consumptions and their expenditures. Through this channel, it is possible that the taxation reduces the out-of-pocket payments and consequently the level of health expenditures.

GDP per capita growth (Growth): controls for the income effect on health expenditures. GDP in level, expressed in per capita (USD PPP) has not been included because it is more correlated with CO2 emissions variable (0.7401). Hence the income is approximated by its growth rate. The second argument supporting the use of GDP per capita growth comes from empirical studies (Narayan and Narayan, 2010; Narayan et al., 2016; Chaabouni et al., 2016; Fan and Savedoff, 2014; Ayubi, 2014) stressing that it significantly increases health expenditures. The effect of GDP per capita and its growth on health expenditures could be theoretically explained. The increase in GDP per capita and its growth has the effect to increase the wealth of countries which could be used to reinforce health financing. Firstly, the growth allows a better mobilization of tax revenue (Ghura, 1998) which appears as a potential determinant of health expenditures based on arguments discussed in the previous paragraph. Secondly, with the growth, the companies will hire more; a fact will increase the number of workers and the level of social security funds. In this way, the growth is likely to increase government health expenditures (Xu et al., 2011). Thirdly, the growth could increase the income and the consumption of households. Through this channel, it is likely to increase health expenditures by positively affecting the out-of-pocket payments. This effect would be effective only in the case where the gains of economic growth would be equally distributed between the individuals; a fact involves that the income inequalities would be have to be reduced. Fourthly economic growth has the advantage of increasing the development of financial systems (Durusu-Ciftci et al., 2017). It is also likely to reinforce the quality and the quantity of provided financial services encompassing insurances ones. In this way, economic growth is a factor that favours the development of insurance sector. On this subject, Guerineau and Sawadogo (2015) highlight that the increase in GDP per capita increase the life insurance premiums in Sub-Saharan African countries. Based on the finding, economic growth could lead to increase health insurance premiums and consequently private health insurance expenditures.

Institutional quality (Institutions): the good governance would enable to increase health expenditures. It firstly allows a more mobilization of tax revenue which in part finance health systems. It could also contribute to the reinforcement and the best management of health systems. Hence a composite index is computed through a Principal Component Analysis (PCA) to account for the different aspects of governance. This method is a statistical procedure used to summarize the information provided by a set of correlated variables into a composite index. It can be also defined as method, which extracts the maximum of variance contained in a set of indicators. This index includes five components ranged from -2.5 (low level) to 2.5 (high level). The first one is government effectiveness index used in the first chapter. The second one is regulatory quality which captures the perceptions of ability of governments to formulate and implement sound policies and regulations that allow and promote private sector development. The third one is the voice and accountability expressing the extent to which a country's citizen are able to participate in selecting their government, as well as freedom of expression, freedom of association, and a free media. The fourth one is rules of law which assesses the perception or the extent to which the agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence. The last one is the control of corruption which refers to the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as "capture of state by elites" and private interests. The acronyms of governance variables are respectively "Effectiveness, "Regulatory, "Voice, "Law and "Corruption. The results of PCA reported in Table 2.1 reveal that the first factorial axis better explains the index variation. It explains 77.62% of total variation within the data. Hence, we construct the index of governance on the basis of this first factorial axis.

Table 2.1: Results of principal component analysis computing the composite index of governance (1995-2012)

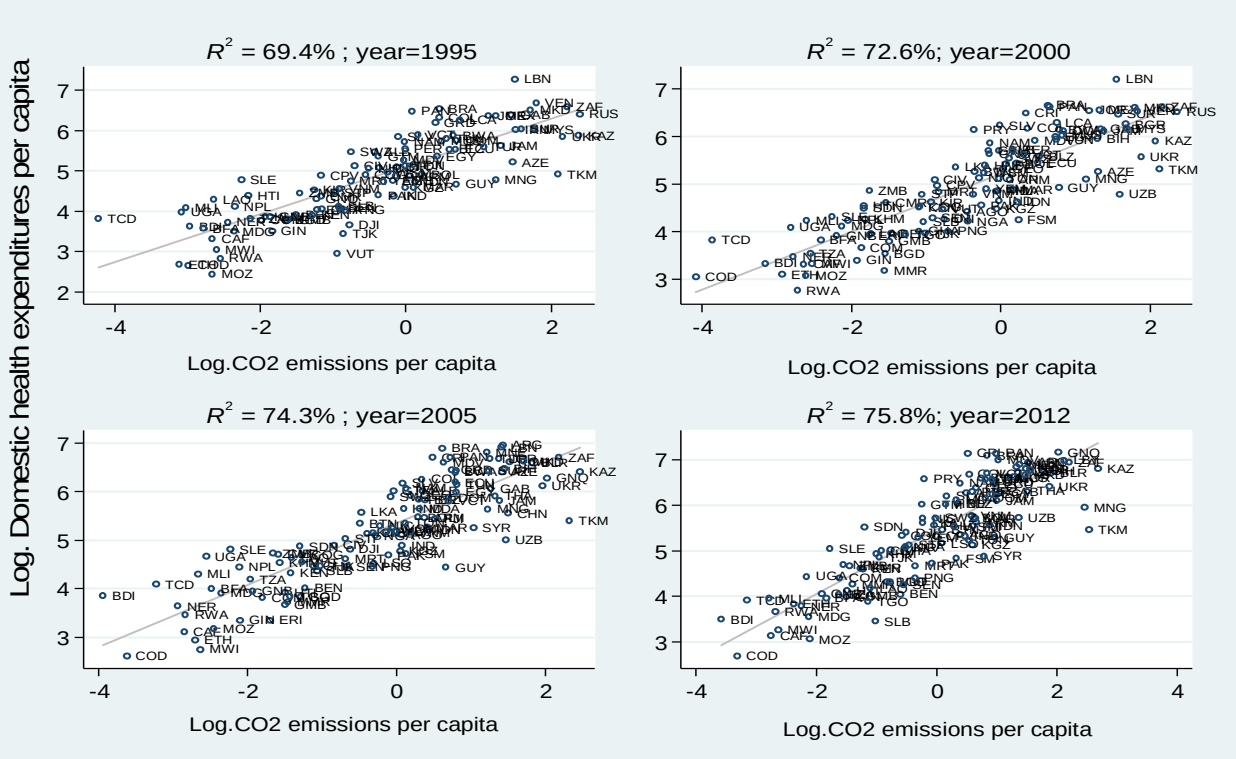
		Component 1	Component 2	Component 3	Component 4	Component 5
Eigen value		3.8810	0.4485	0.3909	0.1605	0.1191
Proportion		0.7762	0.0897	0.0782	0.0321	0.0238
Cumulative		0.7762	0.8659	0.9441	0.9762	1
Variables (Eigenvectors)	Effectiveness	0.4672	-0.2952	-0.3209	-0.2747	0.7185
	Regulatory	0.4387	0.1956	-0.7229	0.2322	-0.4390
	Voice	0.41	0.812	0.3396	0.0434	0.2353
	Law	0.4679	-0.196	0.3209	-0.6363	-0.4847
	Corruption	0.4498	-0.4206	0.3951	0.6811	-0.0283

Source: Author 'calculation using the WGI database.

3.2 Discussion on the variables in the econometric model

We follow the same approach used in the literature on the environmental determinants of health expenditures. It consists of estimating air pollution elasticity against health expenditures. We transform CO2 emissions and domestic health expenditures into logarithm. This transformation is adapted in our case. Indeed, the relationship between both variables seems to be clearer and more adjusted when the logarithm of variables is used (Graphic 2.1)[21] comparatively to the case where they are not transformed (Graphic 2.2)[22]. This relationship reveals a positive correlation that remains higher in the first case compared to the second one.

Graphic 2.1: Scatter plots between the log of CO2 emissions in metric tons per capita and the log of domestic health expenditures in USD PPP per capita

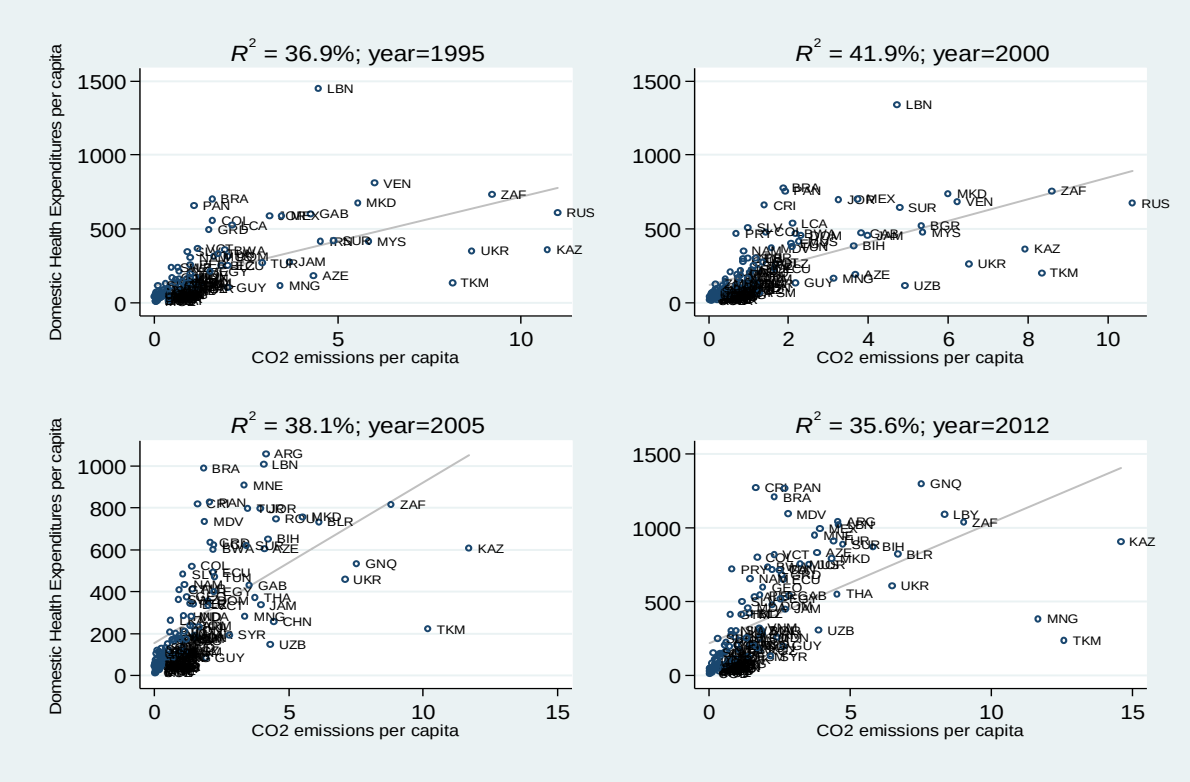


Source: Author using the GHE and WDI databases.

[21] The reason for which the years 1995, 2000, 2005 and 2012 are used in this scatter plots analyses is précised and explained in the subsection 4.1.

[22] The scatter plots with semi-logarithmic forms remain also less adjusted than the logarithmic one.

Graphic 2.2: Scatter plots between CO2 emissions in metric tons per capita and domestic health expenditures in USD PPP per capita



Source: Author using the GHE and WDI databases.

Furthermore the logarithm of CO2 emissions is lagged (the mean value of variable at the previous period "t-1"). Based on the results in literature and the theoretical arguments discussed above, air pollution does not immediately affect the level of domestic health expenditures. Given we test the conditional effect of CO2 emissions compared to external resources for health and to economic vulnerability; we also lag the variable of external resources for health and economic vulnerability index.

The use of lag of external resources for health variable also allows addressing its potential endogeneity due to a reverse causality bias. Despite the potential effect of health aid on health expenditures, the allocation of external resources for health could be conditioned by the level of health expenditures because the main goal of foreign aid is to support the less developed countries in the financing of their development. On this subject, studies focused on the determinants of health expenditures, more specifically government health expenditures evokes a potential endogeneity bias based on the variable of health aid (Dieleman et al., 2013; Lu et al., 2010).

In addition of external resources for health variable, there are other explanatory variables suspected to be endogenous. These are the life expectancy, tax revenue, economic growth and urbanization. Their endogeneity also comes from the reverse causality between these last ones and total domestic health expenditures that could affect them. An increase in health expenditures appears in the literature to be a factor increasing the life expectancy (Bayati et al., 2013; Jaba et al., 2014). Furthermore, the literature has also shown that the increasing in total health expenditures positively affects GDP per capita (Chaabouni and Abdernnadher, 2014; Chaabouni et al., 2016). Tax revenue could be affected by health expenditures. A government experiencing a shortfall in health funds could for example decide to tax unhealthy goods to finance health system. That would have the effect to increase tax revenue. On this subject, Verguet et al., (2015) have shown that the tobacco taxation in China has produced

additional tax revenue. Lastly, health expenditures generally allocated in favour of urban zones could incite the rural individuals to migrate towards the towns to use sophisticated healthcare. In view of these arguments, the other endogenous variables in addition to the variable of health aid are lagged.

The variables used in the econometric model and the direction of their expected effect on domestic health expenditures are summarized through Table 2.2. Given some variables are expressed form in logarithm in the model whereas others are not transformed; we shall depart from Table 2.3 to interpret the coefficients associated with each explanatory variables.

Table 2.2: Tested specifications in econometric model

Variables		Definitions and assessment units	Specifications			Expected effects
			(1)	(2)	(3)	
Dependent variable	Log. THEPC	Logarithm of total health expenditures from domestic sources per capita (PPP USD)	*	*	*	
Explanatory variables	$Log.Pollution_{t-1}$	First lag of logarithm of carbon dioxide (CO2) emissions(metric tons per capita	*	*	*	+
	Ext_Fin_{t-1}	First lag of external resources for health per capita (PPP USD)	*	*	*	+ or - or not significant
	EVI_{t-1}	First lag of index of economic vulnerability (from 0 to 100)	*	*	*	+/-
	$Log.Pollution_{t-1}*Aid_{t-1}$	Interactive variable between the first lag of logarithm of CO2 emissions per capita and the first lag of external resources for health per capita		*		+/-
	$Log.Pollution_{t-1}*EVI_{t-1}$	Interactive variable between the first lag of logarithm of CO2 emissions per capita and the first lag of economic vulnerability index			*	+/-
	$Life\ expectancy_{t-1}$	First lag of life expectancy at birth	*	*	*	+/-
	Old dependency	Percentage of population aged 65 and above (%)	*	*	*	+/-
	Tax_{t-1}	First lag of tax revenue as percentage of GDP (%)	*	*	*	+/-
	$Growth_{t-1}$	First lag of growth rate of GDP per capita (%)	*	*	*	+
	Urbant-1	First lag of Percentage of people living in urban areas (%)	*	*	*	+/-
	Institutions	Composite index of institutional quality	*	*	*	+

Source: Author.

Table 2.3: Different specifications of econometric models

Models	Equations	Interpretations
Specification with the dependent and the explicative variables in level	$Y= \alpha+\beta.X$	An increase in one unit of X results in a variation (an increase or a decrease respectively in case of positive or negative coefficient) of Y by β units.
Specification with the dependent and the explicative variables in logarithm	$Log.Y= \alpha+\beta.Log.X$	A 1% increase in X results in a variation (an increase or a decrease respectively in case of positive or negative coefficient) of Y by β%.
Specification with the dependent variable in logarithm and the explicative variable in level	$Log.Y= \alpha+\beta.X$	An increase in one unit of X results in a variation (an increase or a decrease respectively in case of positive or negative coefficient) of Y by (β*100) %.
Specification with the dependent variable in level and the explicative variable in logarithm	$Y= \alpha+\beta.Log.X$	A 1% increase in X results in a variation (an increase or a decrease respectively in case of positive or negative coefficient) of Y by (β/100) units.

Source: Author.

3.3 Data and descriptive statistics

The variables mainly come from five databases. Total health expenditures from overall sources, external resources for health are retrieved from the Global Health expenditures (GHE) database. The emissions of CO2, urbanization, the old dependency ratio, and GDP per capita growth are provided by the World Development Indicators (WDI) database. Tax revenue variables comes from the World Economic Outlook (WEO) database[23];whereas the indexes of government effectiveness, regulatory quality, corruption control, voice and accountability and rules of law are retrieved from the Worldwide Governance Indicators (WGI) database. Economic vulnerability index is retrieved from the FERDI database[24] (Feindouno and Goujon, 2016).Table 2.4 reports the descriptive statistics of used variables.

[23] http://www.imf.org/external/pubs/ft/weo/2017/01/weodata/index.aspx

[24] Fondation pour les Etudes et les Recherches sur le Développement International.

Table 2.4: Descriptive statistics (1995-2012)

Variables	Mean	Std.Dev.	CV	Median	Min	Max	Observations
Log.THEPC	5.163	1.066	0.207	5.197	2.609	7.248	444
Log.Pollution	13.366	1.356	0.101	13.6	9.737	16.143	444
Ext_Fin	20.020	30.614	1.529	12.020	0.521	318.265	444
EVI	36.627	12.809	0.350	35.450	11.388	85.043	444
Life expectancy	63.441	8.939	0.141	64.744	40.646	78.893	444
Old dependency	4.307	1.555	0.361	3.844	2.340	9.164	444
Tax	23.852	11.224	0.471	22.339	1.001	89.593	444
Growth	2.283	3.213	1.408	2.101	-29.074	13.033	444
Urban	43.102	19.171	0.445	40.990	8.037	87.304	444
Institutions	-1.040	1.194	-1.148	-1.009	-4.425	2.005	444
Effectiveness	-0.503	0.566	-1.125	-0.534	-2.143	1.083	444
Regulatory	-0.448	0.567	-1.265	-0.440	-2.261	0.916	444
Voice	-0.350	0.747	-2.131	-0.324	-2.199	1.224	444
Law	-0.516	0.614	-1.190	-0.545	-2.076	1.033	444
Corruption	-0.497	0.553	-1.113	-0.545	-1.803	1.165	444

Source: Author 'calculation using the WGI, the WDI, the WEO, the GHE and the FERDI databases. Note: Std.Dev: Standard Deviation. CV: Coefficient of Variation.

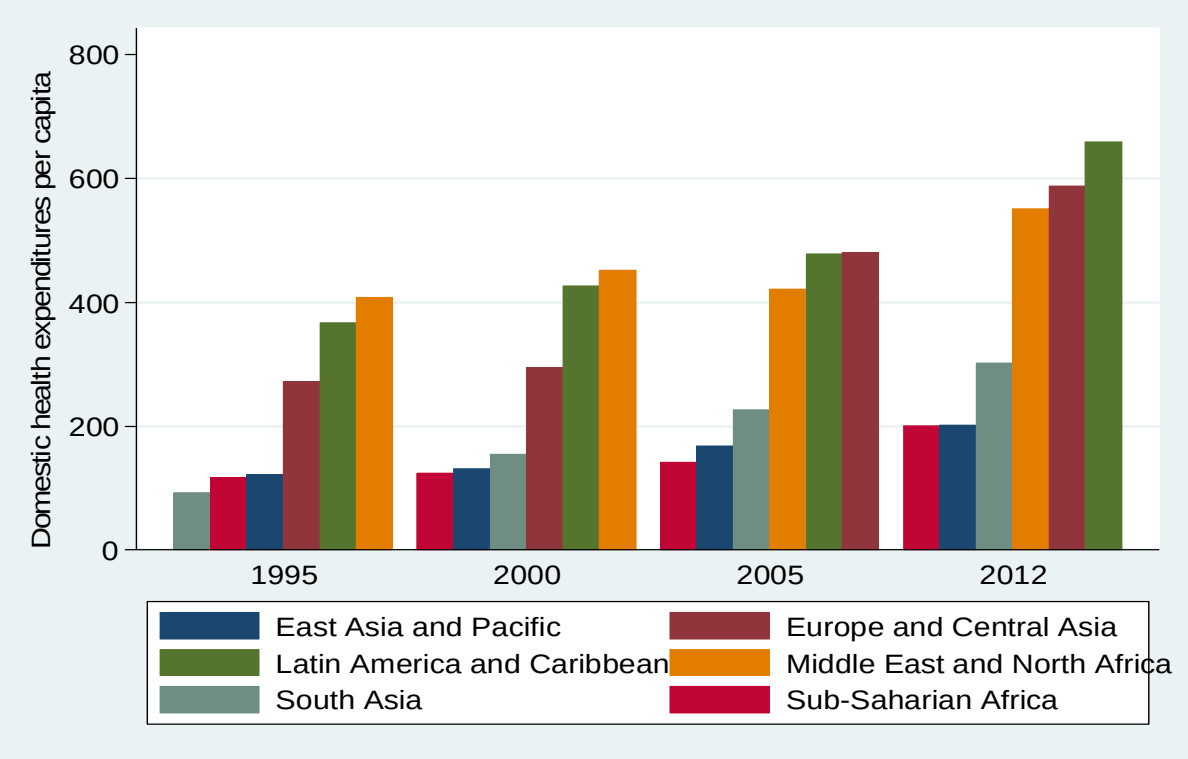
4. Results

4.1 Descriptive analysis on health expenditures and CO2 emissions

The goal of subsection is to analyze the distribution of domestic health expenditures per capita and CO2 emissions per capita. The statistical analysis of distributions consists of exploring the mean and the time trend of each variable by region. On this subject, the calculation of mean on the long period is not rigorous. Hence, for all countries, we calculate the mean of each variable for the four following years such as 1995, 2000, 2005 and 2012. We follow the World Bank classification to get six regions such as Europe and Central Asia, Latin America and Caribbean, East Asia and Pacific, South Asia, Middle East and North Africa and Sub-Saharan Africa.

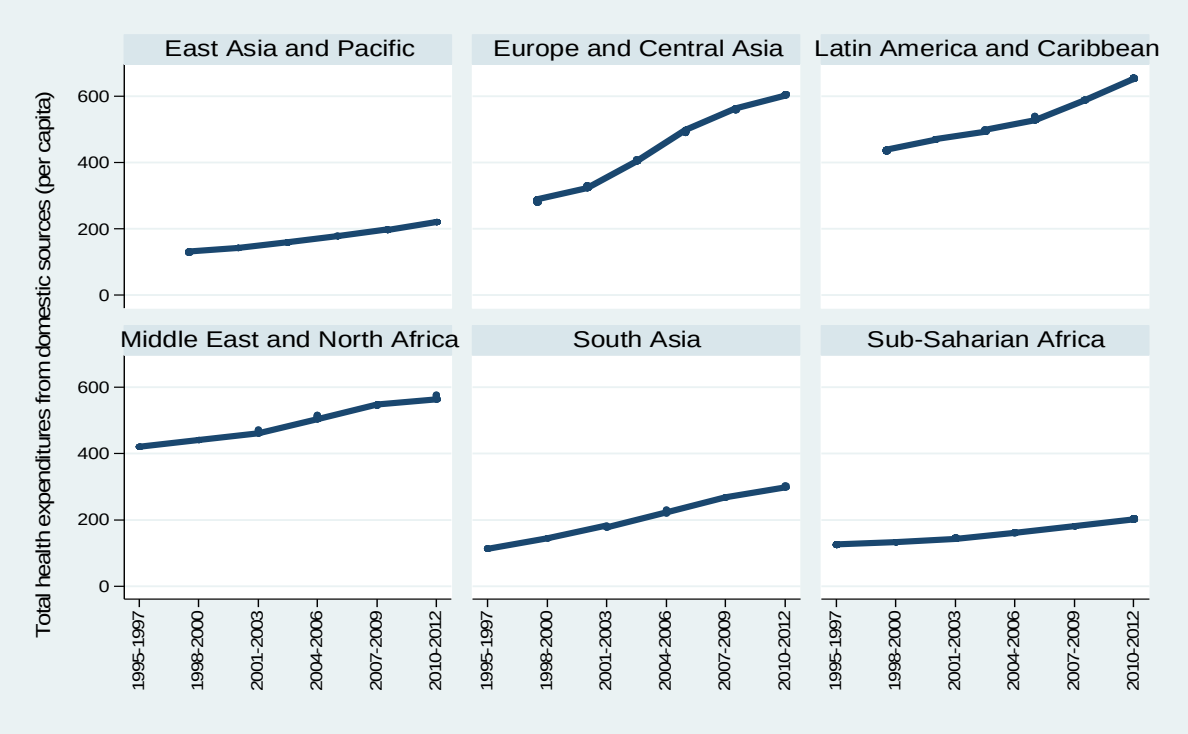
Concerning domestic health expenditures per capita, the findings reported in Graphic 2.3 reveal that Europe and Central Asian, Latin American and Caribbean and Middle East and North African countries record the highest health expenditures compared to East Asian and Pacific, South Asian and Sub-Saharan African countries for which domestic health expenditures per capita are the lowest. The second analysis performed on domestic health expenditures per capita stresses an increasing trend in all regions. It appears that Europe and Central Asian and Sub-Saharan African countries have respectively experienced the highest and the lowest increase in domestic health expenditures per capita (Graphic 2.4).

Graphic 2.3: Distribution of total domestic health expenditures in USD PPP per capita by region



Source: Author using the GHE database.

Graphic 2. 4: Time trend of total domestic health expenditures in USD PPP per capita by region (1995-2012)

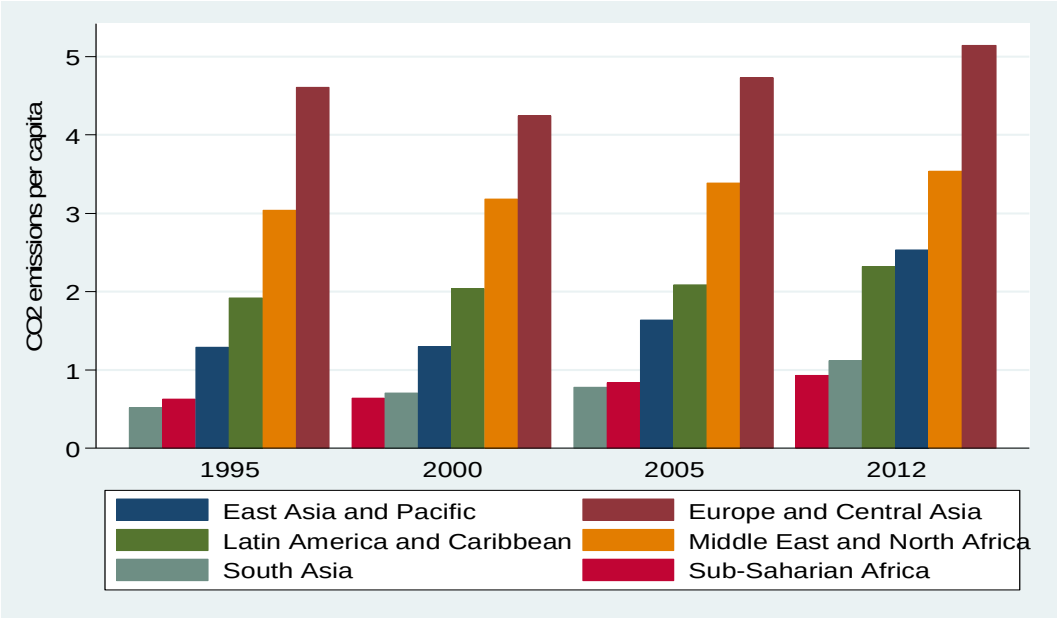


Source: Author using the GHE database.

Regarding CO2 emissions, we globally find that Europe and Central Asia, Latin America and Caribbean and Middle East and North Africa are the regions that pollute the most the atmosphere (Graphic 2.5). The lowest CO2 emissions per capita have been observed in Sub-Saharan Africa, in

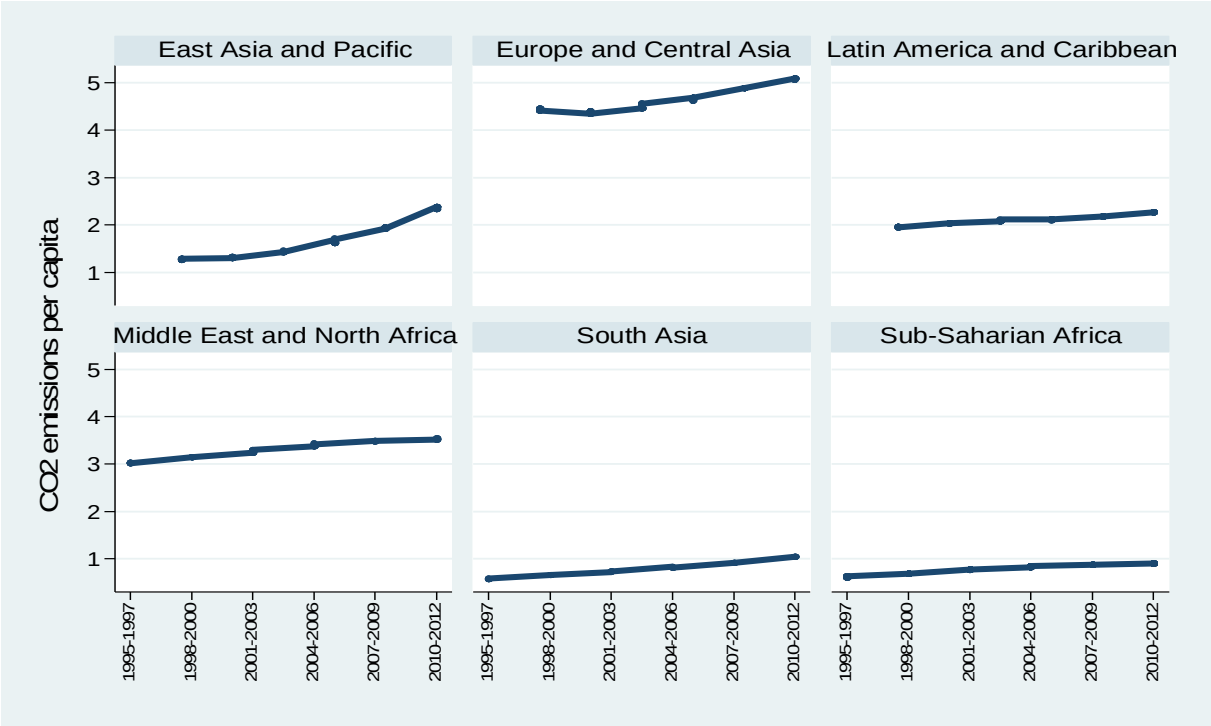
South Asia and in East Asia and Pacific. However, in 2012, East Asia and Pacific was ranked among the three most polluter regions whereas Middle East and North Africa is passed in the group of three least polluter regions. In addition, we observe that CO2 emissions have increased over time in all regions (Graphic 2.6). This increasing trend has been particularly low in the regions that emit the least the dioxide carbon (South Asia and Sub-Saharan Africa). In view of analysis, it appears that the smallest and the biggest polluters are respectively the regions which record the least and the highest levels of domestic health expenditures.

Graphic 2.5: Distribution of CO2 emissions in metric tons per capita by region



Source: Author using the WDI database.

Graphic 2.6: Time trend of CO2 emissions in metric tons per capita by region (1995-2012)

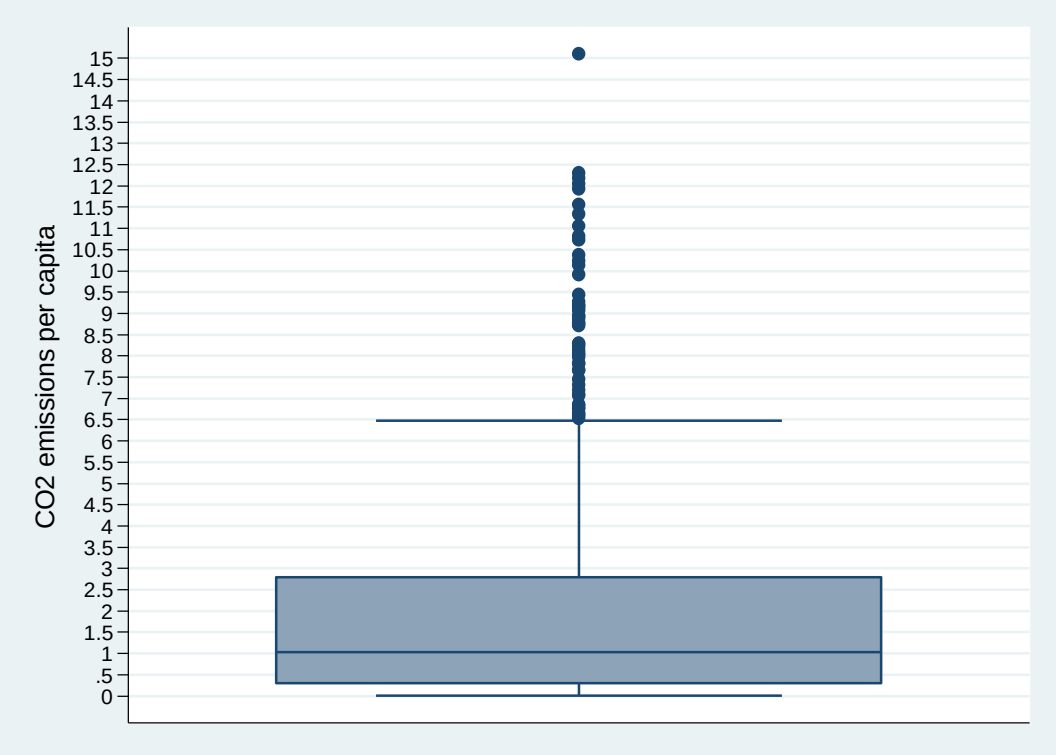


Source: Author using the WDI database.

4.2 Econometric regression results based on the effect of CO2 emissions on total health expenditures

Before performing the regressions, we check whether there are atypical countries that emit more CO2 compared to the others. The presence of atypical countries could result in biases in the estimations. Hence we depart from a box-plot analysis to select atypical countries (Graphic 2.7). We find five countries for which CO2 emissions are greater than 6.5 metric tons per capita. These are China, Libya, and Mongolia (at the period 6), Iran (at the periods 4 and 5) and South Africa (between the periods 3 and 6).

Graphic 2.7: Box-plot analysis of CO2 emissions in metric tons per capita (1995-2012)



Source: Authors using the WDI database.

In view of these last ones, we estimate the model with and without atypical countries to check whether they influence the results. The baseline results of estimations are reported in Table 2.5. The results reveal that the tested model with the three specifications significantly explains domestic health expenditures per capita. The Wald test on each tested specification provides chi-2 statistics for which the p-values are lower than the maximal acceptable threshold of 10%. Hence the null hypothesis of this test attesting the non-significance of model can be rejected.

In the specification excluding the interactive variables, we find that CO2 emissions lead to increase domestic health expenditures. The results show that a 1% increase in CO2 emissions per capita leads to reduce domestic health expenditures per capita by 0.435% and 0.432% respectively with and without atypical countries. In other words, a decrease by 1% in CO2 emissions per capita would allow saving 0.435% and 0.432% of domestic health expenditures per capita respectively with and without atypical countries. These percentages are respectively equivalent to average reductions of 1.12 and 1.10 USD PPP per capita.

Table 2.5: Baseline results of linear and conditional effects of CO2 emissions in metric tons per capita on total domestic health expenditures in USD PPP per capita (1995-2012)

Samples	With atypical countries			Without atypical countries		
Specifications	(1)	(2)	(3)	(1)	(2)	(3)
$Log.Pollution_{t-1}$	0.435***	0.409***	0.351***	0.432***	0.405***	0.347***
	(27.707)	(22.787)	(10.785)	(24.954)	(20.964)	(10.241)
Ext_Fin_{t-1}	-0.001**	-0.019***	-0.001***	-0.001**	-0.019***	-0.001***
	(-2.447)	(-2.767)	(-3.109)	(-2.551)	(-2.788)	(-3.180)
EVI_{t-1}	-0.003***	-0.004***	-0.031***	-0.003***	-0.003***	-0.032***
	(-3.480)	(-3.633)	(-2.901)	(-3.184)	(-3.470)	(-2.930)
$Log.Pollution_{t-1}*Ext\_Fin_{t-1}$		0.001***			0.001***	
		(2.600)			(2.614)	
$Log,Pollution_{t-1}*EVI_{t-1}$			0.002***			0.002***
			(2.616)			(2.666)
Life $expectancy_{t-1}$	0.004**	0.005***	0.004**	0.005**	0.006***	0.006***
	(1.969)	(2.682)	(2.271)	(2.311)	(3.057)	(2.656)
Old dependency	0.112***	0.110***	0.113***	0.125***	0.124***	0.126***
	(8.803)	(8.396)	(8.398)	(9.847)	(9.514)	(9.347)
Tax_{t-1}	0.004***	0.005***	0.004***	0.004***	0.005***	0.004***
	(5.165)	(5.667)	(5.106)	(5.194)	(5.780)	(5.204)
$Growth_{t-1}$	0.006***	0.006***	0.005***	0.007***	0.007***	0.006***
	(2.820)	(2.845)	(2.600)	(3.192)	(3.194)	(2.970)
$Urban_{t-1}$	0.009***	0.009***	0.009***	0.009***	0.008***	0.008***
	(11.909)	(10.940)	(10.549)	(10.516)	(9.803)	(9.474)
Institutions	0.102***	0.104***	0.102***	0.088***	0.090***	0.086***
	(8.145)	(8.312)	(7.774)	(6.875)	(6.953)	(6.393)
Constant	-1.645***	-1.368***	-0.561	-1.717***	-1.423***	-0.621
	(-8.650)	(-6.329)	(-1.293)	(-8.635)	(-6.420)	(-1.409)
Observations	443	443	443	434	434	434
Wald test : chi2 statistics (significance of models)	7202.154***	5767.364***	5234.850***	6403.779***	5767.893***	5081.305***

Note: t statistics in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Next, it appears that an increase in one USD PPP per capita of external resources for health results in a decrease in domestic health expenditures per capita by 0.1% with and without atypical countries. This coefficient attests that the allocation of external resources for health induces low- and middle-income countries to reduce their domestic resources affected to health. In addition, for one unit increase in economic vulnerability index, domestic health expenditures per capita decrease by 0.3% in the samples including and excluding atypical countries.

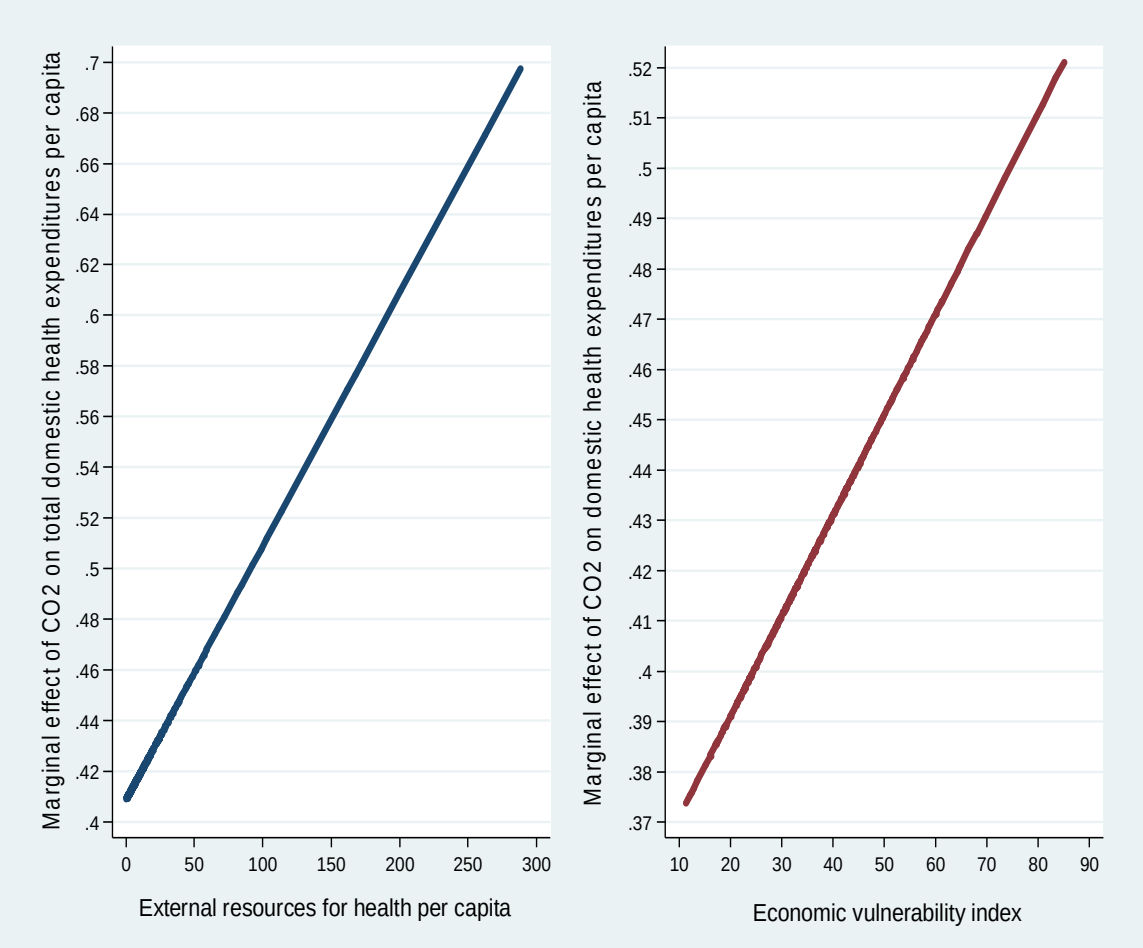
In the specification including the interactive variables, we find that CO2 emissions continue to increase domestic health expenditures; whereas external resources for health and economic vulnerability lead to reduce the volume to these expenditures. It appears that external resources for health and economic vulnerability contribute to further increase the positive effect of CO2 emissions on domestic health expenditures. In other words, in countries receiving higher flows of external resources for health and/or which are more vulnerable, CO2 emissions further increase domestic

health expenditures. This result can be explained by the negative effects of external resources for health and economic vulnerability on domestic health expenditures.

In the sense where these variables contribute to reduce domestic health expenditures, health systems will benefit from fewer resources to counter the illnesses coming from air pollution. In this way, air pollution will further increase domestic health expenditures. The mentioned results lowly vary when atypical countries are removed from the sample. The influence of external resources and economic vulnerability on the marginal effect of CO2 emissions on domestic health expenditures can be summarized through Graphic 2.8 focused on the sample with atypical countries. We have chosen to represent graphic by including atypical countries because the results do not drastically change when atypical countries are removed from the sample. Hence we continue the analyses with the sample including atypical countries to keep more information in our investigations. Through Graphic 2.8, it appears that the marginal effect of CO2 emissions on domestic health expenditures increases as soon as external resources for health and economic vulnerability increase.

Concerning the other explanatory variables, it appears that the life expectancy, the old dependency ratio and tax revenue as percentage of GDP, economic growth, urbanization and institutional quality lead to increase domestic health expenditures per capita. These findings remain robust with the removing of atypical countries.

Graphic 2.8: Representative graphic of interactive effect between CO2 emissions in metric tons per capita and external resources for health in USD per capita and economic vulnerability index on total domestic health expenditures in USD PPP per capita (1995-2012)



Source: Author.

4.3 Testing the effect of CO2 emissions on the structure and the composition of health expenditures

In the previous analysis, we have found that CO2 emissions contribute to increase total health expenditures from domestic sources. Now we are testing this effect by regarding the components of health expenditures. It has been impossible to use the components of health expenditures coming from domestic sources because we have not gotten information about the distribution of external resources for health by type of expenditures.

Hence, we use the components of health expenditures from overall sources. We follow the most disaggregated categorization (see above in the subsection 2.1) of these last ones to select four components such as central government health expenditures, health insurance expenditures, NGOs health expenditures and out-of-pocket payments; all expressed not only in PPP USD per capita but also as share of total health expenditures[25]. All of these variables are retrieved from the Global Health Expenditures (GHE) database.

Before performing the regressions we shall carry out a descriptive analysis of various components of health expenditures and their statistical relationship with CO2 emissions. Then we shall estimate on the one hand the effect of CO2 emissions on the volume per capita of components and on the other one, their effect on the composition of health expenditures.

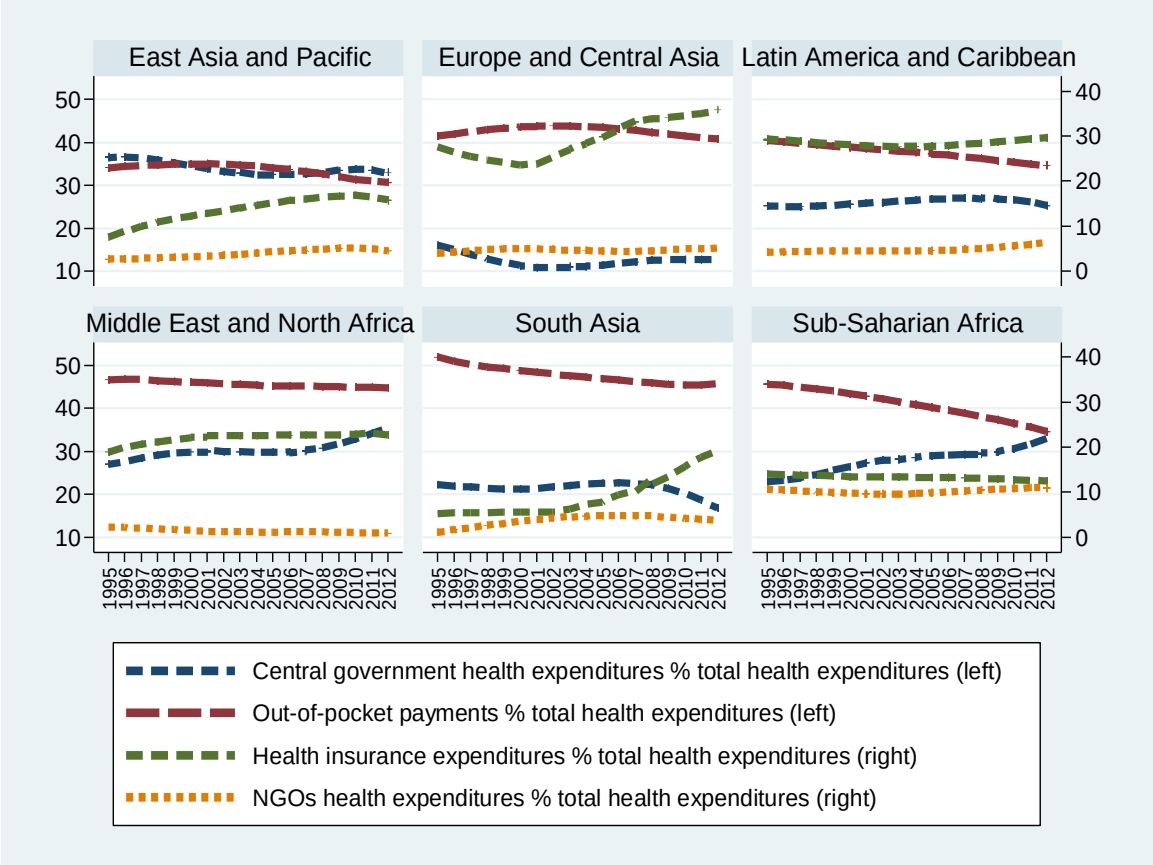
4.3.1 Descriptive analysis in the structure and the composition of health expenditures and their statistical relationship with CO2 emissions

Firstly, we analyze the level and the time trend of composition to health expenditures by region. For each region, we calculate the mean by year of central government health expenditures, health insurance expenditures, out-of-pocket payments and NGOs health expenditures as percentage of total health expenditures (Graphic 2.9). We find in all regions that health systems are majorly financed through the out-of-pocket payments. That shows that in major part of low- and middle-income countries, the out-of-pocket payments remain the main source of health financing. After the out-of-pocket payments, central government expenditures and health insurance expenditures constitute the second source of health financing respectively in East Asia and Pacific and in Europe and Central Asia. Generally, the NGOs remain the agents that finance the least health in low- and middle-income countries.

Then, the time trend of investigated variables shows that health financing through the out-of-pocket payments has decreased in the major part of regions, except in Europe and Central Asia where it has not widely varied. The contribution of insurance schemes to health financing has increased in East Asia and Pacific, in South Asia and in Europe and Central Asia. It has slightly increased and decreased respectively in Middle East and North Africa and in Sub-Saharan Africa whereas it has stagnated in Latin America and Caribbean. Central government health expenditures and NGOs health expenditures as percentage of total health expenditures have not widely progressed over time in all regions. In Sub-Saharan African countries, the participation of central governments to health financing has increased.

[25] The null values of used variables per capita and as share of total health expenditures are removed from the sample.

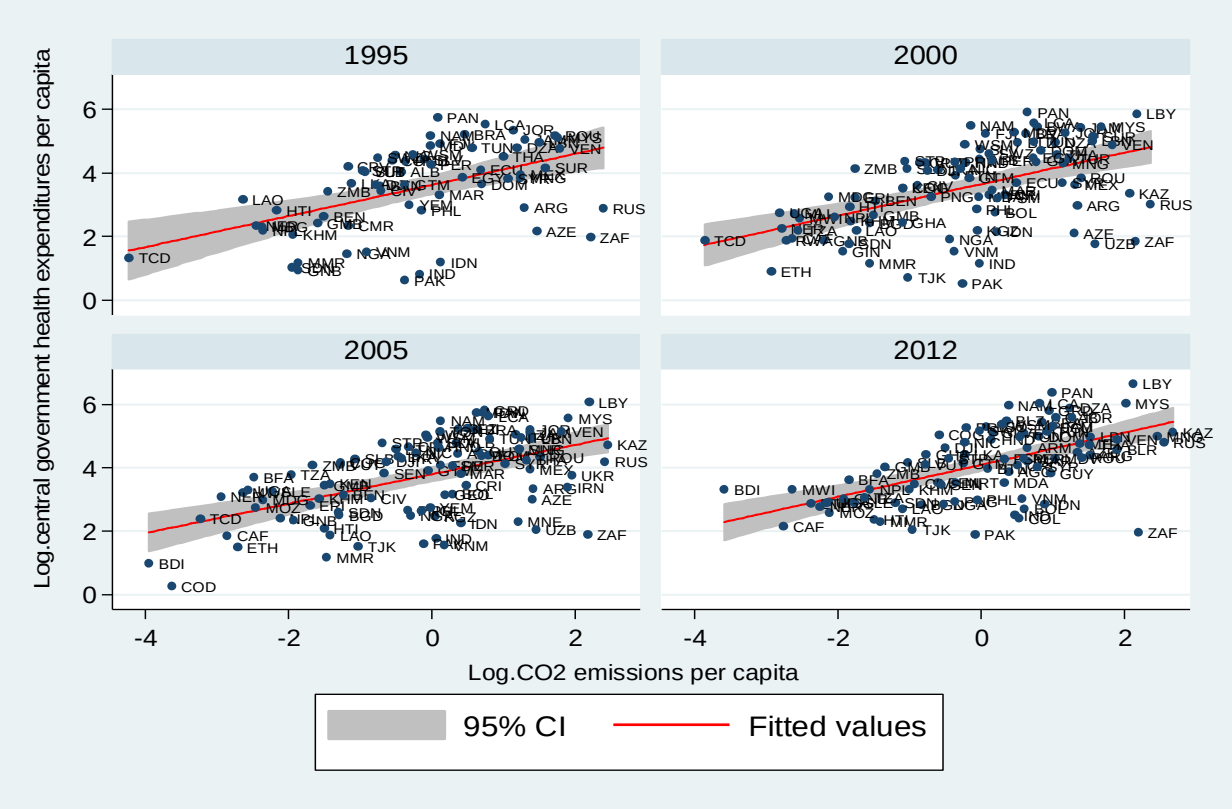
Graphic 2.9: Time trend of composition of total health expenditures from overall sources by region (1995-2012)



Source: Author using the GHE database.

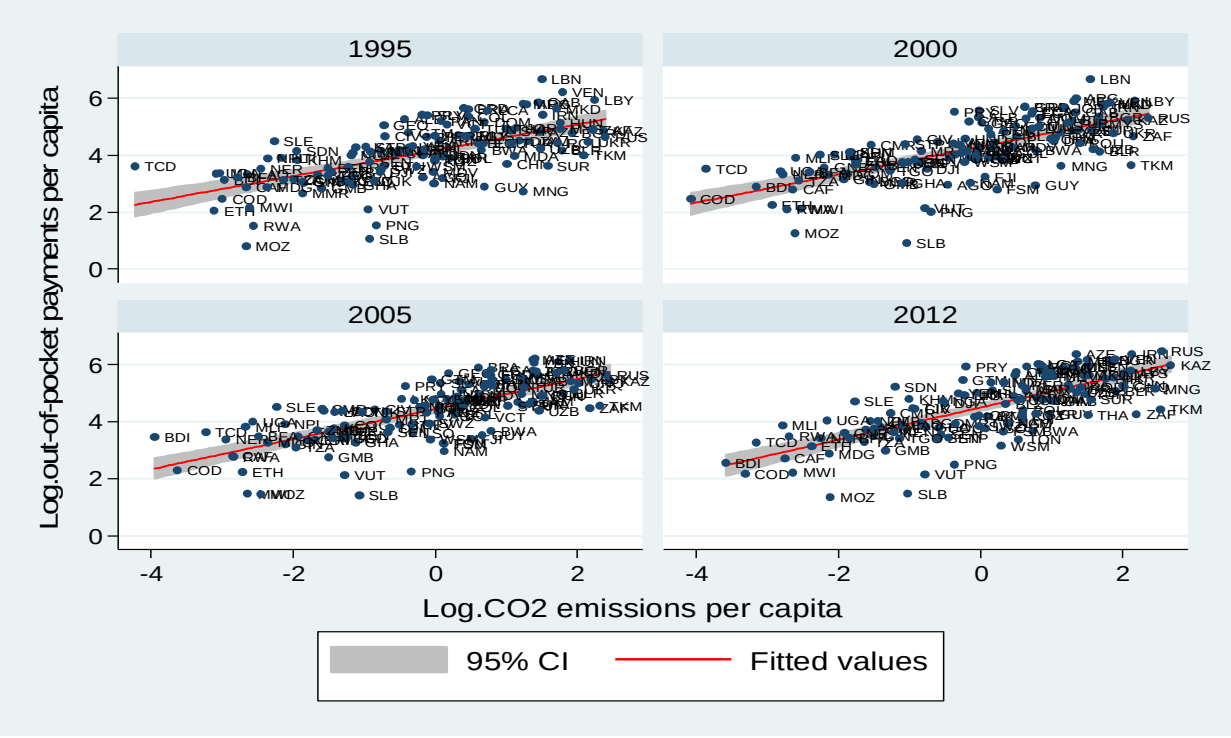
Secondly, we explore the statistical relationship between CO2 emissions per capita and the components of health expenditures expressed not only in USD PPP per capita and as percentage of total health expenditures. We focus on the years mentioned above such as 1995, 2000, 2005 and 2012. It appears a positive correlation between CO2 emissions and central government health expenditures (Graphic 2.10), out-of-pocket payments (Graphic 2.11), health insurance expenditures (Graphic 2.12) and NGOs health expenditures (Graphic 2.13), all expressed in USD PPP per capita. In addition, we observe that CO2 emissions statistically increase the contribution to health financing of all health expenditures 'components (Graphics 2.14 2.15, 2.16); exception made for health insurances expenditures for which the participations diminishes with the increase in CO2 emissions (Graphic 2.16).

Graphic 2.10: Scatter plots between the log of CO2 emissions in metric tons per capita and the log of central government health expenditures in USD PPP per capita



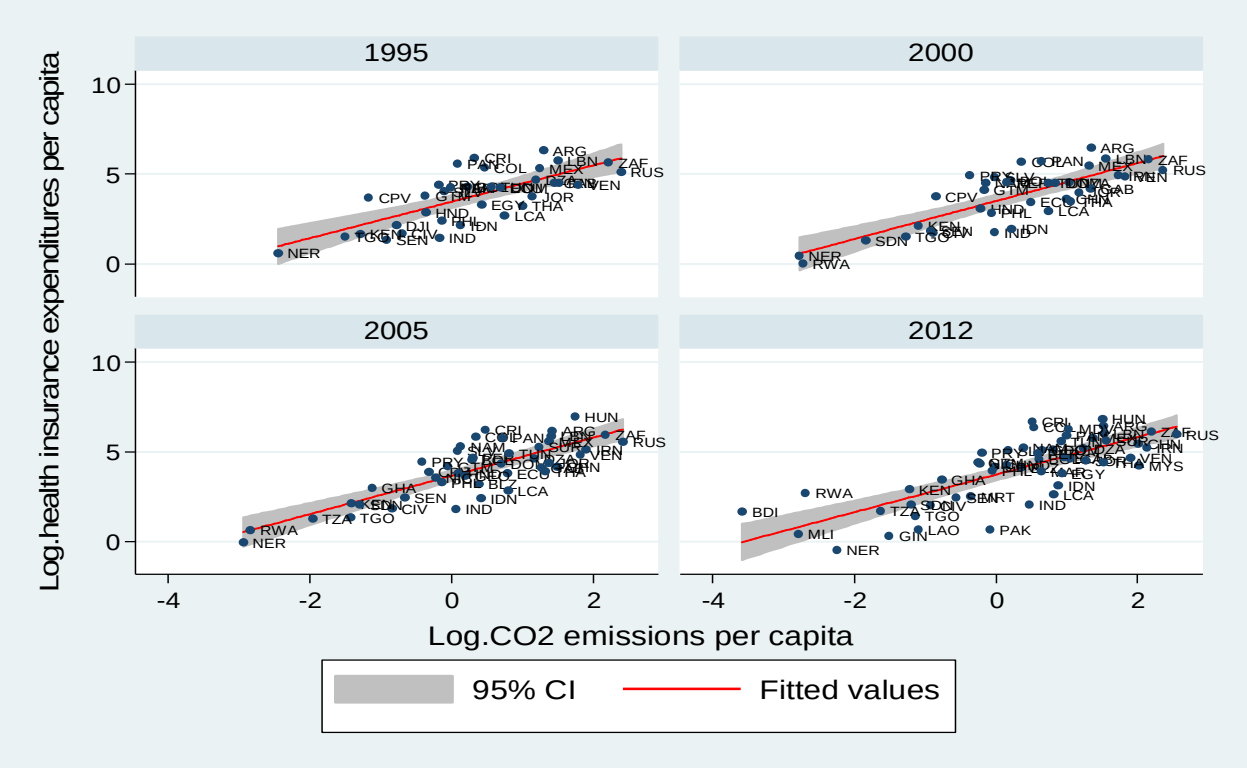
Source: Author using the using the GHE and the WDI databases.

Graphic 2.11: Scatter plots between the log of CO2 emissions in metric tons per capita and the log of out-of-pocket payments in USD PPP per capita



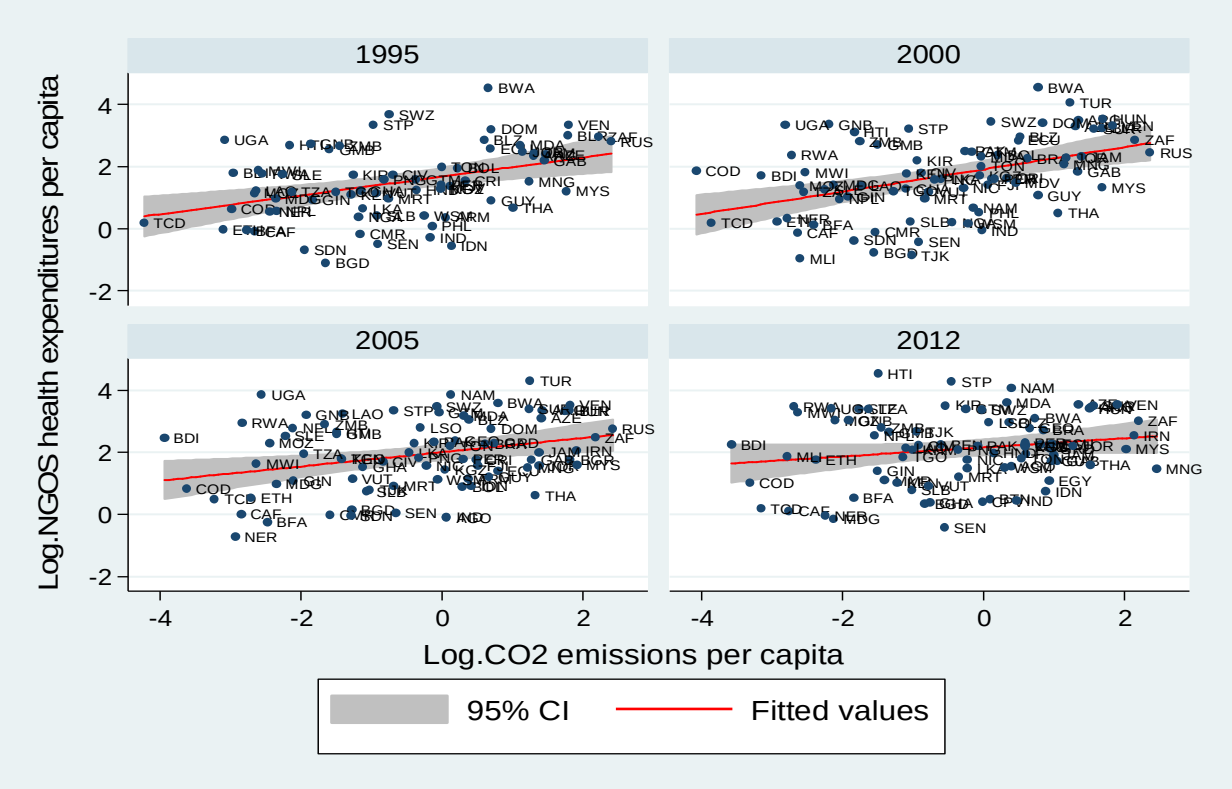
Source: Author using the using the GHE and the WDI databases.

Graphic 2.12: Scatter plots between the log of CO2 emissions in metric tons per capita and the log of health insurance expenditures in USD PPP per capita



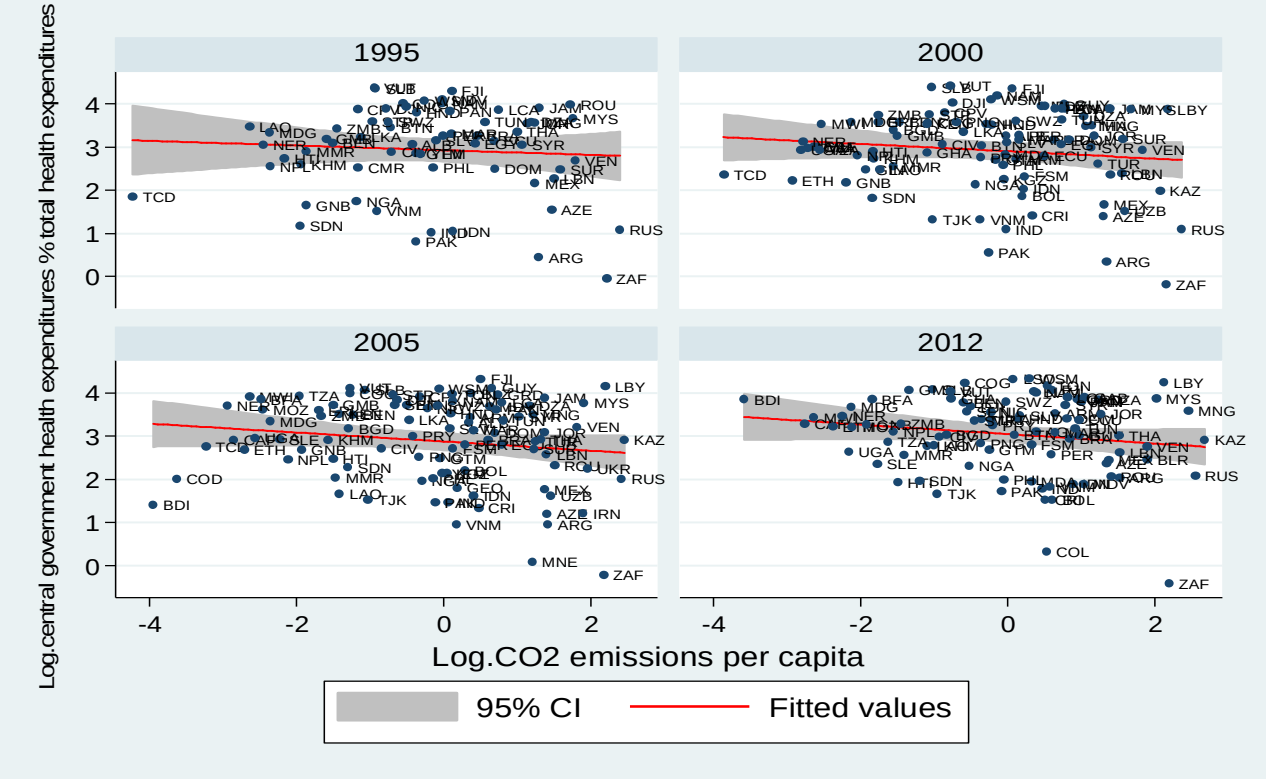
Source: Author using the using the GHE and the WDI databases.

Graphic 2. 13: Scatter plots between the log of CO2 emissions in metric tons per capita and the log of NGOs health expenditures in USD PPP per capita



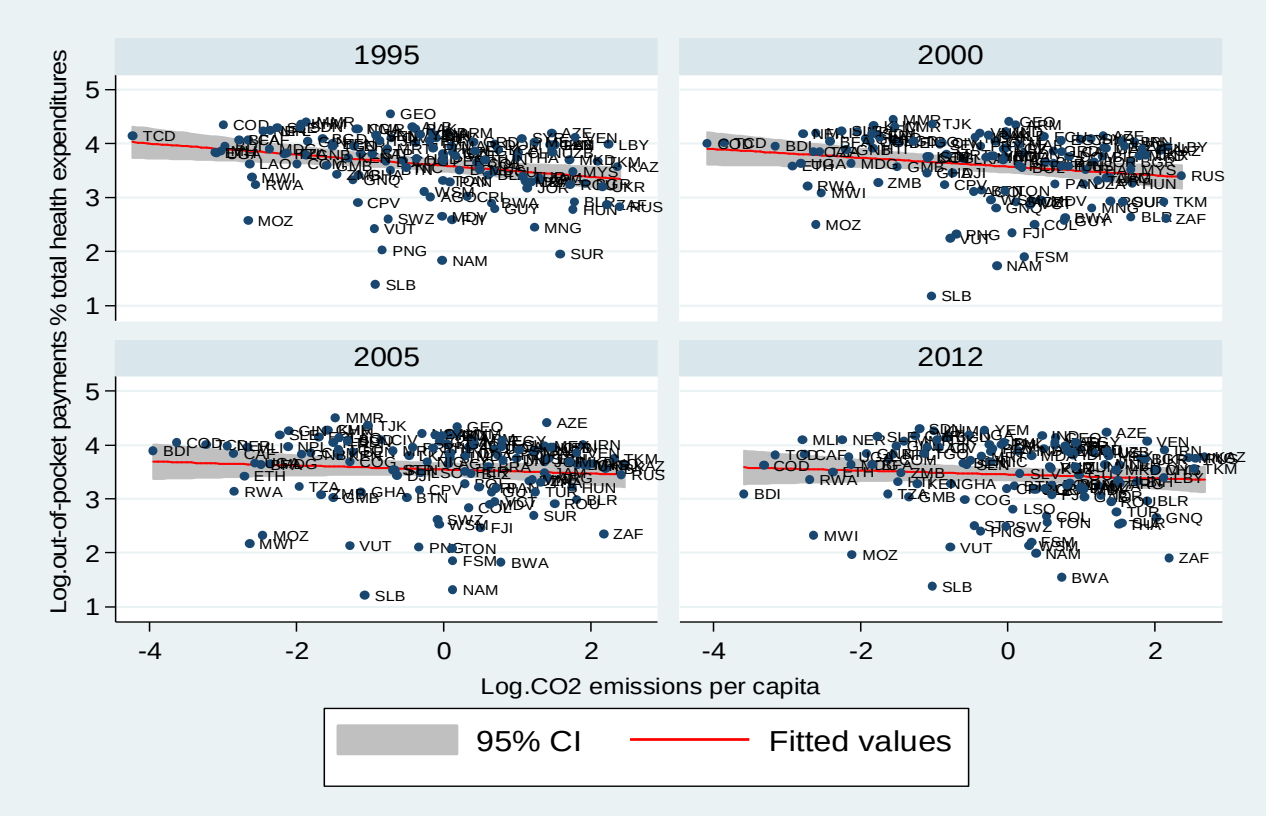
Source: Author using the using the GHE and the WDI databases.

Graphic 2.14: Scatter plots between the log of CO2 emissions in metric tons per capita and the log of central government health expenditures as percentage of total health expenditures from overall sources



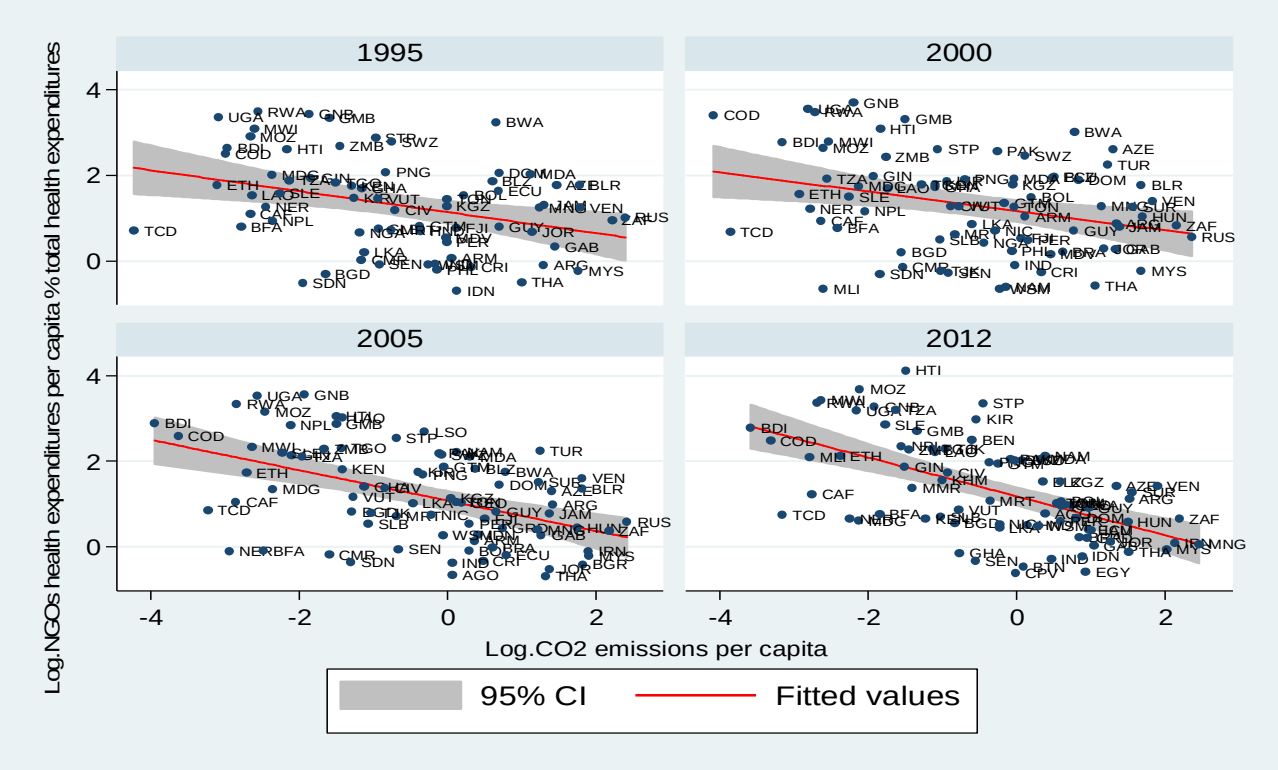
Source: Author using the using the GHE and the WDI databases.

Graphic 2.15: Scatter plots between the log of CO2 emissions in metric tons per capita and the log of out-of-pocket payments as percentage of total health expenditures from overall sources



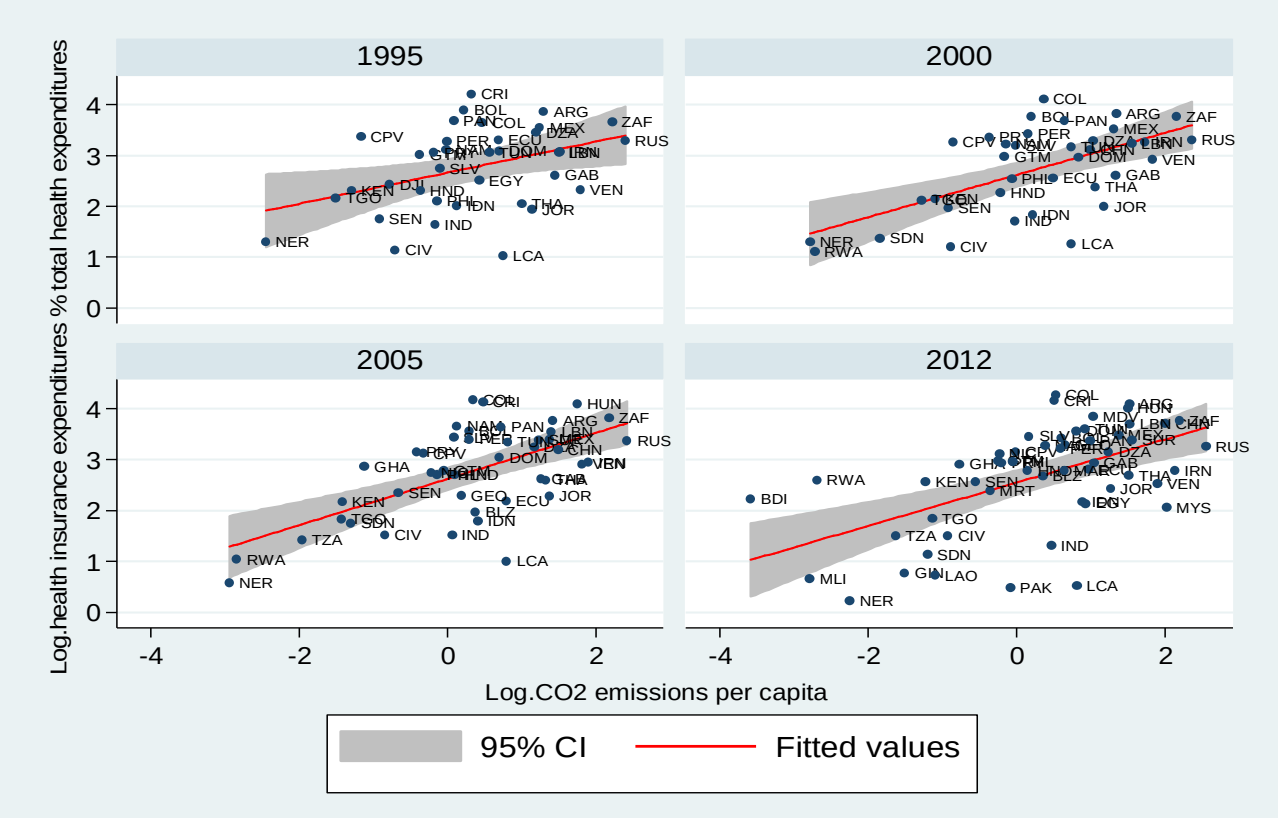
Source: Author using the using the GHE and the WDI databases.

Graphic 2.16: Scatter plots between the log of CO2 emissions in metric tons per capita and the log of NGOs health expenditures as percentage of total health expenditures from overall sources



Source: Author using the using the GHE and the WDI databases.

Graphic 2.17: Scatter plots between the log of CO2 emissions in metric tons per capita and the log of health insurance expenditures as percentage of total health expenditures from overall sources



Source: Author using the using the GHE and the WDI databases.

4.3.2 Testing the effect of CO2 emissions on the volume per capita of health expenditures' components

Here, we use the same econometric method used to test the effect of CO2 emissions on domestic health expenditures. We firstly test the effect of CO2 emissions on the components health expenditures (central government health expenditures, health insurance expenditures, out-of-pocket payments and NGOs health expenditures) expressed in USD PPP per capita. In the estimations, the all starting control variables are used, except the interactive variables. Like domestic health expenditures, the all components of health expenditures are transformed into logarithm. Indeed, the relationship between the last ones and CO2 emissions per capita appears less perceptible when the health expenditures 'components are not transformed in logarithmic form (Annex 2.2).

The goal of these estimations is to check whether CO2 emissions increase in the same way, the volume of all components of health expenditures. However, we admit the presence of reverse causality bias between the components of health expenditures, mostly central government health expenditures (including a large proportion of external resources for health) and the variable of external resources for health. This bias is dampened by the use of first lag of external resources for health variable.

Furthermore, in the model explaining NGOs health expenditures, the variable of external resources for health is excluded because NGOs health expenditures constitute the private component of external resources for health. They are consequently included in external resources for health. The baseline results of estimations are reported in Table 2.6.

The results reveal a one again through the Wald test on each tested specification that the estimated model significantly explains all of health expenditures 'components. Within the model, the results show that CO2 emissions lead to increase the volume of all health expenditures 'components. For a 1% increase in CO2 emissions per capita, central government health expenditures, health insurance expenditures, the out-of-pocket payments and NGOs health expenditures, all expressed in USD PPP per capita, respectively increase by 0.149%, 0.411%, 0.166% and 0.170%. It appears that CO2 emissions affect more health insurance expenditures comparatively to the other components of health expenditures. To confirm these findings, we test in a second series of estimations, the effect of CO2 emissions on the components of health expenditures now expressed as share of total health expenditures and transformed in logarithmic term for the same reason evoked above in this subsection (Annex 2.3).

Table 2.6: Baseline results of effect of CO2 emissions in metric tons per capita on the components of total health expenditures from overall sources expressed in USD PPP per capita (1995-2012)

Dependent variables	Logarithm of out of pocket payments per capita	Logarithm of central government health expenditures per capita	Logarithm of health insurance expenditures per capita	Logarithm of NGOs health expenditures per capita
$Log.Pollution_{t-1}$	0.166***	0.149***	0.411***	0.170***
	(7.185)	(7.191)	(10.624)	(3.824)
Ext_Fin_{t-1}	0.001	-0.002***	-0.003*	
	(1.009)	(-3.000)	(-1.906)	
EVI_{t-1}	-0.016***	0.018***	0.010***	0.007**
	(-12.769)	(10.963)	(4.114)	(2.396)
Life $expectancy_{t-1}$	0.011***	0.017***	0.050***	-0.022***
	(4.510)	(5.874)	(10.767)	(-5.695)
Old dependency	0.163***	0.060***	0.031	0.109***
	(11.117)	(4.029)	(1.303)	(4.412)
Tax_{t-1}	-0.004**	0.032***	0.002	0.003
	(-2.362)	(15.205)	(0.520)	(0.929)
$Growth_{t-1}$	0.007***	-0.007**	0.007**	0.004
	(4.271)	(-2.448)	(1.968)	(1.367)
$Urban_{t-1}$	0.018***	0.009***	0.033***	0.009***
	(12.790)	(7.876)	(19.578)	(3.565)
Institutions	-0.059***	0.311***	0.165***	0.090***
	(-4.028)	(20.019)	(5.409)	(3.470)
Constant	0.424	-0.956***	-7.231***	-0.335
	(1.406)	(-7.388)	(-16.867)	(-0.647)
Observations	438	380	190	317
Number of countries	96	90	44	73
Wald test : chi2 statistics (significance of models)	2558.776***	3825.572***	4250.124***	185.043***

Note: t statistics in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

4.3.3 Testing the effect of CO2 emissions on health expenditures' components as share of total

Here the goal is to identify the components of health expenditures which support the most health cost of air pollution. Let consider for example the component X and its contribution o health financing expressed as follows: (X/total health expenditures from overall sources)*100. Let also suppose two specific cases in which CO2 emissions respectively increase and reduce this percentage.

In the first case (positive effect), X supports the most, health cost of CO2 emissions and their associated diseases. This positive effect would mean that air pollution more than proportionally increases the volume of X comparatively to the one of total health expenditures. Given the inclusion of X in total health expenditures, the positive effect would precisely mean that the increasing effect of air pollution on the volume X is higher than the one estimated on the level of the other components of health expenditures.

In the second case (negative effect), X supports the least, health cost of CO2 emissions; a fact would reveal that air pollution less than proportionally increases the volume of X comparatively to the one of the other health expenditures 'components. The baseline findings of estimations are reported in Table 2.7.

Table 2.7: Baseline results of effect of CO2 emissions in metric tons per capita on the composition of total health expenditures from overall sources (1995-2012)

Dependent variables	Logarithm of out of pocket payments as % total health expenditures	Logarithm of central government health expenditures as % total health expenditures	Logarithm of NGOs health expenditures as % total health expenditures	Logarithm of health insurance expenditures as % total health expenditures	Logarithm of health insurance expenditures as % total health expenditures
$Log.Pollution_{t-1}$	-0.058***	-0.130***	-0.144***	0.070*	0.263***
	(-3.291)	(-6.321)	(-3.884)	(1.803)	(3.028)
Ext_Fin_{t-1}	-0.001**	-0.004***		-0.001	0.001
	(-1.973)	(-5.240)		(-1.213)	(0.709)
EVI_{t-1}	-0.014***	0.015***	0.015***	0.005**	0.093***
	(-10.358)	(8.627)	(7.340)	(2.135)	(3.573)
$Log,Pollution_{t-1}*EVI_{t-1}$					-0.006***
					(-3.298)
$Life\ expectancy_{t-1}$	0.003	0.015***	-0.036***	0.032***	0.028***
	(1.360)	(4.396)	(-8.719)	(6.479)	(6.913)
Old dependency	0.025**	-0.006	0.054**	0.012	0.011
	(2.250)	(-0.287)	(2.304)	(0.437)	(0.486)
Tax_{t-1}	-0.014***	0.019***	-0.008**	-0.006*	-0.002
	(-10.329)	(10.356)	(-2.428)	(-1.701)	(-0.536)
$Growth_{t-1}$	0.002	-0.010***	0.003	-0.001	-0.002
	(0.987)	(-4.034)	(1.317)	(-0.223)	(-0.484)
$Urban_{t-1}$	0.002*	-0.001	-0.001	0.016***	0.017***
	(1.959)	(-1.072)	(-0.363)	(5.460)	(7.075)
Institutions	-0.165***	0.170***	0.011	0.163***	0.161***
	(-13.521)	(12.840)	(0.395)	(6.077)	(6.020)
Constant	4.677***	3.313***	4.687***	-1.143**	-3.990***
	(23.532)	(27.143)	(9.907)	(-2.136)	(-3.211)
Observations	438	380	317	190	190
Number of countries	96	90	73	44	44
Wald test : chi2 statistics (significance of models)	600.016***	849.776***	281.649***	453.301***	953.433***

Note: t statistics in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

The estimations show that CO2 emissions decrease the contribution of central government health expenditures, out-of-pocket payments and NGOs health expenditures to health financing. A 1% increase in CO2 emissions per capita leads to decrease the percentage in total health expenditures of central government health expenditures, out-of-pocket payments and NGOs health expenditures respectively by 0.13%, 0.058% and 0.144%. However, CO2 emissions appear to increase health insurance expenditures as share of total health expenditures. On this subject, a 1% increase in CO2 emissions per capita contributes in increasing health insurance expenditures as percentage of total health expenditures by 0.07%.

The results stress that health cost of air pollution due to CO2 emissions is more supported by health insurance schemes. They consequently reveal that the other agents of health systems, mostly central government and households (through the out-of-pocket payments) get used to air pollution and its associated diseases by reallocating their resources in favour of health insurance development. The goal of this supposed strategy is to counter health cost of air pollution. Health insurance schemes have the advantage to share the risk coming from diseases in general fashion and more specifically from the ones due air pollution. Consequently, health insurance schemes would allow reducing the cost of healthcare caused by these diseases. Central governments could decide for example to increase their

health resources dedicated to social security and households could be encouraged to subscribe to private health insurance contracts than directly pay health fees.

In view of evidences, it would be more interesting to check whether external resources for health and economic vulnerability would influence CO2 emissions effect on the contribution of health insurance schemes to health financing. In other words, we attempt to know whether the adaptation capacity of health systems 'agents to air pollution and its associated diseases would be lower of higher in the most vulnerable countries and in countries receiving higher external resources for health. However, we have found that external resources for health do not significantly affect the percentage in total health expenditures of health insurance expenditures. We consequently re-estimate the model using as dependent variable health insurance expenditures as share of total health expenditures by including only the interactive variable between CO2 emissions variable and economic vulnerability index (see the last column of Table 2.7).

We find one again that CO2 emissions increase the percentage in total health expenditures of health insurance expenditures. It also appears that economic vulnerability has the consequence to reduce the positive effect of CO2 emissions on the contribution of health insurance schemes to health financing. The evidence reveals that the agents of health systems in the most vulnerable countries less get used to air pollution and its associated diseases.

4.3.4 Testing the effect of other explanatory variables on the structure and the composition of health expenditures.

- Looking at the control variables, we find that external resources for health reduce the volume per capita of central government health expenditures and insurance expenditures but they do not significantly affect the one of out-of-pocket payments. They modify the composition of health expenditures by reducing the share of out-of-pocket payments and central government health expenditures.

- Economic vulnerability increases central government health expenditures, health insurance expenditures and NGOs health expenditures but it decreases the out-of-pocket payments, all expressed in per capita. It modifies the composition of health expenditures by increasing the share of central government health expenditures, NGOs health expenditures and health insurance expenditures and by decreasing the one of out-of-pocket payments.

- The life expectancy increases central government health expenditures, health insurance expenditures and the out-of-pocket payments and decreases NGOs health expenditures, all expressed in per capita. It modifies the composition of health expenditures by increasing the share of central government health expenditures and health insurance expenditures and by decreasing the one of NGOs health expenditures.

- The old dependency ratio increases the out-of-pocket payments, central government health expenditures and NGOs health expenditures per capita but it does not significantly affect health insurance expenditures per capita. It modifies the composition of health expenditures by increasing the share of out-of-pocket payments and NGOs health expenditures.

- Tax revenue increase central government health expenditures per capita and decrease the out-of-pocket payments per capita. They do not significantly affect the volume per capita of NGOs health expenditures and health insurance expenditures. It modifies the composition of health expenditures by increasing the share of central government health expenditures and by decreasing the one of out-of-pocket payments, NGOs health expenditures and health insurance expenditures.

- Economic growth contributes in increasing the volume per capita of out-of-pocket payments and health insurance expenditures. It reduces central government health expenditures per capita but its effect on NGOs health expenditures does not significant. It modifies the composition of health expenditures by decreasing the share of central government health expenditures

- Urbanization leads to increases the volume per capita of all health expenditures' components and modifies their composition by increasing the share of health insurance expenditures and out-of-pocket payments.

- Institutional quality contributes in increasing central government health expenditures, health insurance expenditures and NGOs health expenditures and decreases the out-of-pocket payments, all expressed in per capita. It modifies the share of health expenditures by increasing the share of central government health expenditures, health insurance expenditures and by decreasing the one of out-of-pocket payments

5. Conclusion

While the challenge of improving their populations 'health status is not yet completely met due to the shortfall in financial resources for health, low-and middle-income countries have to face a new constraint: environmental degradation, particularly air pollution and its financial costs for their health system. In the context of universal health coverage implementation and achievement, countries need to reduce air pollution to save funds for health. To clarify this assumption, the chapter has suggested exploring the empirical effect of air pollution approximated by CO2 emissions in metric tons per capita on health expenditures. We use a unbalanced panel-data model encompassing 99 low-and middle-income countries over the period 1995-2012 sub-divided into six sub-periods of three years: 1995-1997, 1998-2000, 2001-2003, 2004-2006, 2007-2009 and 2010-2012.

We focus on the Feasible Generalized Least Squares estimator. The econometric model is controlled for the demographic factors including urbanization (the percentage in the total population of persons living in urban areas), the old dependency ratio (the percentage of elderly individuals aged 65 and above), institutional quality approximated by a composite index (including four sub-indexes such as government effectiveness, regulatory quality, the voice and accountability, rules of law and the control of corruption), the life expectancy at birth measuring health status, economic growth, tax revenue, external resources for health and economic vulnerability.

We have tested the effect of CO2 emissions not only on total domestic health expenditures per capita but also on the components of total health expenditures from overall sources such as central government health expenditures per capita, health insurance expenditures per capita, NGOs health expenditures per capita and the out-of-pocket payments per capita. We have also estimated this effect on the composition of health expenditures to identify the agents intervening in health financing for with the budget allocated to health financing is the most affected by air pollution and its associated diseases. Furthermore, we have explored the factors which could influence air pollution effect on health expenditures. We have tested interactive effects between CO2 emissions and external resources for health and between CO2 emissions and economic vulnerability.

Our investigations reveal the following evidences:

- Air pollution increases total health expenditures from domestic sources. This effect remains higher in the most vulnerable countries and in ones that receive more external resources for health (due to their fungibility effects).

- Air pollution increases the per capita volume of central government health expenditures, health insurance expenditures, NGOs health expenditures and the out-of-pocket payments. This effect remains higher on health insurance expenditures.

- Air pollution modifies the composition of health expenditures by decreasing the share of all components of health expenditures; exception made for health insurance expenditures for which the contribution to health financing increases with air pollution.

- Health insurance schemes remain the only agent involved in health financing for which the budget is more affected by air pollution and its associated diseases. They support the most, health cost coming from air pollution.

- The shift in the composition of health expenditures could translate into a form of adaption to air pollution and its associated diseases, from agents of health systems, towards health insurance schemes.

- The capacity of adaption appears lower in the most vulnerable countries in which health insurance schemes are still less developed, mainly because of informational and cost barriers.

- All evidences remain robust even when atypical countries have removed from the sample.

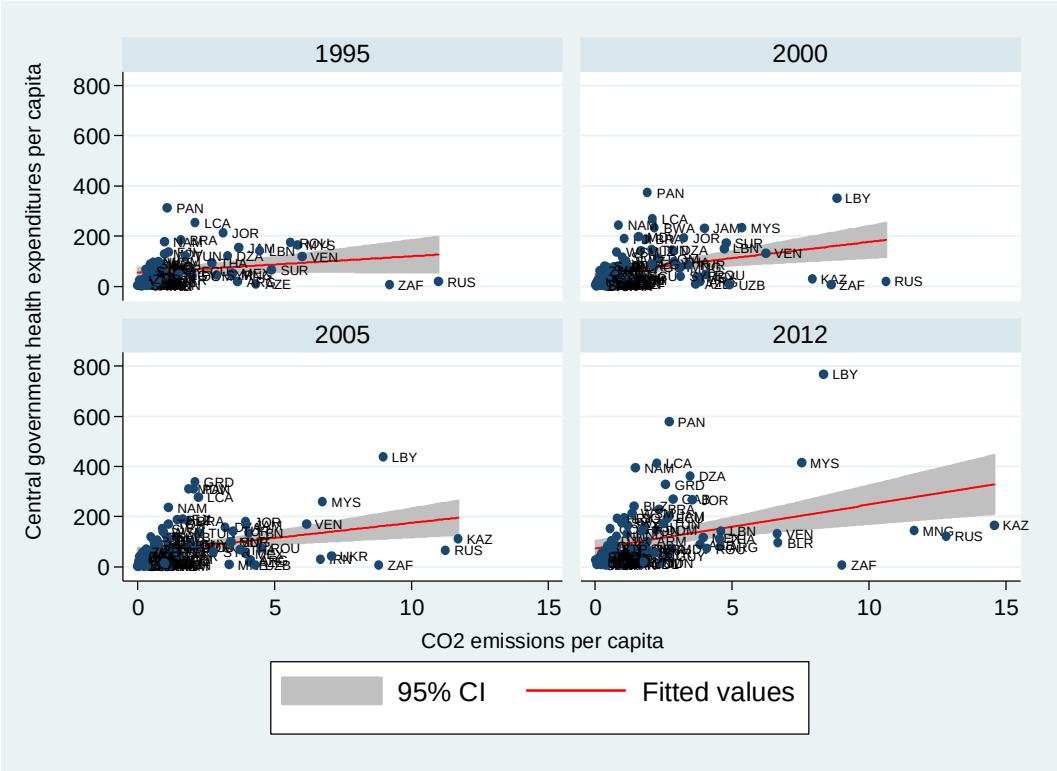
6. Annexes

Annex 2.1: Baseline results of CO2 emissions in metric tons per capita effects on total domestic health expenditures per capita by using fixed effects model (1995-2012)

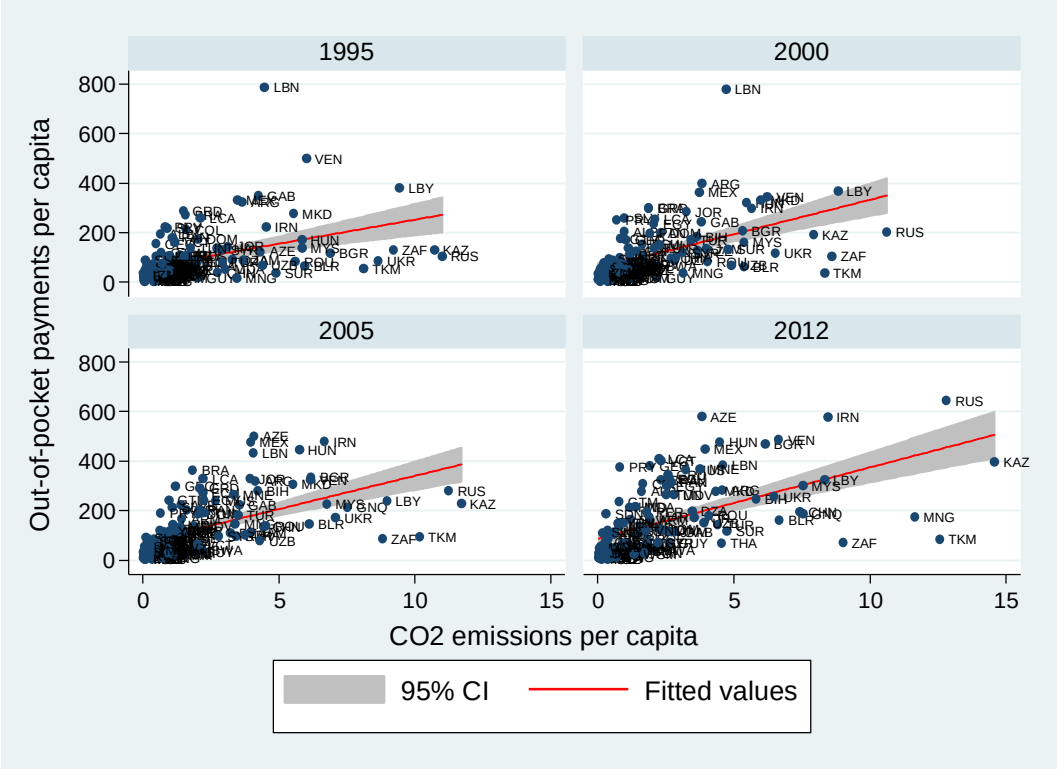
Sample		With atypical countries			Without atypical countries		
Specifications		(1)	(2)	(3)	(1)	(2)	(3)
$Log.Pollution_{t-1}$		0.168***	0.128**	0.109*	0.167***	0.127**	0.106*
		(3.046)	(2.291)	(1.823)	(2.993)	(2.243)	(1.740)
Ext_Fin_{t-1}		0.001	-0.033***	0.001	0.001	-0.033***	0.001
		(0.726)	(-2.961)	(0.758)	(0.734)	(-2.931)	(0.773)
EVI_{t-1}		0.007*	0.009**	-0.036*	0.008*	0.009**	-0.037*
		(1.879)	(2.280)	(-1.926)	(1.878)	(2.282)	(-1.935)
$Log,Pollution_{t-1}*Ext\_Fin_{t-1}$			0.002***			0.002***	
			(3.024)			(2.995)	
$Log,Pollution_{t-1}*EVI_{t-1}$				0.003**			0.003**
				(2.375)			(2.382)
$Life\ extpectancy_{t-1}$		0.014**	0.023***	0.013*	0.015**	0.023***	0.013*
		(2.086)	(3.108)	(1.836)	(2.028)	(3.022)	(1.741)
Old dependency		0.250***	0.245***	0.263***	0.250***	0.244***	0.264***
		(6.854)	(6.787)	(7.183)	(6.675)	(6.608)	(7.021)
Tax_{t-1}		0.006**	0.006**	0.005**	0.005**	0.005**	0.005*
		(2.199)	(2.234)	(2.057)	(2.107)	(2.151)	(1.960)
$Growth_{t-1}$		0.005	0.007	0.005	0.006	0.007	0.005
		(1.237)	(1.619)	(1.205)	(1.280)	(1.643)	(1.260)
$Urban_{t-1}$		0.004	0.004	0.002	0.003	0.003	0.002
		(0.683)	(0.732)	(0.390)	(0.503)	(0.542)	(0.267)
Institutions		0.032	0.048	0.040	0.036	0.052	0.044
		(0.879)	(1.327)	(1.118)	(0.977)	(1.409)	(1.203)
Constant		0.421	0.425	1.308	0.437	0.436	1.358
		(0.541)	(0.555)	(1.527)	(0.554)	(0.562)	(1.558)
Observations		372	372	372	363	363	363
F-statistics (significance of model)		14.925***	14.762***	14.233***	14.156***	14.032***	13.539***
Wald test of heteroskedasticity	Chi2 statistics	1996.28	1998.78	1982.92	2011.96	2015.43	1998.62
	P-value	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Wooldridge test of serial correlation	F-statistics	88.789	93.329	93.709	87.880	92.126	93.863
	P-value	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
R^2		0.337	0.359	0.351	0.331	0.353	0.345

Note: t statistics in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

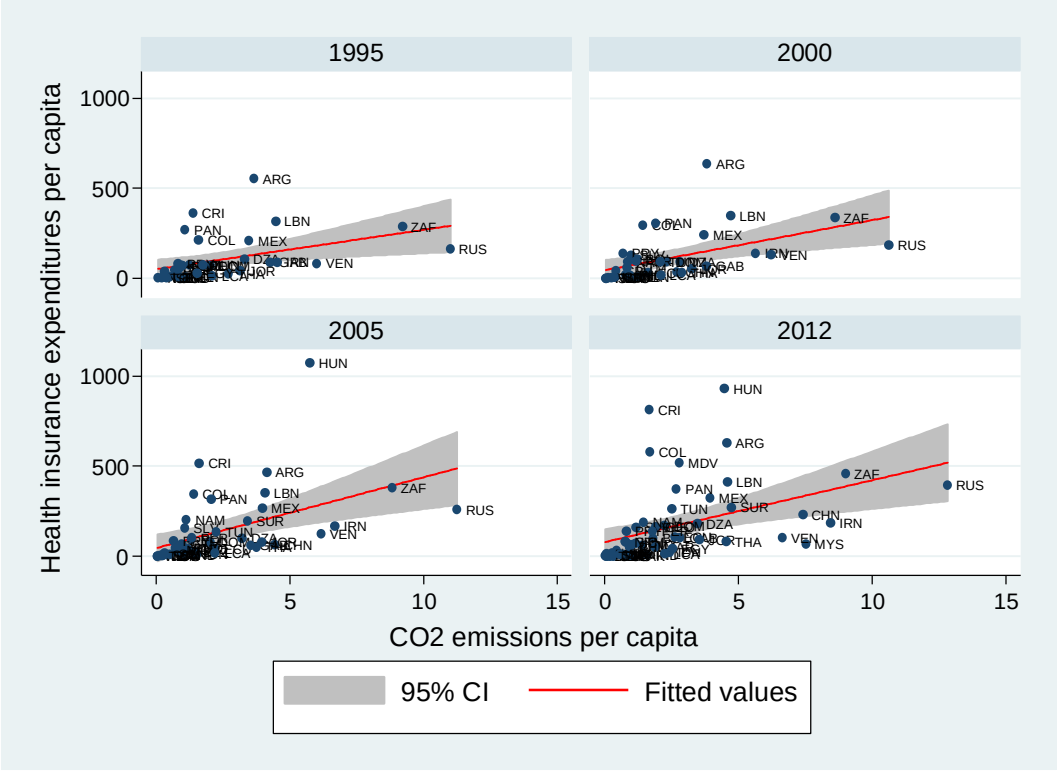
Annex 2.2: Scatter plots between CO2 emissions in metric tons per capita and the components of total health expenditures expressed in USD PPP per capita



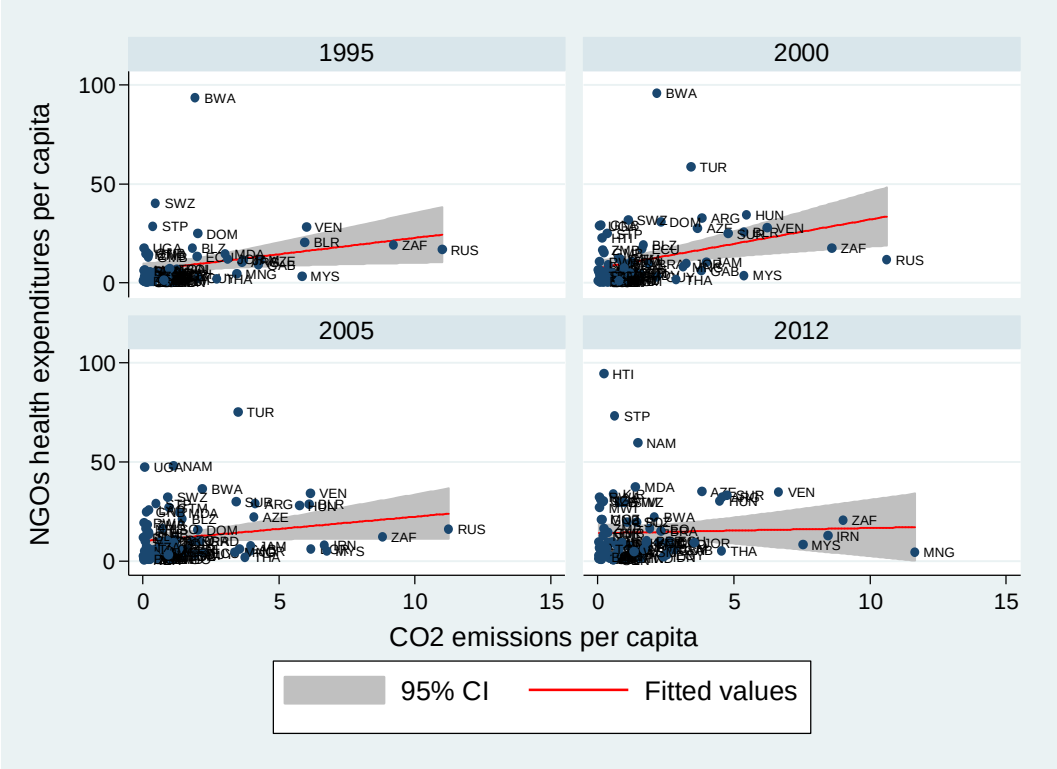
Source: Author using the GHE and WDI databases.



Source: Author using the GHE and WDI databases.

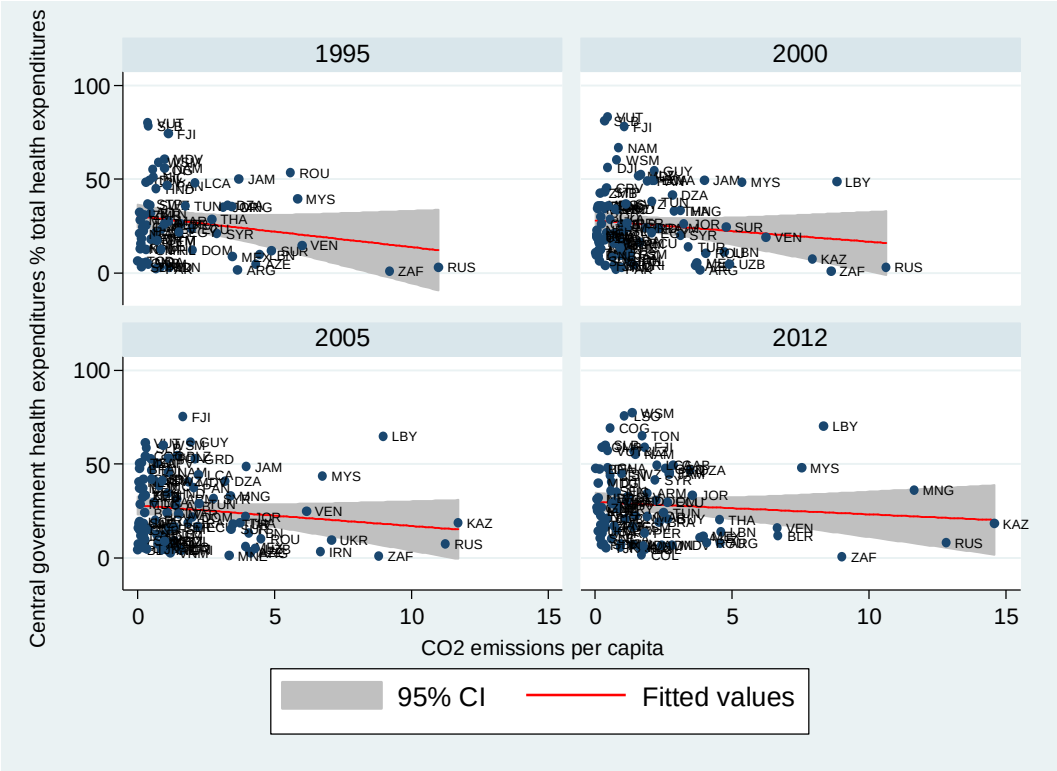


Source: Author using the GHE and WDI databases.

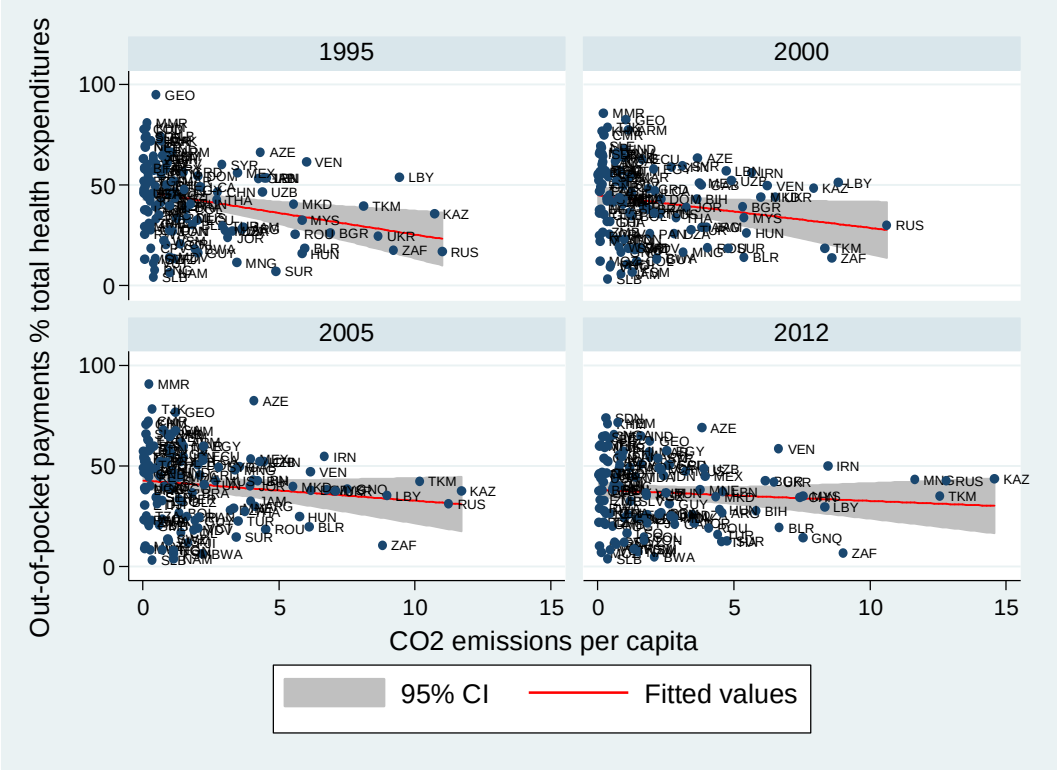


Source: Author using the GHE and WDI databases.

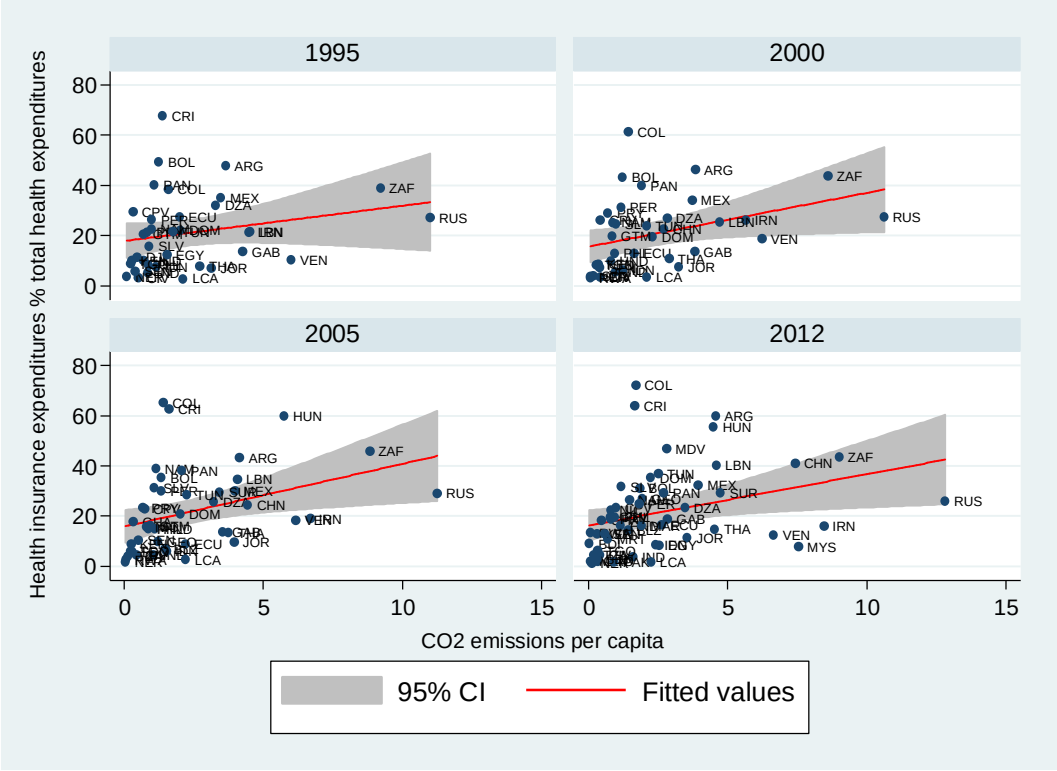
Annex 2.3: Scatter plots between CO2 emissions in metric tons per capita and the components of total health expenditures as share of total



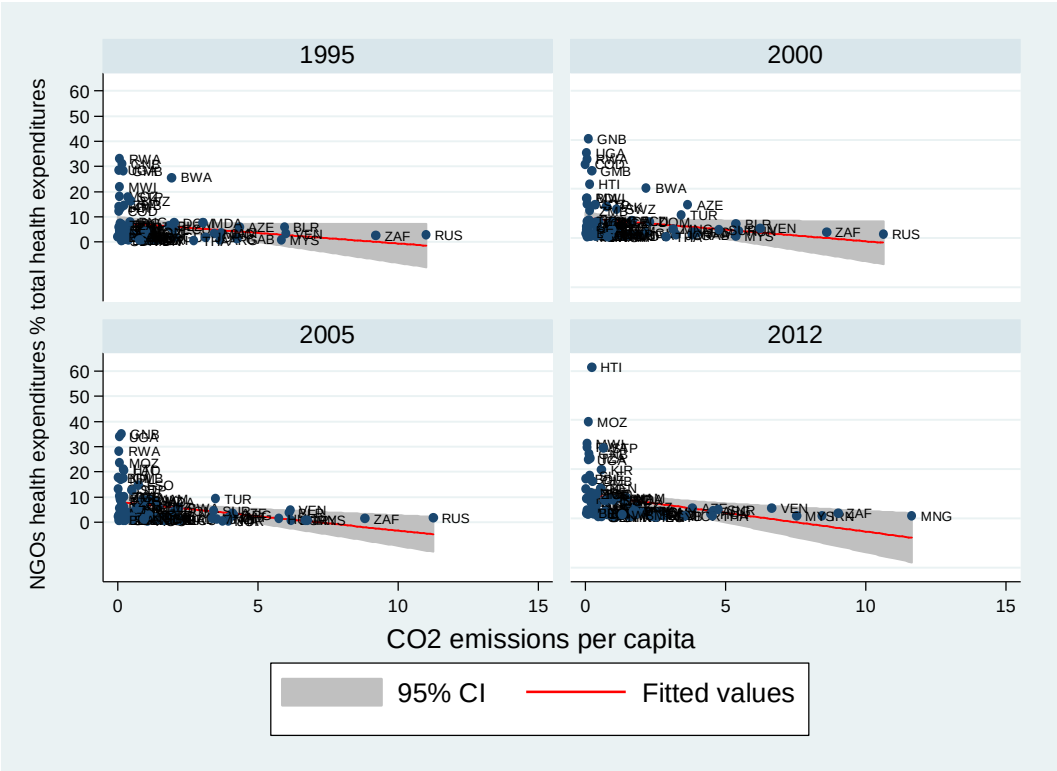
Source: Author using the GHE and WDI databases.



Source: Author using the GHE and WDI databases.



Source: Author using the GHE and WDI databases.



Source: Author using the GHE and WDI databases.

Annex 2.4: Descriptive statistics of supplementary variables (1995-2012)

Variables	Mean	Std.Dev.	CV	Median	Min	Max	Observations
Log. Central government health expenditures per capita	3.827	1.203	0.314	3.938	0.507	6.389	382
Log. Central government health expenditures % total health expenditures	3.095	0.847	0.274	3.190	-0.414	4.472	382
Log. Health insurance expenditures per capita	3.702	1.724	0.466	4.040	-0.594	6.682	192
Log. Health insurance expenditures % total health expenditures	2.601	0.951	0.366	2.747	0.252	4.243	192
Log. Out-of-pocket payments per capita	4.184	1.044	0.249	4.178	1.030	6.714	434
Log. Out-of-pocket payments % total health expenditures	3.486	0.670	0.192	3.710	1.140	4.453	434
Log. NGOs health expenditures per capita	1.809	1.157	0.640	1.815	-0.944	4.569	315
Log. NGOs health expenditures %expenditures	1.304	1.131	0.867	1.088	-0.665	4.019	315

Source: Author using the GHE database. Note: Std.Dev: Standard Deviation. CV: Coefficient of Variation.

Annex 2. 5: Matrix of partial correlations (1995-2012)

	THEPC	CGHE_PC	CGHE_THE	HIE_PC	HIE_THE	OOP_PC	OOP_THE	NGOHE_PC	NGOHE_THE
THEPC	1								
CGHE_PC	0.6227***	1							
CGHE_THE	-0.0719	0.5431***	1						
HIE_PC	0.8206***	0.2206***	-0.2574***	1					
HIE_THE	0.6140***	0.1593**	-0.1923**	0.8782***	1				
OOP_PC	0.8139***	0.4080***	-0.2187***	0.4492***	0.2277***	1			
OOP_THE	-0.1896***	-0.3460***	-0.5165***	-0.4564***	-0.5807***	0.2310***	1		
NGOHE_PC	0.2828***	0.2472***	-0.0533	0.2851***	0.2655***	0.0778	-0.2546***	1	
NGOHE_THE	-0.3206***	-0.2515***	-0.1652***	-0.2217**	-0.2507***	-0.2870***	-0.0886	0.5784***	1
Pollution	0.7212***	0.3997***	-0.0583	0.5245***	0.3955***	0.5507***	-0.1895***	0.1180**	-0.3046***
Life_Exp	0.5881***	0.4439***	0.0924*	0.4714***	0.4758***	0.5547***	-0.1184**	-0.0183	-0.3326***
Ext_Fin	-0.1020**	0.0456	0.0909*	-0.0677	-0.0422	-0.1852***	-0.3928***	0.4403***	0.3147***
EVI	-0.3030***	-0.0163	0.3712***	-0.1211*	-0.1616**	-0.3505***	-0.2903***	0.0679	0.2447***
Old dependency	0.6513***	0.4418***	-0.0282	0.5077***	0.4875***	0.5873***	-0.0783	0.0414	-0.2918***
Tax	0.1228***	0.3284***	0.3106***	0.0742	0.1386*	0.0143	-0.4473***	0.1731**	-0.0441
Growth	-0.0251	-0.1701***	-0.1937***	0.0727	0.1294*	-0.0491	0.0556	0.0056	-0.0528
Urban	0.6480***	0.3129***	-0.1001*	0.5809***	0.6062***	0.5691***	-0.0466	0.1319**	-0.2540***
Institutions	0.5126***	0.5253***	0.2904***	0.4429***	0.4482***	0.2784***	-0.4729***	0.1382**	-0.2619***
	Pollution	Life_Exp	Ext_Fin	EVI	POP65	Tax	Growth	Urban	Institutions
Pollution	1								
Life_Exp	0.4492***	1							
Aid	-0.0545	-0.0217	1						
EVI	-0.2653***	-0.1985***	0.3834***	1					
Old dependency	0.5156***	0.7284***	-0.1177**	-0.2751***	1				
Tax	0.1685***	0.0987**	0.4342***	0.3169***	0.0153	1			
Growth	-0.0405	0.0696	-0.0152	-0.0780	0.1155***	-0.0815*	1		
Urban	0.5449***	0.4418***	-0.1694***	-0.3629***	0.4252***	0.1248***	-0.0730	1	
Institutions	0.3866***	0.4939***	0.1586***	-0.0492	0.4939***	0.2249***	0.0901*	0.2358***	1

Source: Author 'calculation using the WGI, the WDI, the WEO, the GHED and the FERDI databases. Note CGHE_PC, HIE_PC, OOP_PC and NGOHE_PC respectively refer to central government health expenditures, health insurance expenditures, the out-of-pocket payments and NGOs health expenditures in per capita PPP dollars. CGHE_THE, HIE_THE, OOP_THE and NGOHE_THE respectively refer to central government health expenditures, health insurance expenditures, the out of-pocket payments and NGOs health expenditures as percentage of total heath expenditures. Life_Exp is the life expectancy at birth.

Annex 2. 6: List of studied countries

Algeria, Angola, Bangladesh, Belize, Benin, Bhutan, Bolivia, Botswana, Brazil, Burkina Faso, Burundi, Cambodia, Cameroon, Cabo Verde, Central African Republic, Chad, China, Colombia, Congo Democratic Republic, Congo Republic, Costa Rica, Cote d'Ivoire, Djibouti, Dominican Republic, Ecuador, Egypt Arab Republic, El Salvador, Fiji, Gabon, Gambia, Ghana, Grenada, Guinea, Guinea-Bissau, Guyana, Haiti, Honduras, India, Indonesia, Iran Islamic Republic, Jamaica, Jordan, Kenya, Kiribati, Lao PDR, Lebanon, Lesotho, Libya, Madagascar, Malawi, Malaysia, Maldives, Mali, Mauritania, Mauritius, Mexico, Micronesia, Mongolia, Morocco, Mozambique, Myanmar, Namibia, Nepal, Nicaragua, Niger, Nigeria, Pakistan, Panama, Papua New Guinea, Paraguay, Peru, Philippines, Rwanda, Samoa, Sao Tome and Principe, Senegal, Sierra Leone, Solomon Islands, South Africa, Sri Lanka, St. Lucia, St. Vincent and the Grenadines, Sudan, Suriname, Swaziland, Syrian Arab Republic, Tanzania, Thailand, Togo, Tonga, Tunisia, Turkey, Uganda, Vanuatu, Vietnam, Yemen Republic, Zambia.

Chapter 3: The role of prepayment health financing for health improvement in Sub-Saharan African countries

1. Introduction

In the framework of implementation of universal health coverage in low- and middle-income countries, sustainable health financing remains a key challenge, which would allow them to further improve health status of population. In these countries, health fees continue to limit the access to and the use of healthcare. Furthermore, the out-of-pocket payments generally tend to result in financial hardship due to catastrophic health expenditures which contribute to impoverish households. Hence, it is important for countries to progressively reduce the contribution of out-of-pocket payments to health financing and to increase the volume and the percentage in health expenditures of resources from prepayments sources. Let remember that prepayment health resources refer to all funds which are pooled to finance later healthcare of people. In contrary of out-of-pocket payments, prepayment health expenditures have the benefit to share the disease risks among the individuals and the agents involved in health financing. Through this risk-sharing also called cross-subsidization, prepayment health expenditures would allow health improvement in low- and middle-income countries.

Among low- and middle-income countries, Sub-Saharan Africa remains one of regions in which the part of out-of-pocket payments in health financing is important (Mathonnat, 2010). Furthermore, in this region, health fees are a key impediment which limits the access of individuals to healthcare. The hard access to healthcare could explain the low health outcomes in the region. Accordingly, it is relevant to know whether prepayment health expenditures significantly enhance health status in Sub-Saharan African countries.

However, the current level of prepayment health expenditures is not sufficient to meet with all of population' health needs and to insure a total free. Furthermore, the free generally tends to result in a useless induction of health demand. Hence, it is necessary that households contribute, even lowly, to health financing. In this way, strategies must be found to allow for these last ones to participate to health financing, without experiencing a poverty situation. On this subject, international remittances and financial development would allow increasing households' incomes; a fact will give to individuals mostly the poorest, the opportunity to finance a part of healthcare 'costs. In this context, international remittances and financial development would consequently contribute to the enhancement of health of population. Hence, it would be also important to check whether international remittances and financial development would reinforce the effect of prepayment health expenditures on health status in Sub-Saharan African countries.

The literature has documented the effect of prepayment health expenditures on health indicators in developing countries. Some studies have focused on the total level of prepayment health expenditures; whereas others have been interested by the specific components of these expenditures. However, the effect of total level of prepayment health expenditures on health status has not been studied in Sub-Saharan African countries. Moreover, for the moment, there are no studies focusing on these countries, which test differential effects of prepayment health expenditures on health status based on the level of received international remittances and financial development' degree. The present chapter aims to empirically address the following questions: Do prepayment health expenditures contribute in enhancing health status in Sub-Saharan African countries? Do international remittances and financial development influence the effect of prepayment health expenditures on health status in Sub-Saharan African countries?

The rest of chapter is structured as follows. The Section 2 presents the theoretical framework in which we firstly discuss the extent to which the prepayment schemes would constitute a sustainable source of health financing in Sub-Saharan African countries. Secondly, in this section, we focus not only on the literature review based on the works which have empirically investigated the effect of prepayment health expenditures on health status but also on the argument supporting the assumption based to which international remittances and financial development would reinforce the potential positive effect of prepayment health expenditures on health status in Sub-Saharan African countries. Next, the Section 3 defines the methodological framework in which the econometric model, the variables and used data are presented. Then, we discuss the results in Section 4 and finally, the Section 5 suggests some conclusions, whereas the Section 6 is devoted to the annexes.

2. Theoretical framework

2.1 Why promote the prepayment schemes in health financing in Sub-Saharan Africa countries (SSA)?

There are three main reasons motivating health financing through the prepayment schemes in SSA.

2.1.1 Health fees remain a financial impediment limiting the access to and the use of healthcare

Since the Bamako initiative in 1987, the African countries implemented cost-sharing schemes, which consisted in that the users (households) and the communities contribute to the financing of healthcare. The main goal of this strategy was to improve the systems of cost-recovery and to induce health structures to provide quality medical cares. This health policy wasn't enough sustainable because it has resulted in a decrease in access to and in use of healthcare. Healthcare 'costs assumed by the patients were a financial constraint leading the populations, mostly the poorest to limit their use of healthcare. Evidence has been found that the introduction of health fees in some Sub-Saharan African countries has resulted in a decrease in use of healthcare. That is the case of Kenya, Ghana, Zambia and Congo Democratic. Willis and Leighton (1995) show that the introduction of cost-sharing schemes in Kenya has led to reduce the outpatient attendances by 27%, 46% and 33% respectively at provincial hospitals, district hospitals and at health centres. Bititwum (1993) finds that the fee-for-service introduced in 1985 in Ghana has contributed in decreasing the outpatient clinic attendances by 40%. Blas and Limbabala (2001) shed light a drop in outpatient attendances by 35% after fees were introduced in Zambia between 1993 and 1997. In Zaire (ex-Congo Democratic), Haddad and Fournier (1995) uses a cohort of 21 rural centres covering a 60-month period from January 1987 to December 1991 and have observed a decrease in health services by 40%. They find out that 18% to 32% of this reduction is explained by the costs of healthcare.

Hence, given the decrease in use of healthcare, the cost-sharing schemes have been abolished in the major part of Sub-Saharan African countries. After, this abolition, it has been observed an increase in use of healthcare. On this subject, Burnham et al (2004), working on 10 Ugandan health districts encompassing 78 health facilities, find that with the end of cost-sharing, the mean monthly number of new visits has increased by 53.3% among all studied individuals and by 27.3% among children aged under-five years. They also observe that the mean monthly re-attendances have risen by 24.3% among the studied population and by 81.3% among children aged under-five years. Xu et al., (2003) have used data from National Household Survey undertaken in 1997, 2000 and 2003 in Uganda. They stress that the eliminating user fees has increased the use of healthcare in this country. However, this increase was low in non-poor people but high among the poorest. In South Africa, the fees for children aged under-six years and for pregnant women and the charges for primary healthcare were eliminated in 1997. After the abolition of fees and charges, Wilkinson et al., (2001) observe that attendances for curative services in Hlabisa Health district (South Africa) have doubled.

2.1.2 The out-of-pocket payments lead to poverty

The second argument in favour of the use of prepayment schemes in health financing comes from the fact that the out-of-pocket payments lead to poverty by resulting in catastrophic health expenditures. On this subject, Su et al., (2006) carried out investigations on the determinants of catastrophic health expenditures in Burkina Faso. They used data from Nouna district household survey encompassing 800 households over the period 2000-2001. From this study, it appears that in this health district, 6% to 15% (per the catastrophe threshold) of total households incurred catastrophic health expenditures. They also stress that 8% to 18.9% of total households with diseases incurred catastrophic health expenditures. The most interesting result of this study attests that the utilization of healthcare, especially modern medical care, has increased the risks of financial hardship.

Through catastrophic health expenditures, the out-of-pocket payments generally impoverish the vulnerable people and further increase poverty incidence among the poorest. In the vulnerable populations, the increase in out-of-pocket payments leads to reduce the saving and disposal income of households, which must be previously allocated to other expenses items such as the purchase of essential goods. Among the poorest, the out-of-pocket payments induce households to sell their assets and to borrow for financing the use of healthcare.

On this subject, Leive and Xu (2008) attempt to identify the determinants leading households to cope with the out-of-pocket payments by borrowing and depleting their assets. They focus on data from the World Health Organization survey on 15 Sub-Saharan African countries over the period 2002-2003. They have firstly found that 23% (in Zambia) to 69% (in Burkina Faso) of households borrowed and sold their assets to cope with the out-of-pocket payments. They have majorly observed that households with higher impatient expenses were more likely to borrow and deplete assets, compared to households which finance outpatient or routine healthcare. Consequently it seems that the inpatient fees are very costly for households and impoverish them much more. The authors undermined that this tested hypothesis is not effective for Burkina Faso, Namibia and Swaziland. Concerning Burkina Faso, it appears that the drugs ‘purchase is the main source likely to induce households to borrow or to deplete assets. In this country, specifically in Nouna health district, Mugisha et al., (2002) found that 80% of out-of-pocket payments are allocated to drugs ‘purchase. They have also observed that 78.9% of households borrowed money to pay for healthcare, whereas 14.1% sold their assets. Thereby, it is necessary to progressively reduce the share of out-of-pocket payments.

2.1.3 The advantages related to prepayment health financing

In view of arguments supporting the elimination of cost-sharing schemes and the progressive reduction of out-of-pocket payments in health financing, it would be important to find sustainable and equitable mechanisms to finance health systems in Sub-Saharan African countries. On this subject, prepayment health financing generally approximated by prepayment health expenditures (Xu et al., 2011) would be appropriate to do that. Hence, we discuss the extent to which these expenditures remain a no fairest source of health financing.

In contrary to the out-of-pocket payments, the prepayment schemes would be favourable for health financing. On the one hand, through the cross subsidization, they allow health system ‘agents such the government, the foreign sponsors and the NGOs to finance healthcare in favour of households. On the other hand, through the insurance systems, they help people to get healthcare in case of disease episode. The prepayment mechanisms give also the possibility to the richest to finance healthcare for the poorest. By sharing the disease risks, the increase in prepayment health expenditure would contribute in increasing the access to and the use of healthcare in favour of population, particularly the poorest. In this way, this increase will probably improve health status in Sub-Saharan African countries.

Furthermore, the increase in prepayment health expenditures in Sub-Saharan African countries would contribute in reducing the share of health financing coming from the out-of-pocket payments. Through this channel, it would reduce the risks of financial hardship and consequently poverty incidence, which generally tends to deteriorate health status.

2.2 Selective literature review on the effect of prepayment health expenditures on health

In the literature, prepayment health expenditures effect on health status has been documented on developing countries, particularly on African and Sub-Saharan African countries.

Concerning developing countries, one study such as Moreno-Serra and Smith (2013) has focused on total prepayment health expenditures. From this study, it appears that prepayment health expenditures lead to significantly reduce under-five mortality rate.

The other studies carried out their investigations on the specific components of prepayment health expenditures such as prepayment health expenditures from private sources and government health expenditures (see Figure 2.1). From these last ones, it appears that voluntary health expenditures do not significantly affect health status measured by the under-five mortality rate and the female and male adult mortality rates (Moreno-Serra and Smith, 2011).

As far as government health expenditures, evidences remain mixed. The first group of authors found that government health expenditures contribute in reducing the under-five, the infant, the maternal and the female and male adult mortality (Gupta et al., 2002; Wang, 2002; Baldacci et al., 2003; Issa and Ouattara, 2005; Bokhari et al., 2007; Moreno-Serra and Smith, 2011). In addition to these evidences, Moreno-Serra and Smith stress that comparatively to female and male adult mortality; the effect of government health expenditures on under-five mortality is higher.

The second group found the same evidences at the first, but it adds that the poor people are more fostered by public health financing (Anand and Ravaillion, 1993; Deolalikar, 1995; Bidani and Ravaillion, 1997; Gupta et al., 2003). It highlights that government health expenditures improve health measured by the under-five, the infant and the prenatal mortality and by the life expectancy at birth. However, this effect appears greater in the poorest.

In contrary to the two firsts, the third group found that government health expenditures remain a low preacher for health improvement, particularly for the reduction of infant and under-five mortality. Based on evidences raised by this group of studies, it appears other factors which more affect health status. There are for example, the GDP per capita, the income inequalities, the female education, the ethnic fragmentation, the predominance of Muslims (Filmer and Pritchett, 1999), the fertility rate, the female participation in the labour force, the GNP per capita (Zakir and Wunnava, 1999); the better access to healthcare facilities (Turner, 1991) and to improved sanitation (Carrin and Politi, 1996; Kamiya, 2010). Filmer and Pritchett (1999) attempt to explain the low contribution of government health expenditures by the ineffectiveness of medical treatments and the gap between the allocation of public health resources and the needs met by the individuals.

The fourth concludes that concludes that the effect of government health expenditures on health status depends of governance. It stresses that the negative effect of government health expenditures on the under-five and infant mortality is lower in countries where governance, assessed by the effectiveness of policies and institutional quality (Wagstaff and Claeson, 2004), the quality of bureaucracy and corruption perception (Rajkumar and Swaroop, 2008) and government effectiveness (Farag et al., 2009), is jeopardized. This effect comes from the fact that the fragility of institutions undermines the effective provision of health services and consequently results in limited used of government health resources and in a shortfall in incitation mechanisms in public health sector (Lewis, 2006).

Concerning African/Sub-Saharan African countries, the investigations focused on government health financing. Evidences remain the same and reveal that government health expenditures contribute in reducing the infant and under-five mortality and the deaths and in increasing the life expectancy at birth (Atake, 2004; Akinkugbe and Afeikhena, 2006; Anyanwu and Erhijakpor, 2009; Akinkugbe and Mohanoe, 2009; Novignon et al., 2012). Furthermore, Yaqub et al., (2012) carried out their investigations on Nigeria and found that corruption control reduces the negative and positive effects of government health expenditures respectively on the infant and under-five mortality and the life expectancy. In view of these evidences and as mentioned above, there is no study which has investigated the effect of total prepayment health expenditures on health in Sub-Saharan African countries. The detailed information about the literature are reported in the Annex 3.1)

2.3 Does prepayment health financing is sufficient to meet with health needs of population in Sub-Saharan African countries?

The literature supports that prepayment health financing is appropriate for health improvement in low- and middle-income countries. In Sub-Saharan African countries, the per capita level of prepayment health resources and their contribution to health financing remain low comparatively to health needs met by the individuals.

We depart from the Global Health Expenditures database to analyze prepayment health expenditures in Sub-Saharan African countries[26]. Here, prepayment health expenditures are disaggregated into health insurance expenditures, NGOs health expenditures and government health expenditures.

The analyses reveal that the level and the contribution to health financing of health insurance schemes and NGOs remain low. Furthermore, it appears that government health expenditures per capita are low comparatively to the minimum threshold of 86 USD per person recommended by McIntyre et al., (2017) to progress towards universal health coverage. In addition, we observe that the percentage of budget prioritization has slightly increased but remains insufficient based on the recommendation of Abuja Initiative (15% as threshold).

- Health insurance expenditures: their per capita level has slightly increased over time averagely passing from 30.77 USD[27] PPP in 2000 to 32.48 USD PPP in 2012. Their percentage in total health expenditures has slightly decreased averagely passing from 14.06% to 13.99% between 2000 and 2012.

- NGOs health expenditures: in per capita and as percentage of total health expenditures have slightly increased over time. Their volume per capita is averagely passed from 7.63 USD PPP to 10.51 USD PPP between 2000 and 2012. Their share in health financing is averagely passed from 9.38% in 2000 to 10.45% in 2012.

- Government health expenditures: their per capita volume has increased between 2000 and 2012, averagely passing from 19.86 USD to 44.37 USD[28]. Their share in total public expenditures is averagely passed from 8.94% in 2000 to 9.90% in 2012.

In view of these observations, Sub-Saharan African countries need to find strategies which would allow for their population to contribute to health financing, without facing up the risk of financial hardship.

[26] We focus on the sample which will be used for the econometric investigations and will be presented in details in the remainder of chapter.
[27] The amounts have been deflated.
[28] Expressed here in Current dollars 2010.

2.4 Do international remittances and financial development allow for households to contribute to health financing without experiencing poverty situation?

International remittances and financial development could be channels by which households could finance healthcare, without running the risk to be impoverished. By that, they could further reinforce the potential negative effect of prepayment health expenditures on health status. Here we discuss the extents to which international remittances and financial development could reinforce health financing by households without putting them into poverty.

2.4.1 International remittances

International remittances: can be defined as "part of a private welfare system that transfers purchasing power from relatively richer to relatively poorer members of a family or a community" (Gupta et al., 2009). They could contribute to poverty reduction (Gupta et al., 2009; Adams, 2006) and to health improvement (Duryea et al., 2005; Fajnzylber and Lopez, 2007; Chauvet et al., 2008; Zhunio et al., 2012) in Sub-Saharan African countries.

- *International remittances and poverty reduction*: international remittances constitute supports funds allowing people to do business and rewarding activities. They also allow for the individuals to access to formal financial services through the saving services proposed by financial institutions. Through this channel, they would contribute in eradicating poverty which also appears as a factor that improves health.

- *International remittances and health improvement*: two channels could be discussed. Firstly, remittances allow for the households to finance healthcare, a fact would increase the access to and the use of healthcare. On this subject, Drabo and Ebeke (2011) found that international remittances lead to increase the access to child health service in recipient countries. Secondly, international remittances also increase household's income for consumption (Quartey and Blankson, 2004; Combes and Ebeke, 2011). They could serve to improve nutritional status of people, and to particularly reduce the undernourishment of children (Frank and Hummer, 2002) that generally tends to cause child deaths.

2.4.2 Financial development

Financial development can be understood as a process by which a financial system becomes profitable, accessible, effective, stable, diversified and opened to international markets (Meisel and Mvogo, 2007). It appears as a key driver that contributes to poverty reduction and to health improvement.

- *Financial development and poverty reduction*: financial development would reduce poverty by directly facilitating the access of population to financial services; a fact allows an increase in households' income. It would also reduce poverty by fostering economic growth. It allows accumulation and growth of capital productivity through five channels such as: the saving mobilization, the better risks management, the allocation of resources to the most profitable investment projects, the monitoring of financed projects and the facilitation of exchanges in goods and services (Levine, 1997). On this subject, Kiendrebeogo (2010), Donou-Adonsou and Sylwester (2016) and Boukhatem (2016) found a negative effect of financial development on poverty respectively in ECOWAS Community of West African States), in developing and in low-and middle-income countries.

- *Financial development and health*: financial development effect on health has been investigated by Claessens and Feijen (2007). They found financial development improves health by reducing undernourishment prevalence and child mortality and by increasing the life expectancy. The effect on undernourishment passes through a reduction of income inequalities and an increase in agricultural

productivity. In general way, they identify four main channels through which financial development is likely to affect health.

In the first channel, they stress that financial development enables households to get additional revenue that are invested in their welfare improvement (better housing); a fact is likely to reduce the probability of hygiene-related diseases. Furthermore, with financial services provided, households are not obliged to sell their assets and/or to borrow for getting and using healthcare (Parker et al., 2000). Indeed, the additional revenue resulted from financial development would allow for households to purchase healthcare in case of diseases 'episode. In addition, there are households that are struck by diseases such as for example, diabetes and renal failure, for which the treatment is costly and permanently necessitate care. In this way, financial development would allow for these households to keep their income streams relatively stable and to finance healthcare caused by these diseases.

The second channel focuses on investments for health. Financial development is favourable for economic growth and consequently fosters investments in healthcare infrastructure. Through this channel, it would improve health by facilitating the access of households to healthcare.

The third channel passes through education. Indeed, financial development tends to increase the access to education and to enhance the gain from schooling; a fact would be consequently beneficial for household health.

The fourth channel refers to gender equality effects. The access to financial services leads to empower women who contribute to health conditions improvement in household. Comparatively to men, women generally take better care of their children and allocate more of their budget to the improvement of household welfare. That will foster the improvement of health status of household 'members, particularly, children.

Through these arguments, the allocation of international remittances and financial development would be potential channels through which the improvement effect of prepayment health financing on health status could be reinforced.

3. Empirical framework

To test the effect of prepayment health financing on health, we focus on an unbalanced panel-data model covering 31 Sub-Saharan African countries over the period 1996-2012. The data source of variables is presented in subsection 3.6.

3.1 Dependent variables

We propose to work on child and maternal health given pregnant women and children are the most vulnerable populations in Sub-Saharan African countries. Child health is approximated by the under-five mortality rate (Under5). It measures the number of infants dying before reaching age five, per 1,000 live births in a given year. Regarding the proxy of maternal health, we use the maternal mortality ratio (Maternal) which assesses the number of women who die from pregnancy-related causes while pregnant or within 42 days of pregnancy termination per 100,000 live births.

3.2 Independent variables

3.2.1 Variables of interest: prepayment health financing

Two indicators such as prepayment health expenditures as percentage of total health expenditures and prepayment health expenditures per capita may be considered for prepayment health financing. The first indicator measures the contribution of prepayments schemes to health financing; whereas the second one approximates the quantity or the amount of prepayment funds allocated to health financing. Here, the main question is to know whether the volume of prepayment health expenditures

is likely to affect health status in Sub-Saharan African countries. It is a good think to increase the contribution of prepayment resources to health financing but the most important challenge is to increase the quantity of these funds. Here chapter, the most relevant indicator is consequently prepayment health expenditures per capita (Prepayment), expressed in USD PPP. This variable is calculated by retrieving the out-of-pocket payments USD PPP per capita from total health expenditures per capita in USD PPP.

3.2.2 Other variables

We use seven control variables judged as main relevant factors likely to explain mortality indicators : a composite index of immunization coverage, the old dependency ratio used in the first and the second chapters, the growth of GDP per capita, the gross primary enrolment ratio and HIV/aids prevalence in adult population aged 15-49.

Immunization coverage (Immunization): controls for the effect of prevention strategies against some diseases on child health. In Sub-Saharan African countries, children generally suffer from diseases such as diphtheria, pertussis, tetanus, poliomyelitis, tuberculosis and measles. These diseases cause infant deaths and consequently increase child mortality while they may be prevented with vaccinations. In this way, a high immunization coverage rate would reduce the risk of child mortality and then avoid deaths. Instead of introducing an immunization coverage rate for each disease, we compute an index of immunization coverage through a Principal Component Analysis (PCA), considering four rates of immunization such as the immunization coverage rates against DPT (Diphtheria-Pertussis-Tetanus), BCG (Bacilli of Clamette-Guérin), poliomyelitis and measles. They respectively measure the percentage of children less than twelve months who received DPT, BCG, poliomyelitis and measles vaccinations. The results of PCA reported in Table 3.1 indicate that compared to the others, the first factorial axis summarizes 91.99% of total variation within the data. It is accordingly chosen to compute the index. However, given this index only focuses on child health, it has not been introduced in the model explaining maternal mortality ratio.

Table 3.1: Results of principal component analysis computing the composite index of immunization coverage (1996-2012)

		Component1	Component2	Component3	Component4
Eigen value		3.6796	0.2051	0.091	0.0245
Proportion		0.9199	0.0513	0.0227	0.0061
Cumulative		0.9199	0.9712	0.9939	1
Variables (Eigenvectors)	BCG	0.4791	0.8658	-0.1263	0.0696
	DPT	0.5113	-0.2697	-0.3225	-0.7496
	Measles	0.5026	-0.1569	0.8495	0.0338
	Polio	0.5064	-0.3912	-0.3980	0.6574

Source: Author ‘calculation using the HNPS database.

Old dependency ratio: controls of the demographic structure. It appears as a factor increasing infant mortality in Sub-Saharan African countries (Novignon et al., 2012). Population ageing tends to result in lower labour-force participation (Bloom et al., 2010); a fact could jeopardize economic growth, reduce income and consequently increase child and maternal mortality.

GDP per capita growth (Growth): it controls for the income (GDP per capita), which is a key determinant, contributed to the reduction of child and maternal mortality (Bokhari et al., 2007; Issa and Ouattara, 2005). At micro level, the increase in income allows for the individuals to improve their living conditions and to reinforce the access to enhanced sanitations, a drinking water and a qualitative

level of education which are factors fostering the improvement of child and maternal health. At macro level, the increase in income (GDP) also allows to increase the supply of healthcare contributing to the enhancement of child and maternal health. We use the growth of GDP per capita because the level of GDP per capita appears highly correlated with prepayment health expenditures and control variables such as the old dependency ratio. However, the growth rate of GDP per capita is weakly correlated with these mentioned variables (Annex 3.2).

Gross primary enrolment ratio (Education): it refers to the ratio of total enrolment, regardless of age, to the population of age group that officially corresponds to the level of primary education, which provides children with basic reading, writing, and mathematics skills along with an elementary understanding of such subjects as history, geography, natural science, social science, art and music[29]. This variable controls for the assumption attesting that education enhances maternal and child health (Bidani and Ravaillon, 1997; Hanmer et al., 2003; Alves and Belluzo, 2005; Bokhari et al., 2007). At theoretical level, a better education would bring better health knowledge which would allow for the individuals to adopt preventive behaviours and practices to avoid child and maternal deaths. With a better education, the women tend to more frequent healthcare facilities, particularly during the pregnancy (prenatal consultations/visits), during and after the deliveries (assisted childbirths and postnatal consultations). The prenatal, the postnatal consultations and the assisted childbirths tend to reduce the risk of maternal deaths. Furthermore, the improvement of educational background of population would induce them, particularly the women and children to sleep under insecticide-treated mosquito nets. That would reduce the risk of malaria which constitutes one of main causes of child and maternal deaths. Hence the education improvement would reduce the incidence of malaria and consequently child and maternal mortality. In addition education may reduce child and maternal mortality because it results in greater income which is likely to improve the lifestyle of people. Through this channel, education would allow for the individuals to access and to purchase healthcare. It would consequently reduce the risk of maternal and child deaths.

HIV/aids prevalence (HIV): it corresponds to the percentage of adult people, aged 15-49 and infected with HIV/aids. It is likely to impede the enhancement of child and maternal health (Novignon et al., 2012; Anyanwu and Erhijakpor, 2009; Ssozi and Amlani, 2015). Regarding child health, the growth of HIV/aids prevalence in adult population has a disadvantage to increase their level of invalidity that is likely to result in a loss of income and poverty in household. This poverty would jeopardize the capacity of household to finance healthcare of children in case of disease. It would consequently, increase child mortality rate. Furthermore, the HIV/aids infected women are likely to transmit the illness to their children during the pregnancy. On this subject, UNAIDS data show that the coverage rate of pregnant women who receive antiretroviral drugs for preventing mother-to-child transmission of HIV/aids has been passed from 22% in 2010 to 50% in 2016 in West and Central Africa. Despite this improvement, the half of infected pregnant women is still without treatment. In this way, a high HIV/aids prevalence in adult people, particularly in pregnant women would increase the probability of children to be infected; a fact will increase the risk of child deaths. Concerning maternal mortality, it could be also adversely affected by the increase in HIV/aids prevalence. The HIV/aids causes a weakening of immune system in infected pregnant women. Hence, a woman infected by HIV/aids and developing the disease has a higher risk of dying during the delivery compared to the non-infected woman. The HIV/aids can also provoke the opportunistic diseases that can cause maternal deaths.

[29] We have focused on primary education instead secondary or tertiary education because in Sub-Saharan African countries, the major part of individuals is less educated. In these countries the first priority i after illiteracy reduction is to increase the access for individuals to primary education.

3.3 Econometric model

We choose a fixed effects model because the amount of prepayment health funds is not fixed in uncertain fashion. This amount is generally determined based on health needs of moment, the goals targeted by health policies, the quantity of funds domestically and internationally mobilized and budget prioritization for health sector. Hence as prepayment health financing is not based on random decisions, random effects model. The fixed effects model is specified as follows:

$$HEALTH_{it} = \alpha + \beta X_{it} + \sum_{k=1}^{n} \delta_k Z_{kit} + V_i + \varepsilon_{it}$$

$HEALTH_{it}$ refers to indicators approximating health status for country "i" at the year "t".X_{it} is the variable of interest measuring prepayment health financing andε_{it} is the error term. α is the intercept, whereas Z_{kit}represents the "k" (k going from 1 to n) control variables. β; δ_k are the parameters which must be estimated. V_i is country fixed effects which account for the heterogeneity between countries.

3.4 Identification issues

To make a rigorous analysis, it is necessary to identify in the econometric model the explanatory variables likely to be endogenous and to deal with this endogeneity. The first variable, which is suspected to be endogenous, is prepayment health expenditures. Their endogeneity could be caused by two sources.

- The first source of endogeneity is the omitted variables bias coming from the omission of important variables likely to affect mortality indicators and prepayment health expenditures. The model has not been sufficiently controlled for the burden of communicable diseases. This variable is a key driver factors that explains the difference of child and maternal mortality between countries in Sub-Saharan Africa. In this region, the communicable diseases considerably influence the burden morbidity. They cause many deaths, particularly for children and pregnant women. On this subject, except HIV/aids prevalence, we have not found for the moment an indicator available on the studied period which could rigorously approximate this burden of communicable diseases. The use of HIV/aids prevalence could control this omission but that is not sufficient.

Furthermore, regarding maternal mortality, it would be relevant to control for the size of skilled health workers. This variable would be a key determinant of maternal mortality in Sub-Saharan African countries. In these countries, skilled medical staff does not generally attend the major part of deliveries causing maternal deaths. The size of skilled health workers could also affect the volume of prepayment health expenditures. The salaries allocated to these workers constitute a component of prepayment health expenditures from public source. In this way, an increase in size of skilled workers means an increase in public prepayment health expenditures dedicated to payment of salaries of medical staff. Consequently, it would increase the amount of prepayment health expenditures. On this subject, at country-level, the data related on the skilled medical staff are not sufficient to make a rigorous econometric analysis. This variable has been omitted to the model explaining maternal mortality.

- The second source of endogeneity of prepayment health expenditures comes from the reverse causality between these last ones and mortality indicators. Despite the potential effect of prepayment health expenditures on child and maternal health, the level of child mortality rate and the maternal mortality ratio plays an important role in determining prepayment health expenditures. Maternal and under-five mortality have declined in Sub-Saharan African countries over the studied period (see

Graphic 3.2). This reduction could induce the policy-makers to reduce the quantity of allocated funds for the fight of child and maternal mortality in favour of the other health priorities. In this way, the amount of prepayment health expenditures will not vary. However, the reduction of mortality indicators could also encourage the policy-makers to ensure a continual decreasing in these health outcomes. In this case, the policy-makers will tend to allocate more resources in health programs financing for the enhancement of child and maternal health. Hence, prepayment health expenditures will increase in term of quantity, except in the case where the additional resources come from other health expenditures items.

- In addition to prepayment health expenditures, there are control variables, which are suspected to be endogenous: the educational variable and the growth of GDP per capita. For education, the endogeneity comes from a measurement error bias. Indeed, the educational variables that we use doesn't account for the quality of education which appears important in education effect on health. For economic growth the endogeneity could be explained by a reverse causality bias. Economic growth could be affected by human capital (Romer, 1990; Hanushek, 2013), approximated here by mortality indicators. The endogeneity of control variables is addressed in the subsection 3.5.

3.5 Instrumentation strategy

There are various estimators used to resolve the endogeneity biases in econometrics. Usually, two methods are generally used.

- The first method uses the GMM estimator, which is more appropriated for dynamic panel models generally including the first lag of dependent variable as covariate. There are two kinds of GMM estimators: the difference-GMM estimator (Arellano and Bond, 1991) and the system-GMM estimator (Arellano and Bover, 1995; Blundell and Bond, 1998). The use of difference-GMM estimator consists to difference the econometric equation in first order and to consequently remove country fixed effects. Then, the first differentiated variables are instrumented by the lags of variables in level. Regarding the system-GMM estimator, it uses a system of two equations: the equation with variables in level and another one including the variables in first difference. It instruments the explanatory endogenous variables by their lags in difference and in level.

- The second uses the instrumental variables estimator, which is more adapted for static models. This method requires finding external instrumental variables satisfying two conditions such as the relevance and the exogeneity. The relevance supposes that the instrumental variables should affect the supposed endogenous variable whereas the exogeneity assumption involves that they must not directly influence the dependent variable. In other words, the instrumental variables should only affect the dependent variables through the channel of variable suspected to be endogenous or through the bias of other variables that must be controlled for. This method uses the two least squares (IV/2SLS) as estimator for which the model is specified in two stages. In the first stage, the endogenous variable is explained on its instruments and control variables through the Ordinary Least Squares (OLS) estimator. The predicted component of endogenous variable is then introduced instead of its observed value with the control variables in a second-stage equation explaining the dependent variable.

Among the instrumentation methods used in the literature, we choose the method of instrumental variables that seems to be more adapted here. The studied period is not sufficient to use the GMM estimator, which requires working in large temporal dimension. Then, for instance, we do not find rigorous assumptions that necessitate using the lag of each mortality indicator as explanatory variable. Two instrumental variables have been chosen: the development assistance for health (DAH) per capita in constant 2014 USD and the budget balance as share of GDP (Budget).

- ***The DAH variable***: it refers to the amount of financial and in-kind assistance that is allocated by the foreign sponsors to health sector of recipient countries. We have found in the second chapter that in low- and middle-income countries, external resources for health significantly reduces total domestic health expenditures per capita, health insurance expenditures per capita and central government health expenditures per capita. For the moment we have not tested this effect on Sub-Saharan African countries. However, at theoretically and based on fungibility assumption, external resources for health would have mixed effects which could be positive (Brun et al., 2012; Mishra and Newhouse, 2007) or negative (Farag et al., 2009; Lu et al., 2010; Dieleman et al., 2013). The major part of works using health expenditures from overall sources found that external resources for health are partially fungible. It increases health expenditures with an associated coefficient less than 1.Given the use of prepayment health expenditures from overall sources; we suppose that DAH would increase prepayment health expenditures. In view of these arguments, it appears that the first used instrument is relevant.

Given the supposed assumption of partially fungibility of external aid for health, it is possible that a part of this aid is used to finance and to increase the other government expenditures that are likely to affect mortality indicators. Hence it is probable that DAH affects child and maternal mortality through another channel such as the increase in non-health general government expenditures (NHGGE). To tackle this bias, the econometric model is controlled for these non-health general government expenditures for which the acronym in the regression is "NHGGE". This variable is calculated by retrieving government health expenditures per capita in PPP USD from total general government expenditures per capita in PPP USD. Moreover, the DAH could affect child mortality by increasing immunization coverage (Kolesar and Audibert, 2017). This bias is addressed by including the composite index of immunization coverage in the model.

Furthermore it is possible that DAH directly affects child and maternal mortality. A part of DAH is destined to the fight of maternal and child mortality. This component of DAH could directly affect mortality indicators and could be affected by them, mostly in the case where it does not pass by government budget. Hence, we deal with this constraint by retrieving this component (DAH destined to the fight of maternal and child mortality) from the total DAH used as instrumental variable. This component refers to the external funds for health disbursed from sources to channel recipient countries for newborn and child health and for maternal health. By retrieving this component promoting maternal and child health and by controlling for non-health general government, we obtain a relevant and exogenous instrument for which the acronym in the regressions is DAH_net.

- ***The budget balance***: it is calculated as follow: the total revenues of governments minus their total expenditures. This variable assesses the extent to which governments are either putting financial resources at the disposal of other sectors in the economy and non-residents (net lending) or utilizing the financial resources generated by other sectors and non-residents (net borrowing). In case of net lending and net borrowing, the values of budget balance are respectively positive and negative.

The budget balance would be a good instrument addressing the endogeneity of prepayment health expenditures. Countries with a positive budget balance would benefit to more fiscal resources, which could be potentially allocated to health sector and then increases government health expenditures. In countries with a negative budget balance, the increase in budget deficit would have two potential effects. It could firstly result in a decreasing in government expenditures, particularly in government health expenditures. In this way, prepayment health expenditures would decrease. Secondly, the increasing in the budget deficit generally induces governments to negotiate the aid to their foreign partners. The support of these partners to countries passes on one hand from the intervention of NGOs in these recipient countries. In this way, the budget deficit would increase NGOs health expenditures, more specifically those allocated to health sector. That would accordingly increase prepayment health

expenditures. Thereby, the budget balance would indirectly affect mortality indicators by influencing the level of prepayment health expenditures. Its effect could also pass by non-health general government expenditures, which are controlled in the model. Through the channels discussed in the subsection, it seems that the two instruments (DAH_net and budget balance) could be potentially correlated; a fact could cause some biases. We test this correlation between both instruments and find a negative coefficient of correlation, which is almost equal to zero (-0.0456). Hence, these instrumental variables could be jointly included in the same model.

The instrumented model is specified as follows: let consider our first model: $Health_{it} = \alpha + \beta X_{it} + \sum_{k=1}^{n} \delta_k Z_{kit} + V_i + \varepsilon_{it}$. In the first and the second-stages of instrumentation, this model is respectively specified as following way:

- The first stage of instrumentation (auxiliary equation):

$$X_{it} = \pi + \sum_{a=1}^{3} \vartheta_a I_{ait} + \sum_{k=1}^{5} \gamma_k Z_{kit} + V_i + \mu_{it} \text{ , such as:}$$

$$\hat{X}_{it} = \hat{\pi} + \sum_{a=1}^{3} \hat{\vartheta}_a I_{ait} + \sum_{k=1}^{5} \hat{\gamma}_k Z_{kit} + V_i$$

- The second-stage of instrumentation (instrumented equation):

$$Health_{it} = \theta + \lambda \hat{X}_{it} + \sum_{k=1}^{n} \varphi_k Z_{kit} + V_i + \omega_{it}$$

I_{ait} refers to the two used instrumental variables. μ_{it} and ω_{it} are respectively the error terms of auxiliary and instrumented equations. π and θ are respectively the intercept of auxiliary and instrumented equations. ϑ_a, γ_k ,λ , φ_k are the parameters which must be estimated. $\hat{X}_{it}$is the predicted component ofX_{it}.

The use of two least squares (IV/2SLS) as estimator could be biased in case of heteroskedasticity and serial correlation of error term ω_{it}. The heteroskedastic-efficient two step generalized method of moment (IV/GMM) estimator was implemented to address these biases. It has the advantage to produce efficient coefficients and consistent standard errors estimates. It comes from the use of optimal weighting matrix, the over identifying restriction of model and the relaxation of independently and identically distributed (iid) assumption. The heteroskedasticity will be tested through the Modified Wald test for groupwise heteroskedasticity adapted for fixed effects models whereas the serial correlation will be tested through the Wooldridge test for serial correlation in panel-data models (Wooldridge, 2002). The traditional IV/2SLS will be used, except in case of heteroskedasticity and serial correlation where IV/GMM will be chosen.

In the following section, the relevance and the exogeneity of used instruments will be tested respectively through the weak identification test and the over identification test of Hansen. In the weak identification test, the null hypothesis attests that the auxiliary equation is weakly identified. That means that the one or all instruments do not contribute to significantly explain the endogenous variables. In the alternative hypothesis of weak identification test, the auxiliary equation is not weakly identified. This test provides a Cragg-Donald Wald F statistic, which must be compared to critical value of Stock and Yogo (Stock and Yogo, 2004). In the case where the Cragg-Donald Wald F statistic is greater than the critical value of Stock and Yogo, the weakness assumption of used instruments is rejected. However, when the Cragg-Donald Wald F statistic is lower than the critical value of Stock and Yogo, the null hypothesis of weakness of used instrument cannot be rejected. Nevertheless, an instrument, which is not weak, is relevance but a relevant instrument can be weak.

Hence the first stage of instrumentation model will be presented in the baseline results. Concerning the Hansen test, the null hypothesis means that the instruments are exogenous, whereas the alternative one attests the contrary. This test provides a J statistic for which the p-value must be greater than the most acceptable threshold (10%) in the case where the instruments are over identified. A p-value lower than the acceptable threshold, means that the null hypothesis of exogeneity of used instruments can be rejected.

The simultaneity bias of control variables suspected to be endogenous is addressed by directly introducing their one-year lag. These lags are likely to affect mortality indicators but they are not likely to be influenced by these indicators.

In our empirical investigations, two specifications will be tested. Table 3.2 summarizes the variables, which will be used in each specification and the signs of their expected effect on child mortality rate and the maternal mortality ratio. In the first and the second specification, the under-five mortality rate and the maternal mortality ratio are respectively used as dependent variable.

Table 3.2: Tested specifications in the econometric model

Variables		Definitions and assessment units	Specifications		Expected effects
			(1)	(2)	
Dependent variables	Under5	The under-five mortality rate (per 1000 live births)	*		
	Maternal	The maternal mortality ratio (per 100,000 live births)		*	
Explanatory variables	Prepayment	Prepayment health expenditures per capita (PPP USD)	*	*	-
	Growth	Growth rate of GDP per capita (%)	*	*	-
	Education	Gross primary enrolment ratio (%)	*	*	-
	HIV	HIV/aids prevalence rate (%)	*	*	+
	Immunization	Composite index of immunization coverage rate	*	*	-
	Old dependency	Percentage of population aged 65 and above	*	*	+
	NHGGE	Non-health general government expenditures per capita (PPP USD)	*	*	-
Instrumental variables	DAH_net	Development assistance for health per capita in constant 2014 USD (excluding the external funds allocated to the fight against maternal and child mortality)	*	*	+ (with coefficient <1)
	Budget	The budget balance (+lending; -borrowing) as share of GDP (%)	*	*	+/-

Source: Author.

3.6 Data and descriptive statistics

The variables used are retrieved from five databases. The major part of them comes from the World Development Indicators (WDI) database. These are under-five mortality rate, the maternal mortality ratio, GDP per capita in USD PPP and its growth, the gross primary enrolment ratio, the old dependency ratio, and HIV/aids prevalence in adult people. The rate of immunization coverage against DPT, BCG, poliomyelitis and measles are a product of health Nutrition and Population Statistics (HNPS) database. Total health expenditures and the out-of-pocket payments per capita in PPP USD come from the Global Health Expenditures (GHE) database. The variables of Development Assistance for Health are provided by the Institute for Health Metrics and Evaluation (IHME) database. The

budget balance variable is retrieved from the World Economic Outlook (WEO) database. Table 3.3 presents the descriptive statistics of used variables.

Table 3.3: Descriptive statistics (1996-2012)

Variables	Mean	Std.Dev.	CV	Median	Min	Max	Observations
Under5	117.049	48.811	0.417	113.5	14.6	267.1	397
Maternal	647.338	311.183	0.481	652	35	253	397
Prepayment	94.508	131.013	1.386	44.338	8.265	745.164	397
Growth	2.482	5.469	2.204	1.889	-15.284	57.990	397
Edu	91.838	26.127	0.284	93.678	29.076	149.952	366
HIV	4.965	6.130	1.234	2.400	0.300	26	397
BCG immunization rate	84.562	14.523	0.172	89	30	99	397
DPT immunization rate	72.622	20.548	0.283	77	15	99	397
Polio immunization rate	72.877	19.282	0.265	76	15	99	397
Measles immunization rate	70.725	18.242	0.258	72	16	99	397
Immunization index	150.097	35.220	0.235	156.610	50.096	197.941	397
Old dependency	3.289	1.020	0.310	3.023	1.755	8.320	397
NHGGE	75295.790	106527.8	1.415	31479.530	5739.753	735119.1	397
DAH_net	9.732	15.257	1.568	5.110	0.006	152.623	397
Budget	-2.388	6.539	-2.738	-2.764	-31.226	40.340	397

Source: Author 'calculation using the WDI, the HNPS, the GHE, the IHME and the WEO databases. Note: Std. Dev: Standard Deviation. CV: Coefficient of Variation.

4. Results

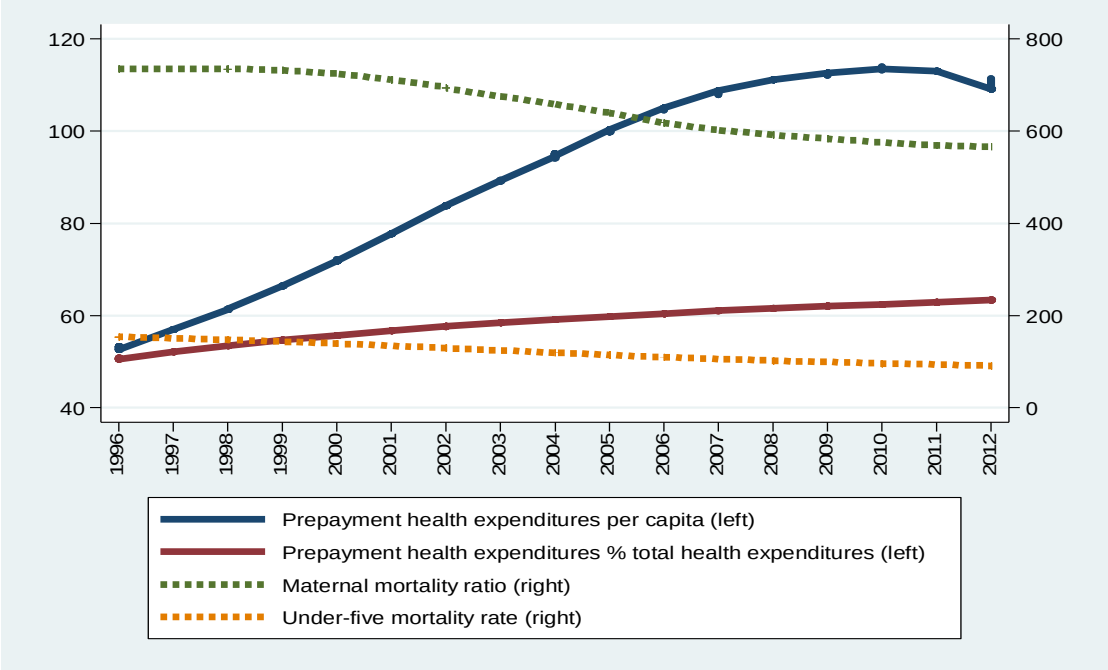
Before the econometric estimations, a descriptive analysis of prepayment health expenditures and mortality indicators is performed. We focus on their time trend (1996-2012) and their statistical relationship.

4.1 Descriptive analysis of prepayment health expenditures, of child and maternal mortality

- The time trend of prepayment health expenditures and mortality indicators is reported in Graphic 3.1. We observe that the under-five mortality rate and the maternal mortality ratio have decreased over time whereas the level per capita and the contribution of prepayment health expenditures to health financing have increased. However, the contribution of prepayment health expenditures has lowly increased compared to their level per capita. It seems that in Sub-Saharan African countries, efforts are being made not only to improve child and maternal health but also to promote prepayment health financing. We also find that mortality indicators have les varied than prepayment health expenditures per capita. Hence, it is necessary for these countries to further reinforce policies promoting the enhancement of child and maternal health.

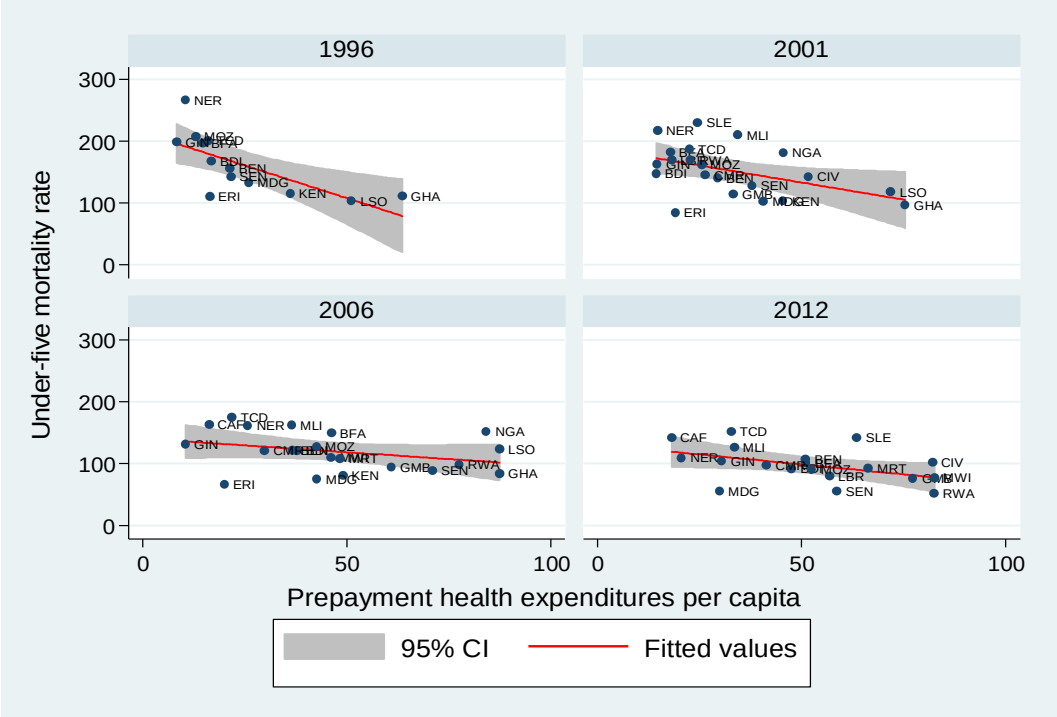
- The statistical relationship between prepayment health expenditures and mortality indicators is explored through a scatter plots analysis. We focus this exploration on some years such as 1996, 2001, 2006 and 2012, instead of calculating mean of variable on the studied period which appears long for this analysis. Annex 3.3 reports the scatter plots on the global sample. It does not appear a clear relation between prepayment health expenditures per capita and mortality indicators. That would be due to some atypical countries that distort the relations. Hence we remove these last ones and then build the scatter plots (Graphic 3.2 and 3.3). We find negative correlations attesting that high prepayment health expenditures are associated with low under-five and maternal mortality. In the following sub-section, the econometric regressions will be used to check whether the relations are statistically significant or not.

Graphic 3.1: Time trend of prepayment health expenditures per capita in USD PPP, of the under-five mortality rate and the maternal mortality ratio (1996-2012)



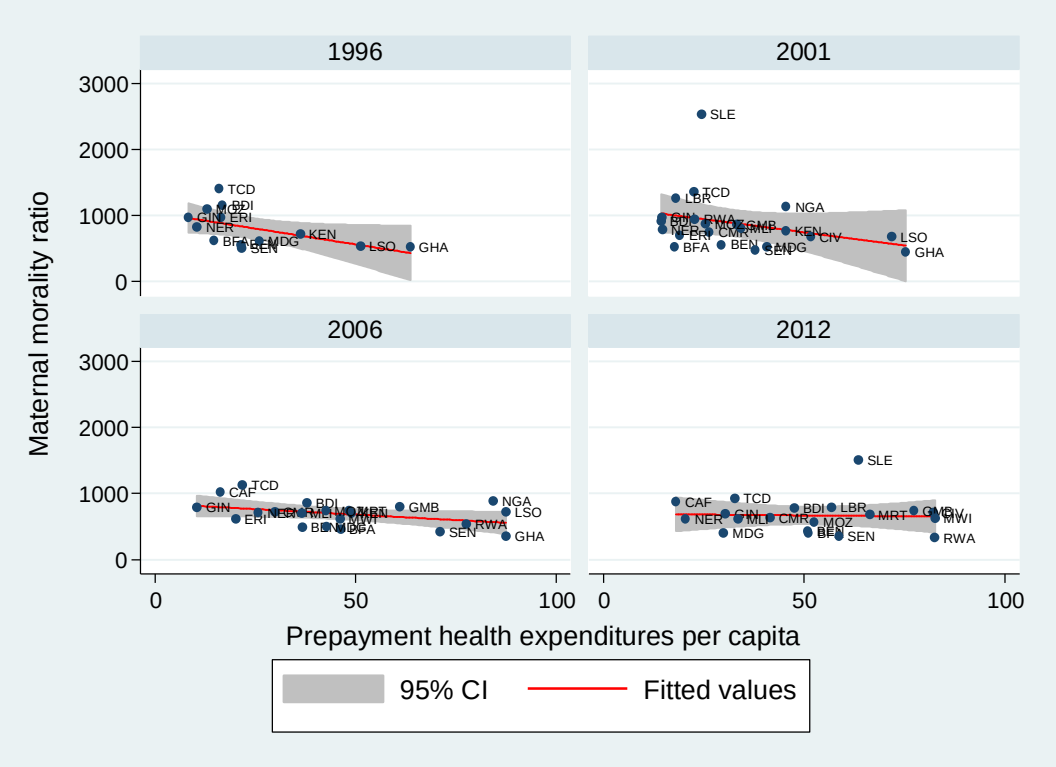
Source: Author using the GHE and the WDI databases.

Graphic 3.2: Scatter plots between prepayment health expenditures per capita in USD PPP and under-five mortality rate



Source: Author using the GHE and the WDI databases.

Graphic 3.3: Scatter plots between prepayment health expenditures per capita in USD PPP and the maternal mortality ratio



Source: Author using the GHE and the WDI databases.

4.2 Findings on econometric regressions

4.2.1 Testing the effect of prepayment health expenditures on child and maternal mortality

Evidences show that the presence of heteroskedastic and auto correlated in the distribution of standard errors. Hence, it would be preferable to use the efficient GMM estimator. In the regressions the global sample is firstly considered. However, the presence of atypical countries could result in biased findings. It is consequently important to check whether they influence the results. Hence, the residual terms based on instrumented model including all countries are extracted. Then, through box-plot analyses (Annex 3.4) of these residuals term, atypical countries are identified and removed from the sample before re-estimating the model.

The baseline results of estimations are reported in Table 3.4. We find that in all tested specifications; the instruments are relevant based on the Cragg-Donald Wald F statistics which are greater than the critical values of Stock and Yogo. The instrumental variables significantly explain prepayment health expenditures. The budget balance and the development assistances for health (DAH_net) adjusted from external funds for health disbursed from sources to channel recipient countries for newborn and child health and for maternal health lead to increase the volume per capita of prepayment health expenditures. Furthermore, it appears that the instruments are also over identified based on the Hansen test.

Through the Fisher-tests, we also observe that the tested model significantly explain mortality indicators. These tests are associated with F-statistics for which the p-values are less than maximal acceptable threshold of 10%. In this case, the null hypothesis of these tests attesting the absence of model significance can be rejected. The explanation powers of model approximated by R^2 (estimated between 92.4% and 94% per the specification) are non-negligible.

Table 3.4: Baseline results of effect of prepayment health expenditures per capita in USD PPP on child and maternal mortality (1996-2012)

	Dependent variable: the under-five mortality rate			Dependent variable: The maternal mortality ratio		
	Instrumentation with atypical countries		Instrumentation without atypical countries	Instrumentation with atypical countries		Instrumentation without atypical countries
	First stage	Second-stage		First stage	Second-stage	
Prepayment		-0.186***	-0.173***		-0.940***	-1.055***
		(-5.426)	(-4.966)		(-5.161)	(-4.702)
$Growth_{t-1}$	0.030	0.289**	0.289**	-0.012	0.971	1.856
	(0.098)	(2.096)	(2.046)	(-0.038)	(1.006)	(1.380)
$Education_{t-1}$	-0.293**	-0.897***	-1.012***	0.037	-4.755***	-4.920***
	(-2.330)	(-9.715)	(-10.109)	(0.407)	(-9.325)	(-9.423)
HIV	1.984	2.479***	1.587*	1.357	11.228**	11.368**
	(1.378)	(2.949)	(1.869)	(0.902)	(2.128)	(1.982)
Immunization	0.480***	-0.554***	-0.471***			
	(4.173)	(-7.535)	(-5.886)			
Old dependency	23.334**	11.740***	6.957**	22.080*	64.405***	56.039**
	(2.090)	(3.444)	(2.084)	(1.812)	(3.046)	(2.479)
NHGGE	0.0005***	0.0009***	0.0005***	0.001***	0.0003*	0.0005**
	(4.830)	(2.819)	(2.916)	(4.740)	(1.959)	(2.257)
Budget	0.604**			0.740**		
	(2.155)			(2.425)		
DAH_net	1.804***			1.867***		
	(5.058)			(4.898)		
Constant	-57.924*	335.225***	340.022***	-30.527	1041.597***	1053.379***
	(-1.679)	(18.720)	(21.552)	(-0.769)	(10.792)	(11.102)
Observations	397	397	306	397	397	359
F-statistics (significance of model)		403.259***	452.225***		664.220***	614.843***
Cragg-Donald Wald F-statistics		108.957	152.177	173.410	111.369	200.055
Wald test of heteroskedasticity		512.64***			903.71***	
Wooldridge test of serial correlation		546.918***			262.783***	
Critical values of Stock and Yogo (10%)		19.93	19.93	19.93	19.93	19.93
Hansen test : p-values		0.411	0.621	0.991	0.362	0.645
R^2		0.924	0.931		0.938	0.940

Note: t statistics in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

After remove atypical countries from the sample, the statistical diagnostic shows that prepayment health expenditures lead to reduce child and maternal mortality. Based on Table 2.3, it appears that for one USD PPP per capita increase in prepayment health expenditures, the under-five mortality rate and the maternal mortality ratio respectively decrease by 0.186‰ and 0.94 per 100,000 in the global sample and by 0.173‰ and 1.055 per 100,000 when atypical countries are removed.

Among the control variables, we find that economic growth increases under-five mortality, but it does not significantly affect maternal mortality. The positive effect of economic growth on under-five mortality is surprising but could be theoretically explained in the sense that health status mostly of children could be decayed whether the gains of growth are not equally distributed across the people. The primary enrolment contributes in reducing child and maternal mortality whereas HIV/aids prevalence, the old dependency ratio and non-health general government expenditures (NHGGE) lead

to increase these mortality indicators. The positive effect of NHGGE shows that they do not benefit to the improvement of child and maternal health. Nonetheless, this effect is very low. The composite index of immunization coverage reduces under-five mortality rate.

In addition, the estimations reveal that the coefficients associated with prepayment health expenditures remain negative after removing atypical countries. However, they decrease but lowly. Furthermore, the coefficients associated with control variables have not drastically changed with the removing of atypical countries. Hence it appears that atypical countries do not drastically influence the estimated effects. To keep the most possible of information, we continue the estimations on the basis of global sample.

4.2.2 Testing the effect of prepayment health expenditures on child and maternal mortality by including additional control variables in baseline specification

We have found that prepayment health expenditures per capita contribute in reducing child and maternal mortality in Sub-Saharan African countries. For the moment, we have controlled the econometric model for the main factors likely to affect mortality indicators. Here, we propose to further add control variables likely to drive mortality indicators and to check whether the evidences will change.

- Definition of additional control variables

- The first one is political stability and absence of violence/terrorism, which is retrieved from the Worldwide Governance Indicators (WGI) database. Ranged from -2.5 (more political instability) to 2.5 (more political stability) and constructed by Kaufman et al., (2010), this index measures the likelihood that government will be destabilized or overthrown by unconstitutional actions and/or politically motivated violence and/or terrorism. The major part of Sub-Saharan African countries has experienced some political instability events which have caused deaths. Accordingly, it would be important to control for these events. Political instability is more likely to affect under-five and maternal mortality rather political stability. Hence we follow Lewis and Sextion (2004) to reverse it through the following formula: Political_instability=1+Max (Political_stability)-Political_stability.

- The second one is a proxy variable of governance, which is an important aspect to account for the assumption attesting that better governance in Sub-Saharan African countries would allow an effective provision of healthcare; a fact which would improve health and would particularly reduce child and maternal mortality. Among the various aspects of governance, we choose a variable measuring the extent to which policies could be continually executed even in case of government changing. The interruption of policies could jeopardize the capacity of health systems to provide a qualitative healthcare. In this way, it would constitute a handicap for health improvement. Consequently we use the bureaucracy quality index ranged from 0 (high risk) to 4 (low risk) and provided by the International Country Risk Guide (ICRG) database. Based on the definition provided by this database, the bureaucracy quality (Bureaucracy) refers to the institutional power and to the quality of bureaucracy as a shock absorber tending to minimize revisions of policies when government changes. In the low-risk countries, the bureaucracy tends to be somewhat autonomous from political pressure and to have an established mechanism for recruitment and training.

- The third one refers to the access to safe water. Despite the progress realized in the access to safe water, Sub-Saharan Africa remains the one of regions in which a part of households do not access to improved water sources. The inaccessibility to safe water could cause child and maternal deaths. The ingestion of unimproved water is likely to result in some diseases that could cause deaths. These are for example diarrhoea, arsenicosis, fluorosis, legionellosis, and cholera. The variable used to control for this aspect is the access of rural populations to safe water (Water). Provided by the World

Development Indicators database, this variable refers to the percentage of rural people that use an enhanced drinking water source. We focus on rural people because in Sub-Saharan Africa the inaccessibility problem to safe water concerns more the rural people

- The fourth one approximates the access to information, which contributes to the enhancement of maternal, and child health. It allows for the individuals to adopt preventive behaviours to avoid diseases. The technologies of information and communication allow health authorities to promote awareness campaigns related to the risked behaviours which must be avoided to enhance maternal and child health. In this way, the access to information would be likely to reduce child and maternal mortality. Through the technologies of information and communication, some unhealthy messages are also conveyed. Consequently it is possible that the access to information impedes child and maternal health. Here, the access to information is approximated by the index of information flows (Information) provided by the Swiss Economic Institute (SEI) database[30] (Dreher et al., 2008). It is an aggregate index including four subcomponents such as the internet hosts per 1,000 people, the internet users per 1,000 people, the number of cables 'television per 1,000 people, and the sum of exports and imports in newspapers as percentage of GDP. It is also ranged from 0 (low level) to 100 (high level).

- The fifth one is urbanization used in the first and the second chapters. In Sub-Saharan African countries, the most people live in the rural areas in which the availability of and the access to healthcare supply is low. Accordingly, the rural population, in particular children and pregnant women are more exposed to high risk of death. In urban areas health services are more available. In this way, urbanization would enhance the access of children and pregnant women to healthcare. Hence, countries in which the urban people are predominant would present a low level of mortality indicators compared to countries with high size of rural populations. The literature highlights a negative effect of urbanization on under-five and maternal mortality (Baldacci et al., 2003). However, urbanization could accentuate the level of poverty, unemployment and insecurity (Herrera and Pang, 2005) which are factors adversely affecting health status, more specifically of vulnerable people such as pregnant women and the children. Hence, urbanization could also impede the enhancement of maternal and child health in developing countries (Moore et al., 2003) more specifically in Sub-Saharan African countries. We use it one-year lag to deal with its endogeneity caused by the reverse causality bias. The level of maternal and under-five mortality could induce the people to migrate towards the urban zones to get better healthcare. Accordingly, under-five and maternal mortality would affect the percentage of urban population. Urbanization variable comes from the Word Development Indicators (WDI) database.

- Evidences from the inclusion of additional controls in the baseline specification

In the regressions, the additional controls are separately included into the model to deal with the potential high correlation between them. In Tables 3.5 and 3.6, the under-five mortality rate and the maternal mortality ratio are respectively used as dependent variables. We follow the same methodology (explanatory variables and instrumentation) for both mortality indicators.

After controlling for the additional variables discussed above, we find that the instruments remain over identified based on the Hansen test. Furthermore, the comparison between Cragg-Donald Wald F statistics and the critical values of Stock and Yogo rejects the weakness assumptions of these instruments. Then, the explanation powers of estimated model remain high and significant respectively based on the F-tests and R^2 estimated between 91.2% and 95 % per the specification. The new estimations reveal that political instability increases maternal mortality but it does not significantly affect under-five mortality. The quality of bureaucracy has not a significant effect on both mortality

[30] http://globalization.kof the.ethz.ch/query/

indicators. Regarding the access of rural populations to improved water, the index of information flows and urbanization variables, they lead to significantly reduce mortality indicators. In addition, the coefficients associated with the variable of prepayment health expenditures remain robust, negative and significant. The first group of controls enter with their starting effect which is not significant in some cases, mostly where the index of bureaucracy quality is included.

Table 3.5: Baseline results of effect of prepayment health expenditures per capita in USD PPP on under-five mortality by including additional control variables in the model (1996-2012)

Included additional variables	Political instability index	Bureaucracy quality index	Access to drinking water	Information flows index	Urbanization
Prepayment	-0.195***	-0.145***	-0.133***	-0.162***	-0.096***
	(-5.235)	(-4.726)	(-3.447)	(-5.142)	(-2.692)
$Growth_{t-1}$	0.255*	0.325	0.303**	0.230*	0.227*
	(1.847)	(1.299)	(2.382)	(1.953)	(1.762)
$Education_{t-1}$	-0.898***	-1.128***	-0.759***	-0.667***	-0.806***
	(-8.650)	(-10.237)	(-8.038)	(-7.906)	(-9.629)
HIV	2.133**	1.411	1.596**	3.005***	2.363***
	(1.990)	(1.213)	(1.983)	(3.499)	(2.851)
Immunization	-0.616***	-0.569***	-0.382***	-0.385***	-0.462***
	(-7.965)	(-6.699)	(-5.986)	(-5.935)	(-5.979)
Old dependency	12.184***	8.192	9.689***	10.789***	6.583**
	(3.311)	(0.882)	(2.707)	(3.266)	(2.155)
NHGGE	0.0001**	0.0001*	0.0001	0.0001***	0.0001
	(2.525)	(1.806)	(1.591)	(2.854)	(1.395)
Political-instability	-2.919				
	(-0.857)				
Bureaucracy		-1.263			
		(-0.466)			
Water			-1.567***		
			(-5.171)		
Information				-1.171***	
				(-8.215)	
$Urbanization_{t-1}$					-2.356***
					(-4.294)
Constant	358.155***	377.588***	351.320***	346.125***	412.834***
	(19.786)	(11.887)	(25.395)	(18.081)	(16.404)
Observations	341	247	397	397	397
F-statistics (significance of model)	351.630***	98.161***	600.894***	290.980***	576.978***
Cragg-Donald Wald F-statistics	78.808	58.627	96.359	107.080	65.038
Critical values of Stock and Yogo (10%)	19.93	19.93	19.93	19.93	19.93
Hansen test : p-values	0.678	0.129	0.847	0.180	0.307
R^2	0.925	0.912	0.938	0.938	0.936

Note: t statistics in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Table 3.6: Baseline results of effect of prepayment health expenditures per capita in USD PPP on maternal mortality by including additional control variables in the model (1996-2012)

Included additional variables	Political instability index	Bureaucracy quality index	Access to drinking water	Information flows index	Urbanization
Prepayment	-0.823***	-0.762***	-0.764***	-0.712***	-0.539***
	(-4.878)	(-5.310)	(-3.768)	(-4.519)	(-2.626)
$Growth_{t-1}$	0.259	1.071	0.971	0.435	0.626
	(0.282)	(0.608)	(1.049)	(0.571)	(0.663)
$Education_{t-1}$	-4.606***	-5.046***	-4.063***	-2.842***	-4.123***
	(-8.871)	(-6.920)	(-6.796)	(-4.955)	(-7.638)
HIV	9.951	-3.309	8.628	12.808**	10.505*
	(1.527)	(-0.510)	(1.600)	(2.280)	(1.937)
Old dependency	63.463***	10.419	56.374***	59.702***	43.397**
	(3.045)	(0.246)	(2.620)	(3.022)	(2.111)
NHGGE	0.0002*	0.0002**	0.0002	0.0002**	0.00004
	(1.694)	(1.988)	(1.342)	(2.029)	(0.629)
Political-instability	34.886**				
	(2.166)				
Bureaucracy		-19.774			
		(-1.611)			
Water			-4.215***		
			(-2.779)		
Information				-6.231***	
				(-7.767)	
$Urbanization_{t-1}$					-9.436***
					(-3.382)
Constant	915.365***	1245.542***	1110.337***	1129.977***	1368.457***
	(10.174)	(7.506)	(11.104)	(13.350)	(10.325)
Observations	341	247	397	397	397
F-statistics (significance of model)	496.891***	305.876***	838.363***	675.303***	1078.781***
Cragg-Donald Wald F-statistics	78.629	61.508	95.622	106.496	63.453
Critical values of Stock and Yogo (10%)	19.93	19.93	19.93	19.93	19.93
Hansen test : p-values	0.310	0.895	0.290	0.828	0.514
R^2	0.941	0.932	0.941	0.950	0.943

Note: t statistics in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

4.2.3 Testing the effect of prepayment health expenditures on child and maternal mortality conditional to international remittances and financial development

For the moment, we have found that the increase in prepayment health expenditures helps to reduce child and maternal mortality even when additional explanatory variables are included in the model. We have theoretically discussed the extent to which international remittances and financial development would contribute in increasing the negative effect of prepayment health expenditures on mortality indicators in Sub-Saharan African countries (seen subsection 2.4). In the present subsection, we attempt to test this assumption.

- Definition and data sources on international remittances and financial development variables

We select two variables provided by the World Development Indicators (WDI) database. These are the personal remittances received as percentage of GDP and the domestic credit to private sector as share of GDP, which approximates here financial development. International remittances include personal transfers and compensation of employees. The personal transfers comprise all current transfers in cash or in kind made or received by resident households to or from non-resident households and all current transfers between resident and non-resident individuals. The compensation of employees integrates the income of border, seasonal, and other short-term workers who are employed in an economy where they are not resident and residents employed by non-resident entities. The domestic credit to private sector refers to financial resources provided to the private sector by financial corporation such as through loans, purchases of non-equity securities, and trade credits and other accounts receivable that establish a claim for repayment.

- Empirical strategy used to test prepayment health financing effect on child and maternal mortality conditional to international remittances and financial development

There are two strategies, which could allow us to test the conditional effect of prepayment health expenditures compared to international remittances and to the variable of financial development. The first one consists of estimating interactive model in which prepayment health expenditures would be combined with international remittances and financial development variables. In this case, it would be necessary to find instruments to deal with the endogeneity of international remittances and financial development variables. This endogeneity is due to reverse causality bias. Despite the potential effects of international remittances and financial development on child and maternal mortality, the level of mortality indicators would affect these last ones. The increase in child and maternal mortality in Sub-Saharan African countries could induce households, mostly the poorest to contract credits to finance healthcare of their ill parents. Furthermore, the degradation of child and maternal health could also encourage the foreign migrants to send more funds, which will be used to finance healthcare of their parents. On this subject, we have not found for the moment instruments, which could address the endogeneity of international remittances and financial development variables. Hence, we use a second alternative consisting of dividing the sample on the basis of median value of international remittances and financial development variables respectively estimated around 1.25% and 16.22%. The goal of this alternative is to test whether the adverse effect of prepayment health expenditures on mortality indicators is greater or not in countries, for which international remittances and/or the domestic credit to private sector contribute more to the wealth creation (GDP), compared to the others. Four subsamples are raised: countries with high international remittances, countries with low international remittances, countries with high financial development and countries with low financial development. Accordingly the effect of prepayment health expenditures is tested in each of subsample.

- Evidences from prepayment health financing effect on child and maternal mortality conditional to international remittances and financial development

The baseline results are reported in Tables 3.7 and 3.8 and show that the instruments remain valid based on the Hansen test of over identification and on the comparison between the Cragg-Donald Wald F statistics and critical values of Stock and Yogo. Moreover, the explanation powers of tested model remain significant and high.

- *Evidences from international remittances*: in Table 3.7, the subsamples with low and high international remittances are compared. We find that prepayment health expenditures reduce child and maternal mortality in countries that receive lower and higher flows of international remittances. Their negative effect is greater in countries that receive higher flows of international remittances compared

to the others. In countries with higher flows of international remittances, a one USD PPP per capita increase in prepayment health expenditures leads to reduce the under-five mortality rate and the maternal mortality ratio respectively by 0.334‰ and 1.887 per 100,000. In countries with lower flows of international remittances, the under-five mortality rate and the maternal mortality ratio respectively decrease by 0.113‰ and 0.558 per 100,000 for one USD PPP per capita increase in prepayment health expenditures.

- *Evidences from financial development*: in Table 3.8, we compare the subsamples with low and high financial development. The results stress that prepayment health expenditures reduce child and maternal mortality in countries with higher degree of financial development but they do not significantly affect mortality indicators in countries experiencing a lower financial development. In countries with higher financial development, for one USD PPP per capita increase in prepayment health expenditures, the under-five mortality rate and the maternal mortality ratio respectively decrease by 0.083‰ and 0.612 per 100,000.

The results show that international remittances and financial development reinforce the negative effect of prepayment health expenditures on child and maternal mortality.

Table 3.7: Baseline results of effect of prepayment health expenditures per capita in USD PPP on under-five and maternal mortality in the subsamples of countries receiving low and high international remittances (1996-2012)

Dependent variables	the under-five mortality rate		The maternal mortality ratio	
Subsamples	Countries with high remittances	Countries with low remittances	Countries with high remittances	Countries with low remittances
Prepayment	-0.334***	-0.113***	-1.887***	-0.558***
	(-5.153)	(-3.814)	(-4.515)	(-4.226)
$Growth_{t-1}$	0.239*	0.115	-0.092	-0.522
	(1.679)	(0.464)	(-0.094)	(-0.450)
$Education_{t-1}$	-0.538***	-1.386***	-2.940***	-6.269***
	(-7.469)	(-13.120)	(-6.429)	(-15.270)
HIV	4.376***	3.276***	29.143***	13.102***
	(5.514)	(3.441)	(5.482)	(2.895)
Immunization	-0.610***	-0.395***		
	(-11.120)	(-3.979)		
Old dependency	10.717*	9.586**	32.733	44.964**
	(1.664)	(2.171)	(0.741)	(2.129)
NHGGE	0.0001***	0.00005**	0.0004	0.0002**
	(3.114)	(1.973)	(1.350)	(1.987)
Constant	264.546***	374.797***	1122.644***	1183.974***
	(11.286)	(22.239)	(7.048)	(16.487)
Observations	232	165	232	165
Number of countries	17	14	17	14
F-statistics (significance of model)	111.366***	142.087***	108.544***	221.340***
Cragg-Donald Wald F-statistics	145.710	47.024	160.282	49.123
Critical values of Stock and Yogo (10%)	19.93	19.93	19.93	19.93
Hansen test : p-values	0.453	0.564	0.824	0.262
R^2	0.949	0.962	0.946	0.974

Note: t statistics in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Table 3.8: Baseline results of effect of prepayment health expenditures per capita in USD PPP on under-five and maternal mortality in the subsamples of countries experiencing low and high financial development (1996-2012)

Dependent variables	The under-five mortality rate		The maternal mortality ratio	
Subsamples	Countries with high financial development	Countries with low financial development	Countries with high financial development	Countries with low financial development
Prepayment	-0.083***	-0.106	-0.612***	-0.398
	(-3.511)	(-1.516)	(-4.185)	(-1.278)
$Growth_{t-1}$	0.595***	-0.071	4.344***	-1.509**
	(3.340)	(-0.390)	(3.707)	(-1.823)
$Education_{t-1}$	-0.362***	-1.192***	-3.044***	-4.080***
	(-5.453)	(-10.604)	(-7.705)	(-9.891)
HIV	5.531***	1.999**	12.983**	13.770***
	(6.500)	(2.219)	(2.286)	(3.473)
Immunization	-0.751***	-0.422***		
	(-13.069)	(-5.539)		
Old dependency	7.599**	1.661	-2.060	185.448***
	(2.180)	(0.187)	(-0.088)	(4.768)
NHGGE	0.0001**	0.00001	0.0004**	-0.0003
	(2.458)	(0.180)	(2.277)	(-1.008)
Constant	300.636***	375.779***	880.234***	794.465***
	(22.994)	(12.809)	(10.507)	(6.266)
Observations	218	179	218	179
Number of countries	17	14	17	14
F-statistics (significance of model)	136.285***	64.385***	197.287***	123.089***
Cragg-Donald Wald F-statistics	151.513	27.325	174.466	27.027
Critical values of Stock and Yogo (10%)	19.93	19.93	19.93	19.93
Hansen test : p-values	0.351	0.926	0.273	0.216
R^2	0.958	0.917	0.969	0.953

Note: t statistics in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

- *Evidences from other explanatory variables*: it appears that economic growth increases under-five mortality in countries with high international remittances and financial development. It does not significantly affect under-five mortality in countries with low remittances and financial development. In addition, it appears that economic growth does not significantly affect maternal mortality in countries with low and high international remittances. However, it increases and reduces maternal mortality respectively in countries with high and low financial development.

The primary enrolment and HIV/aids prevalence respectively contribute in reducing and increasing under-five and maternal mortality in all raised subsamples. In all subsamples, the immunization coverage helps to reduce child mortality rate.

The old dependency ratio and non-health general government expenditures increase under-five mortality in countries receiving low and high international remittances and in countries experiencing high degree of financial development. They do not significantly affect under-five mortality in countries associated with low degree of financial development. These variables increase maternal mortality in countries with low international remittances, whereas they do not significantly affect maternal mortality in countries receiving high international remittances. The old dependency ratio and non-health general government expenditures increase maternal mortality in countries respectively with low and high financial development. They do not significantly affect maternal mortality in countries respectively experiencing high and low degree of financial development.

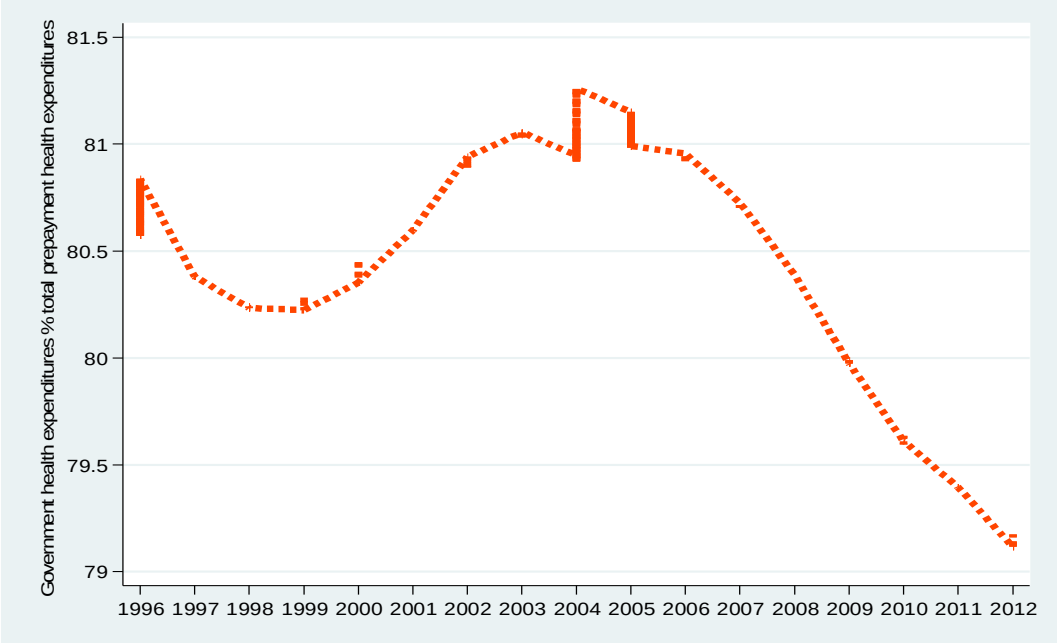
4.2.4 Testing the effect of prepayment health expenditures 'components on child and maternal mortality

The goal of subsection is to check whether all of components of prepayment health expenditures have significant effects on child and maternal mortality. We split prepayment health expenditures into two specific components such as government health expenditures per capita in USD PPP (GHEPC) and prepayment health expenditures from private sources expressed in USD PPP per capita in (PPHEPC). The variable of government health expenditures comes from the Global Health Expenditures (GHE) database. Prepayment health expenditures per capita from private sources are calculated by retrieving government health expenditures per capita from total prepayment health expenditures per capita in USD PPP. The formula is: PPHEPC=Prepayment-GHEPC.

- Descriptive analysis of prepayment health expenditures 'components and their statistical relationship with child and maternal mortality

Before the regressions, the time trend of prepayment health expenditures composition is firstly investigated (Graphic 3.4). It appears that governments' contribution to prepayment health financing has decreased since 2005. Consequently, it seems that since the commitment of countries to promote universal health coverage in 2005, prepayment health financing focuses more and more on private prepayment schemes in Sub-Saharan African countries.

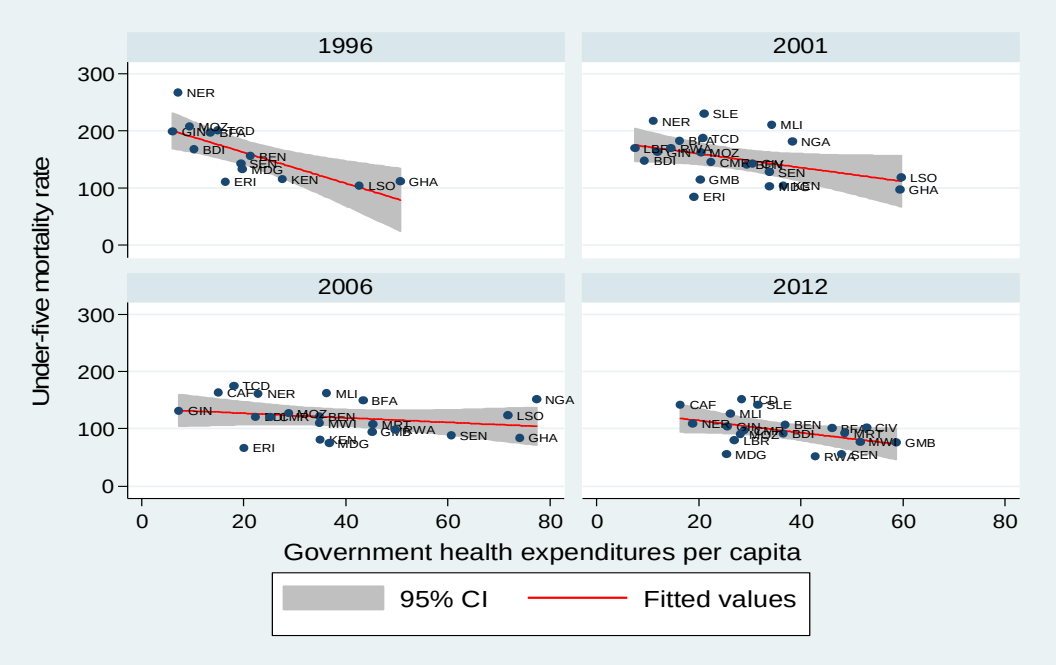
Graphic 3.4: Time trend of composition of prepayment health expenditures (1996-2012)



Source: Author using the GHE database.

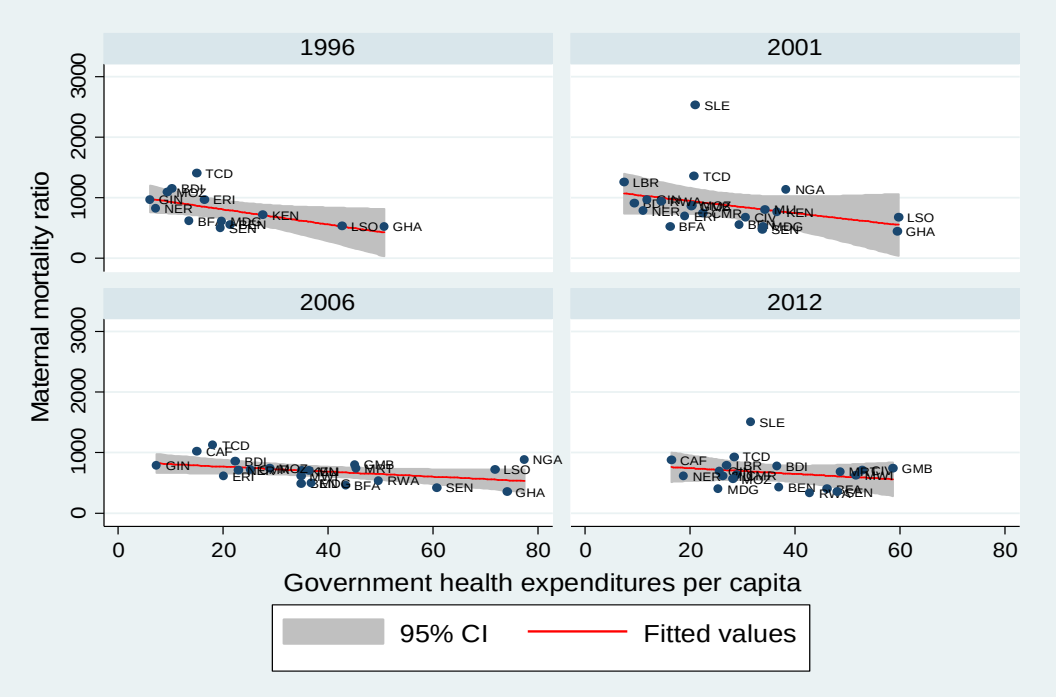
Secondly, the statistical relation by year (1996, 2001, 2006, 2012) between the components of prepayment health expenditures, all expressed in USD PPP per capita and mortality indicators is explored (Graphics 3.5, 3.6, 3.7 and 3.8) without atypical countries that distort the relations (Annex 3.3). The trends reveal a negative correlation, attesting that high government health expenditures and prepayment health expenditure from private sources are associated with low under-five and maternal mortality.

Graphic 3.5: Scatter plots between government health expenditures per capita in USD PPP and under-five mortality rate



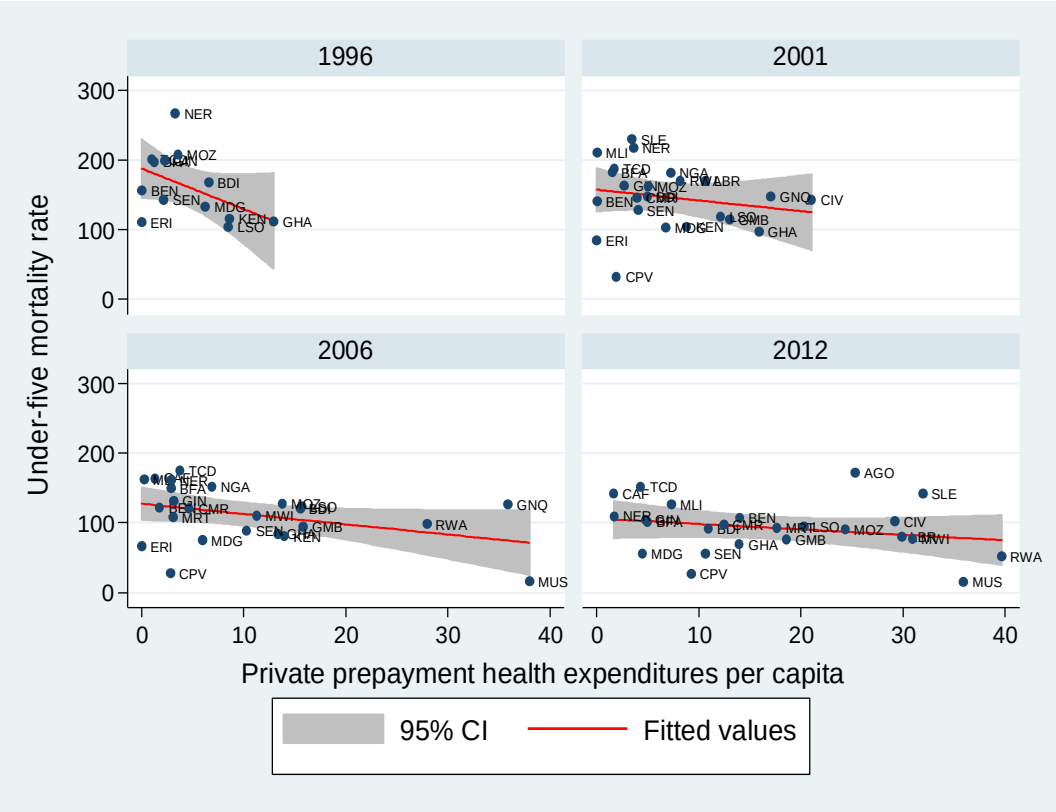
Source: Author using the GHE and the WDI databases.

Graphic 3.6: Scatter plots between government health expenditures per capita in USD PPP and the maternal mortality ratio



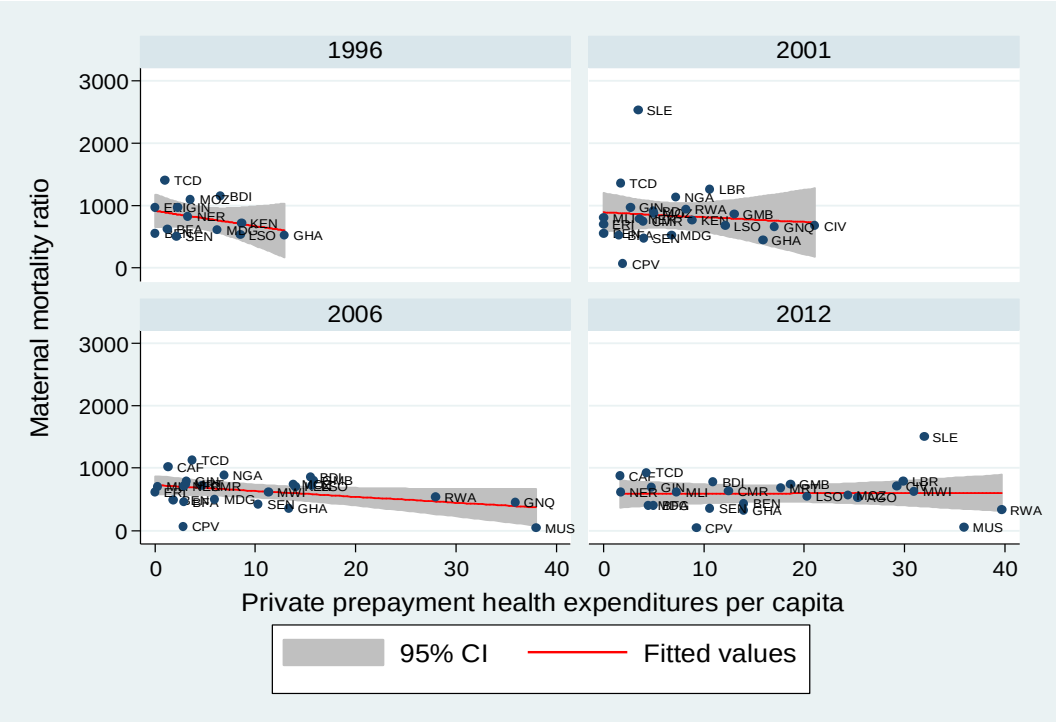
Source: Author using the GHE and the WDI databases.

Graphic 3.7: Scatter plots between prepayment health expenditures from private sources in USD PPP per capita and under-five mortality rate



Source: Author using the GHE and the WDI databases.

Graphic 3.8: Scatter plots between prepayment health expenditures from private sources in USD PPP per capita and the maternal mortality ratio



Source: Author using the GHE and the WDI databases.

- Evidences from the effect of prepayment health expenditures 'components on under-five and maternal mortality

In the regressions estimating the effect of prepayment health expenditures' components, the variables of government health expenditures and prepayment health expenditures from private sources, all expressed in USD PPP per capita, are separately included to avoid potential biases of collinearity. The two variables appear to be highly correlated. The correlation between the last ones is estimated around 72.86% (Annex 3.2). The results of estimations are reported in Tables 3.9 and 3.10 which respectively focus on the effect of government health expenditures per capita and prepayment health expenditures per capita from private sources on child and maternal mortality. We follow the same methodology (specifications and instrumentation) for both variables.

Table 3.9: Baseline results of effect of government heath expenditures per capita in USD PPP on under-five and maternal mortality (1996-2012)

	Dependent variable: the under-five mortality rate			Dependent variable: The maternal mortality ratio		
	Instrumentation with atypical countries		Instrumentation without atypical countries	Instrumentation with atypical countries		Instrumentation without atypical countries
	First stage	Second-stage		First stage	Second-stage	
GHEPC		-0.340***	-0.162***		-1.709***	-1.504***
		(-4.075)	(-6.398)		(-4.509)	(-4.730)
$Growth_{t-1}$	0.011	0.285*	0.284*	-0.022	0.900	0.422
	(0.046)	(1.836)	(1.788)	(-0.090)	(0.895)	(0.349)
$Education_{t-1}$	-0.133	-0.887***	-0.895***	0.127*	-4.539***	-4.941***
	(-1.184)	(-8.861)	(-11.329)	(1.665)	(-8.526)	(-9.276)
HIV	1.907*	2.838***	0.814	1.413	12.766**	9.467
	(1.754)	(3.078)	(1.052)	(1.277)	(2.262)	(1.637)
Immunization	0.378***	-0.518***	-0.542***			
	(3.774)	(-6.063)	(-7.432)			
Old dependency	24.998**	16.047***	-9.370*	24.010*	88.762***	63.270**
	(2.040)	(3.304)	(-1.677)	(1.832)	(3.304)	(2.353)
NHGGE	0.0004***	0.0001**	0.0004***	0.0005***	0.001**	0.001**
	(4.562)	(2.453)	(2.610)	(4.498)	(2.254)	(2.155)
Budget	0.460*			0.567**		
	(1.934)			(2.218)		
DAH_net	0.962***			1.012***		
	(3.667)			(3.602)		
Constant	-74.426**	321.676***	379.210***	-52.853	974.581***	1051.588***
	(-2.044)	(14.175)	(18.609)	(-1.292)	(9.057)	(10.538)
Observations	397	397	272	397	397	327
F-statistics (significance of model)		265.769***	472.658***		397.016***	611.714***
Cragg-Donald Wald F-statistics		46.574	121.431		49.833	90.517
Critical values of Stock and Yogo (10%)		19.93	19.93		19.93	19.93
Hansen test : p-values		0.262	0.462		0.623	0.863
R^2		0.912	0.939		0.932	0.943

Note: t statistics in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Table 3.10: Baseline results of effect of prepayment health expenditures per capita in USD PPP from private sources on under-five and maternal mortality (1996-2012)

	Dependent variable: the under-five mortality rate			Dependent variable: The maternal mortality ratio		
	Instrumentation with atypical countries		Instrumentation without atypical countries	Instrumentation with atypical countries		Instrumentation without atypical countries
	First stage	Second-stage		First stage	Second-stage	
PPHEPC		-0.400***	-0.402***		-1.792***	-2.228***
		(-5.029)	(-5.264)		(-3.809)	(-3.527)
$Growth_{t-1}$	0.042	0.259*	0.191	0.033	0.537	0.538
	(0.230)	(1.835)	(1.055)	(0.182)	(0.572)	(0.549)
$Education_{t-1}$	-0.126**	-0.918***	-1.051***	-0.053	-4.943***	-4.850***
	(-2.075)	(-10.573)	(-11.818)	(-1.320)	(-10.014)	(-11.017)
HIV	0.286	2.002**	1.597*	0.157	9.742*	9.702*
	(0.246)	(2.295)	(1.876)	(0.138)	(1.879)	(1.753)
Immunization	0.106**	-0.543***	-0.431***			
	(2.033)	(-8.224)	(-6.655)			
Old dependency	-2.238	5.814*	-1.705	-2.387	40.935*	57.233
	(-0.798)	(1.688)	(-0.511)	(-0.886)	(1.824)	(1.492)
NHGGE	0.00005*	0.00002	0.00005**	0.00005**	-0.0001	0.0001
	(1.813)	(0.997)	(2.287)	(2.037)	(-1.056)	(1.332)
Tax revenue	-0.292**			-0.266*		
	(-2.054)			(-1.892)		
DAH_net	0.842***			0.854***		
	(4.923)			(4.862)		
Constant	25.433***	347.649***	357.124***	30.051***	1130.320***	1017.041***
	(2.608)	(22.153)	(24.705)	(3.020)	(11.900)	(8.137)
Observations	405	405	334	405	405	333
F-statistics (significance of model)		345.448***	607.248***		625.584***	432.698***
Cragg-Donald Wald F-statistics		80.101	57.656		81.547	83.218
Critical values of Stock and Yogo (10%)		19.93	19.93		19.93	19.93
Hansen test : p-values		0.166	0.372		0.348	0.958
R^2		0.918	0.926		0.936	0.924

Note: t statistics in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Concerning the validity of instruments, we find that the variable of development assistance for health positively and significantly affects government health expenditures per capita and prepayment health expenditures per capita from private sources. However, the budget balance leads to increase government health expenditures per capita (Table 3.9) but it does not have a significant effect on prepayment health expenditures per capita from private sources (Annex 3.5). Hence in the model using prepayment health expenditures from private sources as variable of interest, we replace the budget

balance by a tax revenue variable expressing the total revenues of governments as share of GDP and retrieved from the World Economic Outlook (WEO) database.

The increase in tax revenue is likely to reduce the amount of private prepayment health expenditures. They could decrease private health insurance expenditures. The taxation has generally the consequence to increase the tax burden which could potentially reduce the disposal income of households and accordingly induce them to less subscribe to health insurance contracts. That would reduce private health insurance premiums. On this subject, Guerineau and Sawadogo (2015) stressed that the tax burden approximated by the tax freedom index leads to reduce the life insurance premiums as share of GDP in Sub-Saharan African countries. In these countries, the majority of individuals that pays taxes on households' income and that more subscribes to insurance contracts are the richest and the middle-class people. In this way, the taxation would reduce the disposal income of these last ones, mostly of middle-class populations and induce them to reduce their subscription to insurance contracts, mostly to health insurances schemes. The reduction in these subscriptions will have the consequence to reduce health insurance premiums, the activities of health insurance companies and accordingly the volume of private health insurance expenditures.

We instrumented government health expenditures and prepayment health expenditures from private sources by the development assistance variable. In addition to this last one, we use the budget balance and tax revenue variables as second instruments respectively for government health expenditures per capita and prepayment health expenditures per capita from private sources.

Based on the estimations results, it appears that the instruments are valid based on the Hansen test and the weakness instruments test. The development assistance variable increases government health expenditures and private prepayment health expenditures. The budget balance increases government health expenditures, whereas tax revenue as share of GDP lead to reduce private prepayment health expenditures. Furthermore, the explanation powers of estimated model remain high and significant based respectively on the F-tests and R^2. We find that government health expenditures and prepayment health expenditures from private sources lead to significantly reduce child and maternal mortality. A one USD PPP per capita increase in government health expenditures leads to decrease the under-five rate and the maternal mortality ratio respectively by 0.34‰ and 1.709 per 100,000. Moreover, for one USD PPP per capita increase the under-five rate and the maternal mortality ratio respectively diminish by 0.4‰ and 1.792 per 100,000. In absolute terms, the coefficients associated with government health expenditures and prepayment health expenditures from private sources respectively decrease and increase when atypical countries are removed. However, they remain negative and significant.

4.2.5 Testing the effect of prepayment health expenditures and their components on child and maternal mortality on sub-periods data

In view of evidences, one might evoke non-stationarity problems in our estimations. For more robustness, we perform again the regressions on sub-periods to account for this problem. For the same reason evoked in the second chapter, we retain an annual dimension of three years by sub-period. The sub-periods are: 1996-1997, 1998-2000, 2001-2003, 2004-2006, 2007-2009 and 2010-2012. Then, we calculate the mean of all used variables and re-estimate the econometric model to check whether the results will change. Over these sub-periods, we re-estimate the effects of total prepayment health expenditures per capita, government health expenditures per capita and prepayment health expenditures per capita from private sources on child and maternal mortality. Table 3.11 reports the baselines results of estimations. For each mortality indicator, the first, the second and the third columns respectively refer to the effect of total prepayment health expenditures, government health expenditures and prepayment health expenditures from private sources.

Table 3.11: Baseline results of effect of prepayment health expenditures per capita in USD PPP on under-five and maternal mortality on sub-periods data (1996-2012)

Dependent variables	The under-five mortality rate			The maternal mortality ratio		
Specifications	(1)	(2)	(3)	(1)	(2)	(3)
Prepayment	-0.159***			-0.822***		
	(-3.955)			(-3.257)		
GHEPC		-0.263***			-1.372***	
		(-3.659)			(-3.265)	
PREHEPC			-0.225***			-1.299***
			(-2.670)			(-2.867)
$Growth_{t-1}$	0.993*	1.057**	1.204**	3.959	4.496	5.368
	(1.960)	(2.068)	(2.544)	(1.053)	(1.190)	(1.526)
$Education_{t-1}$	-0.923***	-0.906***	-0.941***	-4.663***	-4.482***	-5.002***
	(-5.938)	(-5.628)	(-6.808)	(-6.635)	(-6.239)	(-7.312)
HIV	3.553**	4.030***	2.915**	9.755	12.017	9.964
	(2.488)	(2.622)	(1.874)	(1.175)	(1.366)	(1.250)
Immunization	-0.600***	-0.569***	-0.567***			
	(-4.255)	(-3.860)	(-4.597)			
Old dependency	16.492***	21.196***	9.120*	100.822***	125.607***	76.091**
	(3.390)	(4.114)	(1.671)	(3.433)	(4.272)	(2.268)
NHGGE	0.0001	0.0001**	-0.00002**	0.0001	0.0003	-0.0002***
	(1.631)	(2.041)	(-2.220)	(0.490)	(1.018)	(-3.803)
Constant	310.812***	293.095***	331.172***	919.457***	840.522***	994.290***
	(16.003)	(13.660)	(15.226)	(8.475)	(7.690)	(8.136)
Observations	136	136	132	136	136	132
F-statistics	511.151***	1167.721***	568.796***	281.011***	281.346***	229.580***
Cragg-Donald Wald F-statistics	36.941	25.219	48.630	37.039	24.884	48.918
Critical values of Stock and Yogo (10%)	19.93	19.93	19.93	19.93	19.93	19.93
Hansen tests: p-values	0.647	0.728	0.340	0.197	0.201	0.981
R^2	0.950	0.947	0.947	0.960	0.959	0.962

Note: t statistics in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Based on the estimations, it appears that the instruments remain valid based on the Hansen test and the comparison between the Cragg-Donald Wald F statistics and the critical values of Stock and Yogo. Then, it appears that the explanation powers of tested model remain also high and significant. The second findings related to these estimations reveal that total prepayment health expenditures; government health expenditures and prepayment health expenditures from private sources lead to significantly reduce the under-five mortality rate and the maternal mortality ratio. Concerning the other explanatory variables, we find that economic growth significantly increases under-five mortality but it does not affect maternal mortality. HIV/aids prevalence and the old dependency ratio lead to increase mortality indicators. The primary enrolment contributes in reducing maternal and under-five

mortality whereas the immunization coverage negatively affects under-five mortality. The effect associated with non-health general government expenditures remains inconclusive. This variable enters with positive and significant coefficients which are negative in some cases. The results raised from the estimations over the sub-periods remain robust when the supplementary variables discussed above (political instability, quality of bureaucracy, access to improved water, and to information and urbanization) are included in the model (see Annexes 3.6 and 3.7).

Over the sub-periods, it would have been interested to perform the regressions by subsample of countries with low/high international remittances and financial development. However, it would be difficult to do that. We work on a low sample of countries. Hence the subdivision of sample would have to reduce the number of observations for each regression carried out by subsample; a fact could result in inconsistent results. In this way, for these estimations we only consider the results based on annual panel-data

5. Conclusion

Since many years the economic literature has been focused on the role of health financing for the improvement of population's health in developing countries. On the time where these countries, namely the ones coming from Sub-Saharan Africa, have committed to promote universal health coverage, it would be fundamental to discuss the extent to which health could be equitable and sustainably financed to improve health without jeopardize the well-being of individuals.

In this context, the chapter has proposed to investigate the effect of prepayment health financing on health status in Sub-Saharan African countries. We have assembled a panel dataset encompassing 31 countries over the period 1996-2012. The under-five mortality rate and the maternal mortality ratio have been retained as proxy indicators of health status of children and pregnant women which are the most vulnerable people in Sub-Saharan Africa in addition to the elderly individuals. Mortality indicators are explained by prepayment health expenditures per capita in USD PPP by controlling for socioeconomic (gross primary enrolment, GDP per capita growth, access to safe water and to information) and demographic (old dependency ratio, urbanization) variables, immunization coverage, morbidity level due to HIV/aids, public financing (non-health general government expenditures per capita in USD PPP), institutional (quality of bureaucracy) and political (political instability and presence of violence/terrorism) factors. The econometric model has been tested through the efficient GMM estimator to address the endogeneity issues based on the variable of prepayment health expenditures.

In addition, we have tested differential effects of prepayment health expenditures by subsample of countries receiving low and high international remittances flows and experiencing low and high degree of financial development. Then, we have estimated the effect of prepayment health expenditures' components such as government health expenditures and prepayment health expenditures from private sources, all expressed in USD PPP per capita.

Our investigations reveal the following evidences:

- Prepayment health expenditures contribute in reducing under-five and maternal mortality.

- The effect of prepayment health expenditures further decrease mortality indicators in countries receiving higher flows of international remittances compared to ones in which the flows of international remittances are lower.

- Prepayment health expenditures lead to reduce mortality indicators in countries experiencing a higher degree of financial development but they do not significantly affect these indicators in countries where the financial sector is less developed.

- Government health expenditures and prepayment health expenditures from private sources also contribute to reduce under-five and maternal mortality.

-Evidences remain robust even when atypical countries are removed from the sample and when the estimations are performed on sub-period data.

6. Annexes

Annex 3. 1: Summary of evidences on prepayment health financing effect on health status

Studies	Samples	Dependent variables	Variables of interest	Evidences
Moreno-Serra and Smith, (2013)	160 developing and developed countries (1995-2011)	Total prepayment health expenditures	The under-five mortality rate	Negative effect
Moreno-Serra and Smith, (2011)	153 low-and middle income countries including 116 low-income countries (1995-2008)	Voluntary health expenditures	Under-five mortality rate, Female adult mortality rate, Male adult mortality rates.	No effect
		Government health expenditures		Negative effect that is larger on under-five mortality and for low-income countries.
Issa and Ouattara, (2005)	160 countries including 106 low-income countries and 54 high-income countries (1980-2000)	Government health expenditures	Infant mortality rate	Negative effect on low-income countries and no effect on high-income countries
		Private health expenditures		Negative effect on high-income countries and no effect on low-income countries
Bokhari et al., (2007)	127 developing countries (2000)	Government health expenditures	Infant mortality rate and the maternal mortality ratio	Negative effect
Baldacci et al., (2003)	94 developing countries (1996-1998)	Government health expenditures	Under-five and infant mortality rates	Negative effect
Wang, (2002)	60 low-income countries (1990-1999)	Government health expenditures	The under-five mortality rate	Negative effect
Gupta et al., (2002)	50 developing countries and transition economies (1993-1994)	Government health expenditures	Under-five and infant mortality rates	Negative effect
Anand and Ravaillion (1993)	22 developing countries (1985-1990)	Government health expenditures	Infant mortality rate, life expectancy at birth	Negative effect on infant mortality and positive effect on the life expectancy; The effects are greater in countries with high poverty headcount
Bidani and Ravaillion (1997)	35 developing countries (1980)		Infant and prenatal mortality rates, life expectancy at birth	
Gupta et al., (2003)	44 developing countries (1990-1999)	Government health expenditures	Under-five mortality rate	Negative effect in the poorest quintile
				No effect in the richest quintile
Deolalikar, (1995)	Indonesia (studied period not provided)	Government health expenditures	Infant diseases	Marginal effect of government health expenditures on the incidence and the duration of infant diseases lower for the non-poor households compared to the poorest.

Filmer and Pritchett (1999)	45 developing countries	Government health expenditures	Under-five and infant mortality rates	95% of cross-national variation in mortality indicators explained by income per capita, income inequalities, female education, ethnic fragmentation and predominance of Muslims
				Government health expenditures explain less of 1/7 of one percentage point variation in mortality indicators
Zakir and Wunnava (1999)	117 developing and developed countries (1993)	Government health expenditures	Infant mortality rate	fertility rate, female participation in the labour force and per capita GNP as higher preacher reducing infant mortality
Carrin and Politi (1996)	57 developing countries (1990)	Government health expenditures	Infant mortality rate	GDP per capita and poverty as important determinants respectively increasing and decreasing infant mortality
Kamiya, (2010)	141 developing countries (1990-2008)	Government health expenditures	Under-five mortality rate	Access to improved sanitation as important determinant decreasing infant mortality
Turner, (1991)	Nicaragua (survey data)	Access to healthcare facilities	Infant mortality rate	Negative effect
Wagstaff and Claeson, (2004)	developing countries (number of countries and studied not provided)	Government health expenditures and CPIA index	Infant mortality rate	CPIA[31] index reduces the negative effect of government health expenditures on infant mortality
Farag et al., (2013)	133 low-and middle-income countries (1995, 2000, 2005, 2006)	Government health expenditures and government effectiveness index	Under-five and infant mortality rates	Government effectiveness reduces the negative effect of government health expenditures on infant mortality
Rajkumar and Swaroop, (2008)	91 developing countries (1990, 1997, 2003)	Government health expenditures, bureaucracy quality and corruption perception index	Under-five mortality rate	Bureaucracy quality and corruption respectively reduces and increases the negative effect of government health expenditures on infant mortality
Anyanwu and Erhijakpor, (2009)	47 African countries (1999-2004)	Government health expenditures	Under-five and infant mortality rates	Negative effect

[31]Country Policy Institutional Assessment.

Novignon et al., (2012)	44 Sub-Saharan African countries (1995-2010)	Government health expenditures	Infant mortality and crude death rate and life expectancy at birth	Negative and positive effects respectively on infant mortality and death rate and life expectancy
		Private health expenditures		
Akinkugbe and Afeikhena, (2006)	45 Sub-Saharan African countries and 12 Middle East and North Africa countries (1980-2003)	Government health expenditures	Under-five and infant mortality rates and life expectancy at birth	Negative and positive effects respectively on mortality indicators and life expectancy
Akinkugbe and Mohanoe (2009)	Lesotho (studied period not provided)	Government health expenditures	Under-five and infant mortality rates and life expectancy at birth	Negative and positive effects respectively on mortality indicators and life expectancy
Atake, (2014)	Togo (1980-2010)	Government health expenditures	Infant survival rate	Positive effect in short term
		Functioning government health expenditures		Positive effect in short term
		Investment government health expenditures		Positive effect in short and long term
Yaqub et al., (2012)	Nigeria (1980-2008)	Government health expenditures, and corruption perception index	Under-five and infant mortality rates and life expectancy at birth	Corruption respectively reduces the negative and positive effects of government health expenditures on mortality indicators and the life expectancy

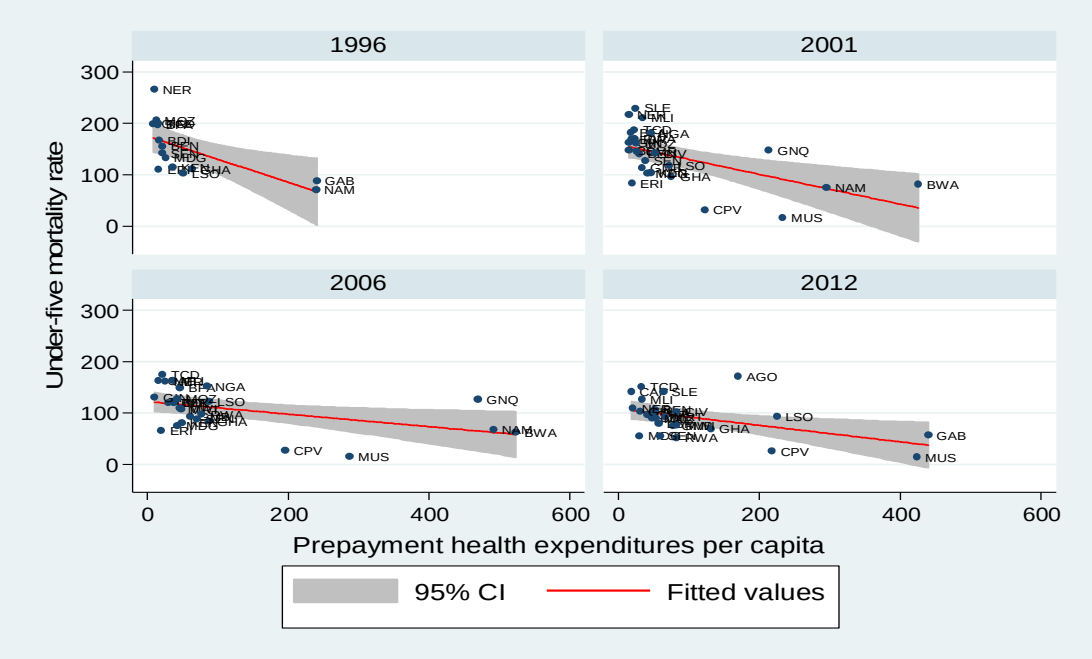
Annex 3.2: Matrix of partial correlations (1996-2012)

	Under5	Maternal	Prepayment	GHEPC	PPHEPC	Growth	GDP	Education	HIV	Old dependency	Immunization
Under5	1										
Maternal	0.7408***	1									
Prepayment	-0.4912***	-0.5304***	1								
GHEPC	-0.5053***	-0.5629***	0.9776***	1							
PPHEPC	-0.3593***	-0.3453***	0.8565***	0.7286***	1						
Growth	0.0324	-0.0112	0.1272**	0.1552***	0.0332	1					
GDP	-0.3871***	-0.4564***	0.7764***	0.8396***	0.4676***	0.2360***	1				
Education	-0.5635***	-0.3807***	0.3542***	0.3510***	0.2899***	0.1408***	0.3170***	1			
HIV	-0.1475***	-0.1157**	0.5233***	0.4639***	0.5649***	0.0229	0.1875***	0.3341***	1		
Old dependency	-0.4814***	-0.4908***	0.4362***	0.5193***	0.1458***	0.0936*	0.5541***	0.3172***	0.1306***	1	
Immunization	-0.7235***	-0.5720***	0.2873***	0.2902***	0.2232***	-0.0606	0.0923*	0.4582***	0.2257***	0.2190***	1
Remittances	-0.0763	-0.0003	-0.0660	-0.0364	-0.1221**	0.0718	-0.1299**	0.1557***	0.3986***	0.2467***	0.1677***
Financial development	-0.4584***	-0.2114***	0.0672	0.0799	0.0228	-0.0501	0.0825	-0.0290	-0.3000***	0.2426***	0.2942***
NHGGE	-0.4136***	-0.4812***	0.8642***	0.9093***	0.5821***	0.1388***	0.9088***	0.3233***	0.3531***	0.5039***	0.1860***
Budget	0.1815***	0.0221	0.1172**	0.1217**	0.0829*	0.2021***	0.2389***	0.1563***	0.1643***	0.0802	-0.1878***
DAH_net	-0.3364***	-0.2873***	0.5769***	0.5128***	0.6195***	0.0438	0.2110***	0.2812***	0.4132***	0.0516	0.3227***
Tax	-0.2335***	-0.2378***	0.3741***	0.3854***	0.2723***	0.0433	0.2373***	0.3071***	0.5788***	0.1537***	0.3375***
Political instability	0.4663***	0.6817***	-0.5370***	-0.5504***	-0.3966***	-0.1160**	-0.3918***	-0.2948***	-0.2805***	-0.4174***	-0.4633***
Bureaucracy	-0.4472***	-0.3648***	0.3554***	0.3612***	0.3061***	-0.1248*	0.3274***	0.3492***	0.3729***	0.2666***	0.2892***
Water access	-0.5752***	-0.4973***	0.4840***	0.4870***	0.3806***	-0.0395	0.2517***	0.2685***	0.3191***	0.4638***	0.6428***
Urbanization	-0.3911***	-0.3749***	0.4187***	0.4534***	0.2505***	0.0420	0.4960***	0.2553***	-0.0238	0.4350***	0.1284**
Information	-0.7314***	-0.6338***	0.5523***	0.5909***	0.3482***	0.0055	0.5552***	0.4813***	0.1618***	0.5999***	0.5136***

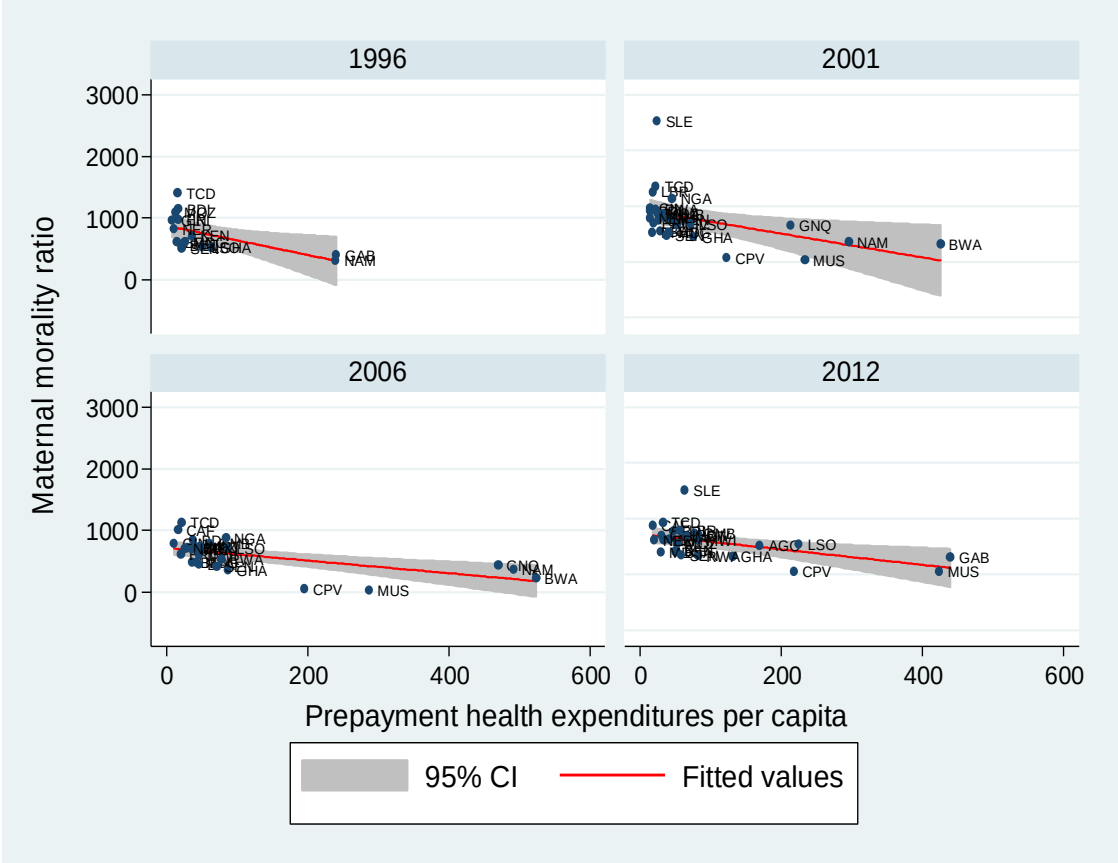
	Remittances	Financial development	NHGGE	Budget	DAH_net	Tax	Political instability	Bureaucracy	Water access	Urbanization	Information
Remittances	1										
Financial development	-0.1559***	1									
NHGGE	-0.0356	0.0644	1								
Budget	0.0512	-0.4608***	0.0944*	1							
DAH_net	0.0402	-0.0064	0.3860 ***	-0.0456	1						
Tax	0.5415***	-0.0537	0.4070***	0.2002***	0.3069***	1					
Political instability	-0.0894	-0.0685	-0.4449***	-0.0348	-0.3437***	-0.2879***	1				
Bureaucracy	-0.2176***	-0.0388	0.3143***	-0.0961	0.1679***	0.1698***	-0.2516***	1			
Water access	0.2313***	0.2127***	0.3189***	-0.0697	0.3231***	0.2795***	-0.3587***	0.3839***	1		
Urbanization	-0.0892	0.0666	0.4970 ***	0.1456***	0.1467***	-0.0210	-0.3666***	0.1114*	0.2050***	1	
Information	0.0824	0.2338***	0.5406	0.0897	0.2118	0.2192	-0.4366	0.1737	0.5305	0.5660	1

Source: Author 'calculation using the GHE, the WDI, the WGI, the ICRG, the WEO and the SEID and the IHME databases. Note: *** p<0.01, ** p<0.05, * p<0.1.

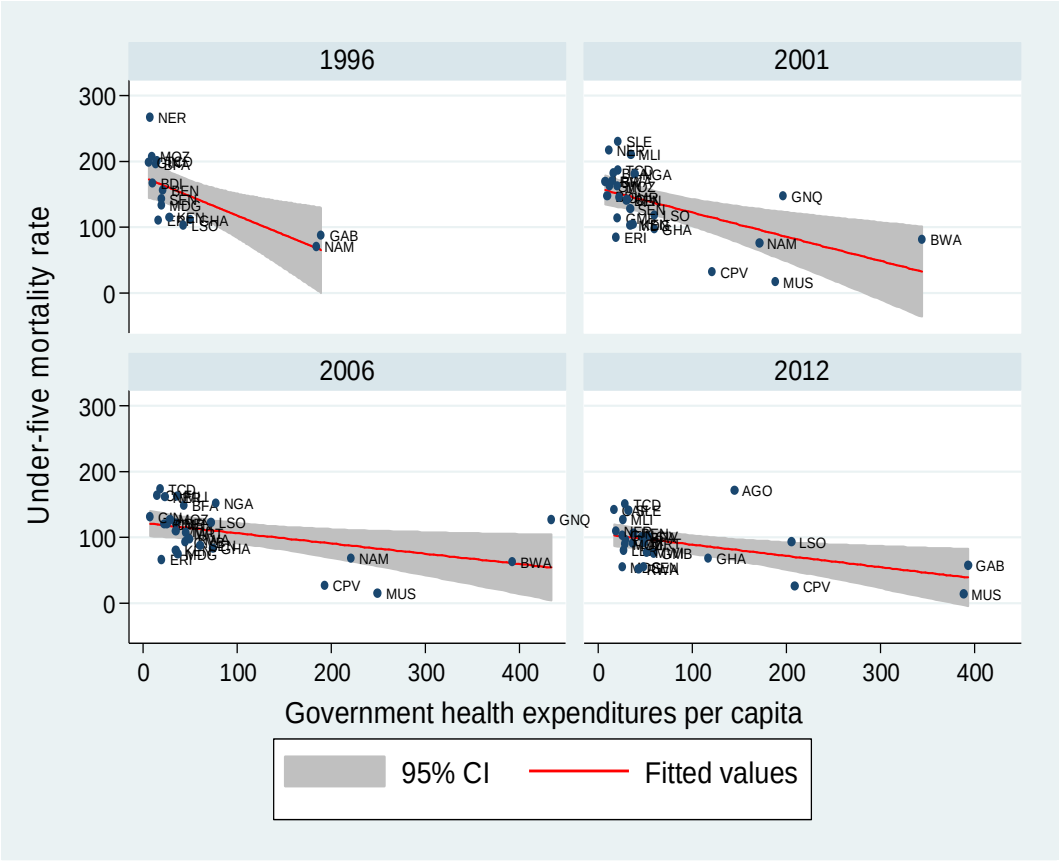
Annex 3.3: Scatter plots between prepayment health expenditures and their components all expressed in USD PPP per capita and the under-five mortality and the maternal mortality ratio using the global sample



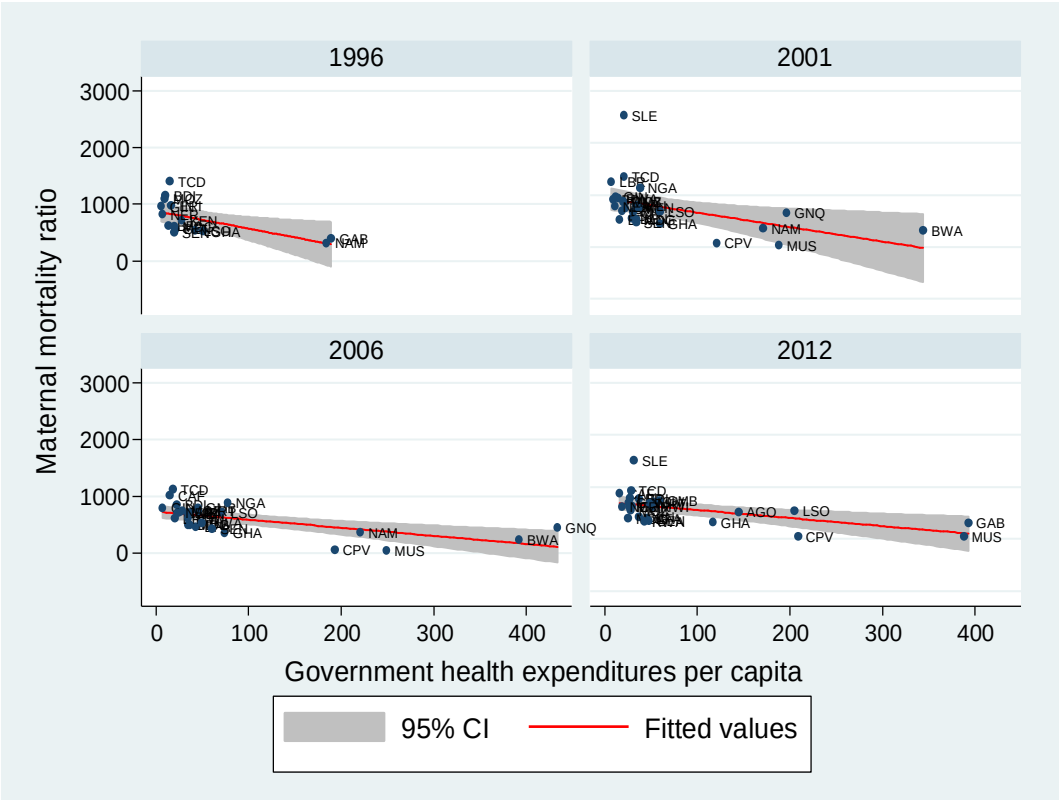
Source: Author using the GHE and the WDI databases.



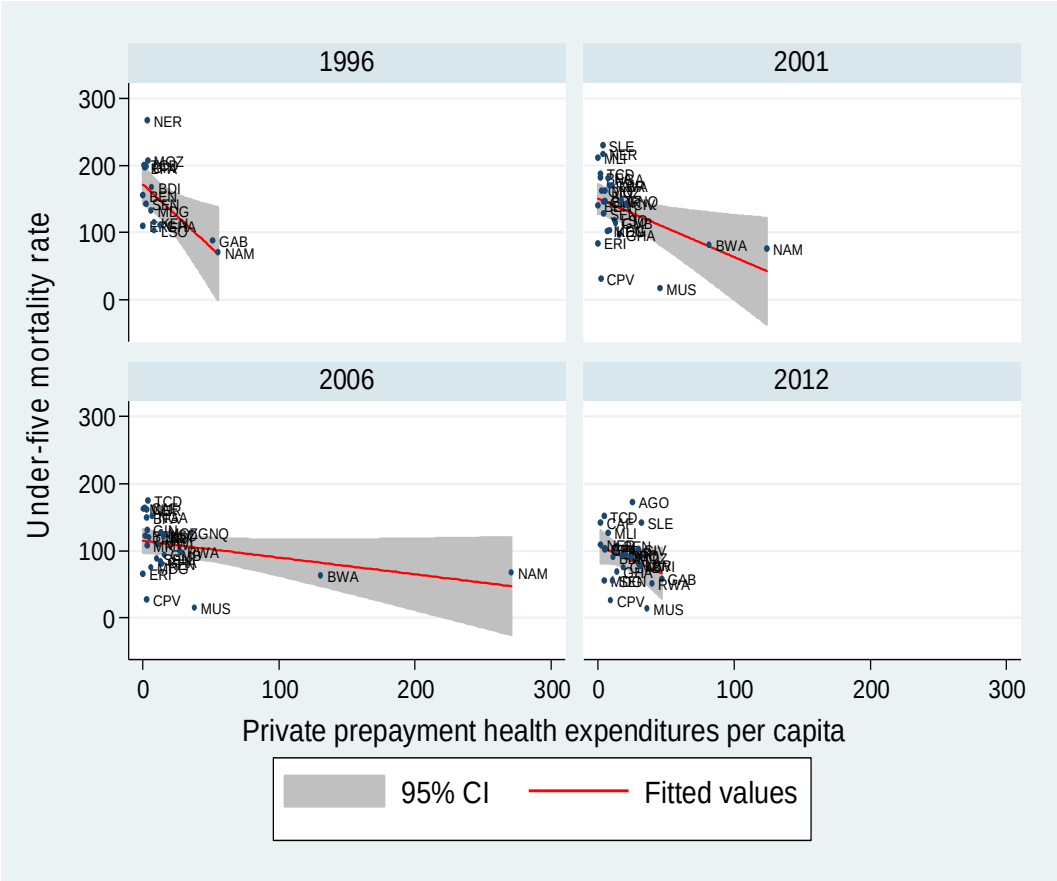
Source: Author using the GHE and the WDI databases.



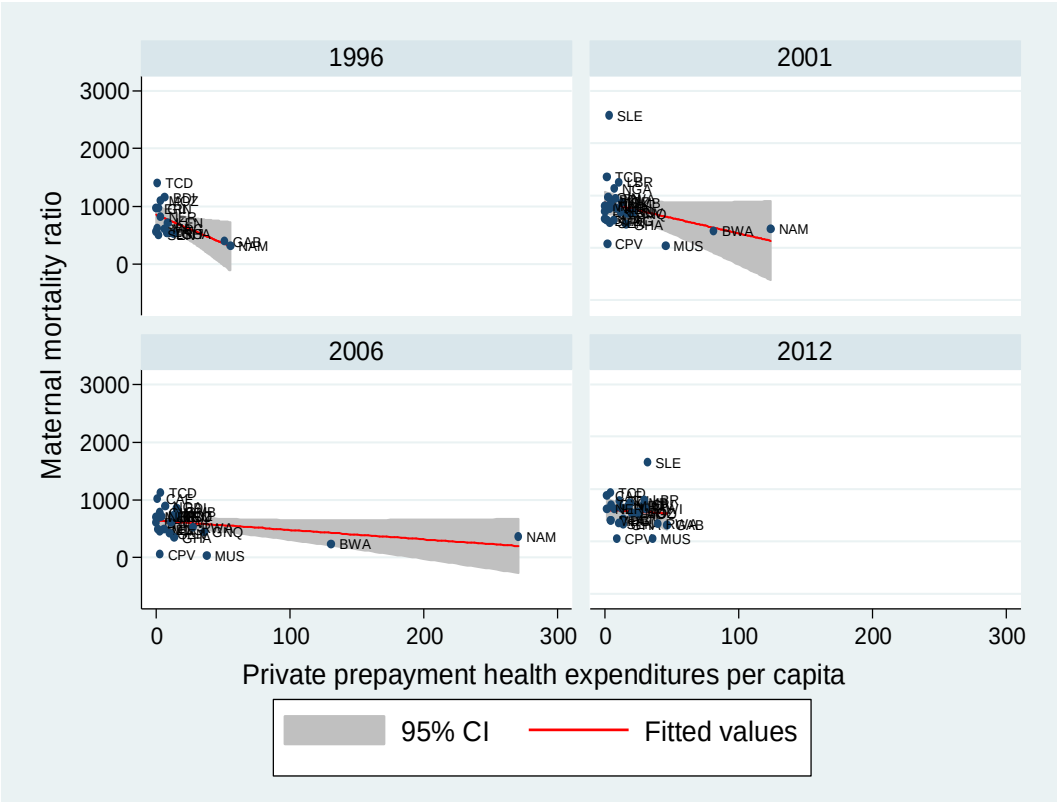
Source: Author using the GHE and the WDI databases.



Source: Author using the GHE and the WDI databases.

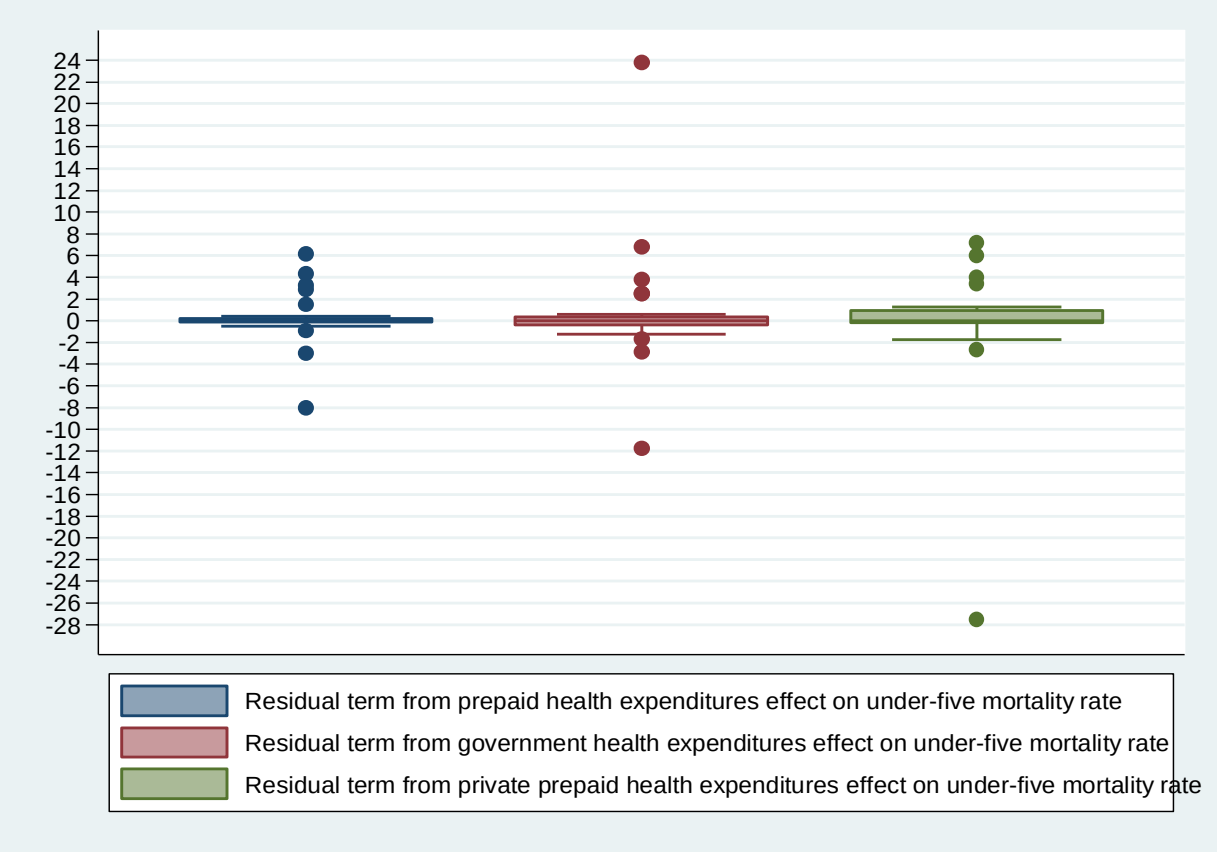


Source: Author using the GHE and the WDI databases.

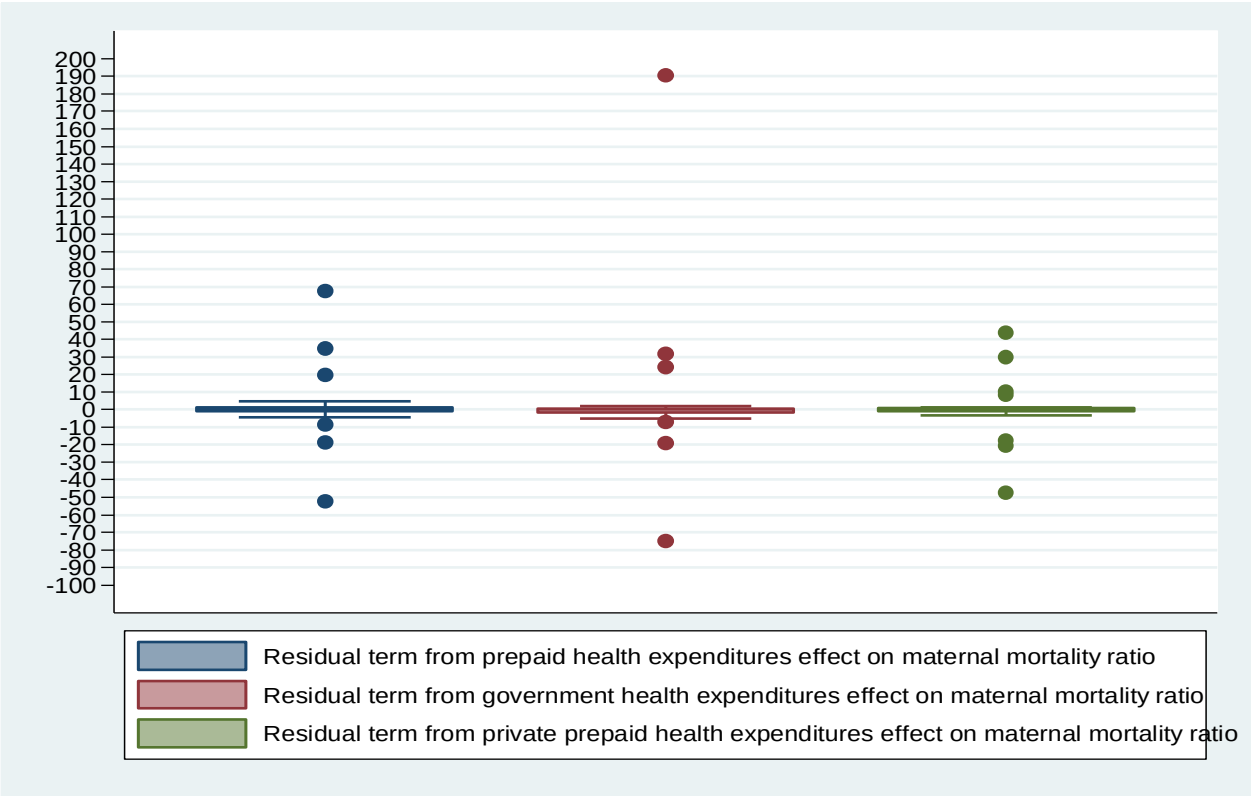


Source: Author using the GHE and the WDI databases.

Annex 3.4: Box-plot analysis of residual terms of tested model (1996-2012)



Source: Author using econometric regressions.



Source: Author using econometric regressions.

Annex 3.5: Baseline results of effect of adjusted DAH per capita and budget balance as share of GDP on private prepayment health expenditures per capita in USD PPP(1996-2012)

Dependent variables	Under5	Maternal
Budget	0.144	0.172
	(1.053)	(1.223)
DAH_net	0.842***	0.855***
	(5.062)	(5.024)
$Growth_{t-1}$	0.019	0.010
	(0.100)	(0.053)
$Education_{t-1}$	-0.160**	-0.090**
	(-2.451)	(-2.074)
HIV	0.077	-0.056
	(0.067)	(-0.050)
Immunization	0.102*	
	(1.849)	
Old dependency	-1.664	-1.930
	(-0.535)	(-0.634)
NHGGE	0.00004*	0.00005**
	(1.782)	(2.029)
Constant	16.502	22.325**
	(1.492)	(1.988)
Observations	397	397

Note: t statistics in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Annex 3.6: Baseline results of effects of total prepayment health expenditures, of government health expenditures and prepayment health expenditures from private sources expressed in USD PPP on under-five mortality by including additional control variables and by using sub-period (1996-2012)

Included additional variables	Political instability index	Bureaucracy quality index	Access to drinking water	Information flows index	Urbanization
Prepayment	-0.167***	-0.209***	-0.093**	-0.154***	-0.087*
	(-3.996)	(-2.660)	(-2.341)	(-3.876)	(-1.736)
$Growth_{t-1}$	1.013**	0.524	1.036**	0.947**	0.900*
	(2.031)	(1.129)	(2.195)	(2.059)	(1.944)
$Education_{t-1}$	-0.914***	-1.026***	-0.756***	-0.689***	-0.810***
	(-5.674)	(-5.839)	(-5.317)	(-5.112)	(-5.496)
HIV	3.432**	3.757**	1.754	3.316**	3.390**
	(2.317)	(2.443)	(1.442)	(2.225)	(2.392)
Immunization	-0.608***	-0.607***	-0.409***	-0.388***	-0.527***
	(-4.166)	(-4.061)	(-3.029)	(-3.104)	(-3.679)
Old dependency	16.825***	13.186	14.387***	17.402***	9.850**
	(3.570)	(0.751)	(3.093)	(3.486)	(2.246)
NHGGE	0.00001*	0.0003**	0.00001	0.0001*	0.00005
	(1.649)	(2.409)	(0.302)	(1.953)	(0.779)
Political-instability	-2.227				
	(-0.519)				
Bureaucracy		-14.491			
		(-1.489)			
Water			-1.700***		
			(-4.889)		
Information				-1.340***	
				(-5.357)	
$Urbanization_{t-1}$					-2.041**
					(-2.540)
Constant	316.838***	321.541***	341.010***	314.582***	377.893***
	(13.116)	(6.336)	(18.400)	(14.796)	(14.106)
Observations	136	89	136	136	136
F-statistics (significance of models)	1084.129***	89.404***	804.996***	345.373***	857.808***
Cragg-Donald Wald F-statistics	33.393	11.233	30.662	36.572	22.748
Critical values of Stock and Yogo (10%)	19.93	19.93	19.93	19.93	19.93
Hansen test : p-values	0.713	0.087	0.883	0.417	0.594
R^2	0.949	0.938	0.962	0.959	0.957

Note: t statistics in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Annex 3.7: Baseline results of effect of total prepayment health expenditures, of government health expenditures and prepayment health expenditures from private sources expressed in USD PPP on maternal mortality by including additional control variables and by using sub-period data (1996-2012)

Included additional variables	Political instability index	Bureaucracy quality index	Access to drinking water	Information flows index	Urbanization
Prepayment	-0.583**	-1.068***	-0.540**	-0.764***	-0.466
	(-2.520)	(-2.977)	(-1.975)	(-3.053)	(-1.466)
$Growth_{t-1}$	3.422	3.385	3.605	3.291	3.553
	(1.101)	(0.628)	(0.970)	(1.102)	(0.973)
$Education_{t-1}$	-4.816***	-4.146***	-3.517***	-2.292***	-3.914***
	(-6.950)	(-5.156)	(-4.089)	(-3.150)	(-4.837)
HIV	12.518	7.627	3.715	5.580	8.584
	(1.591)	(0.935)	(0.453)	(0.598)	(0.997)
Old dependency	92.621***	122.912*	89.984***	95.313***	68.280**
	(3.579)	(1.675)	(3.093)	(3.464)	(2.214)
NHGGE	-0.00002	0.001*	-0.00001	0.0004	-0.00004
	(-0.096)	(1.798)	(-0.324)	(1.433)	(-0.120)
Political-instability	54.348**				
	(2.337)				
Bureaucracy		-111.808***			
		(-2.725)			
Water			-5.872***		
			(-2.580)		
Information				-8.523***	
				(-6.664)	
$Urbanization_{t-1}$					-9.224*
					(-1.935)
Constant	788.579***	855.810***	1056.334***	1045.001***	1244.442***
	(7.057)	(3.789)	(8.933)	(12.831)	(6.913)
Observations	136	89	136	136	136
F-statistics (significance of models)	186.080***	151.449***	288.541***	112.815***	226.283***
Cragg-Donald Wald F-statistics	33.203	11.754	30.963	36.797	23.197
Critical values of Stock and Yogo (10%)	19.93	19.93	19.93	19.93	19.93
Hansen test : p-values	0.355	1.000	0.135	0.603	0.231
R^2	0.964	0.963	0.964	0.971	0.964

Note: t statistics in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Annex 3.8: Descriptive statistics of supplementary variables used in the model (1996-2012)

Variables	Mean	Std.Dev.	CV	Median	Min	Max	Observations
GHEPC	74.232	98.734	1.330	34.482	4.691	528.013	397
PPHEPC	20.277	40.274	1.986	7.288	0	270.854	397
Political instability	2.612	0.902	0.345	2.444	1.006	4.706	341
Bureaucracy	1.360	0.764	0.562	1	0	3.500	247
Water access	58.221	17.851	0.307	56.300	21	99.700	397
Urbanization	34.443	14.921	0.433	34.709	7.412	86.367	397
Information	42.129	13.592	0.323	40.790	4.490	86.400	397
Tax	23.145	10.373	0.448	19.710	8.840	66.471	397
Remittances	4.728	9.934	2.101	1.220	0	61.924	326
Financial development	26.806	32.245	1.203	17.911	-70.378	174.465	388

Source: Author 'calculation using the GHE, the WDI, the WGI, the ICRG, the WEO and the SEID databases. .
Note: Std. Dev: Standard Deviation. CV: Coefficient of Variation.

Annex 3.9: Descriptive statistics of supplementary variables used in the model

Angola, Benin, Botswana, Burkina Faso, Burundi, Cabo Verde, Cameroon, Central African Republic, Chad, Cote d'Ivoire, Equatorial Guinea, Eritrea, Gabon, Gambia, Ghana, Guinea, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mauritius, Mozambique, Namibia, Niger, Nigeria, Rwanda, Senegal, Sierra Leone.

Chapter 4: Political instability: a major concern for prepayment health financing in Sub-Saharan African countries

1. Introduction

Prepayment health financing remains the one of main channels which would allow health improvement in the framework of implementation and the extension of universal health coverage in low- and middle-income countries. The prepayments schemes is an equitable and sustainable source of health financing which would allow for the people, mostly the poorest limited by the out-of-pocket payments, to access to and to use healthcare. In this way, it would be advantageous for countries to reinforce prepayment health financing and to particularly increase prepayment health expenditures. However, health resources are generally insufficient to meet with health needs of populations in low- and middle-income countries. Consequently, it is fundamental to understand why the quantity of health resources, most specifically from prepayment schemes, is low in countries. In this context, the investigations on the determinants of prepayment health expenditures would help the policy-makers in the implementation of health policies.

Among low- and middle-income countries, Sub-Saharan African countries have experienced in the past few years some political instability events that have adversely affected their economic system (Fosu, 2002; Gyimah-Brempong and Traynor, 1999; Muhammad et al, 2013). Between 1946 and 2002, countries experienced forty-seven civil wars. In addition to the degradation of economic systems, political instability is likely to jeopardize the mobilization of tax revenue (Gupta et al., 2004; Yogo, 2015,b) and this could result in a reduction in social expenditures, such as government health expenditures which is a component of prepayment health expenditures (see Figure 2.1). In this way, political instability would adversely affect prepayment health expenditures in Sub-Saharan African countries.

Political instability could also affect prepayment health expenditures by affecting not only the amount of international aid allocated to Sub-Saharan African countries but also their level of governance. Political instability leads to affect the flows of international aid which appear to be support funds serving to reinforce health financing, mostly in Sub-Saharan African countries. Through this channel, political instability could influence the amount of prepayment health expenditures.

Furthermore, political instability appears as factor impeding the implementation of good governance (Adsera et al., 2003; Przeworski et al., 1999). It could consequently result in worse of institutional quality which is a key determinant allowing the increase in health expenditures, mostly government health expenditures and health insurance expenditures in low- and middle-income countries (Mathonnat,2010; Dukhan, 2010 and Liang and Mirelman, 2014), particularly in Sub-Saharan African ones.

In addition to these channels, political instability could impede the attraction of health insurance companies in Sub-Saharan African countries and consequently reduce private health insurance expenditures which are another component of prepayment health expenditures. It would hinder the implementation of health insurance schemes and would accordingly contribute in the reducing the quantity of prepayment funds allocated to health.

On this subject, the literature has documented the effect of a good political environment on some components of prepayment health expenditures. There are for example Ghobarah et al., (2004, a) which have focused on 179 member countries of World Health Organization. They found that the international political conflicts reduce public health expenditures as percentage of GDP. Moreover, Habibi (1994), working on 67 nations, including developing and developed countries, argues that political freedom leads to increase the share of central government expenditures allocated to health

and social security. Regarding Dukhan (2010), she highlights a negative effect of political stability on health insurance expenditures in 83 low and middle-income countries. However, in the literature, there is not for the moment a study, which focuses on Sub-Saharan African countries. Moreover, the endogeneity issues are not addressed in the studies testing the effect of quality of political system on prepayment health expenditures.

In addition to the potential adverse effect of political instability on prepayment health expenditures, we think the cooperation between Sub-Saharan African countries and international community could influence this effect. Sub-Saharan African countries maintain diplomatic relationships with international community. These relations incite international community to intervene in countries, in case of political instability events. The goal of interventions aims at putting pressure on governments of instable countries, by finding out strategies that tend to limit the adverse consequences of political instability events. The intervention of international community could consequently dampen the potential negative effect of political instability on prepayment health expenditures.

Within this framework, we propose in the chapter to analyze the determinants of prepayment health expenditures by particularly focusing the work on political instability. We shall attempt to address the following questions: Does political instability affect prepayment health expenditures and their components in Sub-Saharan African countries? What is/are the channel(s) through which political instability is likely to affect prepayment health expenditures? Does the cooperation between Sub-Saharan African countries and international community play a major role in the effect of political instability on prepayment health expenditures? What is the direction of its influence on political instability effect on prepayment health expenditures?

The contribution of chapter is four-folds. Firstly, we focus the study on Sub-Saharan African countries in which the events of political instability are more and more regular. The second originality of study comes from the dealing of political instability endogeneity, which will be discussed in details in the remainder of work (subsection 5.4). Thirdly we test for the transmissions channels through which political instability affects prepayment health expenditures. Fourthly we test the conditional effect between political instability and Sub-Saharan African countries 'cooperation with international on prepayment health expenditures.

The remainder of chapter is organized as follows: the Section 2 provides a conceptual framework in which we present the concept of political instability and the various methods used to assess it. The Section 3 sheds light the historical evolution of political instability in Sub-Saharan African countries. The Section 4 discusses the theoretical arguments linked political instability and to prepayment health expenditures. The Section 5 is devoted to the presentation of empirical strategy, including the econometric model and the variables, which will be used to investigate our studied effects. The Section 6 outlines and discusses the results; finally the Section 7 concludes, whereas the Section 8 includes the annexes.

2. Analytical Framework

2.1 Understanding the concept of political instability

Political instability is a multidimensional and heteroclite concept defined in different fashion in the literature. Based on Londregan and Poole (1990) and Alesina et al., (1996), it refers to the propensity of countries to experience changes in their political authorities, particularly in the executive power. Based on Abessolo (2003), there are two kinds of political changes. The first one is based on the regular changes in executive power caused by the violence events. These are for example the coup d'état's threats, which could be successful or not. They are regarded as the most destabilized political events Based on Mc Gowan and Johnson (1984). The second one refers to the changes in executive, in

the respect of laws and rules. These are for example the elections. Concerning Daniels et al., (2002), they define political instability as an event for which the political strategy of government results in an interruption of sales and causing damage to public and individual property rights. In addition to these dimensions, some authors consider other aspects, such as the popular protests including political demonstrations, riots and strikes and the events of extreme violence leading in some cases to armed attacks, civil wars, assassinations and executions (Taylor and Hudson, 1972; Schneider and Frey, 1985; Gupta, 1991; Chauvet, 2003; Jong-A-Pin, 2009; Gouenet, 2009). On the basis of these mentioned dimensions of political instability, the literature generally categorizes the events of political instability in three main groups. The most understandable and detailed categorization is provided by Chauvet (2003). This categorization is more or less similar to the ones proposed by the other authors, such as Taylor and Hudson (1972), Jong-A-Pin (2009) and Gupta (1991). Based on Chauvet (2003), there are three forms of political instability. The first one refers to the social instability, which is also called as "mass violence or "civil mass violence" respectively by Gupta (1991) and Jong-A-Pin (2009); it refers to social disorders events including political riots, strikes and demonstrations. The second one refers to the violent or armed instability also called as "internal wars" (Gupta, 1991) or "politically motivated violence (Jong-A-Pin, 2009). It encompasses the events related to civil wars, to armed attacks, and to political assassinations and executions. They capture an instability and chaos implied by the extreme violence. The third form is the executive or elite instability, which is close to the notions of "changes in executive", "violence within the regime" and "instability of political regime" respectively proposed by Taylor and Hudson (1972), Gupta (1991) and Jong-A-Pin (2009). It covers the successful or failed "coups d'état"threats, the revolutions and the major government crises.

2.2 Measuring political instability

The first assessments of political instability were based on one-dimensional measures composed of objective and subjective indicators. Concerning the objective measures, they encompass binary variables assessing the presence of war victims (Easterly and Rebelo, 1993) and counting indicators capturing the intensity of political revolutions and assassinations (Barro, 1991) or the level of political violence (Svensson, 1999). Regarding the subjective measures, they are calculated through survey data (Knack and Keefer, 1995; Brunetti, 1997). They refer to the risk of forced expropriations including land grab, the risk of violent attacks against private business owners and the supremacy of laws.

Over time, the literature has proposed some multidimensional measures of political instability. The authors depart from the dimension of political instability cited above to build indexes approximating political instability. Many approaches have been used. The major part of studies constructing the aggregate indexes (Taylor and Hudson, 1972, Gupta, 1991; Alesina and Perotti, 1996; Gyimah-Brempong and Traynor, 1999; Chauvet, 2003) uses the principal component analysis.

Other authors prefer to use alternative methods such as the discriminant analysis (Venieris and Gupta, 1986) and the explanatory factor analysis (Jon-A-Pin, 2009). The discriminant analysis is a statistical method used to classify units in homogenous groups Based on their characteristics, which are known in advance. The explanatory factor analysis is a statistical tool keeping the common information raised by a set of indicators. It separates the information that is common to all indicators from the information that is unique to each of these last ones. It generates an indicator through a linear combination of unobserved factors and individual error terms.

In addition to these methods, another group of papers finds more interesting to estimate the probability of political instability occurrence (Azam et al., 1996; Alesina et al., 1996). They consist to firstly build a binary variable on the basis of political instability events occurred in country. Then, this dichotomous variable is explained on the determinants leading to political instability events, on the

basis of qualitative variables models such as for example logit or probit model. Through these econometric models, the occurrence probability of political instability events is estimated.

A fourth group of works, such as Cingranelli and Richards (1999) and Kaufman et al.,(2010) respectively depart from a probabilistic cumulative scaling method and from an unobserved components model. The probabilistic cumulative scaling method known as Mokken scaling analysis (Mokken, 1971) simply allows transforming a set of multidimensional indicators hierarchically ordered and approximating the same concept or phenomenon into one-dimensional index. Initiated by Goldberger (1972), the use of unobserved components model consists of combining many indicators from different sources to optimally capture the information related to unobserved or subjective variable such as for example political instability. It assumes that each indicator, which must be linearly summarized, depends on the variable, which must be generated. The unobserved components model is specified as follow:

$$Y_{jk} = \alpha_k + \beta_k(g_j + \varepsilon_{jk})$$

Y_{jk} represents the indicator "k" which must be summarized for country "j" whereas $g_j$refers to the variable approximating political instability. This last one is supposed to follow a standard normal distribution. α_k is the intercept and β_k refers to an estimated parameter, which accounts for the heterogeneity between the measure units provided by the indicators which must be included in the final composite index. ε_{jk} is the error term also following a standard normal deviation for which the mean is null and the standard deviation $\sigma_k^2$is identical distributed for each country but different based on the regarded indicator. The error term accounts for two uncertainty sources such as the measure error of unobserved indicator (political instability in this case) and the imperfection in the estimate of relation between Y_{jk} and g_j . In this model, the serial correlation in the distribution of error term is assumed:$(\varepsilon_{jk}; \varepsilon_{jm}) = 0$. Political instability index is estimated through the conditional Esperance of indicators included in the model. The formula of this index assessment is:

$$E[g_j \backslash y_{j1}, \ldots\ldots, y_{jk}] = \sum_{k=1}^{K} W_k\left(\frac{y_{jk}-\alpha_k}{\beta_k}\right), \text{ with} W_K = \sigma_k^2/(1 + \sum_{k=1}^{K} \sigma_k^2).$$

3. Historical evolution of political instability in Sub-Saharan African countries

Political instability in Sub-Saharan African countries has started from many years ago. There are many events of political instability but here, we shall essentially focus on the events which are more affected countries[32]. For these countries, three waves of political instability have occurred over time.

- The first wave of political instability has started after the Independences which have occurred in the major part of countries at 1960, except Ethiopia, Liberia and South Africa that were accessed to their independence prior to 1950. This first wave of political instability events has continued until the 1980s. They have been caused by the difficulties for countries to form strong and exclusive states after they were recognized as independent states. Over the period, the militaries seize power by force, judging the incapacity of civil to well manage this power.

This situation results in a series of "coups d'état" in many countries. For example, Ghana has experienced the first "coup d'état" in Sub-Saharan Africa. After the independences, the first President of this country, Kwame Nkruma after two mandates has been overthrown by the General Joseph Arthur Ankrah through a "coup d'état" which has occurred on February 24th, 1969 and has resulted in 24 deaths. Over the post-independence period, other "coups d'état" has occurred in this country. There

[32] The information provided in this section essentially come from Marshall (2006) and the website of the Sherbrook university: http://perspective.usherbrooke.ca/bilan/servlet/BMHistoriquePays?codePays=SDNandlangue=fr.

are for example the “coup d’état” orchestrated by the military Ignatius Kutu Acheampong who has taken the place of Edward Akufo-Adddo on January 13th, 1972 and who has been overthrown by the general lieutenant Fred Akuffo through a military putsch on July 05th, 1978. Thereafter, Fred Akuffo will be overturned by the lieutenant Jerry John Rawlings on June 04th, 1979. This last one will be replaced by Hilla Limman on December 24th, 1979 and will be back in power on December 31st, 1981 through a “coup d’état” which was associated with 50 deaths. In addition to Ghana, Chad has also imperilled by “coups d’état” after the independences. On April 13th, 1975, the first Chadian President François Tombalbaye has been overturned by the general Noel Milarew Odingar, a chief of defence, through a “coup d’état” which has resulted in 999 deaths. Before this year, the first President of Niger Hamani Diori has been overthrown through a “coup d’état” orchestrated on April 15th, 1974 by a military officer called as Seyni Kountché. This coup d’état has provoked the death of 20 peoples. Shortly after the 1960-1970s, Gambia has been marked by a “coup d’état” that has occurred in the night from 29 to 30 July 1981. The President Dawda Jawara, governing country since the implementation of Gambian Presidential system, has suffered an attempted a “coup d’état” which has failed but has resulted in 650 deaths. Kukli Samba Sanyang, member of opposition party has orchestrated this coup d’état. In Burkina Faso, the first “coup d’état” has occurred on January 03rd, 1966 and has been driven by the colonel Aboubacar Sangoulé Lamizana which overturns the President Maurice Yaméogo, first civil President of Burkina Faso previously called as Haute Volta. During the post-independence period and after Aboubacar Sangoulé Lamizana, other Presidents such as Saye Zerbo, Jean Baptiste Ouédraogo, Thomas Sankara, who were militaries, have taken the power through “coups d’état”.

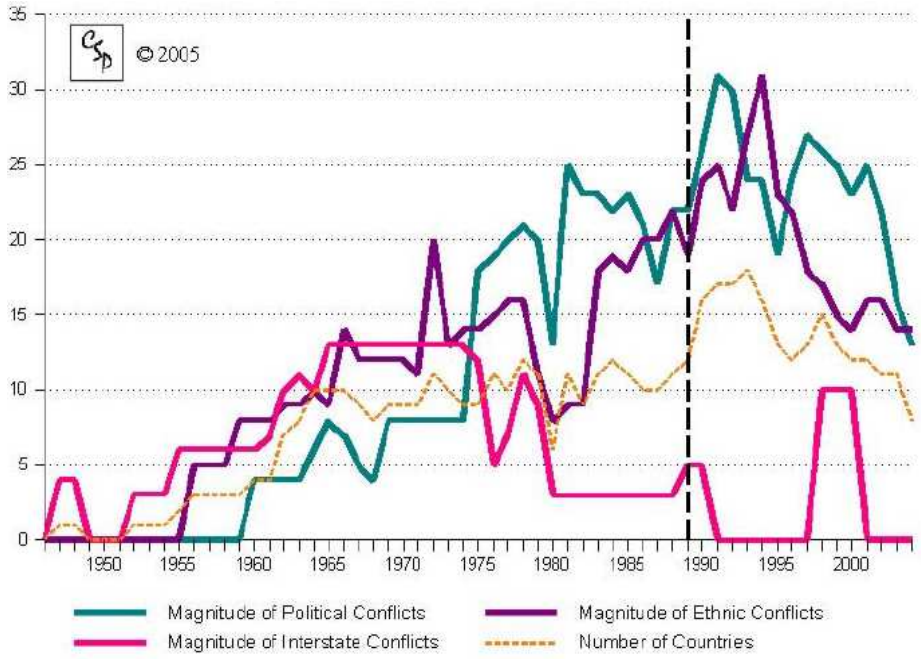
In addition to “coups d’état”, other consequences due to the post-independence political instability are the army, ethnic and civil conflicts. For example, in Angola and Mozambique, civil wars have broken out respectively from 1975 and 1977. Each of these civil wars have resulted in death of more of 1,000, 000 individuals. Civil war in Angola supported by the national union for the total independence of Angola had the goal to eject the Portuguese forces of these last colonial possessions. Civil war in Mozambique has occurred two years after the end of its independence war against Portugal. It were violently opposed the ruling communist party, Front for Liberation of Mozambique (FRELIMO) managed by Samora Machel to the resistance group called Mozambique Resistance Movement (RENAMO) financed by Rhodesia and South Africa. This resistance movement charged the Mozambican state to be corrupted and to promote dictatorship. In addition to Angola and Mozambique, Chad, Ghana and South Africa have been marked by civil and ethnic violence occurred respectively from 1965, 1981 and 1983. The conflicts in Chad and South Africa have resulted in 75,000 and 20,000 deaths, respectively. Burundi has also experienced ethnic conflicts occurred in 1965 and in 1972. These conflicts opposing the “Hutus” to “Tutsi” have provoked the deaths of 5,000 deaths in 1965 and 2,000 deaths in 1972. Between 1972 and 1979, Zimbabwe has been imperilled by ethnic violence in which the ethnics “ZANU” and “ZAPU” were opposed to whites. This violence has resulted in 20,000 deaths.

- The second wave of political instability begins at the end of 1980s. At this ere, the post-independence instability has decayed the economic system of countries. This economic destabilization results in riots, demonstrations and further leads to conflicts. For example, Cameroon has been confronted with conflicts which have occasioned by claims of its armed forces and which have resulted in more of 1,000 deaths of people in 1984. In Burkina Faso, in 1987 the captain Thomas Sankara was assassinated and overturned through a coup d’état driven by the captain Blaise Compaoré which is the last military President of Burkina Faso for the moment. This “coup d’état” has resulted in the death of 100 individuals. In 1988, Liberia has experienced a series of civil violence which has

opposed the group Liberian United for the Reconciliation of Democracy (LURD) to the National Patriotic Front of Liberia managed by the President Charles Taylor. It has resulted in 100,000 deaths.

From the 1990s, the number of conflicts has increased in Sub-Saharan African countries. On this subject, Marshall (2006) performs a graphic which attests an increasing in political and ethnic conflicts in African countries (Figure 4.1). This rise in conflicts politically motivated in Sub-Saharan alerts international community which reacts by bringing directives for which the goal is to help countries in the avoiding the events of political instability. In 1990, M. Francois Mitterand, ex-President of France delivers a speech during the openness solemn sitting of 16th conference of heads of state of France and Africa. In this speech called as "discours de la Baule", M. Francois Mitterand called for the necessity for African states to promote a real political settlement. It has encouraged the African leaders to well manage the democracies to avoid political instability. This speech has contributed to the reduction of political conflicts in these countries. However, some political opposition have resulted in third wave of political instability.

Figure 4.1: Trend in armed conflicts in African countries



Source: Marshall (2006).

- The third wave of political instability has occurred since the 1990s and is continuing today. For example, Sierra Leone has experienced civil and ethnic wars occurred over the period 1991-2001 and resulting in more of 25,000 deaths. In addition Ethiopia has been also marked by a separatist ethnic war occasioned by the "Oromo" that were one of most represented ethnic groups in this country. Over this war which has endured between 1999 and 2000 and that has resulted in more of 2,000 deaths, this ethnic group claimed sovereignty and hegemony compared to the others. Like Sierra Leone and Ethiopia, Guinea-Bissau and Somalia have been imperilled by civil wars, which have respectively resulted in more of 6,000 and 1,000 deaths respectively over the periods 1998-1999 and 2000-2003. Furthermore, Senegal, most specifically in its region, "Casamance, Kenya and Rwanda have seen emerged a series of ethnic violence respectively over the periods 1992-1999, 1991-1993 and 1990-1998. These unfortunate events have respectively led to more of 3,000; to 2,000 and to 530,000 deaths. The violence in Kenya brought into opposition four ethnic groups such as the "Kalenjins", the "Masais", the "Kikuyu" and the "Luos" whereas the one in Rwanda opposed the "Tutsis" to "Hutus" as in the case of Burundi. Concerning Ghana and Niger, they have been also marked by ethnic

violence respectively in 1994 and over the period 1990-1997. In Niger, the ethnic violence has respectively resulted in 1,000 deaths and comes from an opposition between two regions such as Azawad and Toubou. As far as Mali and Côte d'Ivoire, the civil and ethnic wars and violence have respectively occurred over the periods 1990-1995 and 2000-2005. These events have respectively resulted in 1,000 and in more of 3,000 deaths of people. The "Tuaregs" rebels have orchestrated the ethnic violence in Mali. In Burkina Faso, the President Blaise Compaoré resigned on 31st October, 2014 due the usury of political regime implemented at this moment. After the resignation of Blaise Compaoré, country have experienced a transition period driven by Michel Kafando at the end of which, the President Rock Marc Christian Kaboré has been democratically elected since December 29th, 2015.

In addition to ethnic and civil conflicts and violence, the third wave of political instability in Sub-Saharan Africa also includes the events of coups d'état. In September 2003 Guinea Bissau has experienced a "coup d'état" during which the President Kumba Yala has been overthrown by its armed. This coup d'état has orchestrated by the General Veressimo Correira Saebre without bloodshed. In the summer 1994, the lieutenant Yaya Jammed drives a coup d'état and overturns the President Dwada Jawara but also without bloodshed. Yaya Jammed, after long contestations, as been overthrown by a civil Adama Barrow through democratic elections on January 19th, 2017. In addition to Guinea Bissau and Gambia, Guinea has experienced a series of two coups d'état. Dadiss Moussa Camara, military officer, has orchestrated the first one after the death of President Lassana Conté in 2008. One year later (2009), demonstrations broke out. They had the goal to contest the re-election of Moussa Dadiss Camara who in the course of this year has been the victim of a politically motivated crime. It gives up the power in favour of Sekouba Konaté for transitional power from 2010-2011 and then replaced by Alpha Condé democratically elected in 2012. In Chad and Niger, the Presidents Hissène Habré and Mamadou Tandja have been overthrown respectively by Idriss Déby, a civil, on December 02nd, 1990 and by Salou Djibo, a military officer, on February 22nd, 2010. Since the independence, Côte d'Ivoire has experienced one "coup d'état" orchestrated on December 24th, 1999 by the General Robert Guéï on the President Henri Konan Bedie who insures the interim after the death of Félix Houphouët-Boigny on December 07th, 1993 and who has been elected on October 22nd, 1995. In Mali, one "coup d'état" has occurred on April 08th, 2012. This "coup d'état" has been the consequence of war led by the Malian army against and the jihadists of "Ansar" Dine and the national movement for the liberation of "Azawad's", region located in north of country. This rebellion claimed the autonomy and independence of region of "Azawad's" region. In this war occurred since January 17th, 2012, the army suffered from a shortfall in arms compared to "Touaregs" rebels who have benefited from heavy weapons following the fall of Kadhafi in 2011. This balance of power between the Malian army and its belligerents induces it to overturn the President Amadou Toumanie Touré.

4. Political instability and prepayment health expenditures in Sub-Saharan African countries: the theoretical arguments

Political instability is likely to affect prepayment health expenditures not only at total level but also at specific one. We respectively present the potential channels through which political instability could affect prepayment health expenditures and their specific components. Three factors are identified as the main channels through which political instability is likely to influence the levels of prepayment health expenditures. These are: tax revenue mobilization; international aid and governance. Here we focus on the following dimensions of political instability: politically motivated violence, civil wars, "coup d'état" threats, terrorism and extreme violence. The proxy variables of political instability used in our investigations are defined in the Subsection 5.2.1.

4.1 The channel passing through tax revenue mobilization

We firstly discuss the channels through which political instability would affect tax revenue and then we explain the ways by which tax revenue are likely to reduce prepayment health expenditures through the channel of government health expenditures.

4.1 The channel passing through tax revenue mobilization

4.1.1 Political instability and tax revenue mobilization: the channel passing from private investments

Political instability would affect tax revenue by reducing the private investments in three ways. Firstly, it has the effect to increase the interest rates through the channel of a reduction of expected returns of investment projects that would decrease the volume of credit agreed by the banks to companies. In this way, it would reduce the private investments.

Secondly, political instability would result in destruction risks of companies holding and populations' properties. It would accordingly reduce the saving of households (Venieris and Gupta, 1986) and would result in capital flights (Lensink et al 2000) that are factors undermining the private investments.

Thirdly, political instability is generally associated with low stock market returns (Diamonte et al., 1996; Lehkonen and Heimonen, 2015), which are likely to reduce the activity of banks and companies investing on the financial markets. In this way, the low performance of stock markets could reduce the level of domestic investments from private sources.

The reduction in domestic investments caused by political instability would jeopardize tax revenue mobilization. The decreasing in private investments generally results in a reduction of tax base because with low investments, the amount of taxable profits received by companies diminishes. In addition, the accumulation of physical capital constitutes an important source of economic growth. Hence the reduction of private investments would reduce economic growth (Adams, 2009), which has been identified as a factor increasing tax revenue mobilization in Sub-Saharan African countries (Ghura, 1998). In this way, the reduction of private investment would also reduce tax revenue by decreasing economic growth.

4.1.2 Political instability and tax revenue mobilization: the channel passing from foreign direct investments (FDI)

In period of political instability, the economic stability cannot be ensured. That could adversely affect the flows of FDI. On this subject the literature stresses that political stability plays an important role in the attraction of FDI (Cho, 2003; Stein and Daude, 2001). The decrease in FDI flows could be a factor likely to reduce tax revenue mobilization. On one hand, the decrease in FDI contributes in the increasing the unemployment (Yaylı and Değer, 2012; Chaudhuri and Mukhopadhyay, 2014); a fact would decrease the consumption of households likely to reduce the tax base through the bias of VATs. On the other hand, the decrease in FDI could reduce tax revenue in the sense that the foreign companies pay tax corporate. Moreover, the FDI tend to bring new technologies. In this way, they are likely to foster economic growth. On this subject, Adams (2009) found that the increase in FDI positively affects economic growth in Sub-Saharan African countries, which allows more tax revenue mobilization (Brückner, 2012). Whether FDI lead to increase tax revenue by promoting economic growth, their reduction due to political instability would reduce the capacity of countries to mobilize tax revenue.

4.1.3 Political instability and tax revenue mobilization: the channel passing from trade exchanges

Political instability could also reduce tax revenue by impeding trade exchanges. For example, Muhammad et al., (2013) found that the 2007 Kenyan post electoral instability and violence had reduced its exportation flows of flowers towards the European Union. This reduction was estimated around €33 millions. Political instability could also decrease the import flows of countries, which constitute, through customs duties, an important source of tax mobilization. In this way; the decreasing in trade exchanges due to political instability would reduce tax revenue mobilization. On this subject, Ghura (1998), working on a sample of 39 Sub-Saharan African countries, found that the increase in the trade openness rate leads to increase tax revenue expressed as share of GDP.

4.1.4 Tax revenue mobilization and prepayment health expenditures

The decrease in tax revenue mobilization could decrease prepayment health expenditures by reducing government health expenditures. The reduction of tax revenue generally is likely to reduce government social expenditures. In this way, government health expenditures and consequently prepayment health expenditures could be adversely affected by the decrease in mobilized tax revenue.

4.2 The channel passing through international aid

4.2.1 Political instability and international aid

Political instability could affect government health expenditures and consequently prepayment health expenditures through the channel of international aid. The effect of political instability on the public aid flows depends on the kind of political instability, the type of aid and the challenges in the foreign financing in favour of recipient countries, more particularly of Sub-Saharan African economies. Undeniably, given the diplomatic, the geopolitical, trade, and the safe relationships between Sub-Saharan African countries and foreign sponsors, the violent instabilities, causing deaths and assassinations, would induce these sponsors to support the unstable countries by giving them the aid. In this case, the multilateral aid is concerned (Chauvet, 2003). In the case where the interests of sponsors are threatened (deaths of their citizens, destruction of their infrastructures) they could reduce their aid flows. When the instability focuses on demonstrations against governance system, the sponsors would be induced to punish governance ineffectiveness by reducing the level of aid, in particular of bilateral and multilateral aid (Chauvet, 2003; Reinsberg, 2015; Masaki, 2016). Crawford (2000 p.169) defined four types of sanctions such as “full suspension of all aid (exception made of humanitarian assistance)”,“program aid (or balance-of-payments support) suspension”, “new project aid suspension (including technical cooperation)” and “overall reduction of aid allocation or aid disbursements on political grounds”.

4.2.2 International aid and prepayment health expenditures

In view of arguments, political instability remains a factor affecting foreign aid flows in different ways. However, the effect of foreign aid, in particular of external resources for health on government health expenditures depends on many aspects that must be taken into account. Two examples are used to support this argument. We firstly suppose the situation inducing the foreign sponsors to increase the aid flows based on the needs of moment. This aid can be earmarked to health or to other sectors or non-earmarked.

In the case when the aid earmarked to health increases, it is probable that government health expenditures increase too. Nevertheless, in the previous chapters, we have seen that health aid is generally fungible. This fungibility constitutes an impediment for health financing in the sense that it could induce governments to partially or totally reallocate health aid in favour of other sectors or to reduce their domestic resources previously dedicated to health sector to finance other ones. In this

way, the fungibility of health aid could reduce their supposed positive effect on government health expenditures or to reverse this last one.

In the case where the aid earmarked to the other sectors increases, two effects on government health expenditures are expected. Firstly, government health expenditures would not be affected whether the aid affected to the other sectors is not fungible. However, they would increase in case where the aid affected to the other sectors is fungible and allocated in favour of health sector.

In the case where the foreign sponsors decide to increase the non-earmarked aid, the effect of this foreign aid on government health expenditures will depend on budget prioritization in favour of health sector and the needs of moment met with the recipient countries. Compared to the others, countries prioritizing health sector and/or experiencing a decline in health outcomes dues to political instability events would be more likely to use the non-earmarked aid to finance health expenditures. In these countries, the allocation of non-earmarked aid would increase government health expenditures.

The second example refers to a situation in which the foreign sponsors reduce their aid flows. Government health expenditures would be adversely affected whether the aid flows, particularly earmarked to health would decrease.

4.3 The channel passing through governance

Political instability would adversely affect prepayment health expenditures by compromising the good governance. On this subject, the literature points out a significant effect of political system on governance. Serra (2006) found that corruption is higher in countries where political instability is a major problem. Adsera et al., (2003) stressed that political stability contributes to foster the effectiveness of governance and rules of law and to reduce corruption. In view of these results we firstly explain the extent through which political instability would jeopardize the good governance and secondly we discuss the channels linked the impediment of good governance to prepayment health expenditures.

4.3.1 Political instability and governance

Firstly, political instability could reduce the effectiveness of governance. For example the change in elites through “coup d’état” threats or democratic elections could undermine the effectiveness in the implementation of policies. Governments have not the same politic agendas. Hence, a policy implemented by a government which has not been uncompleted by this last one is generally interrupted by the follow government which will replace it. These interrupted policies would be ineffective in the sense that they would not completely achieve their goals.

Secondly, political instability could also increase the risk of corruption. The relationship between population and government is a principle-agent relation in which the population delegates on tasks to government which must be executed by this last one (Przeworski et al., 1999). However, there is generally asymmetry information in this relationship (Adsera et al., 2003), mostly in political instability events inducing the policy-makers to implement policies to meet with their private interests. That could open up the possibility for significant corruption among political practitioners. The practice of corruption generally leads to the disrespect for rules of law. Hence, in this way, political instability would be also likely to impede the effectiveness of rules of law.

4.3.2 Governance and prepayment health expenditures

The exacerbation of corruption and the ineffectiveness of governance and rules of law due to political instability are likely to reduce prepayment health expenditures.

Firstly, a high level of corruption results in an allocation of public resources in favour of a group of individuals, which generally tends to reduce the social government expenditures, in particular affected

to health sector. Furthermore, corruption constitutes a factor undermining tax revenue mobilization (Imam and Jacobs, 2014) and could consequently result in low levels of government health expenditures. On this subject, Mathonnat (2010) and Liang and Mirelman (2014) found that corruption reduces government health expenditures.

Secondly, governance ineffectiveness, it appears that a government with low-performances has generally tended to inefficiently manage health system. That could impede its capacity to mobilize additional funds in favour of health sector. In this way, it is accordingly probable that low governance effectiveness results in a decreasing in government expenditures on health. On this subject, Liang and Mirelman (2014) and Dukhan (2010) respectively found that government effectiveness contributes in increasing government health expenditures and health insurance expenditures.

Thirdly, the disrespect for rules of law could result in perverse behaviours such as for example the fraud which is likely to reduce the quantity of prepayment resources mobilized in favour of health sector.

In addition to channels discussed here, political instability could also have specific effects on the components of prepayment health expenditures such as health insurances expenditures and NGOs health expenditures. These effects are presented in the following subsection.

4.4 Political instability and health expenditures from health insurance schemes and NGOs

4.4.1 Political instability and health insurance expenditures

The effect of political regime' quality on health insurance development has been investigated by Dukhan (2010). The author found that political stability and absence of violence/terrorism leads to reduce the contribution of health insurance expenditures to health financing. She stresses that in an unstable political context associated with a high risk of violence, countries are further encouraged to develop health insurance schemes. Furthermore, an unstable political environment could also induce the individuals to participate to health insurance programs in order to counter the risk of disease.

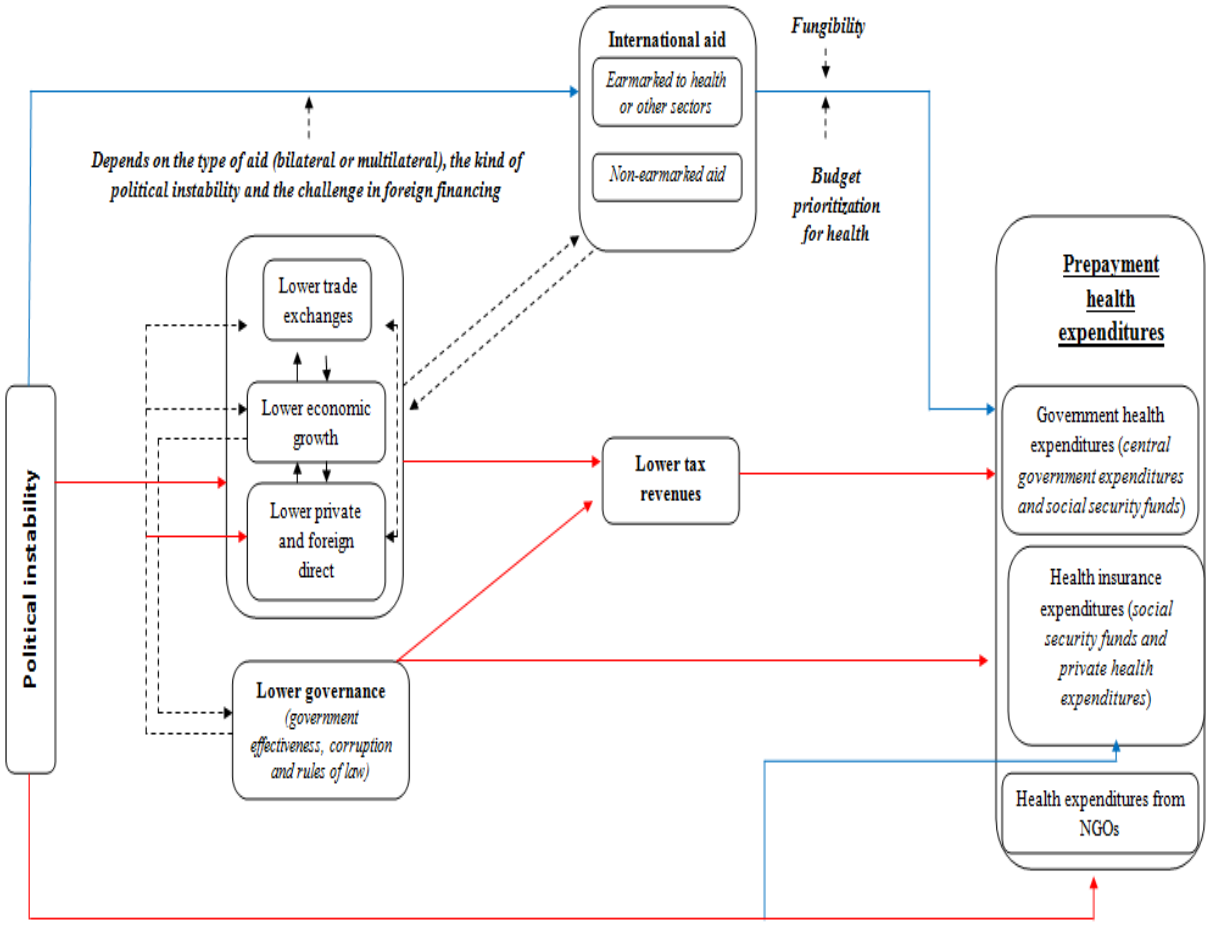
In addition to these arguments, we think political instability could also decrease the influx of private insurance companies and could accordingly reduce private health insurance expenditures and jeopardize health insurance development.

4.4.2 Political instability and NGOs health expenditures

Generally political instability tends to translate into intensified cooperation between armed forces and governments; a fact would result in centralization of decision-making powers that will undermine the involvement and the NGOs participation in the implementation of health policies (Khan and Heuvel, 2007). Through this channel political instability would be likely to diminish NGOs health expenditures.

In view of presented arguments it theoretically appears that the negative effects of political instability on prepayment health expenditures are dominants comparatively to the positive ones. Figure 4.2 can recap the various mechanisms through which political instability could affect prepayment health expenditures.

Figure 4. 2: Various channels linking political instability to prepayment health expenditures



Source: Author. Note: the dotted arrows refer to the accessory effects between the variables entering in political instability effect on prepayment health expenditures. The red and blue arrows respectively refer to the negative and inconclusive (negative or positive) effects.

5. Empirical strategy

The empirical effect of political instability on prepayment health expenditures is explored by using econometric tools, particularly an unbalanced panel-data model spanning 27 Sub-Saharan African countries over the period 1996-2012. The data source of variables is presented in subsection 5.6.

5.1 Dependent variable

The goal of chapter is to work on the determinants, which are likely to affect the amount of prepayment health expenditures by focusing on political instability. Hence we use the same indicator used in the third chapter to approximate prepayment health financing. This indicator refers to prepayment health expenditures expressed in USD PPP per capita. Its acronym used in the regression is “Prepayment”.

5.2 Independent variables

5.2.1 Variables of interest: political instability

Three indexes have used to approximate political instability. They cover all dimensions of political instability proposed in the literature and discussed above the text. The two firsts approximate politically motivated violence (riots, demonstrations) whereas the third focuses on extreme violence

The first one is the internal conflicts index (Conflicts). It approximates the risk of political violence in a country and its actual and potential impact on governance. Ranged from 0 (very high risk) to 12 (very low risk), this index includes three subcomponents assessed from 0 to 4, including the appearance of civil war/ "coup d'état" threats, terrorism/political violence and civil disorders.

The second variable is the index of political stability and absence of violence/terrorism (Political), used in the third chapter.

The third variable is the physical integrity rights index (Integrity) building by Cingranelli and Richards, (1999). Compared to the others, they more approximate the extreme violence dues to political instability events. It is an additive index including four aspects such as the disappearances of political personalities, the extrajudicial killings, the political imprisonments and the politically-motivated tortures. The first subcomponent refers to the disappearances of political personalities which have been not found. The second aspect approximates the presence of killings executed by private groups and ordered by government officials without passing through the law process. The third dimension of this index refers to people incarceration occasioned by government officials; given: their speech, their non-violent opposition to government polities of leaders, their religious beliefs, their non-violent religious practices including proselytizing, or their membership in a group including ethnic or racial group. The last subcomponent results in extreme pains, mental or physical which are purposefully inflicted to people by government officials or by private individuals at the instigation of government officials. This index of physical integrity rights is ranged from 0 (high level) to 8 (low level).

Given the codification of political instability variables, we reverse them to facilitate the interpretation of their associated coefficient. Like the third chapter, we follow Lewis and Sexton (2004) and use the next formula: $1+\text{Max}(X_i)-X_i$ where X_i and $\text{Max}(X_i)$ respectively refer here to political instability variables and their maximum value. The reversed indexes of political stability and absence of violence/terrorism and physical integrity rights will be respectively called as "political instability and presence of violence/terrorism" and "disrespect for physical integrity rights" in the remainder of study.

5.2.2 Other variables

Four main variables are used to control the model: the under-five mortality rate used in the third chapter, urbanization and the old dependency ratio used in the previous chapters, external resources for health as percentage of total health expenditures, and the growth rate of GDP per capita in PPP USD used in the second chapter.

Under-five mortality rate (Under5): is included into the model given it is one of key variables which are likely to play an important role in determining prepayment health expenditures. This mortality indicator has been chosen for the same reason evoked in the third chapter and attesting that children are the one of most vulnerable people in Sub-Saharan African countries. It is likely to have a mixed effect on the level of prepayment health expenditures. We have seen in the third chapter (see Graphic 3.2) that under-five mortality has experienced a general decreasing trend in Sub-Saharan African countries over the studied period (1996-2012). This reduction could induce the policy-makers to reduce the quantity of funds allocated to the fight against child mortality in favour of the other health priorities. In this case the volume of prepayment health expenditures will not vary. However, the decrease in child mortality could also encourage the policy-makers to insure a continual decreasing in this indicator. In this case, these policy-makers will tend to further finance the programs and policies promoting the enhancement of child health. Hence, prepayment health expenditures will increase in term of quantity.

Urbanization (Urban): we have seen in the second chapter that in low-and middle-income countries, urbanization positively affects central government health expenditures per capita, NGOs health expenditures and health insurance expenditures (Table 2.6) that constitute prepayment health expenditures. In Sub-Saharan African countries, we consequently control for this variable by expecting a positive effect on prepayment health expenditures per capita.

Old dependency ratio: in the second chapter, evidences have been found and shown that the old dependency ratio leads to increase central government health expenditures per capita, and health expenditures per capita from NGOs in low-and middle-income countries (Table 2.6). Like, urbanization, we include the old dependency ratio in order to check whether it will be associated with the same positive effect in Sub-Saharan African countries.

External resources for health as percentage of total health expenditures (Ext_Fin %): this variable is a one of key determinants of prepayment health expenditures. Based on the literature and evidences found in the third chapter, external resources for health increase prepayment health expenditures in Sub-Saharan African countries. In the third chapter, we have used Development Assistance for health as instrument of prepayment health expenditures. In the present chapter, we test whether the contribution of external resources for health to health financing significantly affects the volume per capita of prepayment health expenditures in Sub-Saharan African countries. Here a positive effect of external resources for health as share of total health expenditures is expected with an associated coefficient less than the unit.

GDP per capita growth (Growth): controls for the income effect on prepayment health expenditures. In the second chapter, we have found that the growth of GDP per capita contributes in increasing the volume per capita of central government health expenditures, and health insurances expenditures in low-and middle-income countries. Consequently, we expected here a positive effect of GDP per capita growth on prepayment health expenditures per capita.

5.3 Econometric model

Among the existing panel data models such as fixed and random effects models, we follow the second and the third chapter to use a fixed effects model. Let remember that fixed effects model accounts for the unobserved heterogeneity between countries. The choice of this kind of model comes from empirical evidences that attest that the occurrence of political instability events is not due to the hazard. There are factors driven to this occurrence. These are for example democracy (Ellingsen, 2000; Parsa, 2003), the neighbourhood instability (Goldstone et al., 2004; Schatzman, 2005), the income instability (Alesina and Perotti, 1996), the ethnic fractionalization[33] (Collier and Hoeffler, 2004), the level of urbanization and the abundance of natural resources (Le Billon, 2001). Hence it would be more rigorous to depart from fixed effects models. Our fixed effects model is specified as follows:

$$Y_{it} = \alpha + \beta X_{it} + \sum_{k=1}^{n} \delta_k Z_{kit} + V_i + \varepsilon_{it}$$

Y_{it} refers to the variable of prepayment health expenditures for country "i" at the year "t". X_{it} refers to the variable of interest political instability and ε_{it} is the idiosyncratic disturbance. α is the intercept whereas Z_{kit} represents the "k" (k going from 1 to n) control variables. β; δ_k are the parameters which must be estimated. V_i is country fixed effects which account for the heterogeneity between countries.

[33]"Ethnic fractionalization is defined as the probability that two individuals, selected at random from a country's population, will be of the different ethnicities" (Majerovitz, 2015).

5.4 Identification issues

The estimation of econometric model requires to identify and to deal with endogeneity issues. The first variable suspected to be endogenous is the variable of political instability. Two sources of endogeneity are suspected.

- The first source of endogeneity is the measurement error bias. Political instability is a multidimensional concept, which cannot be exactly approximated. Accordingly, there could be some unobserved aspects which cannot be taken into account the calculation of political instability indexes and which could be included in the error term producing biases in the estimation of coefficient associated with these indexes.

- The second source of endogeneity is the reverse causality bias between political instability indexes and prepayment health expenditures. In general fashion, a health system lowly productive which cannot meet with the needs of population, mostly the poorest could result in demonstrations, in claims and consequently in events of political instability. Hence, the reduction in prepayment health expenditures could increase the risk of political instability. More specifically, in Sub-Saharan African countries, government health expenditures are more used by the poorest that do not benefit from money to finance healthcare in case of disease episode. Accordingly, the reduction of government expenditures on health could increase the access inequalities to healthcare in disfavour of poor people. These inequalities could result in political demonstrations and riots. Furthermore, the increase in health insurance expenditures could increase the level of political instability. High levels of these kinds of health expenditures would reflect a high level of subscriptions to health insurance contracts and a high likelihood for people covered by health insurances to access to healthcare in case of disease/disability events. This likelihood could be a signal inducing the individuals to demonstrate when political system is mismanaged. In this way, an increase in health insurance expenditures could result in high risks of political instability.

- In addition to the variables of interest, there are control variables, which are also suspected to be endogenous in the model. These are: under-five mortality rate, the growth of GDP per capita, urbanization and external resources for health as share of total health expenditures. The endogeneity is mostly explained by the reverse causality between the mentioned variables and prepayment health expenditures per capita.

Regarding under-five mortality rate, the first chapter highlights a negative effect of prepayment health expenditures on child mortality in Sub-Saharan African countries. In addition to the mortality indicator, the literature also shows some evidences attesting that government health expenditures, constituting a component of prepayment health expenditures, lead to increase economic growth (Wu et al., 2010; Kurt, 2015).

The endogeneity of urbanization comes from the argument discussed in the second chapter that attests that the availability of healthcare in urban areas could induce the migration of rural people towards these zones. In this way, the increase in prepayment health expenditures could increase the size and consequently the percentage of urban population.

The endogeneity of external resources for health variable comes from a simple assumption. The level of health expenditures plays an important role in the process of foreign aid negotiation. Consequently, the increase in prepayment health expenditures could increase the amount of external resources allocated to health. The endogeneity of control variables is addressed in the subsection 5.5.

5.5 Instrumentation strategy

We use the instrumentation strategy used in the third chapter to address the endogeneity issues. This strategy refers to the method of instrumental variables, which seems to be also adapted here. Three instruments have been selected. There refer to the presence of militaries in politics (Militaries), the religious tensions (Religious) and civil liberties (Liberties). The two firsts are ranged from 0 (very high risk of militaries in politics and religious tensions) to 6 (very low risk of militaries in politics and religious tensions). The last is ranged as from 1 (high freedom) to 7 (low freedom).

- ***The presence of militaries in politics***: it measures militaries participation in government. It would affect the level of political instability (internal conflicts) without directly influencing the level of prepayment health expenditures. The story has shown that countries, which are majorly governed by militaries, have experienced some events of political instability. The most relevant example is the case of Guinea, Guinea-Bissau, Burkina Faso, Cote d'Ivoire and Mali. The militaries tend to decree a dictatorial and autocratic system of governance, which often results in civil protests, in demonstrations, in riots and in assassinations. However, assumptions attesting the direct effect of military in politics on the level of prepayment health expenditures have not been found. The presence of militaries in government has generally the consequence to modify the structure of states' budget in favour of defence expenses and in disfavour of the other expenditures items, mostly allocated to social sectors. However, there are not evidences showing that the budget allocation in the profit of defence reduces the level of prepayment health expenditures, more specifically of government expenditures on health. The index of militaries in politics theoretically consequently appears as a valid instrument.

- ***The religious tensions***: it approximates the likelihood that civil society is dominated by a single religious group for which the goal is to decree a religious law and to promote the exclusion of other religious groups. The presence of these religious groups decreeing their law has generally the consequence to result in rebellions, demonstrations and riots. In this way, the increase in risks of religious tensions would be likely to increase the risk of political instability, but it would not directly affect the level of prepayment health expenditures.

- ***Civil liberties***: it generally approximates democracy accountability. It assesses the propensity of a government to insure the freedom of expression and belief, the associational and organizational rights, rules of law and the autonomy of individuals and organizations without inference to the state. Civil liberties could affect political instability in two ways. They allow for the citizens to freely appreciate and criticize policies implemented by governments. They could encourage the rebellions when policies are not implemented to meet with their needs. In this way, civil liberties could increase the risk of political instability. On this subject, Schatzman (2005) found that countries with more democratic regimes are more likely to experience rebellions but they are more likely to observe less collective protests. In countries where civil liberties are insured, governments are attentive to the requests of population, a fact that is likely to reduce the protests. Hence, an enhancement of civil liberties could also decrease the risk of political instability. However, civil liberties could affect the level of prepayment health expenditures, but this effect is indirect and passes through the channel of an enhancement or not of quality of political system. Civil liberties index would be accordingly a good instrument.

Here the instrumented model is specified as follow: let consider our first model: $Y_{it} = \alpha + \beta X_{it} + \sum_{k=1}^{n} \delta_k Z_{kit} + V_i + \varepsilon_{it}$. In the first and the second-stages of instrumentation, this model is respectively specified as following way:

- The first stage of instrumentation (auxiliary equation):

$$X_{it} = \pi + \sum_{a=1}^{3} \vartheta_a I_{ait} + \sum_{k=1}^{5} \gamma_k Z_{kit} + V_i + \mu_{it}, \text{ such as:}$$

$$\hat{X}_{it} = \hat{\pi} + \sum_{a=1}^{3} \hat{\vartheta}_a I_{ait} + \sum_{k=1}^{5} \hat{\gamma}_k Z_{kit} + V_i$$

- The second-stage of instrumentation (instrumented equation):

$$Y_{it} = \theta + \lambda \hat{X}_{it} + \sum_{k=1}^{n} \varphi_k Z_{kit} + V_i + \omega_{it}$$

I_{ait} refers to the three used instrumental variables. μ_{it} and ω_{it} are respectively the error terms of auxiliary and instrumented equations. π and θ are respectively the intercept of auxiliary and instrumented equations. ϑ_a, γ_k ,λ , φ_k are the parameters which must be estimated. $\hat{X}_{it}$ is the predicted component ofX_{it}.

The most adapted estimator will be chosen per the presence or not of heteroskedasticity and serial correlation in the distribution of standard error term. In presence of these biases, the traditional IV/2SLS will be used but in contrary case, the heteroskedastic-efficient two step generalized method of moment (IV/GMM) will be preferred (Baum et al., 2007). The relevance and the exogeneity of used instruments will be tested respectively through the weak identification test (comparison between Cragg Donald Wald F statistics and critical values of Stock and Yogo) and the over identification test of Hansen.

The simultaneity biases of control variables suspected to be endogenous is addressed by directly introducing their one-year lag. These lagged are likely to affect the level of prepayment health expenditures but they are not likely to be influenced by these expenditures.

In our empirical investigations, three specifications will be tested. Table 4.1 summarizes the variables, which will be used in each specification and the signs of their expected effect on prepayment health expenditures per capita. In the first, the second and the third specification, the variable of prepayment health expenditures are explained on the indexes of internal conflicts, political instability and presence of violence/terrorism and disrespect for physical integrity rights. In all specifications, the control variables discussed above are included. Moreover, each of political instability indexes are instrumented by the three instrumental variables also discussed above the text.

Table 4.1: Tested specifications in econometric model

Variables		Definitions and assessment units	Specifications			Expected effects
			(1)	(2)	(3)	
Dependent variable	Prepayment	Prepayment health expenditures per capita (PPP USD)	*	*	*	
Explanatory variables	Conflicts	Reverse of Internal conflicts index	*			+/-
	Political	Index of political instability and presence of violence/terrorism		*		+/-
	Integrity	Index of disrespect for physical integrity rights			*	+/-
	Under5	The under-five mortality rate (per 1000 live births)	*	*	*	+/-
	Urban	Percentage of urban population (%)	*	*	*	+
	Ext_Fin%	External resources for health as percentage of total health expenditures (%)	*	*	*	+ with a coefficient less than 1
	Growth	Growth rate of GDP per capita (%)	*	*	*	+
	POP65	Percentage of population aged 65 and above (%)	*	*	*	+
Instrumental variables	Militaries	Militaries in Politics index	*	*	*	+
	Religious	Religious tensions index	*	*	*	+
	Liberties	Civil liberties index	*	*	*	+/-

Source: Author.

5.6 Data and descriptive statistics

The variables used here are stemmed of six databases. The indexes of political stability and absence of violence/terrorism and physical integrity rights respectively come from the Worldwide Governance Indicators (WGI) and the Cingranelli-Richards Human Rights (CIRI) databases. The indexes of internal conflicts, militaries in politics and religious tensions are retrieved from the International Country Risk Guide (ICRG) database. Civil liberties index is provided by the Freedom House (FH) database[34]. Under-five mortality rate, urbanization variable, the old dependency ratio, and the growth rate of GDP per capita are retrieved from the World Development Indicators (WDI) database. Total health expenditures per capita, the out-of-pocket payments per capita and external resources for health as percentage of total health expenditures come from the Global Health Expenditures (GHE) database.

Table 4.2 provides the descriptive statistics of used variables. From this table, it appears a gap in terms of magnitude order between, prepayment health expenditures per capita and some explanatory variables particularly political instability indexes, the percentage of urban population, the percentage of population aged 65 and above, health aid variable and economic growth rate. The values of prepayment health expenditures are particularly greater than the ones of mentioned explanatory variables. The measure scales used to assess the variables could explain this gap. Prepayment health expenditures are expressed in USD PPP per capita whereas the explanatory variables are expressed as percentage or index-based units. Accordingly, we transform the variable of prepayment health expenditures into logarithm to smooth its relationship with explanatory variables, particularly with political instability indexes.

Table 4.2: Descriptive statistics (1996-2012)

Variables	Mean	Std.Dev.	CV	Median	Min	Max	Observations
Log. Prepayment	3.996	1.113	0.278	3.870	0.989	6.931	449
Conflicts	4.438	1.647	0.371	4.333	1	11.667	449
Political	2.713	0.882	0.325	2.524	1	4.846	369
Integrity	4.859	1.914	0.394	5	1	9	419
Under5	120.409	45.377	0.377	113.4	47.700	267.1	449
Urban	37.750	15.442	0.409	35.716	13.629	86.367	449
Ext_Fin%	0.175	0.155	0.889	0.135	0.003	0.72	446
Growth	2.061	4.416	2.142	2.014	-29.635	30.342	449
POP65	3.156	0.655	0.208	3.021	2.327	5.959	449
Militaries	2.6	1.752	0.674	2	0	6	449
Religious	4.219	1.364	0.323	5	0	6	449
Liberties	4.138	1.3	0.314	4	2	7	449

Source: Author 'calculation using the GHE, the WDI, the ICRG and the FH, the CIRI and the WGI databases.
Note: Std.Dev: Standard Deviation. CV: Coefficient of Variation.

[34]https://freedomhouse.org/report/freedom-world-2016/table-scores.

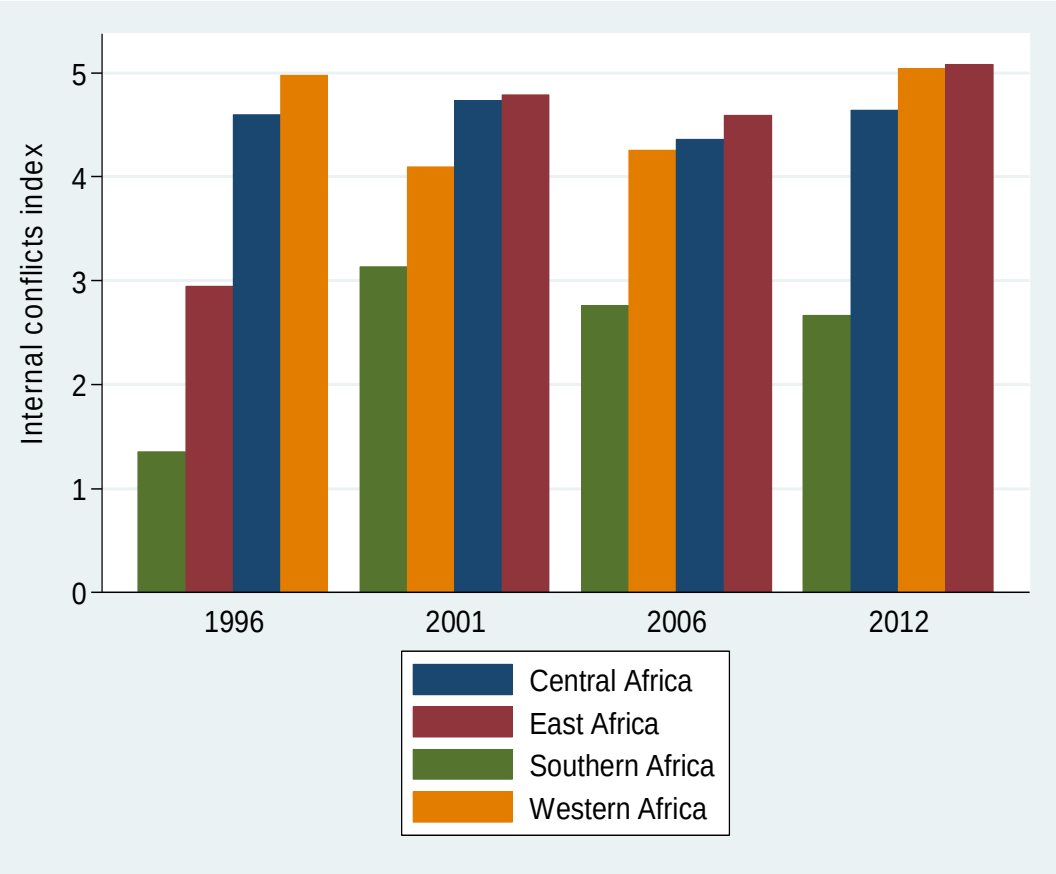
6. Results

6.1 Statistical investigation on political instability indexes and prepayment health expenditures

Before testing the effect of political instability indexes on prepayment health expenditures, we firstly analyze the distribution and the time trend of variables and secondly their graphical relationship.

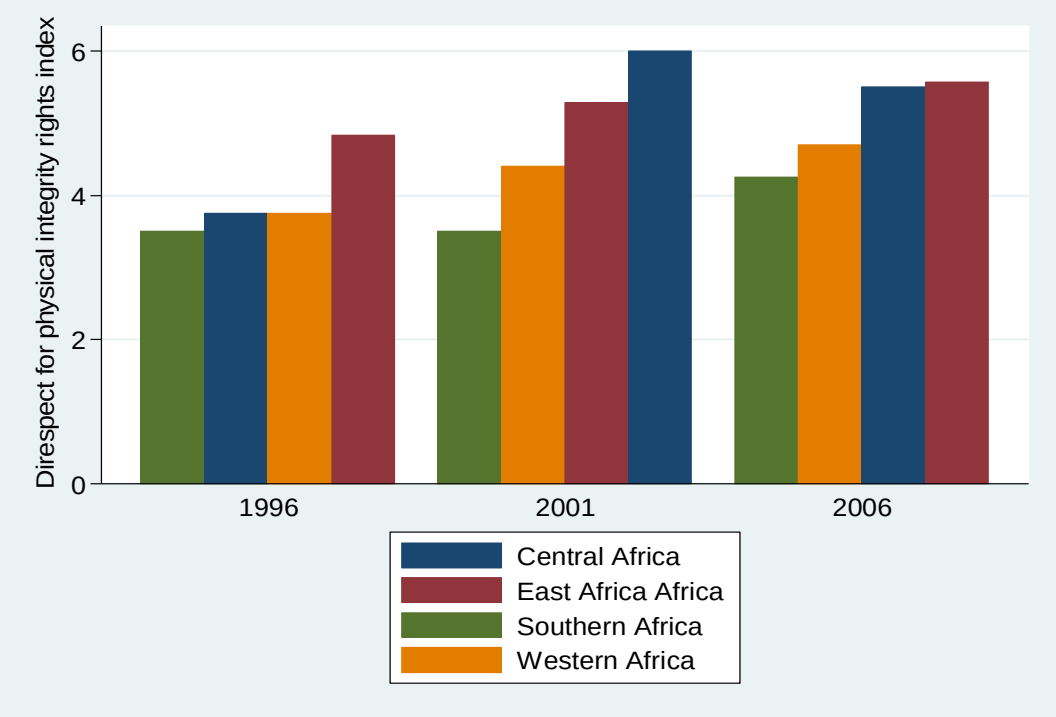
- For the distribution analysis, the mean of variables has been calculated by region. This analysis has been performed by year because the mean calculation of variable on a long period such as studied here would not bring rigorous information. We focus on the following year such as 1996, 2001, 2006 and 2012. There some variables such as the indexes of political instability and presence of violence/terrorism and disrespect for physical integrity rights which have not provided respectively for the years 2001 and 2012.The investigations reported in Graphics 4.1, 4.2 and 4.3 reveal that Southern Africa remains the least unstable region. For all years, we find that South African region records the least mean values of political instability indexes. Then, it appears that in this region, prepayment health expenditures per capita are the highest (Graphic 4.4).

Graphic 4.1: Distribution of internal conflicts index by region



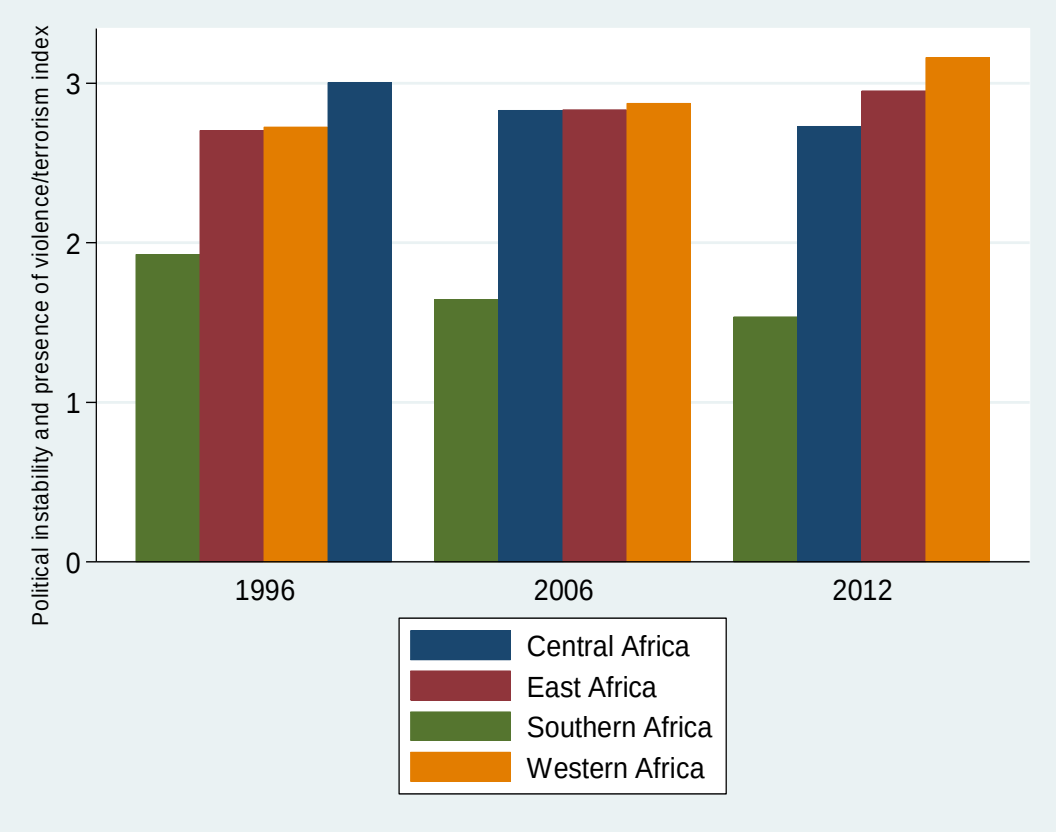
Source: Author using the ICRG database.

Graphic 4.2: Distribution of disrespect for physical integrity rights index by region



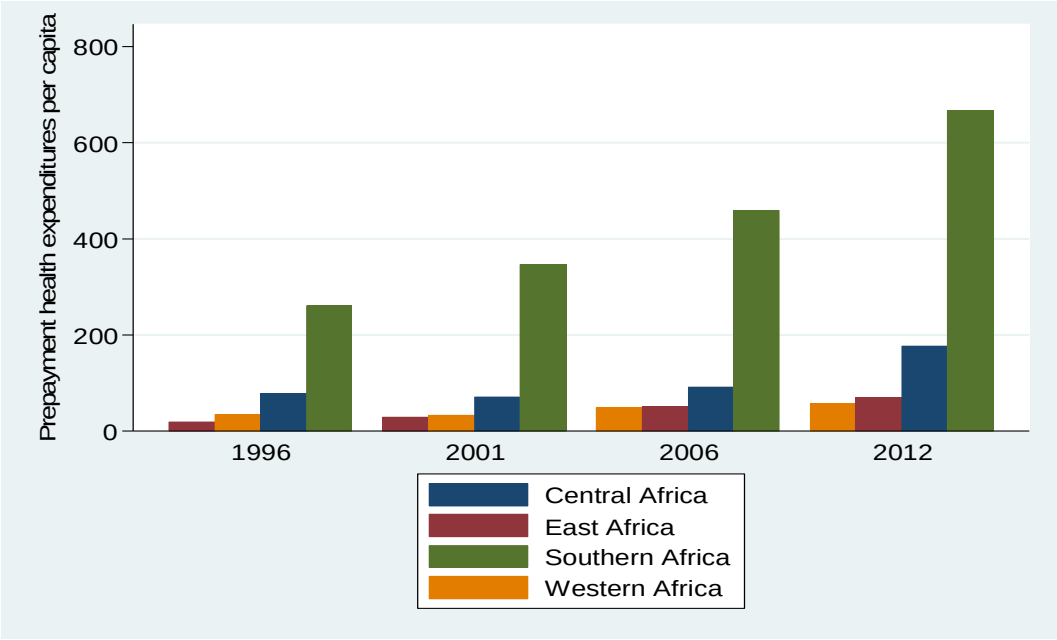
Source: Author using the CRI database.

Graphic 4.3: Distribution of political instability and presence of violence/terrorism index by region



Source: Author using the WGI database.

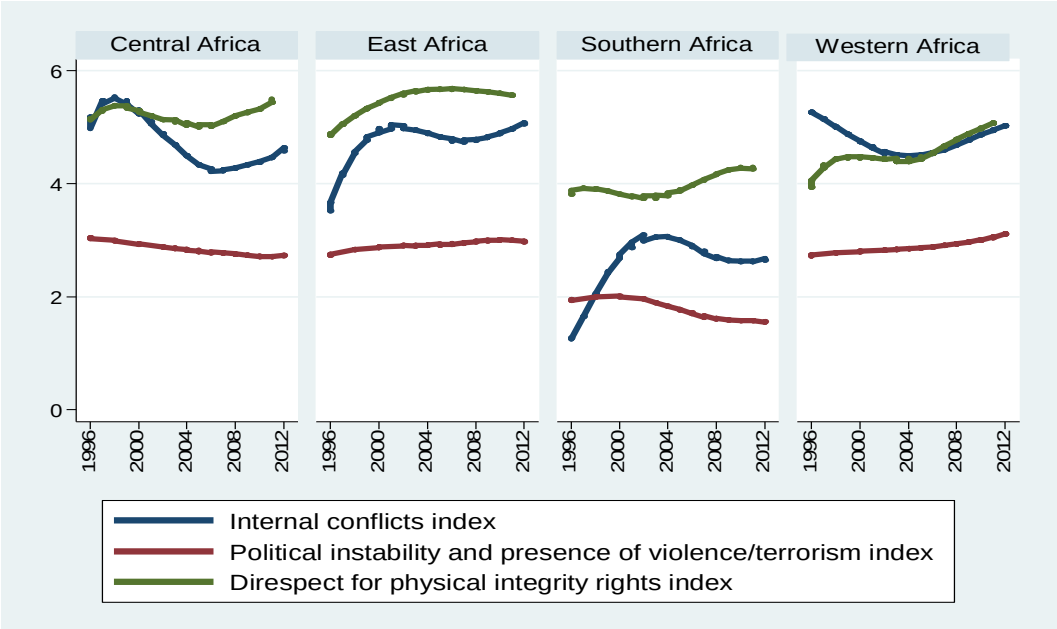
Graphic 4.4: Distribution of prepayment health expenditures per capita in USD PPP index by region



Source: Author using the GHE database.

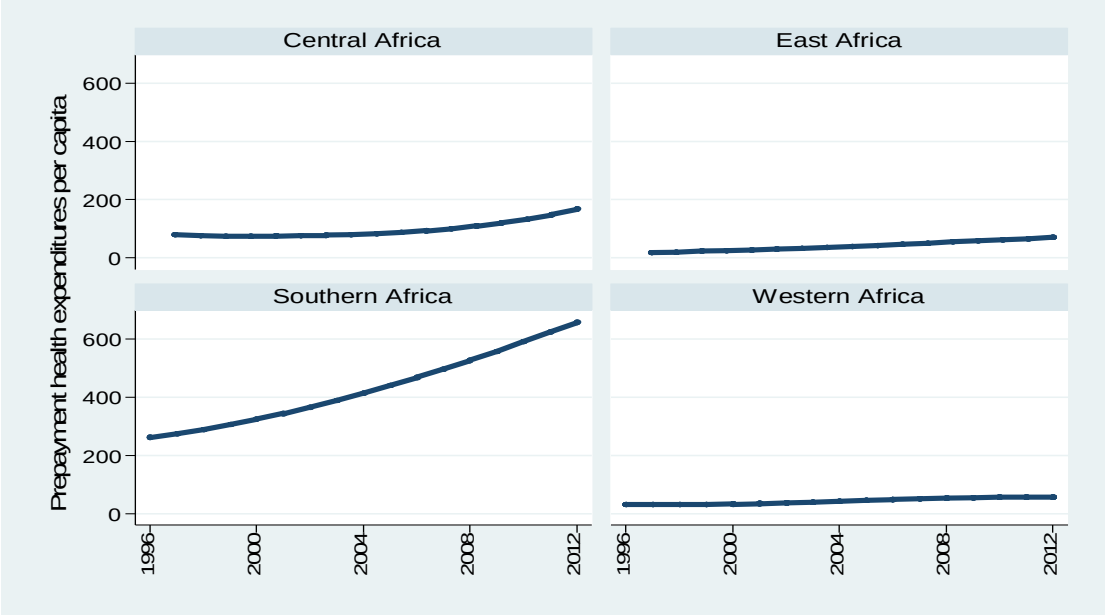
- The time trend of variable by region globally shows that political instability has increased in East and in Western Africa, mostly these last years and has decreased in Central Africa (Graphic 4.5). Since the period 2004-2008, the internal conflicts and the disrespect for physical integrity rights have increased in the region of Central Africa. For the region of Southern Africa, we observe that the proxy indexes of political violence and protests (indexes of internal conflicts and political instability and presence of violence/terrorism) have decreased even if internal conflicts index has increased over the period 1996-2004. In this region the respect for physical integrity rights have been more and more flouted mostly these last years. Concerning prepayment health expenditures per capita, we generally observe an increasing trend (Graphic 4.6). This increasing dynamic has been stronger for the region of Southern Africa.

Graphic 4.5: Trend time of political instability indexes by region (1996-20012)



Source: Author using the ICRG, the CIRI and the WGI databases.

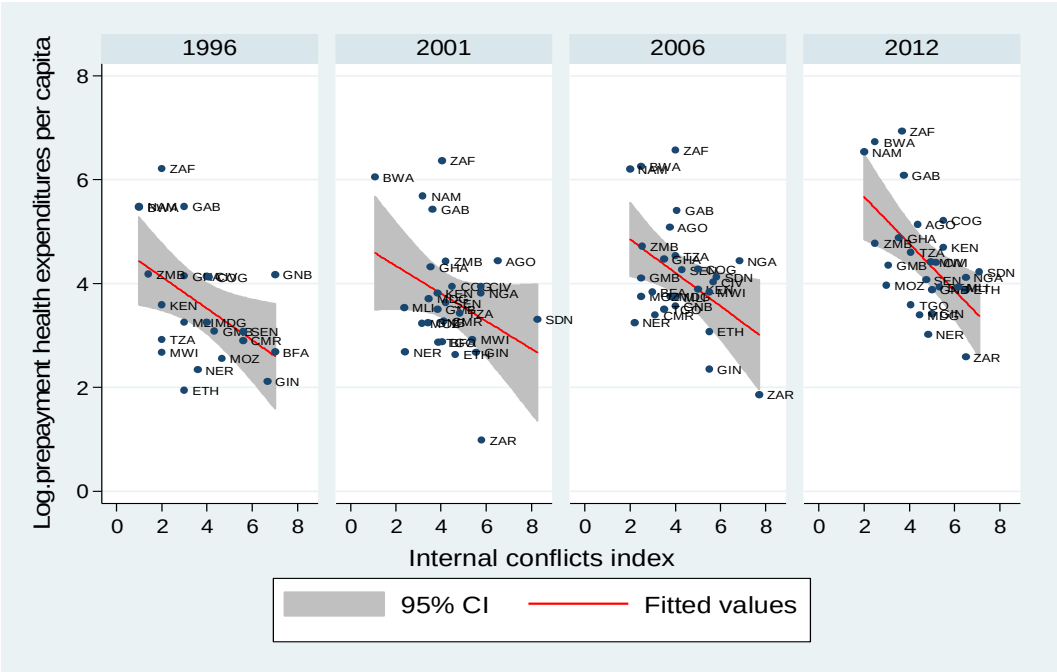
Graphic 4.6: Trend time of prepayment health expenditures per capita in USD PPP by region (1996-20012)



Source: Author using the GHE database.

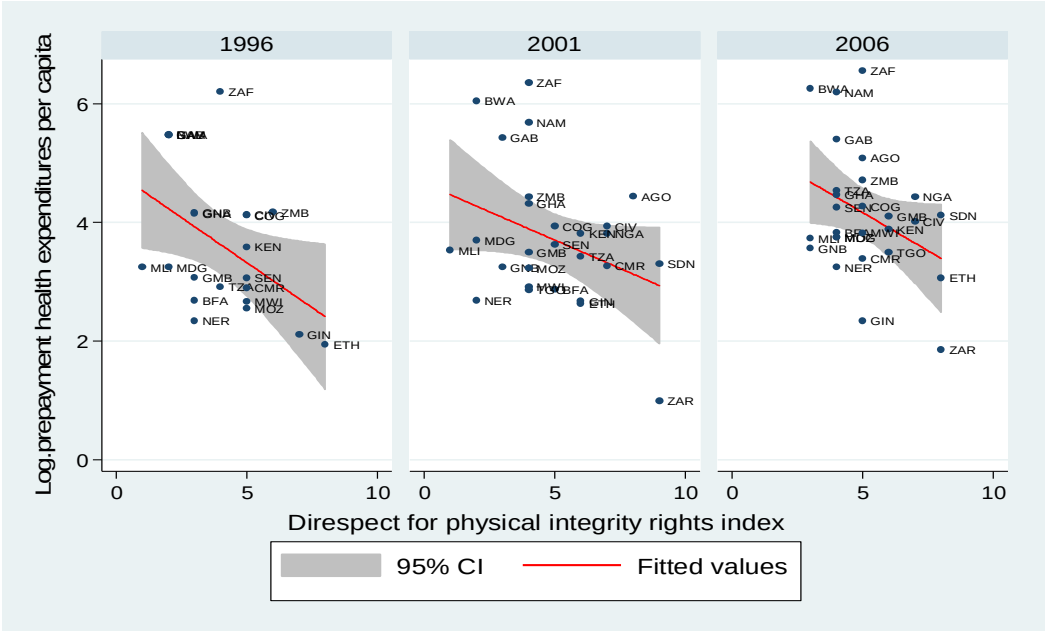
- In view of these findings, it seems that the most stable region such as Southern Africa has recorded and experienced respectively the highest level and the highest increasing trend of prepayment health expenditures per capita. This observation could reveal a negative correlation between the political instability indexes and prepayment health expenditures per capita. We check this assumption by carrying out a scatter plot analysis by year (Graphic 4.7, 4.8 and 4.9) and we find that political instability indexes are negatively correlated to prepayment health expenditures per capita, that is, high political instability is associated with low prepayment health expenditures per capita. In the following subsection, we shall test whether this relationship is significant or not;

Graphic 4.7: Scatter plots between internal conflicts index and the logarithm of prepayment health expenditures per capita in USD PPP



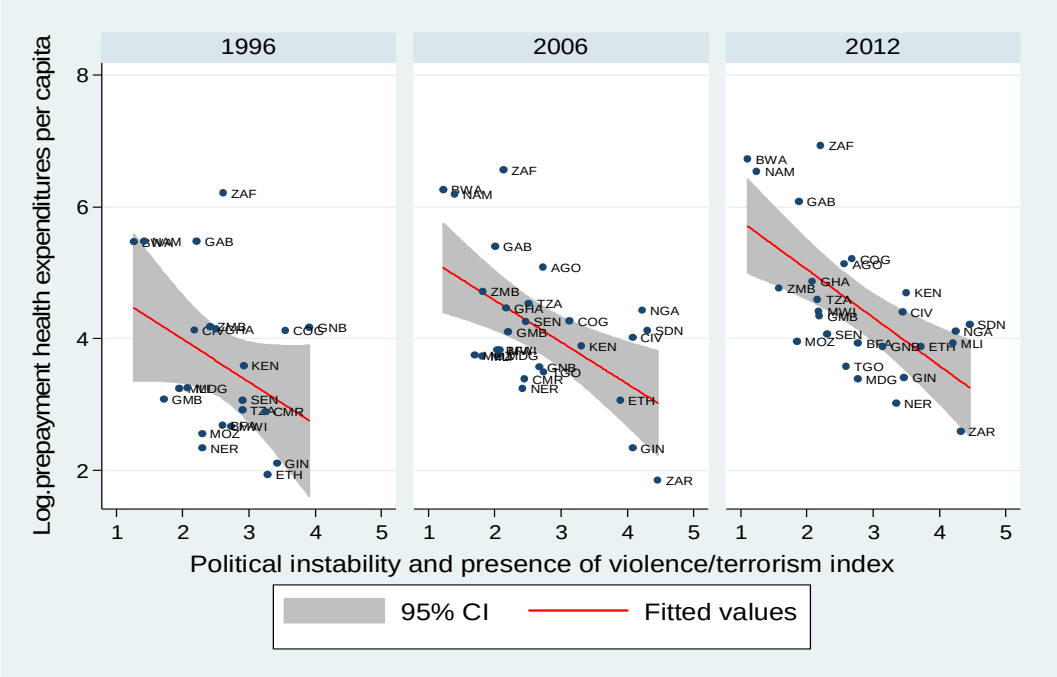
Source: Author using the GHE, and the ICRG databases.

Graphic 4. 8: Scatter plots between disrespect for physical integrity rights indexes and the logarithm of prepayment health expenditures per capita in USD PPP



Source: Author using the GHE, and the CIRI databases.

Graphic 4.9: Scatter plots between political instability and presence of violence/terrorism and the logarithm of prepayment health expenditures per capita in USD PPP



Source: Author using the GHE, and the WGI databases.

6.2 Findings on econometric regressions

6.2.1 Testing the effect of political instability on prepayment health expenditures

The Modified Wald test for groupwise heteroskedasticity and the Wooldridge test respectively reveal the presence of heteroskedasticity and serial correlation in the distribution of standard error. Hence, the regressions are performed on the basis of efficient GMM estimator. The baseline results of estimations are reported in Table 4.3.

Table 4.3: Baseline results of effect of political instability indexes on prepayment health expenditures per capita in USD PPP (1996-2012)

Specifications	(1)		(2)		(3)	
Stages of instrumentation	First	Second	First	Second	First	Second
Conflicts		-0.104*** (-3.473)				
Political				-0.231*** (-2.607)		
Integrity						-0.098*** (-2.950)
$Under5_{t-1}$	-0.002 (-0.917)	-0.007*** (-9.479)	-0.002 (-1.574)	-0.008*** (-9.150)	0.004 (1.200)	-0.006*** (-7.493)
$Urban_{t-1}$	-0.138*** (-4.599)	0.036*** (5.171)	-0.045*** (-3.490)	0.037*** (4.628)	-0.009 (-0.289)	0.051*** (7.086)
$Ext\_Fin\%_{t-1}$	1.004 (1.422)	0.601*** (2.980)	-0.002 (-0.007)	0.184 (0.901)	2.621*** (3.104)	0.764*** (3.549)
$Growth_{t-1}$	0.020 (1.558)	0.011*** (3.373)	-0.001 (-0.188)	0.010*** (3.340)	-0.004 (-0.318)	0.008** (2.173)
Old dependency	0.434 (1.300)	0.482*** (6.530)	-0.251** (-2.042)	0.358*** (3.956)	0.384 (1.129)	0.408*** (5.499)
Religious	-0.392*** (-4.067)					
Militaries	-0.457*** (-5.177)		-0.233*** (-3.807)		-0.479*** (-4.161)	
Liberties	-0.338*** (-3.346)		-0.096** (-2.470)		-0.411*** (-4.215)	
Constant	14.031*** (7.281)	4.209*** (10.327)	6.755*** (9.742)	4.776*** (7.706)	8.164*** (4.459)	3.721*** (9.263)
Observations	449	449	369	369	396	396
F-statistics (significance of model)		409.246***		520.507***		507.867***
Cragg-Donald Wald F statistics		20.037		21.358		22.503
Wald test of heteroskedasticity: chi2 statistics	892.82***		572.70***		785.10***	
Wooldridge test of serial correlation: F-statistics	41.381***		88.464***		36.319***	
Critical values of Stock and Yogo (5%)		13.91		13.91		13.91
Hansen test : P-values		0.762		0.910		0.293
R^2		0.946		0.949		0.949

Note: t statistics in parentheses; *** p<0.01, ** p<0.05, * p<0.1. . Note: let remember that the coefficients associated to the instrumental variable need to be reversely interpreted.

- We generally observe through the F-tests that the estimated model significantly explains prepayment health expenditures in all specifications. The F-tests are associated with statistics for which the p-values are less than the maximal acceptable threshold of 10%. In this way, the null hypothesis of these tests attesting the absence of significance of models can be rejected. Furthermore, the explanation powers of model approximated by R^2 are estimated around 95%.

- Next, in the first stage of instrumentation, the findings stress that the three used instruments significantly explain the internal conflicts index. They all enter with negative coefficients. Given the

way through which these instrumental variables have been assessed, the negative coefficients show that civil liberties, the risk of militaries participation in politics and the risk religious tensions result in more internal conflicts. Hence, these instrumental variables are relevant. They are not also weak based on the comparison between the Cragg-Donald Wald F statistic and the critical values of Stock and Yogo. Then, based on the Hansen test, we find that the instruments are over identified in the model using the internal conflicts index as variable of interest. The all three instruments are consequently valid in this regression.

- Concerning the estimations regarding the other political instability indexes as variables of interest, it appears that religious tensions do not significantly affect political instability and presence of violence/terrorism and the disrespect for physical integrity rights indexes (Annex 4.1). Hence, this instrument is removed from the regressions (using the political instability and presence of violence/terrorism and the disrespect for physical integrity rights indexes as variables of interest) and the model is re-estimated on the basis of the other two. In the new estimations (Table 4.3), we find that the indexes of civil liberties and militaries participation in politics are associated with significant and negative coefficients. This finding reveals once again that civil liberties and militaries participation in politics leads to increase the risk of political instability. In addition, the weakness assumptions of both instrumental variables can be rejected through the comparison between the Cragg-Donald Wald F statistics and the critical values of Stock and Yogo. Regarding the Hansen test, it also shows that the two instruments are over identified.

- The statistical diagnostics attest the validity of used instruments and accordingly allow us to interpret the tested effects. We firstly find that political instability indexes are associated with negative and significant coefficients.

- Based on Table 2.3 of the second chapter, we find that an increase in one unit of indexes of internal conflicts, political instability and presence of violence/terrorism and disrespect for physical integrity rights results in a reduction in prepayment health expenditures per capita respectively by 10.4%, 23.1% and 9.8%. Consequently, it appears that the index of disrespect for physical integrity rights less affects prepayment health expenditures compared to the others. Hence, it seems that civil wars and disorders, “coup d’état” threats, and political motivated violence and/or terrorism more affect prepayment health expenditures compared to extreme violence.

- As far as the other explanatory variables it appears that the under-five mortality rate leads to reduce prepayment health expenditures; whereas urbanization, external resources for health[35], economic growth and the old dependency ratio significantly increase prepayment health expenditures. The coefficient associated with the variable of external resources for health is less than the units and shows that external resources for health are partially allocated to health sector.

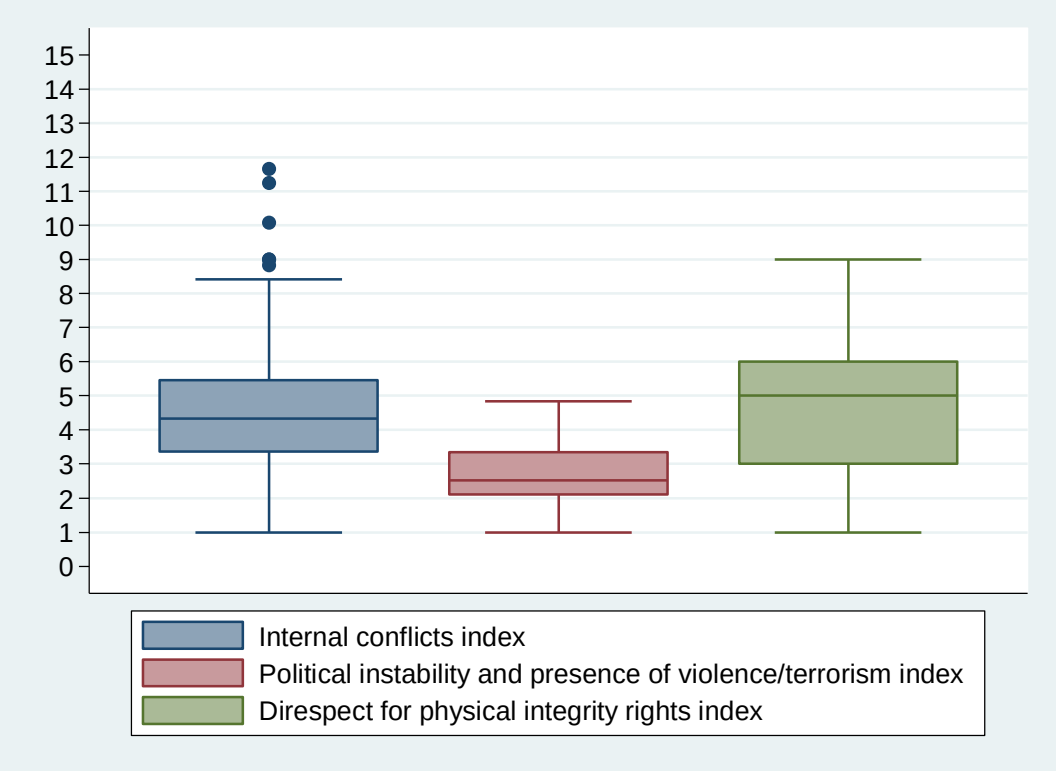
6.2.2 Testing the effect of political instability on prepayment health expenditures by removing atypical countries on the sample

In the starting model, evidences show that political instability leads to reduce prepayment health expenditures. However, the tested effects could come from the presence of atypical countries in the sample. It is possible that the estimated effects are only significant in these countries presenting lower or upper levels of political instability indexes. Consequently, here, atypical countries are firstly identified through box-plot analyses (Graphic 4.10). We do not find anomalies in the distribution of political instability and presence of violence/terrorism and in one of disrespect for physical integrity rights indexes. However, in the distribution of internal conflicts index, we find atypical countries for

[35] External resources for health do not significantly affect prepayment health expenditures in the specification using the index of political instability and absence of violence/terrorism as variable of interest.

which the index value is greater than 9. They refer to Sudan (at years 1998 and 1999) and Angola (between 1995 and 2000).

Graphic 4.10: Box-plot graphic of distribution of political instability indexes (1996-2012)



Source: Author using the ICRG, the WGI, and the CIRI databases.

Next, atypical countries are removed from the sample and the model explaining prepayment health expenditures on internal conflicts index is re-estimated. The baseline results of estimations excluding atypical countries are reported in Table 4.4.

The estimations reveal that the explanative power of model remains significant based on the F test and R^2, estimated around 94.8%. Furthermore, we find that the instruments are also valid. They are not weak and they are over identified respectively based on the comparison between the Cragg-Donald Wald F statistics and the critical values of Stock and Yogo and the Hansen test. In addition, the coefficient associated with the internal conflicts index remains negative and significant. This coefficient decreases after the exclusion of atypical countries but the change is low. The coefficient associated with internal conflicts index passes from 0.104 to 0.095. This low gap shows that atypical countries do not considerably influence the results. Concerning the other explanatory variables, their effects do not significantly change. Given the use of low sample, we continue the analyses with atypical countries to keep more information.

Table 4.4: Baseline results of effect of internal conflicts index on prepayment health expenditures per capita in USD PPP by excluding atypical countries (1996-2012)

Stages of instrumentation	First	Second
Conflicts		-0.095***
		(-3.082)
$Under5_{t-1}$	-0.004	-0.007***
	(-1.364)	(-9.282)
$Urban_{t-1}$	-0.117***	0.038***
	(-4.486)	(5.662)
$Ext\_Fin\%_{t-1}$	0.407	0.610***
	(0.661)	(3.041)
$Growth_{t-1}$	0.019	0.011***
	(1.641)	(3.372)
Old dependency	0.502	0.462***
	(1.566)	(6.344)
Religious	-0.366***	
	(-4.144)	
Militaries	-0.442***	
	(-5.430)	
Liberties	-0.327***	
	(-3.408)	
Constant	12.533***	4.080***
	(7.128)	(10.603)
Observations	444	444
F-statistics (significance of models)		433.834***
Cragg-Donald Wald F statistics		21.349
Critical values of Stock and Yogo (5%)		13.91
Hansen test : P-values		0.827
R^2		0.948

Note: t statistics in parentheses; *** p<0.01, ** p<0.05, * p<0.1. Note: let remember that the coefficients associated to the instrumental variable need to be reversely interpreted.

6.2.3 Testing the effect of political instability on the components of prepayment health expenditures

Here we test the effect of political instability on the volume per capita of prepayment health expenditures' components. We slip prepayment health expenditures into three components, such as government health expenditures, NGOs health expenditures and health insurance expenditures, all expressed in USD PPP per capita and coming from the Global Health Expenditures (GHE) database. However, the variable of health insurance expenditures does not provide sufficient observations to make a rigorous econometric analysis. Hence, we only focus on the other two. We separately explain the components of prepayment health expenditures on the three political instability indexes the same methodology (specifications and instrumentation). In the specification in which NGOs health expenditures is used as dependent variable, health aid variable is excluded because the expenditures financed by NGOs are a component of external resources for health. Hence, it would be biased to include the external resources variable in this specification. The variables of health expenditures from governments and NGOs are transformed into logarithm to smooth their relation with political instability indexes. The baseline results of estimations are reported in Tables 4.5 and 4.6.

Table 4.5: Baseline results of effect of political instability indexes on government health expenditures per capita in USD PPP (1996-2012)

Specifications	(1)		(2)		(3)	
Stages of instrumentation	First	Second	First	Second	First	Second
Conflicts		-0.080**				
		(-2.070)				
Political				-0.182*		
				(-1.673)		
Integrity						-0.032
						(-0.827)
$Under5_{t-1}$	-0.004	-0.007***	-0.003**	-0.007***	0.002	-0.006***
	(-1.466)	(-8.288)	(-2.077)	(-8.194)	(0.623)	(-6.857)
$Urban_{t-1}$	-0.131***	0.046***	-0.049***	0.046***	-0.027	0.056***
	(-4.053)	(5.682)	(-3.568)	(4.974)	(-0.764)	(6.630)
$Ext\_Fin\%_{t-1}$	1.149	1.085***	0.248	0.547*	2.668***	1.095***
	(1.409)	(3.496)	(0.700)	(1.926)	(2.844)	(3.478)
$Growth_{t-1}$	0.020	0.013***	-0.000	0.010***	-0.009	0.011**
	(1.481)	(2.798)	(-0.047)	(2.699)	(-0.663)	(2.151)
Old dependency	0.683	0.763***	-0.211	0.596***	0.016	0.619***
	(1.528)	(6.121)	(-1.063)	(3.872)	(0.036)	(4.537)
Religious	-0.171*					
	(-1.653)					
Militaries	-0.530***		-0.240***		-0.469***	
	(-5.812)		(-3.866)		(-3.985)	
Liberties	-0.361***		-0.107**		-0.425***	
	(-3.319)		(-2.586)		(-4.083)	
Constant	12.852***	2.714***	7.021***	3.386***	10.123***	2.249***
	(5.677)	(4.956)	(8.132)	(4.224)	(4.638)	(3.816)
Observations	365	365	300	300	321	321
F-statistics		318.243***		263.256***		256.408***
Cragg Donald Wald F statistics		16.187		21.127		20.241
Critical values of Stock and Yogo (10%)		9.08		19.93		19.93
Hansen test : P-values		0.291		0.365		0.571
R^2		0.923		0.932		0.934

Note: t statistics in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Table 4.6: Baseline results of effect of political instability indexes on NGOs health expenditures per capita in USD PPP (1996-2012)

Specifications	(1)		(2)		(3)	
Stages of instrumentation	First	Second	First	Second	First	Second
Conflicts		-0.081*				
		(-1.692)				
Political				-0.622**		
				(-2.380)		
Integrity						-0.198***
						(-2.808)
$Under5_{t-1}$	-0.002	-0.007***	-0.002	-0.008***	-0.0004	-0.006***
	(-0.716)	(-4.711)	(-1.503)	(-4.378)	(-0.126)	(-3.493)
$Urban_{t-1}$	-0.148***	0.038**	-0.040***	0.028	0.028	0.074***
	(-5.404)	(2.238)	(-3.038)	(1.180)	(0.809)	(3.348)
$Growth_{t-1}$	0.015	0.006	-0.002	0.009	-0.005	0.010
	(1.126)	(0.837)	(-0.246)	(0.997)	(-0.290)	(0.955)
Old dependency	0.881***	0.347**	-0.194*	0.162	0.549	0.262
	(2.741)	(2.140)	(-1.826)	(0.815)	(1.487)	(1.338)
Religious	-0.546***					
	(-5.448)					
Militaries	-0.317***		-0.185***		-0.416***	
	(-3.336)		(-2.968)		(-3.749)	
Liberties	-0.314***		-0.076*		-0.397***	
	(-3.127)		(-1.818)		(-3.592)	
Constant	12.721***	0.092	5.936***	2.548	6.834***	-0.415
	(7.135)	(0.096)	(8.481)	(1.412)	(3.448)	(-0.351)
Observations	395	395	327	327	345	345
F-statistics		314.802***		172.811***		136.188***
Cragg Donald Wald F statistics		25.155		14.149		19.024
Critical values of Stock and Yogo (10%)		9.08		19.93		19.93
Hansen test : P-values		0.1034		0.613		0.868
R^2		0.832		0.830		0.835

Note: t statistics in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

The estimations show that our tested model significantly and highly explains health expenditures from governments and NGOs (R^2 varying from 83% to 93.4%) in all specifications. Furthermore, in the specification explaining government health expenditures, the instruments remain valid based on the Hansen test and the comparison between the Cragg-Donald Wald F statistics and the critical values of Sock and Yogo. In the specification explaining NGOs health expenditures, the instrumental variables appear to be over identified (Hansen tests). However, the weakness assumption of instruments is only rejected in the specification regarding the internal conflicts index as variable of interest. In the other two, these instruments significantly explain the indexes of political instability and presence of violence/terrorism and disrespect for physical integrity rights. Hence, we think acceptable to interpret the findings. We observe that the indexes of internal conflicts and political instability and presence of violence/terrorism significantly and negatively affect government health expenditures. Their associated coefficients can be interpreted as follows: for an increase in one unit of these indexes, government health expenditures per capita respectively decrease by 8% and 18.2%.

Regarding the disrespect for physical integrity rights index, it enters with a non-significant coefficient showing that the disrespect for physical integrity rights does not significantly affect government health expenditures per capita. Next, we find all political instability indexes lead to reduce NGOs health expenditures. A one unit increase in indexes of internal conflicts, political instability and presence of violence/terrorism and disrespect for physical integrity rights has the effect to reduce NGOs health expenditures per capita respectively by 8.1%, 62.2% and 19.8%.

Regarding the control variables, they generally appear with their starting tested effects which are not significant in some cases. The under-five mortality rate leads to reduce government and NGOs health expenditures. Urbanization contributes in increasing these expenditures. Economic growth increases government health expenditures but it does not affect the level of health expenditures financed by NGOs. The old dependency ratio increases government health expenditures but its effect on NGOs health expenditures is less clear. It significantly affects these expenditures in one of three specifications. External resources for health appear to increase government health expenditures.

6.2.4 Testing the channels of transmission through which political instability affects prepayment health expenditures

- Empirical strategy used to test the channel of transmission

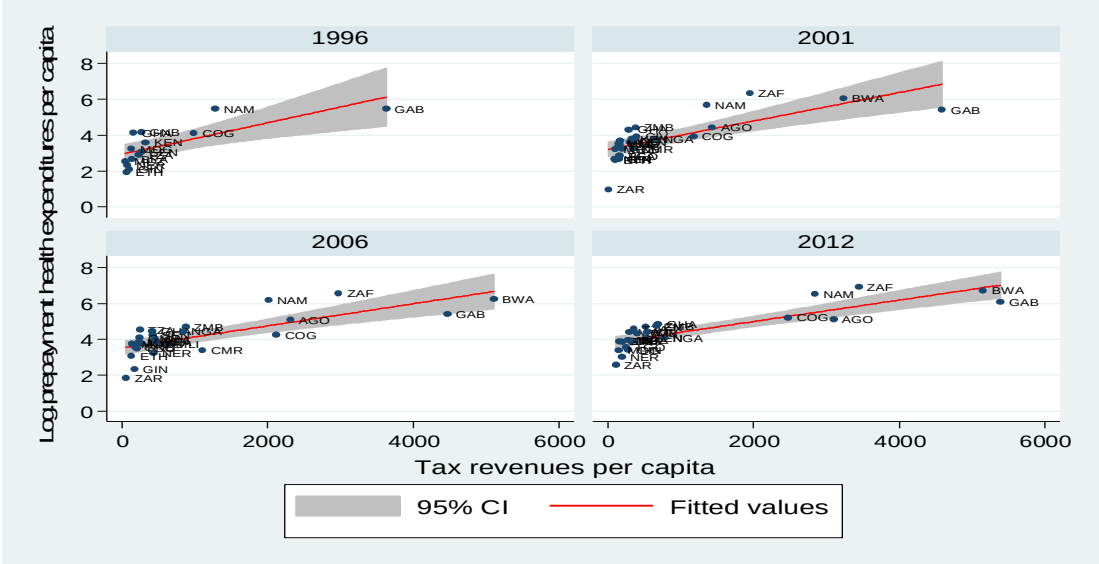
Generally, in econometric, the procedure used to test the channels of transmission is this: let consider a model including three variables such as Y, X and Z which respectively refer to the dependent variable, the variable of interest and the variable of transmission channel. In this model, X is likely to affect Y through Z. Firstly, Y is firstly explained on X only and then it is secondly explained on X and Z. The variable Z would be regarded as a channel of transmission in two cases. In the first one, the coefficient associated with X remains significant when Z is included into the model but its value diminishes. That means that a part of X effect on Y passes through Z.

In the second one, the coefficient associated with X becomes non-significant. That means that the total X effect on Y passes through Z. In both cases, Z needs to enter with a significant coefficient. Furthermore, in the second case, it is necessary to test whether Z and X are highly correlated or not. In the case where Z and X is highly correlated, the non-significant coefficient associated with X could be explained by this great correlation. Based on the arguments discussed above and linking political instability to prepayment health expenditures, we test three channels such as the ones passing through tax revenue, international aid and governance.

- Presentations of transmission channels 'variables

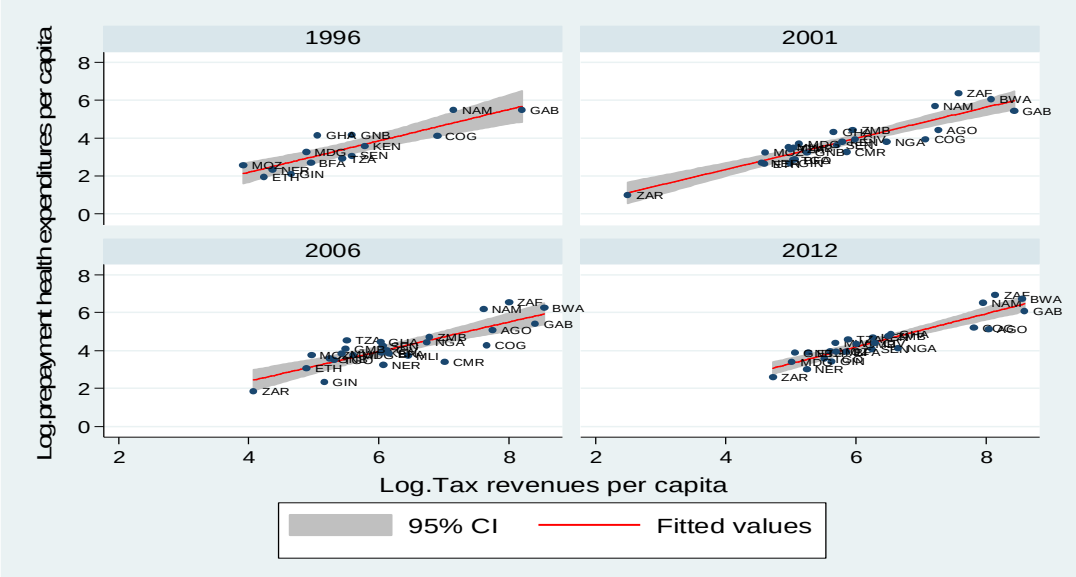
Tax revenue variable is expressed in USD PPP per capita to account for the quantity of mobilized tax resources. It is calculated by multiplying tax revenue as percentage of GDP by the level of GDP per capita in USD PPP. Tax revenue as share of GDP and GDP per capita respectively come from the World Development Indicators (WDI) and the World Economic Outlook (WEO) databases. The relationship between prepayment health expenditures per capita and tax revenue per capita is less clear when the variable of tax revenue is not transformed into logarithm (Graphic 4.11). That means that the form of statistical relationship between both variables is not linear. This relationship becomes more perceptible when we use the logarithm of tax revenue variable (Graphic 4.12). Consequently, we include the logarithm of tax revenue variable in the regressions.

Graphic 4.11: Scatter plots between tax revenue per capita in USD PPP and the logarithm of prepayment health expenditures per capita in USD PPP



Source: Author using the GHE, the WEO and the WDI databases

Graphic 4. 12: Scatter plots between the logarithm of tax revenue per capita in USD PPP and the logarithm of prepayment health expenditures per capita in USD PPP



Source: Author using the GHE, the WEO and the WDI databases.

International aid is generally approximated by the official development assistances variables. These variables include some components which must repaid by recipient countries. These are the external debt services including the principal repayments on external debt and the interests on this external debt. Hence, the estimation of international aid effect on prepayment health expenditures requires retrieving the repaid resources from the total funds allocated by foreign sponsors to Sub-Saharan African countries.

We follow Mathonnat et al., (2016) to calculate the total net public flows per capita variable by firstly adding the level of received grants excluding technical cooperation and the net amount of transfers on external debt public and publicly guaranteed, all expressed in current USD. The grants are the set of disbursement of funds that are allocated to a country by another without any repayment requirement. Net transfers correspond to disbursements received by the States in view of loans they contracted minus debt service including the interest payments and amortizations (Mathonnat et al., 2016).Then, the sum of these variables is divided by the size of total population. All variables that are used to compute the indicator of total net public flows per capita come from the World Development Indicators (WDI) database.

However, the inclusion of total net public flows' variable could be correlated with external resources for health; a fact could bias the coefficients associated with these last ones. Accordingly, we check the correlation between these last ones and we find a coefficient correlation which is low (0.2102). Moreover, the variable of total net public flows is expressed in USD per capita whereas our dependent variable is expressed into logarithm. The magnitude of values provided by the both variables is different. The total net public flows variable presents high values compared to the logarithm of prepayment health expenditures per capita. To smooth this gap, we include the logarithm of total net public flows. Before transforming this variable into logarithm, we firstly standardize it between 0 and 1. This standardization comes from the fact that the total net public flows per capita provide some negative values (Annex 4.2). Hence its logarithmic transformation will result in a loss of observations because it is impossible to calculate the logarithm of negative values. The general formula used in the standardization is:$\bar{X} = [Max(X_i) - X_i]/[Max(X_i) - Min(X_i)]$, where $\bar{X}$ and $X_i$respectively refer here to the standardized and the non-standardized variables.

Governance is approximated by a composite index constructed through a Principal Component Analysis (PCA) .This composite index includes four sub-indexes ranged from -2.5 (low level) to 2.5 (high level) and retrieved from the Worldwide Governance Indicators (WGI) database. Used and defined in the second chapter, these variables are government effectiveness, the control of corruption, rules of law and regulatory quality. Here, the acronyms of variables are respectively "Effectiveness", "Corruption", "Law" and "Regulatory". The results of PCA are reported in Table 4.7. They reveal that the first factorial axis better explains the index variation. It explains 90.56% of total variation within the data. Hence, we construct the index of governance, called as "Institutions" in the regressions on the basis of this first factorial axis.

Table 4.7: Results of principal component analysis computing the composite index of governance (1996-2012)

		Component1	Component2	Component3	Component4
Eigen value		3.6222	0.1697	0.1141	0.0940
Proportion		0.9056	0.0424	0.0285	0.0235
Cumulative		0.9056	0.9480	0.9765	1
Variables (Eigenvectors)	Effectiveness	0.5064	-0.0823	0.1988	-0.8350
	Corruption	0.4948	0.7227	0.3650	0.3157
	Law	0.5026	0.0474	-0.8579	0.0959
	Regulatory	0.4962	-0.6846	0.3021	0.4403

Source: Authors 'calculation using the WGI database.

- Evidences from channels of transmission estimations

Like in the other chapters, the regressions are performed by progressively and separately including the additional control variables in the model. That would allow us to avoid the potential collinearity biases between the additional variables. We follow the same methodology (specifications and instrumentation). The baseline results are reported in Table 4.8.

Table 4.8: Baseline results of effect of political instability indexes on prepayment health expenditures per capita in USD PPP, by including tax revenue per capita in USD PPP, governance index, the total net public flows per capita in USD PPP (1996-2012)

Added variables	Tax revenue			Institutions			Total net public flows		
Specifications	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
Conflicts	-0.064*			-0.085**			-0.091***		
	(-1.687)			(-2.128)			(-3.237)		
Political		-0.171			-0.235**			-0.213**	
		(-1.463)			(-2.079)			(-2.346)	
Integrity			-0.070**			-0.084**			-0.097***
			(-2.303)			(-2.268)			(-2.792)
$Under5_{t-1}$	-0.005***	-0.006***	-0.004***	-0.008***	-0.008***	-0.007***	-0.008***	-0.008***	-0.006***
	(-6.485)	(-5.487)	(-4.536)	(-8.080)	(-8.612)	(-6.514)	(-9.157)	(-8.710)	(-6.965)
$Urban_{t-1}$	0.028***	0.026***	0.040***	0.038***	0.036***	0.059***	0.029***	0.033***	0.047***
	(3.873)	(2.790)	(4.914)	(4.285)	(3.934)	(6.664)	(3.829)	(3.790)	(5.787)
$Ext\_Fin\%_{t-1}$	0.263	-0.002	0.441**	0.270	0.182	0.249	0.568***	0.183	0.752***
	(1.240)	(-0.008)	(2.019)	(1.348)	(0.881)	(1.128)	(2.802)	(0.872)	(3.344)
$Growth_{t-1}$	0.008**	0.009***	0.004	0.009***	0.010***	0.008***	0.010***	0.010***	0.008**
	(2.406)	(2.876)	(1.180)	(2.644)	(3.277)	(2.822)	(3.147)	(3.242)	(2.086)
Old dependency	0.358***	0.296**	0.288***	0.469***	0.356***	0.374***	0.468***	0.346***	0.406***
	(3.536)	(2.559)	(3.031)	(5.370)	(3.894)	(4.362)	(6.855)	(4.010)	(5.830)
Log. tax	0.254***	0.234**	0.327***						
	(3.282)	(2.321)	(4.082)						
Institutions				0.079	-0.010	0.108*			
				(1.299)	(-0.120)	(1.699)			
Log. Total net public flows per capita							0.898***	0.651*	0.690**
							(2.792)	(1.801)	(2.105)
Constant	2.275***	3.068**	1.346**	4.339***	4.787***	3.832***	4.713***	5.091***	4.024***
	(2.978)	(2.269)	(1.975)	(8.427)	(7.357)	(7.876)	(10.663)	(8.401)	(9.478)
Observations	401	340	357	369	369	318	431	354	380
F-statistics (significance of model)	560.783***	615.807***	723.726***	438.832***	521.378***	500.393***	381.306***	461.580***	448.565***
Cragg Donald Wald F statistics	11.243	14.716	20.444	14.194	15.067	18.989	21.928	21.276	20.836
Critical values of Stock and Yogo (10%)	9.08	19.93	19.93	9.08	19.93	19.93	9.08	19.93	19.93
Hansen test : P-values	0.788	0.523	0.137	0.997	0.920	0.129	0.610	0.943	0.273
R^2	0.958	0.958	0.960	0.948	0.949	0.954	0.942	0.943	0.943

Note: t statistics in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

- The findings underlines that the instruments are over identified based on the Hansen test. Regarding the weakness of used instruments, it generally appears that the instruments are not weak. But the Cragg-Donald Wald F statistics is less than the critical values of Stock and Yogo, precisely in the

specifications including the composite index of governance and in which prepayment health expenditures are explained by the indexes of political instability and presence of violence/terrorism and disrespect for physical integrity rights. However, in the two specifications, the difference between the Cragg-Donald Wald F statistics and the critical values of Stock and Yogo is low. Hence, in these specifications, it appears that the instruments are weak but they remain relevant because they significantly explain political instability indexes (Annexes 4.3; 4.4 and 4.5). Hence we think acceptable to interpret the results.

- Firstly, we observe that tax revenue increase total prepayment health expenditures (public and private sources). After include this variable, the coefficients associated with political instability indexes diminish.

For internal conflicts and disrespect for physical integrity rights indexes, the coefficients remain significant and respectively pass from 0.104 to 0.064 and from 0.098 to 0.07 in absolute terms. Furthermore, these indexes are negatively correlated with tax revenue variable, with coefficients of correlation, respectively estimated around 27.49% and 25.43%, that appears low. These evidences show that the two first political indexes reduce on the one hand prepayment health expenditures per capita by decreasing the volume of mobilized tax resources. Indeed, the variation in the coefficients of political instability indexes reveal that 38.46% (for internal conflicts index) and 28.57% (for disrespect of physical integrity rights index) of their effect on prepayment health expenditures pass by a reduction of tax revenue mobilization.

For political instability and presence of violence/terrorism, the coefficient passes from 0.237 to 0.171 (in absolute terms) but becomes non-significant. Moreover we find that this index is also negatively correlated with tax revenue variable (-.0.4048). These observations could mean that the total effect of this index passes by a reduction in tax revenue mobilization. They could be also due to a high collinearity between the index and tax revenues variable. On this subject, the coefficient of correlation that we think low[36], confirms a low collinearity between both variables and attests that the index of political instability and presence of violence/terrorism reduces prepayment health expenditures by only decreasing tax resources mobilization.

In view of evidences, tax revenues mobilization constitutes a channel through which political instability leads to reduce the volume per capita of prepayment health expenditures in Sub-Saharan African countries.

- Secondly, we find that the total net public flows significantly increase prepayment health expenditures. We also observe that political instability indexes enter once again with negative and significant coefficients. Moreover, it appears that these coefficients decrease passing from 0.104 to 0.091 for the internal conflicts index, from 0.231 to 0.213 for the index of political instability and presence of violence/terrorism and from 0.098 to 0.095 for the disrespect for physical integrity rights index. That is respectively equivalent to relative decreases of 12.5%; 7.79% and 3.06%. However, the correlations between the total net public flows and political instability indexes, -0.1036 (for the internal conflicts index), -0.1619 (for the index of political instability and presence of violence/terrorism) and - 0.0425 (for the disrespect for physical integrity rights index), are low and do not allow us to conclude a potential transmission through international aid in political instability effect on prepayment health financing.

- Thirdly, the estimations on channel of governance are less clear. The index of governance significantly affects prepayment health expenditures per capita in one of three tested specifications. It

[36] We consider that two variables are highly correlated when the coefficient of correlation exceeds the threshold of 50%

only affects (increases) prepayment health expenditures per capita in the specification using the index of disrespect for physical integrity rights index as variables of interest. In this specification, the index of disrespect for physical integrity rights appears with a negative and significant coefficient. Its associated coefficient diminishes and passes from 0.098 to 0.084 (in absolute terms); a fact is equivalent to a reduction of 14.28%. With its negative correlation with governance index (-0.5095), we can suppose that the disrespect for physical integrity rights reduces prepayment health expenditures by jeopardizing governance. However, given the non-significant coefficients associated with governance index in the specifications used the two other indexes of political instability, it is difficult in this case to conclude that the quality of institutions constitutes a channel through which political instability affects prepayment health expenditures. To go into this result in depth and to confirm this finding, we separately include the indicators used to construct the composite index of governance and we check whether evidences will change.

- Desegregated analysis on the transmission channel passing from governance

The baselines results are reported in Tables 4.9 and 4.10. In Table 4.9, we separately include government effectiveness and corruption control indexes whereas in Table 4.10, the indexes approximating the respect for rules of law and regulatory quality are progressively introduced in the model.

- Though Tables 4.9 and 4.10, we find that the instruments are over identified in the major part of tested specifications. Regarding the weakness test, it appears that the instrumental variables are not generally weak but in some cases the weakness hypothesis cannot be rejected. In the case where this weakness assumption cannot be rejected, we observe once again that the instrumental variables are relevant and significantly explain political instability indexes (Annexes 4.3; 4.4 and 4.5). Hence we think acceptable to interpret the findings resulting from these estimations.

- We find that government effectiveness and the control of corruption do not significantly affect the level of prepayment health expenditures. Moreover, the coefficients associated with political instability indexes remain negative and significant when the both governance indexes are added in the model. Hence, government effectiveness and the control of corruption are not channels of transmission which link political instability to prepayment health expenditures.

- Then, we find that the index of rules of law enters with a significant and positive coefficient only in the specification using the index of disrespect for physical integrity rights as variable of interest. In the one including the indexes of internal conflicts and political instability and presence of violence/terrorism the coefficients associated with the index of rules of law are not significant. It appears that the respect for rules of law does not constitute a channel through which internal conflicts and the political instability and presence of violence/terrorism reduce prepayment health expenditures[37].

- Nonetheless, it seems that the respect for rules of law is a channel through which the disrespect for physical integrity rights reduces prepayment health expenditures. In addition to the significant coefficient associated with rules of law index in the specification regarding the index of disrespect for physical integrity rights as variable of interest, we find that the coefficient associated with this political instability index decreases by 27.55% passing from 0.098 to 0.071 in absolute terms. At theoretically and as discussed above, in countries where the physical integrity rights are disrespected, rules of law will be also flouted; a fact will result in perverse behaviours such as for example the fraud which is likely to reduce the quantity of prepayment resources mobilized in favour of health sector.

[37] Let remember that these two indexes nearly approximate the same dimension of political instability such as violence, riots, demonstrations and terrorism.

Furthermore, we observe that the disrespect for physical integrity rights index is negatively correlated with the index of respect for rules of law (-0.5783). In view of evidences, it appears that 27.55% of effect of disrespect for physical integrity rights passes by disrespect for rules of law.

Table 4.9: Baseline results of effect of political instability indexes on prepayment health expenditures per capita in USD PPP, by including government effectiveness and corruption control indexes (1996-2012)

Added variables	Government effectiveness (Governance)			Control of corruption (Corruption)		
Specifications	(1)	(2)	(3)	(1)	(2)	(3)
Conflicts	-0.088**			-0.097**		
	(-2.289)			(-2.473)		
Political		-0.226**			-0.244**	
		(-2.277)			(-2.515)	
Integrity			-0.087**			-0.092**
			(-2.303)			(-2.432)
$Under5_{t-1}$	-0.008***	-0.008***	-0.007***	-0.008***	-0.008***	-0.007***
	(-8.064)	(-8.636)	(-6.467)	(-8.426)	(-9.255)	(-6.618)
$Urban_{t-1}$	0.038***	0.037***	0.060***	0.036***	0.035***	0.058***
	(4.440)	(4.133)	(6.772)	(4.165)	(4.098)	(6.375)
$Ext\_Fin\%_{t-1}$	0.262	0.183	0.257	0.270	0.181	0.266
	(1.315)	(0.899)	(1.158)	(1.324)	(0.881)	(1.186)
$Growth_{t-1}$	0.009**	0.009***	0.008***	0.010***	0.010***	0.009***
	(2.465)	(3.136)	(2.698)	(2.761)	(3.422)	(3.148)
Old dependency	0.488***	0.363***	0.394***	0.476***	0.354***	0.399***
	(5.698)	(3.976)	(4.554)	(5.464)	(3.795)	(4.528)
Effectiveness	0.139	0.029	0.147			
	(1.505)	(0.271)	(1.459)			
Corruption				0.034	-0.066	-0.000
				(0.436)	(-0.746)	(-0.001)
Constant	4.239***	4.753***	3.668***	4.331***	4.807***	3.601***
	(8.274)	(7.113)	(7.460)	(8.260)	(7.554)	(7.032)
Observations	369	369	318	369	369	318
F-statistics (significance of model)	418.022***	518.667***	503.581***	401.366***	484.599***	467.9***
Cragg Donald Wald F statistics	14.977	18.126	19.200	15.397	18.770	20.18
Critical values of Stock and Yogo (10%)	9.08	19.93	19.93	9.08	19.93	19.93
Hansen test : P-values	0.788	0.523	0.137	0.476	0.587	0.688
R^2	0.947	0.949	0.954	0.946	0.949	0.953

Note: t statistics in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

- In addition, we find that regulatory quality index does not significantly affect prepayment health expenditures in the specifications regarding the indexes of internal conflicts and political instability and presence of violence/terrorism. In this way, regulatory quality is not a channel of transmission through which internal conflicts and political instability and presence of violence/terrorism reduces prepayment health expenditures. Nevertheless, we observe that regulatory quality index is associated with a significant and positive coefficient in the model explaining prepayment health expenditures on the index of disrespect for physical integrity rights. Furthermore, in this specification, the coefficient associated with this political instability index decreases with the addition of regulatory quality index. Hence, we can suppose that regulatory quality constitutes a channel through which the disrespect for physical integrity rights reduces prepayment health expenditures. On this subject, it appears that the coefficient associated with the index of disrespect for physical integrity rights pass from 0.098 to

0.093. This reduction is not sufficient to attest an assumption of channels of transmission. In view of evidences, regulatory quality does not constitute a channel of transmission linking political instability to prepayment health expenditures.

Table 4.10: Baseline results of effect of political instability indexes on the logarithm of prepayment health expenditures per capita in USD PPP, by including tax revenue, the respect for rules of law and regulatory quality indexes (1996-2012)

Added variables	Rules of law (Law)			Regulatory quality (Regulatory)		
Specifications	(1)	(2)	(3)	(1)	(2)	(3)
Conflicts	-0.084*			-0.095**		
	(-1.897)			(-2.348)		
Political		-0.246*			-0.221**	
		(-1.746)			(-2.401)	
Integrity			-0.071*			-0.093**
			(-1.692)			(-2.527)
$Under5_{t-1}$	-0.008***	-0.008***	-0.007***	-0.008***	-0.008***	-0.007***
	(-7.475)	(-7.166)	(-6.278)	(-8.360)	(-9.015)	(-6.743)
$Urban_{t-1}$	0.037***	0.036***	0.059***	0.035***	0.037***	0.057***
	(3.901)	(3.508)	(6.684)	(4.167)	(4.610)	(6.542)
$Ext\_Fin\%_{t-1}$	0.295	0.167	0.231	0.262	0.182	0.261
	(1.431)	(0.751)	(1.040)	(1.286)	(0.897)	(1.187)
$Growth_{t-1}$	0.010***	0.010***	0.009***	0.009***	0.009***	0.008***
	(2.870)	(3.324)	(3.127)	(2.682)	(3.188)	(2.798)
Old dependency	0.461***	0.357***	0.359***	0.472***	0.358***	0.373***
	(4.672)	(3.939)	(3.998)	(5.382)	(3.949)	(4.237)
Law	0.124	-0.065	0.227*			
	(0.870)	(-0.285)	(1.710)			
Regulatory				0.074	0.065	0.180*
				(0.892)	(0.783)	(1.880)
Constant	4.321***	4.793***	3.765***	4.408***	4.827***	3.975***
	(8.334)	(6.784)	(8.218)	(8.126)	(7.726)	(7.506)
Observations	369	369	318	369	369	318
F-statistics (significance of model)	404.902***	513.439***	529.281***	402.495***	515.712***	461.612***
Cragg Donald Wald F statistics	12.854	13.360	16.327	14.425	20.104	20.648
Critical values of Stock and Yogo (10%)	9.08	19.93	19.93	9.08	19.93	19.93
Hansen test : P-values	0.951	0.810	0.185	0.997	0.820	0.088
R^2	0.948	0.949	0.955	0.946	0.949	0.953

Note: t statistics in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

- For the major part of estimation performed in this subsection, it appears that the first group of controls generally enter with their effect tested in the starting model, except aid health which is majorly associated with non-significant coefficients.

6.2.5 Testing the effect of political instability by taking into account potential unobserved characteristics

In the previously sections, we have observed an increasing trend in prepayment health expenditures, mostly in countries of Southern Africa. This trend could be due to some unobserved structural or cyclical characteristics which have affected the level of prepayment health expenditures and political instability over time. Hence, we control the model for these unobserved characteristics and check whether the tested effect of political instability on prepayment health expenditures will change. There are two ways that could be used to control for these characteristics.

The first one used in the previous chapters consists of estimating the model on sub-periods data by focusing on the mean of used variables. This strategy would allow smoothing the irregular movements of used variables which could obscure the actual trend of this variable. In this case it would have been necessary to get sufficiently long sub-periods because political instability variables slowly vary over time. However, the studied period does not allow us to get them. The studied period is composed of seventeen years. In this strategy, we think the minimal number of years by sub-period that could accounts for the high intertie of political instability index is five or six. The subdivision of overall period into sub-periods of five or six years would induce us to work on three sub-periods; a fact is not sufficient to perform regressions on a panel-data model.

The second alternative that we use here consists of including a time trend variable ranged from 1 to 17 respectively for the first and the last years. The baseline results of estimations are reported in Table 4.11.

Evidences reveal that the instruments are valid based on the comparison between Cragg-Donald Wald F statistics and the critical values of Stock and Yogo. Next we find that the time trend variable enters with a positive and significant coefficient attesting a structural increase in prepayment health expenditures over the studied period. After control for this trend variable, the coefficients associated with political instability indexes remains negative and significant. This result shows that the estimated effect of political instability indexes remains robust when the model is controlled for the structural time trend.

Table 4. 11: Baseline results of effect of political instability indexes on the logarithm of prepayment health expenditures per capita in USD PPP, by including time trend (1996-2012)

Specifications	(1)	(2)	(3)
Conflicts	-0.104***		
	(-3.376)		
Political		-0.263***	
		(-3.046)	
Integrity			-0.095***
			(-2.743)
$Under5_{t-1}$	-0.003*	-0.002	-0.002
	(-1.930)	(-1.577)	(-0.962)
$Urban_{t-1}$	-0.012	-0.020	0.003
	(-1.004)	(-1.288)	(0.175)
$Ext\_Fin\%_{t-1}$	0.648***	0.276	0.748***
	(3.388)	(1.308)	(3.505)
$Growth_{t-1}$	0.011***	0.010***	0.009**
	(3.553)	(3.508)	(2.440)
Old dependency	0.261***	0.084	0.206**
	(3.258)	(0.849)	(2.242)
Trend	0.050***	0.059***	0.050***
	(4.746)	(4.682)	(3.288)
Constant	4.899***	5.725***	4.363***
	(12.197)	(8.983)	(10.553)
Observations	449	369	396
F-statistics (significance of model)	486.054***	552.161***	490.270***
Cragg Donald Wald F statistics	19.855	21.463	23.276
Critical values of Stock and Yogo (10%)	9.08	19.93	19.93
Hansen test : P-values	0.476	0.587	0.688
R^2	0.949	0.952	0.952

Note: t statistics in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

6.2.6 Testing the effect of political instability on prepayment health expenditures conditional to the cooperation with international community

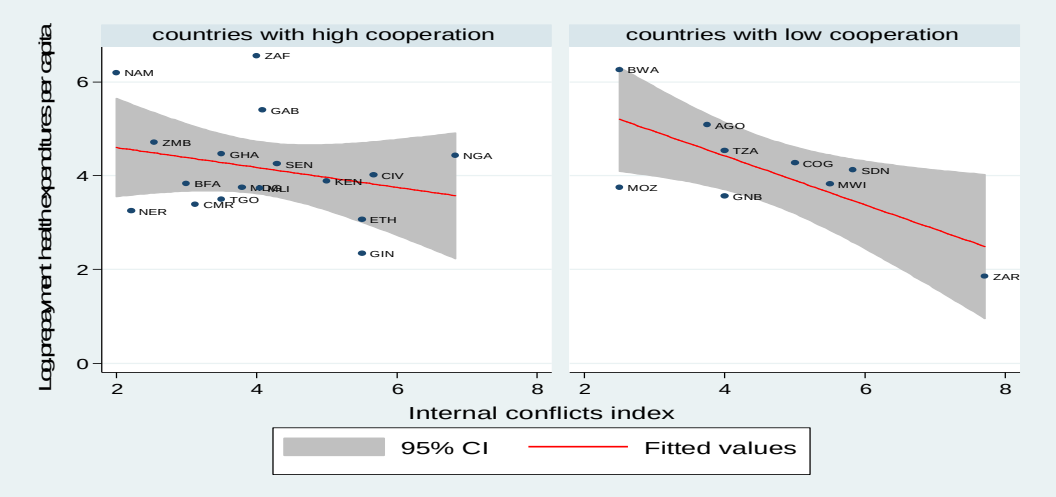
The findings show that political instability in Sub-Saharan Africa jeopardizes the performance of health systems by reducing the volume per capita of prepayment health expenditures. This observation remains unchanged when atypical countries are removed from the sample. Now we are testing the conditional effect between political instability and the cooperation with international community on prepayment health expenditures. The cooperation with international community is approximated by the KOF index of political globalization retrieved from the Swiss Economic Institute (SEI) database (Dreher et al., 2008). Constructed through a Principal Component analysis, this index is ranged from 0 (low level) to 100 (high level), it is an aggregate index including four subcomponents such as the number of embassies in country, the number of international organizations to which country is a

member, the number of United Nation peace missions country participated in and the number of treaties signed by country since 1945.

- Descriptive analysis of the relationship between political instability and prepayment health expenditures per the level of cooperation with international cooperation

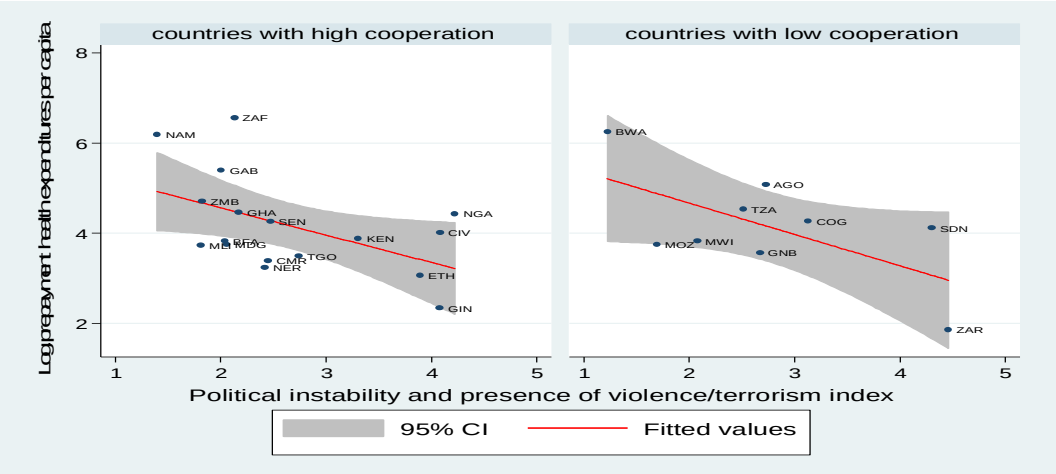
Before testing the mentioned conditional effect, we firstly analyze the statistical relationship between political instability indexes and prepayment health expenditures in two subsamples raised by dividing the global sample on the basis of median KOF index of political globalization. Countries for which the KOF index is greater than the median maintain a high cooperation with international community and the ones with KOF index less than the median present a low cooperation with international community. For this analysis, we focus on the year 2006 because the observations of political instability indexes are more provided on this year. We find that the slops of adjusted lines provided by graphics 4.13, 4.14 and 4.15 are lower in the sample of countries with high cooperation with international community compared to the others. It seems that the correlation between political instability indexes and prepayment health expenditures is lower in countries maintaining strong cooperation with international community.

Graphic 4.13: Scatter plots between the internal conflicts index and the logarithm of prepayment health expenditures per capita in USD PPP by subsample (2006)



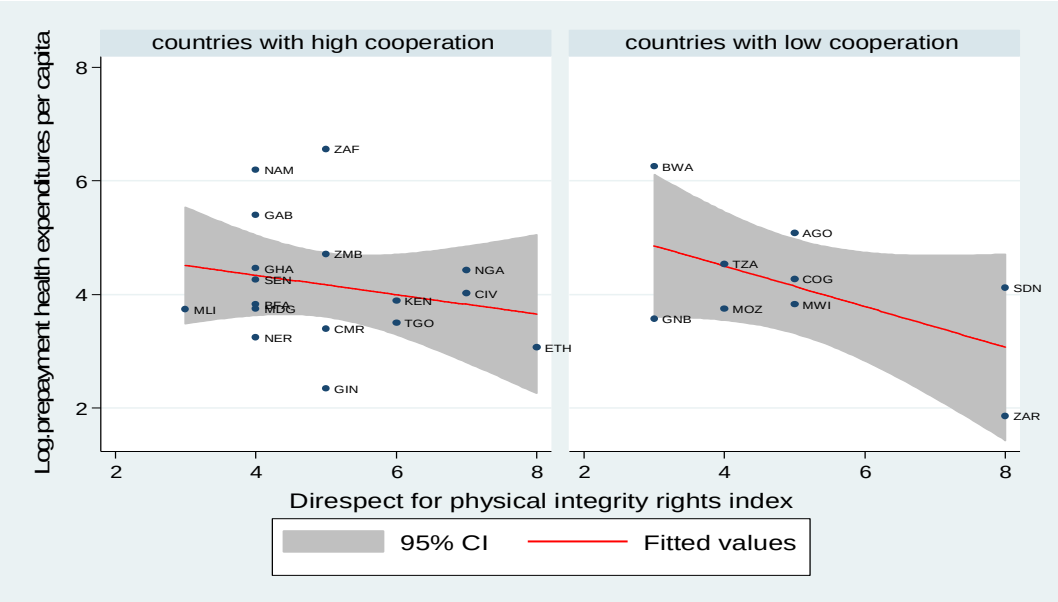
Source: Author using the ICRG, the SEI and the GHE databases.

Graphic 4.14: Scatter plots between the index of political instability and presence of violence/terrorism and the logarithm of prepayment health expenditures per capita in PPP USD by subsample (2006)



Source: Author using the WGI, the SEI and the GHE databases

Graphic 4.15: Scatter plots between the disrespect for physical integrity rights index and the logarithm of prepayment health expenditures per capita in USD PPP by subsample (2006)



Source: Author using the CIRI, the SEI and the GHE databases.

- Empirical strategy used to test political instability effect on prepayment health expenditures conditional to the cooperation with international community

Here, we test an interactive variables model specifying as follows:

$$Y_{it} = \alpha + \beta X_{it} + \varphi KOF_{it} + \vartheta(X_{it} * KOF_{it}) + \sum_{k=1}^{n} \delta_k Z_{kit} + V_i + \varepsilon_{it}$$

KOF_{it} refers to the KOF index of political globalization. The other variables and parameters are presented in details above the text (section 5). Here the index of political globalization is not suspected to be endogenous. Given the endogeneity of political instability indexes, the interactive variables are also supposed to be endogenous. Hence, the interactive variables are instrumented by the multiplicative variables coming from the product between the instruments of political instability indexes and the KOF index. The summary of used instruments for each endogenous variable is reported in Table 4.12.

Table 4. 12: Summary of used instruments in the interactive variables model

	Instrumental variables					
Endogenous variables	Militaries	Religious	Liberties	Militaries*KOF	Religious*KOF	Liberties*KOF
Conflicts	*	*	*			
Political	*		*			
Integrity	*		*			
Conflicts*KOF				*	*	*
Political*KOF				*		*
Integrity*KOF				*		*

Source: Author.

- Evidences from political instability effect on prepayment health expenditures conditional to the cooperation with international community

The baseline results of estimations are reported in Table 4.13. The findings reveal through R^2 that the explanative powers of model remain high (from 94% to 95%). They also highlight that the instruments are valid based on the comparison between the Cragg-Donald Wald F statistics and the critical values of Stock and Yogo and the Hansen test.

Table 4. 13: Baseline results of effect of political instability on prepayment health expenditures per capita in USD PPP conditional to the political globalization (1996-2012)

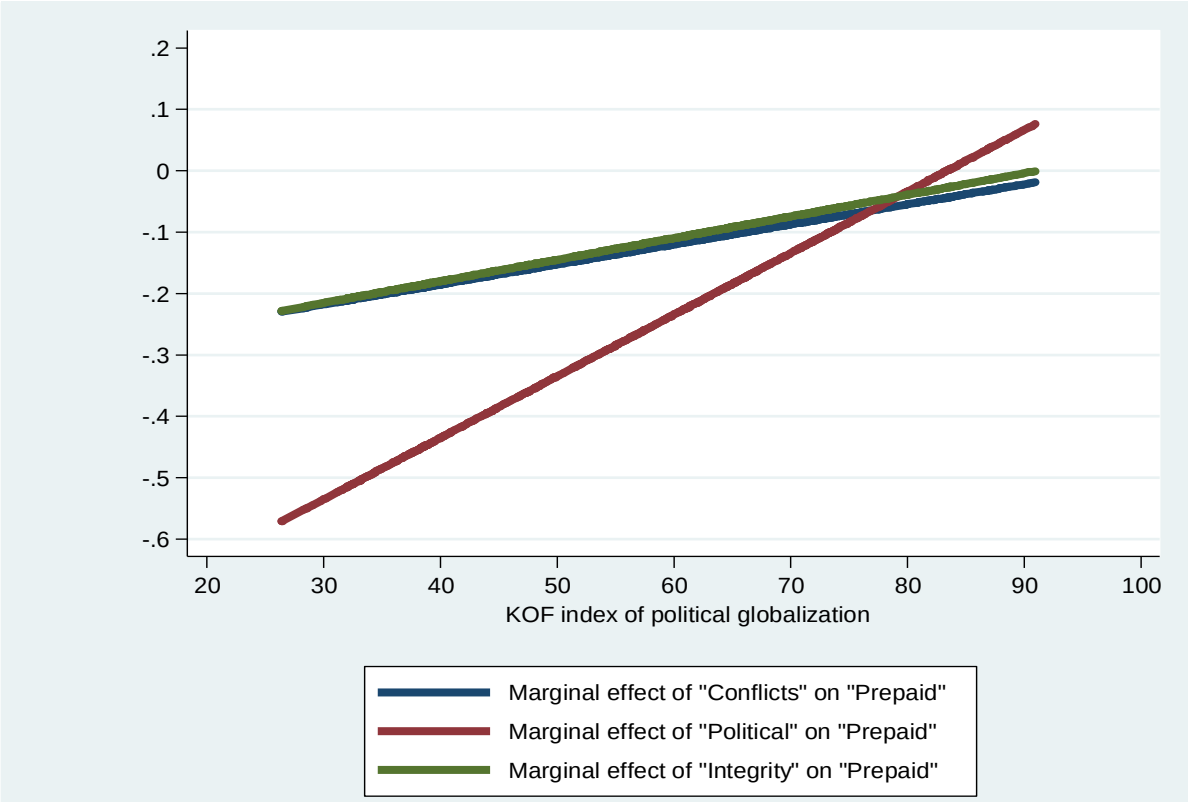
Specifications	(1)	(2)	(3)
Conflicts	-0.316***		
	(-3.070)		
Conflicts*KOF	0.003*		
	(1.904)		
Political		-0.837***	
		(-3.473)	
Political* KOF		0.010***	
		(2.900)	
Integrity			-0.321***
			(-2.977)
Integrity* KOF			0.004**
			(2.018)
KOF	-0.008	-0.018**	-0.006
	(-1.062)	(-2.153)	(-0.834)
$Under5_{t-1}$	-0.006***	-0.007***	-0.005***
	(-7.533)	(-7.526)	(-6.411)
$Urban_{t-1}$	0.032***	0.032***	0.041***
	(4.247)	(3.621)	(4.863)
$Ext\_Fin\%_{t-1}$	0.619***	0.156	0.662***
	(3.016)	(0.745)	(3.105)
$Growth_{t-1}$	0.010***	0.009***	0.008**
	(3.188)	(3.124)	(2.183)
Old dependency	0.494***	0.334***	0.229**
	(5.706)	(3.359)	(2.144)
Constant	4.799***	6.026***	4.961***
	(9.154)	(6.500)	(5.794)
Observations	449	369	396
F-statistics (significance of models)	352.667***	491.782***	441.006***
Cragg-Donald Wald F statistics	10.938	11.725	10.756
Critical values of Stock and Yogo (5%)	15.72	11.04	11.04
Critical values of Stock and Yogo (10%)	9.48	7.56	7.56
Hansen test : P-values	0.528	0.974	0.149
R^2	0.943	0.950	0.949

Note: t statistics in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Furthermore, they show that political instability indexes remain associated with negative and significant coefficients. The index of political globalization enters with non-significant coefficients,

except in the specification of model regarding the index political instability and presence of violence/terrorism as variable of interest and in which the KOF index of political globalization leads to significantly reduce prepayment health expenditures. However, the KOF index significantly affects the effect of political instability indexes on prepayment health expenditures. The interactive variables between political instability indexes and the KOF index appear with positive and significant coefficients. These coefficients attest that the KOF index of political globalization leads to dampen the negative effect of political instability on prepayment health expenditures. In other words, the negative effect of political instability on prepayment health expenditures is more reduced in countries which more maintain diplomatic relations with international community. The contribution of political globalization to the effect of political instability on prepayment health expenditures is formalized in Graphic 4.16.

Graphic 4.16: Representative graphic of interactive effect between political instability and political globalization on prepayment health expenditures per capita in USD PPP (1996-2012)



Source: Author.

Through graphic above, the negative marginal effect of political instability indexes on prepayment health expenditures progressively diminishes with the increase in KOF index of political globalization. We particularly find that the effect of political instability indexes finishes being null. More specifically, the effect of index of political instability and presence of violence/terrorism on prepayment health expenditures becomes positive with the increase in KOF index of political globalization. These results attest the advantages based on the cooperation between Sub-Saharan African countries and international community.

7. Conclusion

Since some years, Sub-Saharan African countries have experienced some events of political instability, which have jeopardized their socioeconomic system and have caused many deaths of people. On the time where they need to reduce the share in health financing of out-of-pocket payments and to increase prepayment health expenditures to insure a sustainable and equitable health financing, it has been important to investigate the determinants of prepayment health expenditures by focusing on political instability. We have tested whether political instability has affected the volume per capita of prepayment health expenditures. We have also tested this effect on the components of prepayment health expenditures such as government health expenditures and NGOs health expenditures all expressed in per capita USD PPP. In addition we have tested the channels of transmission through which political instability is likely to affect prepayment health expenditures. Lastly, we have checked whether the cooperation between Sub-Sahara African counties and international community, approximating by the KOF index of political globalization, influences political instability effect on prepayment health expenditures.

We have used an unbalanced panel dataset of 27 Sub-Saharan African countries covering the period 1996-2012. We depart from an econometric model using the efficient GMM estimator to address the suspected endogeneity issues related to political instability. Political instability has been approximated by three indicators such as: the internal conflicts index, the index of political instability and presence of violence/terrorism and the index of disrespect for physical integrity rights. The estimated model has been controlled for the under-five mortality rate, urbanization, the old dependency ratio, economic growth, external resources for health as share of total health expenditures, tax revenue per capita, a time trend variable, the international aid approximated by the total net pubic flows per capita and institutional quality computed to a Principal Component Analysis and including four subcomponents such as government effectiveness, the control of corruption and rules of law and regulatory quality.

Our investigations reveal the following evidences:

- Political instability leads to reduce prepayment health expenditures per capita.

- Political instability affects prepayment health expenditures by reducing the volume of mobilized tax resources.

- Among the three proxy variables of political instability we find that the disrespect for physical integrity rights of people reduces prepayment health expenditures by flouting the respect for rules of law.

- The international aid (the total net public flows) does not seem to be a channel of transmission that links political instability to prepayment health expenditures.

- The adverse effect of political instability is more reduced and always annulled in countries for which the cooperation with international community is more intensified.

- Political instability reduces NGOs health expenditures per capita.

- Government health expenditures per capita are negatively affected by two of the three political instability variables such as the indexes of internal conflicts and political instability and presence of violence/terrorism.

- The disrespect for physical integrity rights index does not significantly affect government health expenditures per capita.

- Evidences remain robust even when atypical countries are removed from the sample.

8. Annexes

Annex 4.1: Baselines results of estimations based on the first stage instrumentation excluding additional control variables and using the three instruments for each political instability index (1996-2012)

	Conflicts	Political	Integrity
Religious	-0.392***	-0.041	0.025
	(-4.067)	(-0.859)	(0.294)
Militaries	-0.457***	-0.227***	-0.531***
	(-5.177)	(-4.007)	(-5.311)
Liberties	-0.338***	-0.102**	-0.195*
	(-3.346)	(-2.524)	(-1.927)
$Under5_{t-1}$	-0.002	-0.002	0.005
	(-0.917)	(-1.452)	(1.358)
$Urban_{t-1}$	-0.138***	-0.046***	0.013
	(-4.599)	(-3.625)	(0.416)
$Ext\_Fin\%_{t-1}$	1.004	0.003	2.319***
	(1.422)	(0.008)	(2.900)
$Growth_{t-1}$	0.020	-0.001	0.005
	(1.558)	(-0.110)	(0.352)
Old dependency	0.434	-0.281**	0.289
	(1.300)	(-2.359)	(0.877)
Constant	14.031***	7.038***	6.376***
	(7.281)	(9.717)	(3.353)
Observations	449	369	419

Note: t statistics in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Annex 4.2: Descriptive statistics of supplementary variables used in the model (1996-2012)

Variables	Mean	Std.Dev.	CV	Median	Min	Max	Observations
KOF	63.715	14.556	0.228	64.899	26.455	90.946	449
Log, Tax	5.952	1.238	0.208	5.736	0.962	8.593	401
Institutions	-1.259	1.053	-0.837	-1.267	-3.792	1.714	369
Effectiveness	-0.677	0.548	-0.810	-0.720	-1.961	0.877	369
Corruption	-0.609	0.558	-0.917	-0.704	-1.566	1.250	369
Regulatory	-0.549	0.533	-0.971	-0.501	-2.110	0.791	369
Law	-0.682	0.584	-0.855	-0.645	-2.072	0.668	369
Total net public flows per capita	35.047	110.792	3.161	28.604	-1676.586	606.777	432
Log. Total net public flows per capita	-0.301	0.042	-0.140	-0.306	-0.536	-0.014	431
Log. Government health expenditures per capita	3.611	1.108	0.307	3.535	-0.551	6.317	365
Log. NGOs health expenditures per capita	1.518	1.241	0.818	1.588	-0.686	4.411	387

Source: Author using the SEI, the WEO, the GHE, the WDI and the WGI databases. Note: Std.Dev: Standard Deviation.

Annex 4.3: Relevance of used instruments in the explanation of internal conflicts index in the model including additional control variables (1996-2012)

Dependent variable	Conflicts	Conflicts	Conflicts	Conflicts	Conflicts	Conflicts	Conflicts	Conflicts
Religious	-0.163*	-0.365***	-0.393***	-0.399***	-0.400***	-0.376***	-0.385***	-0.404***
	(-1.738)	(-3.840)	(-3.168)	(-3.328)	(-3.407)	(-3.133)	(-3.186)	(-4.228)
Militaries	-0.451***	-0.488***	-0.443***	-0.448***	-0.452***	-0.421***	-0.434***	-0.469***
	(-5.098)	(-5.400)	(-4.029)	(-4.179)	(-4.266)	(-3.990)	(-3.989)	(-5.258)
Liberties	-0.235**	-0.313***	-0.337***	-0.334***	-0.333***	-0.313**	-0.336***	-0.389***
	(-2.360)	(-3.093)	(-2.809)	(-2.779)	(-2.782)	(-2.489)	(-2.761)	(-3.822)
$Under5_{t-1}$	-0.006*	-0.012**	-0.004	-0.004	-0.004	-0.005	-0.005	-0.004
	(-1.803)	(-1.988)	(-1.318)	(-1.262)	(-1.307)	(-1.506)	(-1.394)	(-1.567)
$Urban_{t-1}$	-0.112***	-0.047	-0.141***	-0.138***	-0.137***	-0.141***	-0.142***	-0.165***
	(-3.218)	(-0.858)	(-3.662)	(-3.496)	(-3.612)	(-3.797)	(-3.829)	(-5.143)
$Ext\_Fin\%_{t-1}$	0.870	0.985	0.730	0.737	0.754	0.653	0.707	0.884
	(1.108)	(1.373)	(0.949)	(0.944)	(0.965)	(0.844)	(0.914)	(1.257)
$Growth_{t-1}$	0.031**	0.019	0.000	-0.001	-0.000	0.001	0.001	0.018
	(2.397)	(1.532)	(0.020)	(-0.075)	(-0.010)	(0.065)	(0.076)	(1.359)
Old dependency	0.613	0.844**	0.432	0.452	0.415	0.455	0.443	0.453
	(1.515)	(2.202)	(1.025)	(1.085)	(0.985)	(1.080)	(1.049)	(1.311)
Log tax	-0.571***							
	(-2.767)							
Trend		-0.093*						
		(-1.833)						
Institutions			0.078					
			(0.274)					
Effectiveness				0.239				
				(0.602)				
Corruption					0.297			
					(1.000)			
Law						-0.290		
						(-0.627)		
Regulatory							-0.025	
							(-0.057)	
Log. Total net public flows								0.102
								(0.077)
Constant	16.045***	12.514***	14.346***	14.251***	14.444***	13.591***	14.095***	15.682***
	(6.441)	(6.290)	(5.779)	(5.844)	(5.787)	(5.296)	(5.835)	(7.615)
Observations	401	449	369	369	369	369	369	431

Note: t statistics in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Annex 4.4: Relevance of used instruments in the explanation of index of political instability and presence of violence/terrorism in the model including additional control variables (1996-2012)

Dependent variable	Political	Political	Political	Political	Political	Political	Political	Political
Militaries	-0.192***	-0.235***	-0.185***	-0.204***	-0.210***	-0.187***	-0.224***	-0.231***
	(-3.581)	(-3.840)	(-3.740)	(-3.884)	(-3.900)	(-3.910)	(-3.853)	(-3.794)
Liberties	-0.080**	-0.094**	-0.093**	-0.102***	-0.101***	-0.033	-0.100**	-0.099**
	(-2.050)	(-2.354)	(-2.425)	(-2.689)	(-2.635)	(-0.825)	(-2.513)	(-2.490)
$Under5_{t-1}$	-0.006***	-0.003	-0.003**	-0.003*	-0.003*	-0.004***	-0.002	-0.002
	(-4.217)	(-1.368)	(-1.983)	(-1.908)	(-1.729)	(-2.661)	(-1.516)	(-1.336)
$Urban_{t-1}$	-0.051***	-0.036	-0.051***	-0.054***	-0.051***	-0.043***	-0.045***	-0.036**
	(-3.538)	(-1.505)	(-4.083)	(-4.100)	(-3.968)	(-3.856)	(-3.472)	(-2.475)
$Ext\_Fin\%_{t-1}$	0.225	-0.010	-0.107	-0.054	-0.053	-0.169	-0.013	0.084
	(0.692)	(-0.031)	(-0.344)	(-0.167)	(-0.165)	(-0.589)	(-0.041)	(0.256)
$Growth_{t-1}$	0.003	-0.001	0.003	0.003	0.000	-0.001	-0.000	0.000
	(0.656)	(-0.186)	(0.521)	(0.564)	(0.065)	(-0.163)	(-0.049)	(0.028)
Old dependency	-0.199	-0.213*	-0.237**	-0.291**	-0.234**	-0.229**	-0.239*	-0.231*
	(-1.237)	(-1.961)	(-2.069)	(-2.416)	(-1.983)	(-2.085)	(-1.889)	(-1.907)
Log tax	-0.340***							
	(-3.009)							
Trend		-0.009						
		(-0.506)						
Institutions			-0.403***					
			(-4.024)					
Effectiveness				-0.468***				
				(-2.997)				
Corruption					-0.344***			
					(-3.122)			
Law						-0.885***		
						(-5.271)		
Regulatory							-0.144	
							(-0.977)	
Log. Total net public flows								-1.174**
								(-2.321)
Constant	9.942***	6.628***	5.952***	6.710***	6.519***	5.290***	6.531***	5.974***
	(9.430)	(9.053)	(8.387)	(9.512)	(9.306)	(7.468)	(9.367)	(7.774)
Observations	340	369	369	369	369	369	369	354

Note: t statistics in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Annex 4.5: Relevance of used instruments in the explanation of physical integrity rights index in the model including additional control variables (1996-2012)

Dependent variable	Integrity	Integrity	Integrity	Integrity	Integrity	Integrity	Integrity	Integrity
Militaries	-0.456***	-0.514***	-0.492***	-0.489***	-0.523***	-0.476***	-0.543***	-0.477***
	(-3.940)	(-4.536)	(-3.400)	(-3.253)	(-3.881)	(-3.434)	(-4.167)	(-4.104)
Liberties	-0.416***	-0.380***	-0.484***	-0.483***	-0.488***	-0.435***	-0.479***	-0.389***
	(-4.261)	(-3.956)	(-4.271)	(-4.311)	(-4.328)	(-3.783)	(-4.215)	(-3.971)
$Under5_{t-1}$	-0.001	-0.011**	0.004	0.003	0.004	0.002	0.004	0.005
	(-0.234)	(-2.032)	(0.827)	(0.731)	(0.939)	(0.432)	(0.910)	(1.511)
$Urban_{t-1}$	0.015	0.141***	0.002	-0.006	0.007	-0.001	0.008	0.009
	(0.401)	(2.592)	(0.052)	(-0.163)	(0.186)	(-0.025)	(0.189)	(0.244)
$Ext\_Fin\%_{t-1}$	2.700***	2.619***	2.378**	2.315**	2.453**	2.333**	2.487**	2.902***
	(2.911)	(3.106)	(2.462)	(2.420)	(2.527)	(2.427)	(2.555)	(3.367)
$Growth_{t-1}$	0.000	-0.005	0.007	0.012	0.004	0.006	0.003	-0.002
	(0.004)	(-0.381)	(0.445)	(0.734)	(0.254)	(0.357)	(0.160)	(-0.120)
POP65	1.038**	1.016**	0.832**	0.776**	0.778**	0.904**	0.736*	0.388
	(2.157)	(2.503)	(2.122)	(1.998)	(1.972)	(2.281)	(1.828)	(1.132)
Log tax	-0.731***							
	(-2.611)							
Trend		-0.158***						
		(-3.312)						
Institutions			-0.382					
			(-1.377)					
Effectiveness				-0.943**				
				(-2.005)				
Corruption					-0.069			
					(-0.211)			
Law						-1.308***		
						(-3.044)		
Regulatory							0.304	
							(0.735)	
Log. Total net public flows								-0.872
								(-0.683)
Constant	12.195***	6.039***	5.932**	6.269***	6.773***	5.047**	7.375***	6.851***
	(4.445)	(3.119)	(2.592)	(2.801)	(3.051)	(2.168)	(3.139)	(3.328)
Observations	357	396	318	318	318	318	318	380

Note: t statistics in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Annex 4. 6: Matrix of partial correlations (1996-2012)

	Prepayment	Conflicts	Political	Integrity	Under5	Urban	Ext_Fin	Growth	Old dependency	Militaries	Religious	Liberties
Prepayment	1											
Conflicts	-0.3389***	1										
Political	-0.4182***	0.7461***	1									
Integrity	-0.1916***	0.5877***	0.7640***	1								
Under5	-0.4731***	0.2063***	0.2304***	0.0748	1							
Urban	0.4959***	-0.1447***	-0.2149***	-0.1505***	-0.4309***	1						
Ext_Fin	-0.2970***	-0.0652	-0.1302**	-0.0678	-0.0443	-0.4382***	1					
Growth	0.0156	-0.0443	-0.0163	0.0530	0.0271	-0.1235***	0.0626	1				
Old dependency	0.5102***	-0.0900*	-0.2218***	-0.1927***	-0.3763***	0.6768***	-0.2458***	-0.1057**	1			
Militaries	0.5314***	-0.5796***	-0.6349***	-0.4108***	-0.1995***	-0.0002	0.0571	0.0877*	0.0861*	1		
Religious	0.2953***	-0.4964***	-0.5412***	-0.3653***	-0.1504***	0.1914***	0.0526	0.0017	0.2012***	0.3308***	1	
Liberties	-0.5084***	0.4641***	0.6042***	0.5100***	0.2962***	-0.1071**	-0.0982*	-0.0831*	-0.1837***	-0.6269***	-0.3961***	1
Tax	0.7663***	-0.2749***	-0.4048***	-0.2543***	-0.3763***	0.7026***	-0.4383***	-0.0050	0.6642***	0.2995***	0.1798***	-0.2873***
GDP	0.7895***	-0.2448***	-0.3480***	-0.2205***	-0.4558***	0.7577***	-0.4280***	-0.0292	0.7532***	0.3007***	0.1934***	-0.3101***
KOF	0.0214	0.0493	0.1089**	0.1544***	-0.1922***	-0.0137	0.0805*	0.0548	0.0410	0.0985**	-0.1277***	-0.1631***
Institution	0.6436***	-0.5579***	-0.7279***	-0.5095***	-0.4286***	0.1511***	-0.0118	0.0432	0.2541***	0.7473***	0.4445***	-0.7775***
Effectiveness	0.6625***	-0.4845***	-0.6117***	-0.3963***	-0.4205***	0.1554***	-0.0551	0.0799	0.2800***	0.7408***	0.4046***	-0.7211***
Corruption	0.6106***	-0.4948***	-0.6680***	-0.4721***	-0.3831***	0.1226**	-0.0327	0.0249	0.2075***	0.6406***	0.4642***	-0.7219***
Regulatory	0.6145***	-0.5527***	-0.6898***	-0.4770***	-0.3909***	0.1770***	-0.0374	0.0015	0.2598***	0.7611***	0.4093***	-0.7731***
Law	0.5559***	-0.5809***	-0.7846***	-0.5783***	-0.4284***	0.1204**	0.0745	0.0547	0.2182***	0.6936***	0.4076***	-0.7333***
Tnt	-0.0180	-0.1036	-0.1619***	-0.0425	-0.1200**	-0.1268***	0.2771***	0.1478***	-0.3023***	0.0500	0.0027	-0.1094**
Ghepc	0.9840***	-0.4178***	-0.5143***	-0.3282***	-0.4830***	0.4926***	-0.3139***	0.0442	0.3848***	0.5085***	0.2750***	-0.4415***
Ngopc	0.5134***	-0.4757***	-0.4820***	-0.3598***	-0.3296***	0.2403***	0.0378	0.0532	0.0871*	0.5171***	0.2714***	-0.4461***
	Tax	GDP	KOF	Institution	Effectiveness	Corruption	Regulatory	Law	Tnt	Ghepc	Ngopc	
Tax	1											
GDP	0.9659***	1										
KOF	-0.1877***	-0.0553	1									
Institution	0.4100***	0.4192***	0.1091**	1								
Effectiveness	0.4078***	0.4269***	0.1333**	0.9536***	1							
Corruption	0.3741***	0.3622***	-0.0078	0.9458***	0.8776***	1						
Regulatory	0.4013***	0.4301***	0.2018***	0.9451***	0.8837***	0.8444***	1					
Law	0.3716***	0.3728***	0.0909*	0.9466***	0.8558***	0.8638***	0.8613***	1				
Tnt	-0.1442***	-0.2051***	0.0739	0.0333	0.0049	0.0641	-0.0315	0.0832	1			
Ghepc	0.8586***	0.8316***	-0.1934***	0.5822***	0.5667***	0.5653***	0.5357***	0.5400***	0.0569	1		
Ngopc	0.3806***	0.3515***	-0.2447***	0.4736***	0.4418***	0.4705***	0.4389***	0.4430***	0.0171	0.5326***	1	

Source: Author 'calculation using the GHE, the WDI, the WGI, the CIRI, the ICRG, the WEO, the SEI and the Freedom House databases. *** p<0.01, ** p<0.05, * p<0.1. Note: Tnt, Ghepc and Ngopc respectively refer to the total net public flows, government health expenditures and NGOs health expenditures

Annex 4.7: List of studied countries

Angola, Botswana, Burkina Faso, Cameroon, Congo Democratic Republic, Congo Republic, Cote d'Ivoire, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Madagascar, Malawi, Mali, Mozambique, Namibia, Niger, Nigeria, Senegal, South Africa, Sudan, Tanzania, Togo, Zambia.

General Conclusion

In the context where low- and middle-income countries attempt to achieve universal health coverage, this thesis has explored the extents to which countries could insure a sustainable financing of health systems. It has firstly carried out investigations on the determinants of efficiency and the level of health expenditures in low- and middle-income countries. The goal of these investigations has been to help the policy-makers in the implementation of strategies which could allow countries, not only to improve health outcomes in view of existing health expenditures that they use, but also to save more resources for health.

To insure sustainable health financing, it is fundamental for low- and middle-income countries to reduce the share in health financing of out-of-pocket payments which tends to result in financial hardships and to consequently impoverish the populations. It is essential for countries to reinforce prepayment health financing. Among low- and middle-income countries, Sub-Saharan African ones continue to experience the highest levels of poverty and the most deteriorated health indicators. That could be explained by the high contribution of out-of-pocket payments to health financing in these countries. In this framework, this thesis has proposed in second place to check whether prepayment health financing would improve health status in Sub-Saharan African countries. This exploration could enlighten the policy-makers about the necessity to promote prepayment health financing in countries. In addition, it is also important for policy-makers to identify the various factors which would be likely to promote or to jeopardize prepayment health financing in countries. The present thesis has set a third goal to work on the determinants of prepayment health expenditures in Sub-Saharan African countries. The present thesis is written under four chapters.

The first chapter analyses the determinants of technical efficiency of health expenditures in 89 low- and middle-income countries over the period 1995-2012; by focusing on the role of trade openness. The technical efficiency scores have been assessed through the method of partial frontier analysis. Two outputs such as obesity prevalence rate and the deaths rate caused by the non-communicable diseases and two inputs such as public and private health expenditures have been used. Furthermore, the technical efficiency scores have been estimated based on output-oriented models and by assuming Variable Returns-to-Scale (VRS). After estimate the technical efficiency scores, we have explained them on the trade openness rate by using Fractional Regression Models (FRMs). These models have been controlled for urbanization, the old dependency ratio, education, external resources for health, governance, the similitude in trade structure, GDP per capita and air pollution. In addition, we have tested trade composition effect on the technical efficiency of health expenditures.

Evidences reveal that trade openness decreases the technical efficiency of health expenditures in low- and middle-income countries by increasing obesity prevalence and the deaths caused by the non-communicable diseases in view of used public and private expenditures on health. Within the structure of trade, we have found that the imports of fuels and the manufactured exports lead to reduce the technical efficiency of health expenditures. The fuels imports increase obesity prevalence; whereas the manufactured exports contribute in increasing the deaths dues to the non-communicable diseases in view of existing level of public and private health expenditures. Moreover we find that the imports of Information and Communication Technologies increase the technical efficiency of health expenditures by precisely reducing obesity prevalence in view of used health expenditures from public and private sources. However, it appears that the exports of primary commodities do not significantly affect the technical efficiency of health expenditures.

The second chapter has explored the effect of air pollution approximated by CO2 emissions in metric tons per capita on health expenditures per capita in 99 low- and middle-income countries over the period 1995-2012. The Feasible Generalized Least Squares are used as estimator to perform the

regressions. The econometric model is controlled for urbanization, the old dependency ratio, institutional quality, the life expectancy at birth, economic growth, tax revenue, external resources for health and economic vulnerability. We have estimated CO2 emissions effects on the volume per capita of total health expenditures and their components such as central government health expenditures, health insurance expenditures, NGOs health expenditures and the out-of-pocket payments. We have also tested CO2 emissions effect on the composition of total health expenditures. We have also explored the potential influence of external resources for health and economic vulnerability on CO2 emissions effect.

We find that air pollution fosters the increase in total health expenditures (from domestic sources) and their components all expressed in terms of per capita volume. The effect remains higher on health insurance expenditures per capita. It also remains higher in the most vulnerable countries and in ones that receive higher flows of external resources for health (because of fungibility effects). The second result shows that air pollution modifies health expenditures composition by decreasing the share of their all components to health financing; exception made for health insurance expenditures for which the contribution is positively affected. Evidence implies that health insurance schemes remains the agent intervening in health financing for which the budget is more affected by air pollution. It also shed lights an adaptation form to air pollution and its associated diseases, from agents of health systems, in favour of health insurances schemes. This adaptation capacity appears lower in the most vulnerable countries.

The third chapter investigates the role of prepayment health financing for health improvement in Sub-Saharan African countries. We have empirically tested the effect of prepayment health expenditures per capita in USD PPP on health status measured by the under-five mortality rate and the maternal mortality ratio on a sample of 31 Sub-Saharan African countries over the period 1996-2012. The effects are estimated by using the method of instrumental variables for panel-data models. We have namely used the efficient GMM estimator to address the endogeneity of prepayment health expenditures. In addition to the variable of prepayment health expenditures, we have also included into the model a set of socioeconomic, immunization coverage, morbidity, demographic, public finance, political, and institutional variables. Furthermore, we have tested differential effects of prepayment health expenditures by subsample of countries receiving low and high flows of international remittances and experiencing low and high financial development.

The results stress that prepayment health expenditures contribute in reducing under-five and maternal mortality in Sub-Saharan African countries. This effect remains higher in countries that receive higher flows of international remittances comparatively to ones for which these flows are lower. It remains also negative in countries associated with developed financial sector but non-significant in the least financially developed countries. Next, we find that government health expenditures and prepayment health expenditures from private sources also contribute to the decrease in mortality indicators.

The fourth chapter has taken an interest in the determinants of prepayment health expenditures in Sub-Saharan African countries. It has particularly focused on political instability which has imperilled countries during the last years. The effect of political instability on prepayment health expenditures has been empirically tested by using a panel-data model using the efficient GMM estimator to deal with the endogeneity character of political instability. We have worked on 27 Sub-Saharan African countries over the period 1996-2012. Three proxy indexes of political instability have been used: the internal conflicts index, the index of political instability and presence of violence/terrorism and the index of disrespect for physical integrity rights. We have also included into the regressions the following variables: under-five mortality, urbanization, the old dependency ratio, economic growth, external resources for health as percentage of total health expenditures, tax revenue

per capita, a time trend variable, the total net public flows per capita and a composite index measuring the quality of governance including government effectiveness, the control of corruption, rules of law, and regulatory quality indexes. In addition we have examined whether the cooperation between Sub-Saharan African countries and international community would make any difference in political instability effect on prepayment health financing.

Evidences indicate that political instability impedes the reinforcement of prepayment health financing in Sub-Saharan African countries. Political instability leads to decrease the volume per capita of prepayment health expenditures by reducing tax revenue mobilization. Furthermore, we find that the disrespect for physical integrity rights of individuals adversely affects prepayment health expenditures by flouting the respect for rules of law. However, the international aid approximated by the total net public flows does not constitute a channel through which political instability affects prepayment health expenditures. Next, it appears from estimations that political instability effect on prepayment health expenditures is reduced, always annulled in countries that maintain intensified cooperation with international community (approximated by KOF index of political globalization). In addition to these evidences, we find that political instability reduces NGOs health expenditures per capita. However, the effect seems to be mitigated on government heath expenditures. Violence/terrorism, riots demonstrations, and coups d'états approximated by the indexes of internal conflicts and political instability and presence of violence/terrorism reduces government health expenditures per capita. Nonetheless, extreme violence approximated by the disrespect for physical integrity rights does not significantly affect government health expenditures per capita.

Policy implications and recommendations

In view of evidences, this thesis suggests for low- and middle-income countries to counter the channels through which trade openness is likely to impede the enhancement of technical efficiency of health expenditures. These countries need to accompany trade policies, mostly ones focused on the fuels imports and the manufactured exports, by awareness campaigns aiming the consumption of healthy foods and the exercise of physical activities which would allow for the people to avoid the risk of obesity and non-communicable diseases. It would be also favourable to promote the imports of ICTs in order to improve the efficiency of health expenditures.

Then, it is also important for countries to reduce and to regulate air pollution, particularly CO2 emissions. The decrease in CO2 emissions would allow for countries to save funds for health. Furthermore, our investigations call on low- and middle-income countries to adopt structural policies to reduce their economic vulnerability in order to facilitate the transition towards health insurance schemes. An appeal must be also made on the necessity to effectively and actually use the external resources previously destined to health sector, a fact supposes to reduce the fungibility effects of external resources for health The decreasing in economic vulnerability and the effective and actual use of foreign resources for health would allow for countries to counter health cost of air pollution and its associated. Another strategy would be to develop health insurance schemes, mostly in the most vulnerable countries. That would allow sharing the financial risks coming from diseases caused by air pollution.

For Sub-Saharan African countries, evidences suggest that policies promoting the prepayment schemes in health financing are appropriate for the improvement of child and maternal health. Furthermore, it appears important for countries to reinforce the cooperation between the public and private sectors involved in prepayment health financing. In addition, it would be interesting for Sub-Saharan African countries to reinforce policies attracting international remittances and facilitating financial development.

The second series of suggestions that imply evidences for Sub-Saharan African countries is to take actions to avoid the events of political instability. Given political instability reduces prepayment health expenditures by decreasing the mobilized quantity of tax revenue; it would be also essential, mostly in period of political instability, to find other sources of health financing except the out-of-pocket payments. For example it would be advantageous for these countries to further develop compulsory health insurances schemes to counter the risk of political instability hindering the mobilization of traditional prepayment funds in favour of health sector. It would be also profitable to increase not only the volume of external resources for health but also and mostly the effectiveness in their use. Next, Sub-Saharan African countries need to reinforce their cooperation with international community and to ensure the respect for rules of law, mostly in case of political instability events.

Limits of thesis and future researches

Despite the contribution of this thesis, it has some limits that could serve as an avenue for future researches.

In the first chapter, the technical efficiency has been assessed without account for the environment that could play an important role in the process of health outcomes 'production. For our future researches, we shall attempt to include environmental factors in the assessment of technical efficiency.

Furthermore, we have estimated the efficiency scores by focusing on obesity and non-communicable diseases because they have been identified as the most convincing health indicators through which trade openness is likely to affect the technical efficiency of health expenditures. They also appear as public health problems in low-and middle-income countries. However, these countries face up to other health priorities. Hence in our future investigations, we shall estimate again trade openness effect on the technical efficiency of health expenditures by using other outputs in order to check whether evidences will change or not.

Moreover, we shall test threshold effects of trade openness on the technical efficiency because it could eventually exist a potential threshold from which trade openness would significantly affect the technical efficiency of health expenditures. Next, we shall identify and test the channels of transmission which link trade openness to the technical efficiency of health expenditures. We have also as avenue of research to investigate the effect of other aspects of globalization that are likely to affect the technical efficiency of health expenditures. There are for example international migrations and remittances, foreign direct investments and financial liberalization.

In the second chapter, we have estimated an increasing effect of air pollution on health expenditures. Hence in our future researches we shall use other proxies of air pollution in order to confirm the robustness of findings. Then, we shall estimate air pollution effect by region in order to understand the regional disparities in this effect.

The increasing effect of air pollution suggests for low-and middle-income countries to reduce air pollution. Hence, we shall check whether the regulation in air pollution could reduce CO2 emissions effect on health expenditures. In addition to regulation we shall also test whether urbanization could play a significant role in this effect. Indeed, generally, the urban populations are more affected by air pollution. Air pollution effect could consequently depend on the size of urban individuals in the population.

In our investigations we have not assume the existence of potential threshold from which air pollution effect would be significant. Hence, we shall attempt to identify and to estimate this threshold. In the

chapter we have also tested the effect of air pollution on health expenditures conditional to external resources for health and to economic vulnerability. Hence, we shall desegregate economic vulnerability index and external resources for health in order to identify their component(s) that effectively influence air pollution effect.

One of the most important evidences of chapter reveal that the agents intervening in health financing get used to air pollution and its associated diseases by reallocated their funds in favour of health insurance. However, health insurance schemes include social security agencies and health insurance companies. Hence, we shall identify among health insurance schemes, the one which more benefits to the adaptation of health systems from air pollution.

In the third chapter, we have tested a negative effect of prepayment health expenditures on child and maternal mortality in Sub-Saharan African countries. To confirm the robustness of evidences, we shall use other health indicators. Then prepayment health expenditures have been desegregated into two components such as government health expenditures and private prepayment health expenditures that all appears to reduce mortality indicators. In our future researches, we shall further desegregate prepayment health expenditures in order to bring better conclusions and recommendations.

In the chapter, we have also tested the effect of prepayment health expenditures on mortality indicators by subsample of countries receiving low and high international remittances and experiencing low and high financial development. The goal of this investigation was to check whether international remittances and financial development would influence prepayment health financing effect. This strategy could be less consistent than the one where the interactive/conditional effects between prepayment health expenditures and both variables would be estimated. However, the estimation of these conditional effects needs to find instrument for international remittances and financial development variables. For the moment we have not found strong instruments for these variables. We shall consequently attempt to find them in order to improve the quality of evidences. In the chapter, threshold effects have not been estimated. We shall consequently attempt to estimate the potential threshold from which the effect of prepayment health financing would be significant.

In the fourth chapter, we have estimated a negative effect of political instability on prepayment health expenditures in Sub-Saharan African countries. In future researches, we shall use other variables that approximate other aspects of political instability. They will serve us to confirm the robustness of evidences.

In addition to prepayment health expenditures, political instability effect has been also tested on their components such as government health expenditures and NGOs health expenditures. However, given the data availability, we have not able to test this effect on health insurance expenditures that appear as a key channel through which countries attempt to progress towards universal health coverage. Hence we shall enlarge the database to low-and middle-income countries in order to estimate the effect of political instability on health insurance development.

Furthermore, we have tested the role that plays the cooperation with international community in political instability effect on prepayment health financing. This cooperation has been approximated by the KOF index of political globalization. In the future, we shall attempt to desegregate this index in order to identify the component of this international cooperation which more affects political instability effect.

However, in the chapter, political instability effect has been estimated without supposing the existence of threshold effects. Hence, we shall attempt to estimate the potential threshold from which political instability effect would be significant.

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