École Doctorale des Sciences Économiques, Juridiques, Politiques et de gestion
Centre d'Études et de Recherche sur le Développement International (CERDI)

Université Clermont Auvergne, CNRS, IRD, CERDI, F-63000 Clermont-Ferrand, France

Three Essays On Education Inequality

Thèse présentée et soutenue publiquement le 24 Mai 2022
pour l'obtention du titre de Docteur en Sciences Economiques

par

Constantin COMPAORE

sous la direction de
Jean-François BRUN

Membres du jury

Oliver MORRISSEY	Professeur, FSS University of Nottingham	Rapporteur
Sebastian VOLLMER	Professeur, University of Göttingen	Rapporteur
Martine AUDIBERT	Directrice de recherches émérite, CNRS-UCA	Suffragant
Jean-François BRUN	Maître de Conférences HDR, CNRS-CERDI UCA	Directeur Thèse

Remerciements

La rédaction d'une thèse est à première vue une aventure solitaire, par excellence dans la mesure où le document final porte le nom seul du doctorant qui la rédiger. Mais cette aventure n'aurait été possible sans la contribution et le soutient de nombreuses personnes. Ces quelques lignes sont destinées à exprimer ma reconnaissance et ma gratitude aux personnes qui m'ont permis de mener à bien ce projet de thèse

Je remercie particulièrement mon directeur de thèse monsieur Jean-François BRUN pour la confiance, l'encadrement ainsi que l'attention qu'il m'a accordée tout au long de ce travail. Monsieur BRUN, merci infiniment d'avoir œuvrer pour la réalisation de cette thèse. Vos conseils avisés, votre générosité, votre patience, votre soutien indéfectible et votre bonne humeur lors de nos séances de travail serons gravés dans ma mémoire et dans mon cœur.

J'exprime également ma profonde gratitude aux membres du jury : Oliver MORRISSEY, Sebastian WOLMER et Martine AUDIBERT pour avoir accepté d'évaluer cette thèse et de prendre part au jury. Je vous remercie sincèrement pour l'honneur que vous me faite en prenant part à mon jury de thèse ainsi que pour le temps que vous avez consacré à la lecture de ce travail.

J'exprime également ma reconnaissance à l'Etat burkinabé qui à travers Ministère de l'Enseignement Supérieur, de la Recherche Scientifique et de l'Innovation a assuré le financement de cette thèse et de mes études supérieures en France.

Mes remerciements s'adressent aussi au CERDI, à travers l'ensemble de ces enseignants et de son personnel administratif pour l'accueil chaleureux, l'excellence des conditions de travail et la qualité des enseignements dont j'ai bénéficié. J'exprime ma gratitude à mon comité de suivi (professeur Jean-Louis COMBES et monsieur Michael GOUJON) dont les conseils ont aidé à la réalisation de la thèse. Merci à Agnès Carcenac, Aurélie GOUMY, Chantal Brige-Ukpong, Martine Bouchut, Johan Guiot pour leur aide et leur sympathie qui m'ont permis de travailler aisément. Merci à monsieur Olivier SANTONI pour son aide dans la réalisation des cartes géographiques. J'adresse ma profonde reconnaissance à monsieur Gerard CHAMBAS avec qui j'ai travaillé sur un chapitre de ma thèse. Ses conseils, sa disponibilité et les questionnements

qu'il a suscité en moi durant nos échanges ont non seulement permis d'approfondir ce travail mais constituerons un socle pour de futurs travaux dans l'avenir.

Je remercie chaleureusement mes anciens et actuels collègues doctorants du CERDI. Ababacar Guay, Abdramane Camara, Aime Lompo, Aimé Okoko, Aissata Coulibaly, Alexandra Tapsoba, Claire Gaubert, Claire Ricard, Elsa Gautrain, Éric Sawadogo, Éric Dago, Hyppolite Balima, Jean-Marc Atsebi, Jocelyn Okara, Kabinet Kaba, Macoura Doumbia, Mahamady Ouedraogo, Mohamed Traore, Hugues Champaux, Mohamed Boly, Moulaye Bamba, Yann Tapsoba, Sébastien Desbureau, Nestor Sawadogo, Carine Meyimdjui, Christelle Tchoupé, Maimouna Barro, Melaine Yoffo, Maria ElKhdari, Martha Woldemichael, Saliou Diallo, Seydou Coulibaly, Tiangboho Sanogo, Axelle Kere, Hermann Yohou, Mousse Sow, Africa Ndongozi-Nsabimana, Olivier Kodjo, Cyril Chalendard, Pierre Mandon, Pierre Lesuisse, Aliou Diallo, Akim Wandaogo, André Gbato, Aristide Mabali, Jérôme Valette, Victor Stéphan, Ali Compaore, Alou Dama, Aicha Sanou, Fayçal Sawadogo, Regina Séri, Awa Diouff, Yashmina Nebie, Harouna Kinda, Neimatou Ouedraogo Hamid Silue et tous ceux que je n'ai pas nommé directement. Merci à tous pour la bonne ambiance de travail, les échange et les moments de convivialité durant ces années de thèse.

Merci également à mes camarades de la promotion 2014 du Master Finances Publiques (Rhodes, Yanick, Vanessa, Fatou, Guay). J'exprime aussi ma gratitude aux camarades que j'ai rencontrés au cours de mes études universitaires (Université de Reims, Université de Bordeaux, et l'université Saint Thomas d'Aquin). J'ai aussi une pensée particulière pour mes camarades et mes enseignants (merci à Grégoire Compaore et Silvestre Aweh) du collège saint Jean-Baptiste De La Salle où j'ai effectué toute ma scolarité secondaire. J'exprime aussi ma gratitude à l'École des Jeunes Aveugles de Ouagadougou et à l'UNABEPAM qui m'ont permis d'y effectuer ma scolarité primaire.

Ma reconnaissance va ausse à tous les membres de l'Association des Burkinabès de Clermont-Ferrand (ABUC) ainsi que son bureau. Merci particulièrement à Serge Koblavi, Alassane Drabo, Edgard Bere, Ines et Simon Zanga, Rachid Ouedraogo, Carolle Sandamba, Nestor Ouoba, et toutes les personnes que j'ai pu rencontrer lors des activités réalisées par l'ABUC.

Merci à mes amis et frères Maïmouna Diakité (i ni ce), Tanou Balde,

Ibrahima Diallo, Yoro Diallo, Gaoussou Diarra (merci de m'avoir inciter à faire une thèse), Rachid Konaté pour leurs encouragements leurs soutiens, leurs amitiés et leurs fraternités. Vous êtes des frères, car à chaque moment de joie ou de peine vous avez été présents (Que le Seigneur vous récompense au centuple).

En fin, Je remercie grandement mes parents Laurant et Lucie pour leurs soutiens, leurs prières, et leurs conseils au cours de cette thèse. Je remercie aussi mes frères Alain Charles et Lionnel pour leurs encouragements. Merci à mon oncle Ousséni et à mes tantes Nathalie (mami) et Djeneba qui ont non seulement œuvrer à m'ont arrivé en France et mon soutenu durant mes études. Merci également à ma tante Colette mon oncle Adama, ma cousine Ines ainsi qu'aux autres membres de ma famille pour leurs soutiens. A tout ceux qui m'ont soutenu matériellement et spirituellement merci infiniment.

Résumé

Malgré une réduction sans précédent des inégalités d'éducation ces 50 dernières années, elles restent très élevées dans certaines zones géographiques. Pourtant une distribution inégalitaire de l'éducation est néfaste au bien-être économique et social. La réduction des inégalités d'éducation devrait donc être un objectif des gouvernements et de la communauté internationale.

Tenant compte de l'état des inégalités d'éducation dans certaines régions du monde et de leur impact négatif considérable sur le plan économique et social, cette thèse propose trois études liées aux inégalités d'éducation. Nous analysons les canaux de transmission des inégalités d'éducation aux inégalités de revenu. Nous examinons l'impact de la démocratie sur les inégalités d'éducation. Nous évaluons également l'efficacité des dépenses publiques d'éducation notamment en termes de réduction des disparités d'éducation dans les pays en développement.

Le premier essai est une revue de la littérature théorique et empirique de l'impact des inégalités d'éducation sur les inégalités de revenu. A travers cette revue, nous avons identifié l'économie politique, le marché du travail, l'imperfection du marché du crédit, la fertilité et l'espérance de vie comme les principaux canaux de transmission des inégalités d'éducation aux inégalités de revenu. La revue de la littérature empirique a conclu à l'absence de consensus sur l'effet de l'inégalité d'éducation sur l'inégalité de revenu. Les changements technologiques axé sur les compétences, la mondialisation, l'accroissement des rendements d'éducation sont des facteurs qui pourraient affecter l'effet de la réduction des inégalités d'éducation et contribuer à l'accroissement des inégalités de revenu.

Le second essai étudie empiriquement l'impact de la démocratie sur les inégalités d'éducation. Il puise ses fondements théoriques dans « la théorie de l'électeur médian » et les analyses d'Amartya Sen. Ces théories ont mis en évidence le rôle redistributif de la démocratie. Les fondements théoriques de ce chapitre s'appuient également sur le rôle de la compétition politique dans l'efficacité des réponses gouvernementales aux demandes des électeurs. L'analyse empirique repose sur l'économétrie des données de panel particulièrement sur l'utilisation des estimateurs à effets fixes et à variables instrumentales. Nous

étudions également l'impact de la démocratie sur les composantes des inégalités d'éducation. Les résultats suggèrent que la démocratie réduit les inégalités d'éducation. Cet effet s'explique par l'impact de la démocratie sur l'accès à l'éducation au plus grand nombre. La démocratie réduit davantage les inégalités d'éducation dans les pays à faible revenu et dans les pays les moins avancés (PMA). Les résultats sont robustes aux autres indicateurs de démocratie.

Le dernier essai évalue l'efficacité des dépenses publiques d'éducation en termes de réduction des inégalités d'éducation dans les pays en développement sur la période 1980-2010. A cette fin, nous utilisons la méthode non paramétrique des frontières partielles pour calculer les scores d'efficacité des dépenses publiques d'éducation. Nous analysons également les déterminants de l'efficacité des dépenses publiques en utilisant les modèles exponentiels des régressions fractionnelles. Nos résultats montrent qu'en moyenne, les pays en développement pourraient réduire les disparités d'éducation de 30% en conservant le même niveau de dépense d'éducation. Nous observons également une amélioration de l'efficacité des dépenses publiques d'éducation dans le but de minimiser les inégalités d'éducation (orientation output) sur la période étudiée. Cependant, l'efficacité des dépenses publiques dans le but de minimiser les ressources (orientation input) a relativement baissé, depuis 2005. L'analyse des déterminants de l'efficacité des dépenses publiques montre une relation non linéaire entre les scores d'efficience output et le PIB par tête. L'urbanisation, la stabilité du gouvernement ainsi que la démocratie sont identifiées comme les principaux déterminants de l'efficacité des dépenses publiques.

Mots clés : Inégalité d'éducation, Inégalité de revenu, Canaux de transmission, Démocratie, accès à l'éducation, Efficacité des dépenses publiques

Summary

Despite an unprecedented reduction of education inequality due to massive access to education over the past 50 years, education distribution remains very unequal in some parts of the world. Yet, unequal distribution of education is harmful to economic and social well-being. The reduction of education inequality should be a priority issue for governments and the international community.

Focusing on the issue of education inequality in some parts of the world, this dissertation investigates three issues related to the distribution of education. First, it identifies the mechanisms linking education distribution to income inequality. Second, it studies the effect of democracy on education inequality. Last, it assesses the efficiency of public expenditures in terms of reducing the education inequality in developing countries and it studies the determinants of education output efficiency.

The first essay reviews the theoretical and empirical literature on the impact of education inequality on income distribution. This literature review identifies political economy, labor market, credit market constraint, fertility, and life expectancy as the main transmission channels of education inequality to income inequality. The essay also notices a lack of consensus in the empirical literature related to the impact of education inequality on income distribution. Factors such as skill-biased technological change, globalization, and increasing returns to education could counterbalance the equalizing effect of education inequality reduction and then increase income inequality.

The second essay empirically examines the effect of democracy on education inequality. The theoretical framework rests on "the median voter theorem" and Sen's analysis, which pointed out the impact of democracy on redistribution policies and public goods' provision. The theoretical assumptions also include the impact of political competition on governments' effectiveness to respond to voters' demands. We employ panel data with fixed effects instrumental variables estimators in the empirical analysis. The chapter also studies the impact of democracy on the different component of education inequality. The results suggest that democracy reduces education inequalities. This result is explained by the positive effects of democracy on access to education. The impact of democracy on education inequality is higher in low-income and

Least Developed Countries (LDC) compared to the other economic groups. The robustness of the results has been checked using various indicators for democracy.

The last essay assesses the efficiency of public expenditures in the reduction of the unequal distribution of education in developing countries over the period 1980–2010. For this purpose, the essay uses the nonparametric partial frontier estimator to compute output and input efficiency scores. Moreover, it analyzes the determinants of education output efficiency scores using Exponential Fractional Regression Models (EFRM). The results show that, on average, developing countries can reduce their education inequality by 30% without increasing their public expenditures on education. We find that developing countries improved their output efficiency over the study period. However, their input efficiency has decreased relatively slightly since 2005. The results of the EFRM regressions show a nonlinear relationship between education output efficiency and GDP per capita. Urbanization, government stability and democracy have also been identified as determinants of education output efficiency.

Keywords: Education inequality, Income inequality, Transmission channels, Democracy, Access to education, Public expenditures efficiency

Acronyms

Cloglog	Complementary loglog
DAC	Development Assistance Committee
DEA	Data Envelopment Analysis
DMU	Decision Making Unit
ECHP	European Community Household Panel
EFRM	Exponential Fractional Regression Models
EU	European Union
FDH	Free Disposal Hull
FDI	Foreign Direct Investment
FRM	Fractional Regression Models
GDP	Gross Domestic Product
GMM	Generalized Method of Moments
HRD	Human Development Report
IISA	International Institute for Applied Systems Analysis
IMF	International Monetary Fund
IV	Instrumental Variables
LDCs	least developed countries
ODA	Official development assistance
OECD	Organisation for Economic Co-operation and Development
OLG	overlapping generation
OLS	Ordinary Least Square
OWS	Occupy Wall Street
PPP	Purchasing Power Parity
PWT	Penn World Table
SADC	Southern African Development Community
SBTC	Skill Biased Technological Change
SFA	Stochastic Frontier Analysis
SUR	SeeminglyUnrelated Regression
SWIID	Standardized World Income InequalityDatabase
UNCRC	United Nations Convention on the Rights of the Child
UNDP	United Nations Development Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
VID	Vienna Institute of Demography
WDI	World Development Indicators
WIID	World Income Inequality Database

Contents

List of Figures

List of Tables

Chapter 1

General Introduction

Contents

General Introduction

"Education is the most powerful weapon we can use to change the world" Nelson MANDELA

1.1 INTRODUCTION

Education lights every stage of the journey to a better life, especially for the poor and the most vulnerable. It is a fundamental component of human capital.

Before to the nineteenth century, systematic investment in human capital was not considered especially important in any country. Expenditures on schooling and other form of investment in human capital were relatively small. This began to change radically during this century with the application of science to develop new goods and more efficient methods of production, first in Great Britain and then gradually in other countries (Ozturk, 2001). During the twentieth century, education, skills, and knowledge acquisition have become crucial determinants of a person's and a nation's productivity. Twentieth century can be called the "Age of Human capital" in the sense that the primary factor of a country's standard of living is how well it succeeds in developing and utilizing the skills and knowledge and furthering the health and educating the majority of its population.[1]

Education is now recognized as a fundamental human right.[2] This right has been reaffirmed in the United Nations Convention on the Rights of the Child (UNCRC). Education is one of the main aims of Sustainable Development Goals (Goal 4) and at the heart of development policies. It is also a key element of economic development. According to the International Commission on Financing Global Education Opportunity "Economies will rise or fall depending more on their intellectual resources than their physical resources".

Several efforts have improved education levels and increased access to education thanks to governments and the international community. However the distribution of education is still unequal among and within countries.

[1] Ozturk (2001)

[2] Article 26 of The Universal Declaration of Human Rights

This general introduction aims at the following goals. First, it investigates the role of education in economic development. Second, it not only explains why education inequality is matter but also analyze the state of education inequality in the world. Last it provides the main contributions of the thesis.

1.2 Education and Economic development

Among the factors of development, education is the most role-playing. Social scientists have recognized education as one of the fundamental factors of development. According to these researches, education not only raises human capital, productivity, incomes, economic growth, reduce inequality and poverty, but its benefits go beyond these monetary gains.

1.2.1 Monetary benefits of education

Education has been recognized as a a critical determinant of individuals earning and national income. In fact, the *human capital theory* (Mincer, 1958; Schultz, 1961; Becker, 1962, 1985) linked the level of education to individuals' income via their productivity. Human capital refers to "Productive investments embodied in human persons, including skills, abilities, ideals, health, and locations, often resulting from expenditures on education, on-the-job training programs, and medical care"[3]. This theory has attributed increasing importance to the accumulation of human capital and productive knowledge and the interaction between these two factors. Education is a part of the production process, similar to physical capital (Schultz, 1961; Sauer and Zagler, 2012). Therefore, education is an investment that enhances individuals' human capital. The human capital theory assumes that individuals decide on their education, training, medical care, and other additions to knowledge and health by weighing the benefits and costs. Benefits include cultural and other non-monetary gains and improvement in earnings and occupations, while costs usually depend mainly on the foregone value of the time spent on these investments (Becker, 1993). According to this theory education makes workers more productive by giving them the skills to increase their output. Each additional year of schooling typically raises an individual's earnings. Consequently, more

[3] Todaro and Smith (2012, p.360)

investment in education and training will increase workers' productivity and hence wages. For example, "A dollar invested in a one-year increase in the mean years of schooling generates more than $5 in additional gross earnings in low-income countries and $2.5 in lower-middle income countries".[4] According to (Montenegro and Patrinos, 2021), each additional year of schooling typically raises an individual's earnings by 10% with a more considerable increase for women (20%). Education can also act as a "label" or a "signal" of high ability for potential employers. For instance, "having a university degree does signal perseverance, grit, and ability—all valuable skills for the labor market".[5].

Education is a significant determinant of economic growth. At the national level, education can boost growth in two ways. First, by improving the capacity to absorb and adapt new technology, which will affect short to medium-term growth. Second, by catalyzing the technological advances that drive sustained long-term growth (The World Bank, 2017). In the classic growth model, all growth was considered to be a product of either an increase in labor or an in capital. But economists in the 1950s and 1960s recognized that these models failed to explain a large part of the variance in economic growth and thereby began exploring the effects of investment in human capital. The Solow's model of neoclassical growth has contributed to identify the relatedness of education to the aggregate production function. Indeed, the neoclassical Solow's model includes labor as an additional production factor and exogenous time-varying technological progress as determinants of long-run growth. In this model, technological progress incorporates education, skills, abilities, knowledge and all sort of thing that enhance the ability of labor to produce.[6] However, endogeneity remained the drawback of this model because it did not explain how technological progress occurs (Andreas Savvides, 2008).

In the 1980s *endogenous growth theory* (Lucas, 1988; Romer, 1986, 1987, 1990) overcame the perceived shortcomings of the Solow's growth model (Romer, 1986). According to this theory, the long-term growth rate is determined endogenously within the model, and an economy can grow perma-

[4] International Commission on Financing Global Education Opportunity
[5] see The World Bank (2017, p.40)
[6] see Solow (1957, p.312) and Andreas Savvides (2008, p.33)

nently due to factors other than exogenous technological progress (Romer, 1986, 1987). The endogenous growth theory framework highlights the importance of research and human resource development, including education, as mechanisms for accumulating technological knowledge.[7] In this theory, technological progress is considered as a process whereby purposeful research and application lead over time to new and better products and methods of production and the adoption of superior technologies developed in other countries or sectors.

Empirical studies also pointed out the role of education in economic growth. One of the first to estimate the effects of education was Edward Denison. He found that between 1930 and 1960, approximately 23 percent of GDP growth in the United States was due to education (Denison, 1962). Since then, the vast majority of empirical studies have supported this finding (Barro, 1991; Benhabib and Spiegel, 1994; Barro, 1997, 2001; Sala-i-Martin et al., 2004; Hanushek and Wößmann, 2010). For Instance, one crucial factor in the "East Asian miracle" during the 1965–90 period was "getting the basics right" including accumulation of human capital through providing universal primary and secondary education, while tertiary education was largely met by self-financed systems (The World Bank, 1993). Moreover, according to UNESCO, educational attainment explains about half the difference in growth rates between East Asia and sub-Saharan Africa between 1965 and 2010.

There is considerable evidence that education tackles poverty and reduces income inequality. Education can eliminate poverty in families. Indeed, the incomes of parents and their children are highly correlated. Consequently, income inequality persists, and poverty is transmitted from one generation to the next.[8] Improving education can give poor people a boost. It can break the intergenerational transmission of poverty and reduce inequality of opportunity (Corak, 2013), which reduces future income inequality (Coady and Dizioli, 2018). According to UNESCO (2013) "If all students in low income countries left school with basic reading skills, 171 million people could be lifted out of poverty, which would be equivalent to a 12% cut in world poverty".

Education can also reduce poverty and inequality via economic growth. Education builds human capital, which translates into economic growth. If

[7] Permani (2009, p.2)
[8] Solon (1999)

economic growth benefits the disadvantaged, additional growth will reduce poverty, inequality, and promote social mobility (The World Bank, 2017).

Some empirical studies have corroborated the positive impact of education on poverty and inequality. For example a survey of more than 60 studies with meta-regression analysis led by Abdullah et al. (2015) concluded that education substantially reduces income inequality. Park (1996) showed that a higher level of educational attainment of the labor force has an equalizing effect on income distribution.

1.2.2 Non-monetary benefits of education

The non-monetary advantages of education have also been pointed out. Education leads to better health. Indeed, education is vital to eliminate malnutrition in the long term. According to UNESCO (2013), malnutrition is the cause of more than a third of global child deaths. Educated mothers are more likely to ensure that their children receive the best nutrients to help them prevent or fight off ill health, know more about appropriate health and hygiene practices, and have more power in the home to make sure children's nutrition needs are met. For instance, 22 million fewer children would be stunted in South Asia if all mothers reached secondary education.[9] Women's education is linked to other health benefits for their children, including immunization rates and lower mortality. According to Cleland and van Ginneken (1988), each additional year of maternal education corresponds to 7–9 percent decrease in child mortality. Better education also lower fertility rate. In effect, schooling reduces teenage pregnancy indirectly by increasing girls' aspirations, empowerment, and averting child marriage and early birth. Moreover, the increase in mothers' education rises women's use of contraception and rises their role in family decisions on fertility such as the reduction in the desired number of children (Lavy and Zablotsky, 2011).

Education strengthens the political development of nations. The modernization theory, articulated by Lipset (1959) suggests that economic development, including education, promotes political development, particularly democracy. Lipset emphasized the role of the intelligent middle class that participates in politics and develops the self-restraint necessary to resist dic-

[9] UNESCO (2013)

tatorship.[10] Education is considered as an essential requirement of democracy that enables people to understand the need for norms of tolerance, make rational electoral choices, and support democratic practices. Education also improves democracy via civic engagement and socialization. Indeed, education encourages participation in political activities. It increases awareness and understanding of political issues, fosters the socialization needed for effective political action, and improves civic skills (The World Bank, 2017). Many empirical studies have confirmed the determining role of education on democracy (Barro, 1999; Bobba and Coviello, 2007; Balaev, 2014).

Education could contribute to protecting the environment. Educated people tend to be more concerned with the environment. They are also interested in actions promoting and supporting political decisions that protect the environment (UNESCO, 2013). By improving knowledge, instilling values, fostering beliefs, and shifting attitudes, education has considerable power to change environmentally harmful lifestyles and behavior.[11] Education can also encourage people to use energy and water more efficiently and recycle household waste. In developing countries affected by climate change, education helps people adapt to its effects. For example, in Ethiopia, six years of education improve by 20% the chance that a farmer will adapt to climate change by adopting techniques such as soil conservation, variation in planting dates, and changes in crop varieties.[12]

In short, education brings several monetary and non-monetary benefits. Education is associated with many social and well-being outcomes. It is a great independent variable (Kingston et al., 2003). However, the distribution of education must not be ignore.

1.3 Education inequality matter

There is a difference between equality and equity in education. Equality in education means that all citizens should be treated the same with regard to certain schooling or equal access to education (Prasartpornsirichoke and Takahashi, 2012). Education inequality is then defined as unequal access to education. As for equity in education, it is based on two dimensions which are

[10] see Barro and Lee (2015, p.158)
[11] UNESCO (2013)
[12] UNESCO (2013)

fairness and inclusion. Fair education refers to "making sure that personal and social circumstances for example gender, socioeconomic status or ethnic origin should not be an obstacle to achieving educational potential".[13] Inclusion is defined as "ensuring a basic minimum standard of education for all–for example that everyone should be able to read, write and do simple arithmetic" (OECD, 2008).

For several decades, the availability of education data for a significant number of countries and periods enabled the development of education inequality indicators. This permitted to take into account the distribution of education in many issues.

1.3.1 Why education inequality matter ?

Several reasons justify the interest of economic literature in education inequality. First, existing measure of education largely employed in literature such as expenditures on education and average years of schooling tell part of the story, but they leave the picture incomplete. Measurement problems make it difficult to compare education spending across different regions of the same country, let alone across different countries (Torpey-Saboe, 2019). Distinct populations may require different levels of spending to achieve comparable education outcomes, depending on local cost of living and factors such as geography, language barriers, and so on.[14] Furthermore, much money does not necessarily yield high quality. Another problem is that expenditures on education are a resource then an education input and inputs for school are not independent of the income (Thomas et al., 2001). The average years of schooling is also an incomplete measure. As income inequality measures something utterly different from GDP per capita, education inequality is a different phenomenon than average years of education. Similar averages across countries can hide significant differences in distribution (Torpey-Saboe, 2019).

Second, unequal distribution of education harms economic performance. Indeed, the theoretical and empirical literature has highlighted the negative effect of unequal distribution of education on economic growth. According to theoretical literature education inequality may negatively affect economic growth via three mechanisms. First, in a situation of imperfect or fully absent

[13] OECD (2008, p.2)
[14] Torpey-Saboe (2019, p.5)

credit market, the initial wealth is the only source for financing human capital accumulation, and the poor are constrained in their education investment. Initial distribution of wealth, therefore, lead to the initial distribution of human capital, which in return may hinder economic growth both in the short and in the long term (Galor and Zeira, 1993). Second, education inequality can lower economic growth via the demographic channel (fertility and life expectancy). A greater education inequality is linked to higher fertility rate and higher differential fertility between low-educated and high-educated parents. This will lead to a lower accumulation of human capital and hence a lower rate of economic growth (De la Croix and Doepke, 2003; Moav, 2005). Greater inequality in education is also associated with lower life expectancy and low investment in human capital, which lead to low economic growth. Last, high education inequality may reduce economic growth through the political economy channel. According to this approach, high education inequality may lead to low-quality institutions. These institutions could, in turn, perpetual the persistence of income and education inequality and hence lower long term economic growth (Engerman and Sokoloff, 2005; **?**). Following theoretical works, empirical literature confirmed the negative impact of education inequality on economic growth (Lopez et al., 1998; Castelló and Doménech, 2002; Castelló-Climent and Doménech, 2008; Castelló-Climent, 2010a; Sauer and Zagler, 2014). For example, Lopez et al. (1998) found that unequal distribution of education has a negative effect on per capita income.

Third, education inequality contributes to explaining inequality in other dimensions of well-being. According to literature based on human capital theory, inequality in education is a major determinant of income inequality. In effect, education is an essential factor in determining the wage level and thus contributes significantly to the distribution of initial income in society. In this way, high education inequality may lead to high wage inequality and then to high income inequality. Several empirical studies have investigate the relationship between education distribution and income inequality (Becker and Chiswick, 1966; Chiswick, 1971; De Gregorio and Lee, 2002; Földvári and van Leeuwen, 2011; Castelló-Climent and Doménech, 2021).

Last, the distributional dimension of education is extremely important for both welfare consideration and for production. If an asset (physical capital) is traded across firms in a competitive environment, its marginal product will be

equalized through the free-market mechanism.[15] Consequently, its contribution to aggregate output will not be affected by its distribution across firms or individuals. If an asset is not traded or is imperfectly traded, however, then the marginal product of the asset across individuals is not generally equalized, and there is an aggregation problem. In this case, aggregate production depends not only on the total level of the asset but also on its distribution (Lopez et al., 1998). As education or skill is partially tradable (only certain services of these skills are traded), the average level of educational attainment alone is not sufficient to reflect the characteristics of a country's human capital (Thomas et al., 2001). It is then necessary to look beyond averages and investigate the distribution of education.

1.3.2 The main indicators of education inequality

Many indicators have been developed to measure education inequality. We can classify them into three categories: the standard deviation, the Gini index, and quantile ratio.

The Standard deviation of schooling is a measure of absolute dispersion. It was used in the earliest studies on education inequality (Ram, 1990; Inter-American Development Bank, 1998; Birdsall and Londono, 1997). It has also been used to test the existence of an inverted U-shaped relationship between the dispersion and the average level of schooling (called education Kuznets curve). However, this measure is only a measure of absolute dispersion. It does not provide a consistent picture of the distribution of education outcomes across individuals, especially for countries with very low and high levels of average schooling (Crespo-Cuaresma et al., 2013). It does not control for differences in the mean of the distribution (Castelló and Doménech, 2002).

The most indicator used to measure education inequality is the Gini coefficient of education. It is a measurement of relative inequality. This indicator is computed by applying the following formula

$$Ginih = \frac{1}{\mu} \sum_{i=2}^{n} \sum_{j=1}^{i-1} P_i |Y_i - Y_j| P_j \tag{1.1}$$

Where

[15] Thomas et al. (2001, p.5)

Ginih is the education Gini based on educational attainment distribution;
μ is the average years of schooling for the concerned population;
P_i and P_j stand for the proportions of population with certain levels of schooling;
Y_i and Y_i are the years of schooling at different educational attainment levels;
n is the number of levels/categories in attainment data.

This formula was developed by Thomas et al. (2001). They were among the first to propose a new dataset of the Gini index of education, based on school attainment which is considered as a stock variable). Following this formula, numerous dataset on education inequality have been developed (Castelló and Doménech, 2002; Lim and Tang, 2008; Benaabdelaali et al., 2012; Crespo-Cuaresma et al., 2013; Morrisson and Murtin, 2013; Meschi and Scervini, 2013; Földvári and van Leeuwen, 2011; Torpey-Saboe, 2019; Castelló-Climent and Doménech, 2021).

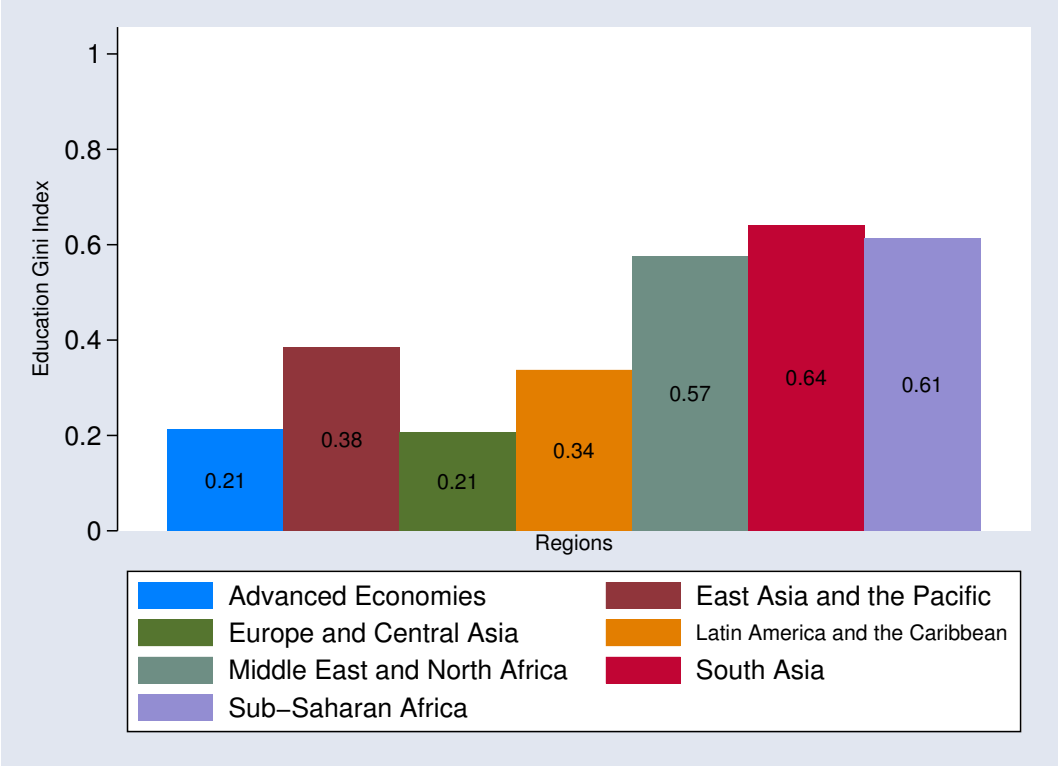
The educational Gini coefficient ranges from zero to one. A zero value indicates a perfectly equally distributed education structure (This case corresponds to a situation in which the whole population attains the same education level). However, the education Gini index does not consider the quality of education (e.g. cognitive and performance). It is also level-dependent, meaning that it depends on the average years of school completed and tends to be higher in countries where a larger share of the population has no schooling (Frankema and Bolt, 2006; Petcu, 2014). Other indicators such as Theil index, quintile and decile are also used by literature to capture education inequality. For example Castelló and Doménech (2002) and Castelló-Climent and Doménech (2014) developed a distribution of distribution of education by quintiles. Morrisson and Murtin (2013) also computee a Theil index of education.

1.3.3 State of education inequality

According to Castelló-Climent and Doménech (2014) and Castelló-Climent and Doménech (2021) dataset, the average level of education inequality in the world is relatively low. Their data show that the areas with the largest human capital inequality are South Asia, followed by Sub-Saharan African, and Middle East and North Africa. On the other end, the Eastern European and Central Asian countries and advanced economies are the regions where

education is more distributed. Latin American and Caribbean countries and the East Asian and the Pacific region are in the middle of the extremes (see figure1.1).

Figure 1.1: Education Inequality for population aged 15 years and above



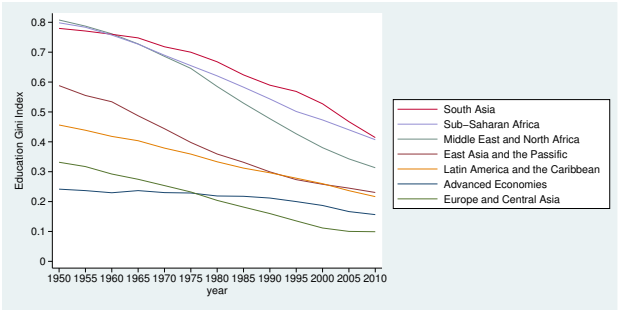
Source: author with Castelló-Climent and Doménech's dataset

Despite significant differences in the distribution of education across regions, there has been a general reduction of education inequality worldwide. Indeed, many studies on education inequality have noticed a remarkable decrease of education inequality (Castelló-Climent and Doménech, 2014; Castelló-Climent and Doménech, 2021; Morrisson and Murtin, 2013; Benaabdelaali et al., 2012; Thomas et al., 2001). For example, Morrisson and Murtin (2013) observed a continuous and rapid decrease of education inequality since 1870. They showed that the Gini coefficient has been divided by more than two. According to Benaabdelaali et al. (2012), education inequality has been declining for all regions and for all age groups during the last six decades (1950-2010). The long-run decline in illiteracy can largely explain this massive decline in education inequality. In fact, all the countries that have experienced

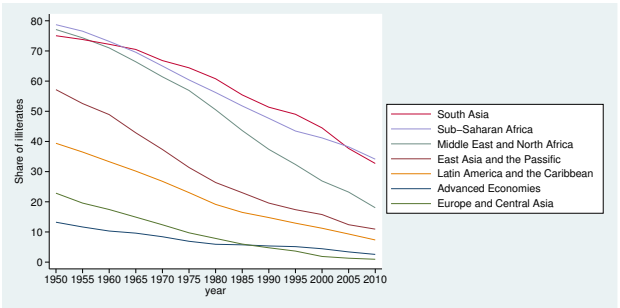
a substantial reduction in the share of illiterates also show a similar decline in the education Gini coefficient over time, suggesting the reduction in the Gini coefficient over time has been largely caused by the decrease in the share of illiterates (see figure1.2). This fact is due to the weight of of the share of illiterates in the computation of Gini coefficient of education (Castelló-Climent and Doménech, 2021; Morrisson and Murtin, 2013). Although this significant decrease, the level of education inequality is still high in some part of the world particularly in South Asia and Sub-Saharan Africa. In fact, in 2010, the level of education inequality was still high in South Asia and Sub-Saharan Africa (0.41) . The proportion of the illiterate in these areas was more than two times the average share of illiterates (see table2 appendix page163).

Figure 1.2: Evolution of Education Inequality and share of illiterates for population aged 15 years and above

(a) Education Inequality



(b) Share of illiterates



Source: author with Castelló-Climent and Doménech's dataset

In sum, the distribution of education is a welfare measure and complements the other education indicators. Unequal distribution of education can be detrimental to economic growth and other dimensions of well-being. Gini

index and standard deviation are the main indicators used in literature to capture education inequality. Education inequality has dramatically decreased worldwide due to the drop in the share of illiterates. However, it is still high in some developing areas.

1.4 The contribution of the thesis

Based on education inequality in some parts of the world and its harmful effects on economic and social well-being, this thesis investigates three main issues related to education inequality. The first essay focus on the impact of education inequality on income distribution by surveying economic literature. The increase of income inequality within countries receives considerable attention today. This has become an important issue for government and social science researchers. The rise of income inequality could cause several harmful economic, social and political consequences. Indeed, high-income inequality could affect negatively economic growth, its sustainability, growth drivers, and poverty reduction (Dabla-Norris et al., 2015). It could also generate political and social tensions (Figueroa, 1996; Goda, 2016).

The importance of income inequality for society leads researchers and other actors concerned to identify its potential causes. The human capital theory explained income inequality by the gap of investment in human capital among individuals (Mincer, 1958; Schultz, 1961; Becker, 1962). Following this theory, several empirical studies have investigated the effect of education on income inequality (Mincer, 1974, 1970; Fields, 1980; Shapiro, 2006; Shahabadi et al., 2018; Hovhannisyan et al., 2019). The availability of data on education for many countries and years permitted to generate indicators on education inequality. This led literature to investigate the relationships between education inequality and income distribution (Ram, 1984, 1989; De Gregorio and Lee, 2002; Checchi, 2004; Földvári and van Leeuwen, 2011; Castelló-Climent and Doménech, 2021). However, this literature, mainly based on the human capital theory, was interested in the labor market as the transmission channel between education distribution and income inequality.

This first essay (Chapter2) reviews existing theoretical and empirical literature on the impact of education inequality on income distribution. It contributes to the literature to identify theoretical mechanisms by which edu-

cation inequality could affect income inequality. It also identifies the main results of the empirical literature on the impact of education inequality on income distribution.

The second essay (Chapter3) of this thesis investigates the effect of political institutions, especially democracy on education inequality. According to North (1990) "Institutions are the rules of the game in a society or, more formally, are the humanly devised constraints that shape human interaction. In consequence they structure incentives in human exchange, whether political, social, or economic". They consist of both informal constraints (sanctions, taboos, customs, traditions, and codes of conduct), and formal rules (constitutions, laws, property rights).[16] There are two main types of institutions. First, economic institutions which consist of the policies and laws that constrain economic interactions and thus determine the current level of protection of property and contractual rights (Davis, 2010). These institutions shape economic incentives, contracting possibilities, distribution. They include security of property rights, entry barriers, the set of contracts available to businessmen, perfection of markets, labor regulations, commercial law etc. Political institutions include form of government (e.g. democracy versus. dictatorship or autocracy), constraints on politicians and elites, separation of powers, etc. They shape political incentives and the distribution of political power (Acemoglu et al., 2005).

Economists and the international organizations support the necessity of political democracy in the improvement of economic and social well-being. For example, according to the United Nations Development Programme, democracy must widen and deepen to promote human development and safeguard the freedom and dignity of all people.[17] In their book entitled "Why Nations Fail", Acemoglu and Robinson (2013) support the need for an open, pluralistic political system, including competition for political office, widespread electorate, and openness to new political leaders (Which are attributes of political democracy) for to fight poverty. In the same vein, an abundant theoretical and empirical literature has studied the impact of democracy on education inequality. The theoretical framework of this literature is mainly based on redistribution policies generated by democracy (Meltzer and Richard,

[16] North (1991)
[17] United Nations Development Programme (2020)

1981; Sen, 1999). There were also several empirical studies on the impact of democracy on education based on this theoretical framework (Brown, 1999; Lake and Baum, 2001; Vollmer and Ziegler, 2009; Gallego, 2010; Murtin and Wacziarg, 2014; Bittencourt, 2014; Eterovic and Sweet, 2014; Acemoglu et al., 2015; Dahlum and Knutsen, 2017). However, this literature did not take into account the distribution of education.

The essay bases its theoretical assumption on the redistribution effects of democracy. It also considers that high political competition may lead governments to respond more effectively to voters' demands (Eterovic and Sweet, 2014). It contributes to the literature by providing an empirical study of the impact of democracy on education inequality using fixed effects and instrumental variables estimators. It also investigates the effect of democracy on the components of education inequality, i.e., education inequality among the literates and the share of literates.

The last essay (Chapter4) assesses the efficiency of public expenditures in decreasing the unequal distribution of education in developing countries. Developing countries are facing high education inequality with limited resources to reduce it. In this case, the improvement of public expenditures efficiency becomes crucial. "Public spending efficiency is defined as the ability of the government to maximize its economic activities given a level of spending, or the ability of the government to minimize its spending given a level of economic activity"[18]. Many reasons justify the interest of economists and policy makers in public expenditures efficiency. First, it facilitates comparison across similar units. Second, further analysis can be undertaken to identify the causes of variations in efficiency among economic units. Third, such analyses bear policy implications for improving efficiency (Kalirajan and Shand, 1999). fourth, In a context of macroeconomic constraints and fiscal discipline, public expenditures efficiency could be an indicator to evaluate the effectiveness of the public policy. Last, improving public expenditures efficiency can improve accountability.

The measurement of efficiency of public expenditures in education has been the subject of several empirical studies (Gupta and Verhoeven, 2001; Christiaensen et al., 2002; Afonso et al., 2005; Herrera and Pang, 2005; Afonso and Aubyn, 2006; Gavurova et al., 2017; Afonso et al., 2010; Herrera and Oue-

[18] Chan and Karim (2012)

draogo, 2018). These studies offer several techniques to measure efficiency, classified into parametric and nonparametric. Although some studies analyzed the determinants of efficiency, none of them consider the distribution of education according to our knowledge.

This last chapter provides three main contributions to the literature. First, It empirically assesses the efficiency of public expenditures in improving the distribution of education in developing countries. Second, it uses a nonparametric partial frontier estimator (Cazals et al., 2002; Aragon et al., 2005; Daouia and Gijbels, 2011; Tauchmann, 2012), which is more robust than the previous estimators (e.g., Data Envelopment Analysis and Free Disposal Hull). Last, It analyzes the determinants of the output–oriented efficiency scores using Exponential fractional regression models (EFRM), which is the most natural way of modeling bounded proportional response variables (Ramalho, 2019).

Chapter 2

Impact of Education Inequality on Income Inequality: A survey

Contents

Abstract

The chapter surveys the theoretical and empirical literature on the impact of education inequality on income distribution. It first identifies the mechanisms by which education inequality affects income inequality. It also points out the main results of the empirical relationship between education inequality and income distribution.

The analysis of theoretical relationships between education distribution and income inequality identifies political economy, labor market, credit market constraint, fertility, and life expectancy as the main transmission channels. As far as empirical literature is concerned, we notice no consensual results. The literature also identifies some factors, which could counterbalance the equalizing effect of education equality and then raise income inequality.

Keywords: *Education inequality, Income inequality, Political economy, Labor market, credit constrain, Demography*

JEL codes: *I20, D63 I24, P26, J20, G20, J10*

2.1 INTRODUCTION

Inequality is one of today's most widely discussed and controversial issues. In recent decades, income inequality has almost increased in all world regions, but at different speeds (Alvaredo, 2018). In fact, the poorest half of the global population has seen its income grow significantly thanks to high growth in Asia. But the top 0.1% has captured as much growth as the bottom half of the world adult population since 1980.[1] Furthermore, even if income inequality has remained relatively stable in some areas of the world (e.g. middle east, sub-Saharan Africa), it is still high in these parts of the world.

According to Roy and Husain (2019), "Inequality may be defined as the uneven distribution of rights among individuals or groups, where rights encompasses rights to participate in the political process, rights over economic resources, rights over access to education, rights on healthcare, and so on".

Economic inequality is defined as the disparity in wealth (i.e, all financial asset including income, capital, gains on stocks and income from struts and investments) among households at different socioeconomic level (DeSilver, 2015).[2] It refers to disparities in income and wealth. Income inequality refers to the dispersion in the distribution of income (Husted and Salazar, 2020). This distribution can range from a relatively equal distribution among individuals or households to a highly concentrated one in the hands of a few people.[3] Inequality can be broadly classified into horizontal inequality or vertical inequality. Horizontal inequality refers to inequality between socially constructed groups like religion, ethnicity etc. Vertical inequality is inequality among individuals belonging to different income or expenditure groups (Roy and Husain, 2019).

Inequality causes several harmful economic, social and political consequences. First, high inequality hinders economic growth. Indeed, "high levels of income inequality are bad for growth, and they weaken the rate at which growth is converted into poverty reduction: they reduce the size of the economic pie and the size of the slice captured by the poor".[4] Furthermore, according to Stiglitz (2012), economic crisis like "the Great Depression" was

[1] Alvaredo (2018, p.40)
[2] see Torraco (2018, p.28)
[3] Husted and Salazar (2020); US Congressional Budget Office (2011)
[4] UNDP (2005, p.6)

preceded by large increases in inequality. Extreme income inequality also leads to economic inefficiency. Widely unequal societies do not function efficiently, and their economies are neither stable nor sustainable in the long term (Stiglitz, 2012). This is partly because at any given average income, the higher the inequality, the smaller the fraction of the population that qualifies for a loan or other credit (UNDP, 2005; Todaro and Smith, 2012). Indeed, poor people remain poor partly because they cannot borrow against future earnings to invest in production, the education of their children, and assets to reduce their vulnerability.[5] Furthermore, the rich do not generally save and invest significantly larger proportions of their incomes (in the real economic sense of productive domestic saving and investment) than the middle class or even the poor (Todaro and Smith, 2012). Allowing unequal asset distribution to perpetuate mass poverty is not only bad for poor people but also restricts the development of investment opportunities and markets for the rest of society (UNDP, 2005). Last high inequality may lead to political and social crisis. Inequalities in income often reflect inequalities in political power. Disadvantaged groups are disadvantaged partly because they have a weak political voice, and have a weak political voice because they are disadvantaged. Moreover, the influence of money in today‘s political system helps the rich to succeed in getting governments to adopt policies that favor them as a class (Stiglitz, 2012; Roy and Husain, 2019). As a result, the inequality in the system is self-perpetuating in an unequal society. In this situation, excessive inequality may lead to political and social tensions (Figueroa, 1996). Historically, the idea of class struggle arose from a perception that individuals in the upper portion of the income distribution had too large a share of national income (Goda, 2016). Protest movements like “Occupy Wall Street” (OWS) in the United States and the indignant (or outraged) in Spain result from the interest of income and wealth concentration in the hand of a few people (Stiglitz, 2012; Keister, 2014). More unequal societies are also more politically unstable. In fact, income inequality increases social discontent and fuels social unrest. This increases the probability of coups, revolutions, mass violence, or, more generally, increases policy uncertainty. Political stability is then enhanced by the presence of a wealthy middle class (Alesina and Perotti, 1996).

[5] UNDP (2005, p.53)

The issue of inequality is then too important to be left to economists, sociologists, historians, philosophers and politicians. It is of interest to everyone, and that is a good thing (Piketty, 2014).

Among the factors which may affect income inequality, the research emphasizes that education and education inequality play an essential role. Indeed, education is an appropriate proxy for measuring human capital. Human capital refers to "Productive investments embodied in human persons, including skills, abilities, ideals, health, and locations, often resulting from expenditures on education, on the job training programs, and medical care".[6] Since Mincer (1958); Schultz (1961), and Becker (1962), the economics literature reports evidence on the importance of education as a determinant of income inequality (Becker and Chiswick, 1966; Mincer, 1970, 1974; Fields, 1980; Berry and Glaeser, 2005; Shapiro, 2006; Shahabadi et al., 2018; Van Leeuwen et al., 2012; Hovhannisyan et al., 2019). For instance, Tanzi (1998) stated that human capital is the most vital element, not only to push the wheels of growth and development, but also to boost the wheels of justice and equality in society.[7] The availability of education data for many countries and periods enabled the development of education inequality indicators This permitted economists to investigate the relationships between income inequality and educational inequality (Ram, 1984; De Gregorio and Lee, 2002; Checchi, 2001, 2004; Földvári and van Leeuwen, 2011; Abdelbaki, 2012; Petcu, 2014; Castelló-Climent and Doménech, 2021).

This chapter surveys the theoretical and empirical literature of the effect of education inequality on income inequality. More specifically, it identifies the theoretical mechanisms by which education inequality could affect income inequality. It also identified the main results of the empirical literature on the impact of education inequality on income distribution.

2.2 Education and income inequality: which Channels?

Education inequality affects income inequality via several mechanisms grouped in four large categories.

[6] Todaro and Smith (2012, [p.360)
[7] see Abdelbaki (2012, p.675)

2.2.1 Political economy

Several theoretical works highlighted the role of political economy in the relationship between education inequality and income inequality. Two main approaches are distinguished:

The comparative historical analysis based on historical events focused on and provided insights on specific regions or countries. Thus, Engerman et al. (2002); Engerman and Sokoloff (2005, 2009), suggest that the degree of inequality in wealth, human capital, and political power that emerged early in the history of the American continent (during the late eighteenth and early nineteenth centuries) have influenced the directions in which institutions evolved and these institutions, in turn, could affect the degree of inequality in the long term. In societies (Latin America and the Caribbean) that began with extreme inequality in wealth, human capital, and political power, the elites were both inclined and able to establish a basic legal framework that ensured them a disproportionate share of political power and to use that influence to establish rules, laws, and other government policies that gave them greater access to economic opportunities than the rest of the population (Engerman and Sokoloff, 2009). This created societies where property rights, legal systems, and fiscal institutions perpetuated the unequal distribution of wealth and political power, always ensuring the elite a disproportionate influence on the economy.[8] According to Savoia et al. (2010), ". . . countries were historically associated with high inequality . . . led to oligarchic (rather than democratic) politics and exploitative institutions". Qualifications based on wealth or income were widespread throughout Latin America during the early 1800s. However, over time the literacy requirement became virtually universal (Engerman and Sokoloff, 2005). For example, restriction on literacy was abolished in Chile in 1970 and in Brazil in 1985 (Eterovic and Sweet, 2014). Citizenship was also conditioned to literacy.[9] These latter structures, which were generally set forth as qualifications for being a citizen, excluded the great majority of wage-earners, whether urban or rural and of Native Americans, from voting.[10] As a result, the share of the voting population has always been very low until late in the nineteenth century, especially in

[8] Savoia et al. (2010, p.145)
[9] Engerman and Sokoloff (2009, p.127)
[10] Engerman and Sokoloff (2005, p.909)

countries with low literacy rates (Engerman and Sokoloff, 2002; Engerman et al., 2002; Engerman and Sokoloff, 2005, 2009; Savoia et al., 2010). The initial extreme inequality in wealth and human capital in Latin America led to low levels investment in public schooling and of literacy attainment (because elites procured schooling for their own children and resisted being taxed to underwrite or subsidize services to others). The evolution of suffrage institutions might constitute a mechanism by which extreme inequality in wealth and human capital explained the persistence of inequality in Latin America and the Caribbean (Engerman and Sokoloff, 2005).

In contrast, in societies that began with greater equality (The United States and Canada) in wealth and human capital, the elites were either less able or less inclined to institutionalize rules, laws, and other government policies that grossly advantaged them, and thus the institutions that evolved tended to provide equal treatment and opportunities, thereby contributing to the persistence of the relatively high degree of equality.[11]

Analytical models were also interested in the political economy mechanism by which education inequality affect income inequality. Thus, Glomm and Ravikumar (1992) present an overlapping generations (OLG) model with heterogeneous agents in which human capital investment through formal schooling is the engine of economic growth. Their model used a simple functional forms for preferences, technologies, and income distribution to highlight the distinction between economies with public education and those with private education. The authors found that public education reduces income inequality more quickly than private education. The median-voter decisions will result in a public education regime. In other words, the majority of agents will vote in favor of public education if their income is below average. In contrast, in a private education regime, each household chooses its quality of education.

Ferreira (2001) presented a simple model of distribution dynamics, in which the distribution of wealth, education, and political power are circularly endogenous. Although the absence of credit markets, public education, financed through a proportional wealth tax, enables poor individuals to attain, at least, some education. In this model, if inheritance falls short of private education cost, agents reach public education, with the opposite being true for inheritances being equal or greater than private education cost (Sauer and

[11] Engerman and Sokoloff (2005)

Zagler, 2012). Since private education is considered to be more expensive and more productive than public schooling and is further associated with higher optimal time investment in human capital accumulation, individuals who have attained private education earn higher incomes. The model includes a voting mechanism through which policies are determined endogenously. As the median voter's wealth endowment establishes the tax rate, public schooling is most productive in poor economies.[12] The model includes a voting mechanism, through which policies are determined endogenously. As the tax rate is established by the median voter's wealth endowment, public schooling is most productive in poor economies.

2.2.2 Labor market outcomes

The premise of this mechanism called "the schooling model" is based on the idea that education increases a worker's productivity and that this increase in productivity raises wages (Mincer, 1958; Becker, 1962; Becker and Chiswick, 1966). This model was promoted by the human capital theory, which extends the neoclassical model. According to the wage-schooling model, a worker rationally chooses the number of years of schooling that maximize his/her earnings in the labor market (Borjas, 2013). Indeed, the wage-schooling locus gives the salary that a worker earns if he or she completes a particular level of schooling.[13] Workers choose the level of education on the wage-schooling locus that maximizes the present value of lifetime earnings. In particular, workers quit school when the marginal rate of return to schooling equals the discount rate.

An alternative model, "the signaling model," supports that education need not increase the worker's productivity but acts as a "label" or a "signal". More specifically, his model posits a situation in which the possibility of higher pay for more educated people has little to do with academic and vocational skills, because formal education is seen as an elaborate device for detecting and labeling those who have skills (Champernowne and Cowell, 1998; Wolf, 2004).[14] In this view, education increases earnings not because it increases productivity but because it certifies that the worker is suitable for work. Even

[12] Sauer and Zagler (2012, p.938)
[13] see Borjas (2013, p.281)
[14] see Rodríguez-Pose and Tselios (2009, p.415)

if education plays only a signaling role, workers with more schooling earn more not because education increases productivity but because education signals a worker's innate ability (Spence, 1973; Arrow, 1973; Stiglitz, 1975). Based on this, we can draw the assumption that unequal investment in education leads to unequal distribution of education which leads to unequal distribution of productivity and unequal earning distribution.

Nevertheless, other researchers expressed theoretical challenges to these theories. Thus, Bhagwati (1973) argued that education is much more likely to be used to signal productivity in the developing world rather than to build human capital. Jobs that would only require a high school diploma tend to be filled by those with a master's degree simply because employers interpret their diploma as more productive. However, the employees would not use those skills, so the resources spent on education are essentially wasted (Petcu, 2014). Consequently, there appears an excess supply of educated labor and an absence of demand for high-skilled labors.[15] According to Bhagwati (1973), this would have ambiguous effects on income inequality because even employees with a high amount of schooling may be employed below their levels due to job scarcity, so their earnings would not necessarily be higher.[16]

2.2.3 Credit market imperfections

The credit market constraint models assume imperfect (the interest rate for individual borrowers is higher than that for lenders[17] or absent credit markets and fixed cost of human capital investment for demonstrating that the initial wealth distribution affects the division of the population between skilled and unskilled labor both in short and in the long run (Galor and Zeira, 1993). Indeed, the assumption that perfect markets for educational loans are not tenable since human capital cannot be used as collateral (Loury, 1981; Dao, 2008). Consequently, if education is only privately funded, the initial distribution of wealth determines each individual's ability to invest in education. Individuals, differing only with respect to their wealth endowment, whose inheritance is enough to cover the cost of human capital accumulation, provide skilled labor, whereas the remaining work in the unskilled labor sector

[15] Petcu (2014, p.4)
[16] see Petcu (2014, p.4)
[17] see Galor and Zeira (1993, p.36)

(Sauer and Zagler, 2012). Given that the productivity of skilled workers is greater than that of unskilled workers, the unequal distribution of human capital coupled with credit market constraints may lead to income and wealth inequality. More specifically, if initial wealth is the only source for financing human capital accumulation because of credit restriction, poor people with no collateral are prevented from understanding an investment in education. . Therefore, initial wealth inequality directly translates into the unequal distribution of education, which constitutes the main source of income and wealth differences.

The essential model that describes the credit market imperfection approach has been provided by the seminal work of Galor and Zeira (1993). In their two-period overlapping generations (OLG) economy, they also assume the indivisibility of human capital investment in addition to credit market imperfection. The indivisibility of human capital investment means that there is a technological non-convexity. The assumption of technological non-convexity allows the effect of initial wealth distribution not only in the short run but also in the long run. In this model, wealth transmission from parents to children through bequests depends on parents' human capital. As a result, the initial distribution of wealth could be driven by the initial distribution of human capital as well (Castelló-Climent, 2010a).

2.2.4 Demography

Education inequality may affect income distribution via demographic variables. Several theoretical studies (De la Croix and Doepke, 2003; Moav, 2005; Castelló-Climent and Doménech, 2008) have addressed the relationship between inequality in the distribution of human capital, demographic indicators, human capital investment and income inequality. For instance, De la Croix and Doepke (2003) analyzed the effect of inequality on growth through fertility decisions. In this model, fertility and education decisions are interdependent. Thus, poor parents with low levels of education decide to have more children and provide them less education, whereas fewer and more educated children characterize wealthy parents' decisions. The reason is that the opportunity cost of raising a child increases with parents' education. Consequently, parents with low human capital decide to have more children with less education than parents with more human capital (Castelló-Climent, 2010a). Therefore, the

increasing differential fertility between the educated rich and the uneducated poor decreases the average education level and growth, leading to persistent income inequality.

Moav (2005) developed a theory of fertility that explains the persistence of poverty within and across countries. The model assumes that individuals' productivity increases with their human capital, whereas the minimum amount of time devoted to raising a child is not influenced by parents' level of education (Castelló-Climent, 2010a). As a result, educated parents have a comparative advantage in raising quality or educated children[18]. Hence, poor parents choose quantity instead of quality, that is, high fertility rates with low investment in their offspring's education, depriving their descendants of future opportunities. This model generates multiple steady states based on the effect of parental education on child quantity cost in which the dynasties within a country can converge to two alternative equilibria. A low-income steady state in which a poverty trap is characterized by high fertility rates, low investment in human capital and low income. A high-income steady state is described by low fertility, higher investment in offspring education and, therefore, higher income.

A different amplifying mechanism was presented by Castelló-Climent and Doménech (2008). Indeed, Castelló-Climent and Doménech assumed that life expectancy is conditioned by the human capital of the families in which individuals are born. This assumption is strongly supported by empirical evidence. Based on this hypothesis, Castelló-Climent and Doménech developed an overlapping generation (OLG) model in which individuals decide to invest in education in their first period of life depending on their second period survival probability which in turn, is a function of parental education (Sauer and Zagler, 2012). Given this expected probability of survival, individuals optimally choose the investment in education that maximizes their inter-temporal utility (Castelló-Climent, 2010a). As expected, the results show that the time individuals devote to schooling increases with their expected survival probability. In this way, poor individuals optimally do not accumulate human capital, and work as unskilled labor because their relatively low life expectancy increases their opportunity cost of becoming educated, whereas rich individuals choose to invest in human capital as the time-horizon to enjoy the returns to

[18] Castelló-Climent (2010a, p.401)

their investment is relatively long (Sauer and Zagler, 2012). This OLG model exhibits multiple steady states depending on initial conditions due to the calibrated survival probability function. The model predicts that individuals born into a poor uneducated family have low life expectancy and optimally invest in a low amount of human capital, since their low life expectancy increases the opportunity cost of becoming educated. On the contrary, rich individuals have more incentives to invest in human capital since the time horizon for enjoying the returns of education is longer (Castelló-Climent, 2010a). These results imply that the initial distribution of education determines the distribution of income via life expectancy.

2.3 Empirical literature review between education inequality and income inequality

2.3.1 Dispersion of schooling

Empirically, there are many studies which investigated the effect of education inequality on income distribution. Earlier works used dispersion of schooling (variance or the standard deviation of education) as a measure of education inequality (Becker and Chiswick, 1966; Chiswick, 1971; Chiswick and Mincer, 1972; Tinbergen, 1972; Lam and Levison, 1992; Park, 1996; Ram, 1984, 1989; De Gregorio and Lee, 2002). Some of them was in the human capital tradition and some was not. The first studies showed close relation between education and income distribution in developed countries. For instance, Becker and Chiswick (1966) found that inequality in schooling is positively correlated with income inequality (distribution of earning) in the United States. Chiswick (1971), using cross-sectional data from nine countries (Argentina, Canada, France, Japan, Mexico, United Kingdom, and the United States, Brazil, and Chile), suggested that earnings inequality increases with educational inequality. Tinbergen (1972) also found a considerable influence of both education and educational inequality on income distribution by using data for the United States, Canada, and the Netherlands. The study concludes that an increase in years of schooling and a smaller dispersion of schooling contributed to a reduction in the degree of income inequality.[19] Subsequent studies based

[19] Park (1996, p.52)

on a slightly larger sample of countries found that inequality of educational attainment increases income inequality. Thus, Winegarden (1979), in an interesting article used a cross-section data pertaining to the 196Os, for 32 countries (including eighteen developing countries).[20] He concludes that inequality in educational attainment (variance of logarithm of educational attainment of adult population) plays a larger role in generating income disparities (share of income of the bottom four-fifths of households in each country).[21] In the same vein, Park (1996), using cross-section data covering 59 countries showed that the dispersion of schooling (standard deviation of years of schooling) among the labor force has a much greater disequalizing effect on income equality (income share of the top 20%, income share of the bottom 40% and the Gini coefficient). De Gregorio and Lee (2002), found that more equal distribution of education (standard deviation of educational distribution) plays a significant role in making income distribution (Gini coefficient) more equal. Their study used an unbalanced panel dataset covering a broad range of countries from 1960 to 1990.

However, some research by using the same dispersion of schooling found no significant relationship between education distribution and income inequality. For example, Chiswick and Mincer (1972) by analyzing changes in income inequality in the United States during the period 1939–1969, concluded that although the level and the dispersion of schooling do affect income inequality, these effects were small over the period studied. Ram (1984) found no disequalizing effect of schooling inequality (variance of schooling) on income inequality (income share of bottom 80% or bottom 40% of population). He used a model almost identical to Winegarden's specification with a sample consisting of 28 countries (including 26 developing countries).

2.3.2 Educational Gini Index

The relationships between education inequality and income distribution were investigated using educational Gini index. In this case, findings are also not consensual. So Checchi (2001) computed a Gini index on educational attainments and explored the relationship between inequality in incomes and inequality in educational achievement. The study identified a U-shaped re-

[20] see Fields (1980, p.283)
[21] Fields (1980, p.283)

lationship between income inequality and educational inequality. Major regional differences were also found. In Fact, if there is U-curve relationship for OECD[22] sub-sample in a fixed panel specification as well as for whole sample, the coefficients are insignificant for other regions. This study covered 94 countries from 1960 to 1995. Földvári and van Leeuwen (2011) used nonlinear (quadratic) functional forms to study the effect of inequality in schooling on income inequality. They found an insignificant relationship between education inequality and income distribution.

Petcu (2014) investigated the question of whether educational inequality (Educational Gini index of 25 years and computed with Barro and Lee's dataset) explains income inequality (Gini index from WIID[23]) by using Ordinary Least Square (OLS) regression. This study used a sample including 58 developing countries (low income and lower middle income countries) and 81 developed countries (upper middle income and high income countries) for the year 2010. The findings highlighted a positive and significant effect of educational inequality on income distribution in developed countries and almost non significant impact in developing countries. According to Petcu (2014) this can be explained by several factors, from brain drain in the developing countries, or simply due to already existing institutions which affect income inequality masking the effect of educational Gini. Dao (2013) by using a sample of 19 developing countries found that cross-country variations in income/consumption inequality may be explained by inequality of investment in human capital as measured by inequalities in child health as well as inequality in education.

Coady and Dizioli (2018) investigated the relationship between education expansion and income inequality (Gini coefficient for disposable income from Bastagli et al. (2012) dataset) by using dynamic panel estimation techniques to address issues of persistence and endogeneity. They found a large, positive, statistically significant and stable relationship between inequality of schooling (education Gini index) and income inequality, especially in emerging and developing economies and among older-age cohorts.

Lee and Lee (2018), empirically analyzed the important factors for income inequality (Gini index of net income from SWIID) across countries over the period between 1980 and 2015. This study covered 95 countries and show that

[22]Organisation for Economic Co-operation and Development
[23]World Income Inequality Database

more equal distribution of education has contributed significantly to reducing income inequality. Their results also showed that the rising income inequality in many economies (East Asia) in recent decades is due to a fast income increase, trade expansion, and rapid technological progress. In this area, the unequalizing effects of these factors on income distribution have surpassed the impact of educational equality. The authors concluded that an important reduction of education inequality could counterbalance these income unequalizing forces over the period.

Castelló-Climent and Doménech (2021) addressed the relationship between human capital and income inequality and examined the role of earnings inequality in the interaction between these two inequality indicators. This study provided several results. First, it established an inverted U-shaped relationship between educational inequality and earnings inequality (from Hammar and Waldenström (2020) dataset). Nevertheless, the authors noticed significant differences across countries concerning the turning point where the relationship between education inequality and earnings inequality becomes positive. The findings also identified skill-biased technological change (SBTC) as an additional force that may blur the relationship between human capital inequality and earnings inequality. In this view, despite the increase in the relative supply of skilled workers, labor earning inequality has risen over the years due to SBTC.[24] Second, Castelló-Climent and Doménech (2021) estimated the average contribution of earnings inequality to income inequality. The results indicated that the estimated coefficient of earnings inequality is statistically significant, relatively stable and economically relevant: approximately each one-point change in the Gini coefficient of earnings contributes to a half-point change in the Gini coefficient of income. Finally, besides its indirect effect via earnings inequality, educational inequality influences directly income inequality. Indeed, the authors found a positive and direct effect of educational inequality on income inequality, even when controlling for the Gini of earnings. The direct effect is mainly explained by channels related to redistribution policies, fertility, trade openness and financial globalization. Overall, earnings inequality and the direct channels explain about 65 percent of the variation in income inequality. The remaining 35 percent could be explained by other forces that have driven income inequality upwards (Castelló-Climent

[24] Castelló-Climent and Doménech (2021)

and Doménech, 2021).

Sağlam (2021), using panel data from 101 countries between 1970 and 2010, explored the dynamic interaction between educational (from Castelló-Climent and Doménech's dataset) and income (Gini index from SWIID[25] WID and LIS[26] database) inequalities. This study employed a panel VAR approach with system GMM estimates. It also incorporated all factors possibly leading to a rising skill premium (e.g. globalization, labour market institutions skill-biased technological progress etc). The empirical results highlighted that a more equal distribution of education has contributed significantly to reduce income inequality for low, middle-income countries and high-income OECD countries. However, in the higher middle-income and high-income OECD countries, the significance of educational inequality disappears once the level of development, educational attainment and the degree of trade openness are included in the analysis. Moreover, the results revealed that an unfair distribution of income acts as a barrier to achieve a better distribution of education in the low and middle-income countries. Specifically, in the low and lower middle-income countries, educational inequality and income inequality accentuate each other and generate a vicious cycle of inequalities under all estimation techniques and control variables

Some empirical studies have been done at regional level. Thus, Rodríguez-Pose and Tselios (2009) by analyzing the determinants of income inequality across regions of the European Union (EU), found a positive relationship between inequality in educational attainment and income distribution (Theil entropy index). This study covered 102 regions from 13 EU countries over the period 1995–2000. Tselios (2008) by examining the relationship between income (Theil index) and educational inequalities in the regions of the European Union, found a positive relationship between the two inequalities. This study uses a balanced dataset extracted from the European Community Household Panel (ECHP) data survey for 94 regions from 12 EU countries from 1995 to 2000. Földvári and van Leeuwen (2014), in an article, tested a Kuznets-type relationship between educational and income inequalities in a historical perspective in Europe. The results provided inverse U-curve before the 1950s but the relationship changes into a normal U-curve afterward. This finding

[25]Standardized World Income Inequality Database
[26]Luxembourg Income Study

is explained by a change in the trend of skill premium during the second half of the twentieth century due to an increased relative demand for skills, which contradicts the usual assumption of decreasing returns to education. Van Leeuwen et al. (2012), by analyzing the effect of education on income inequality among African nations since the early 1930s found that a reduction in educational inequality leads to a reduction in income inequality. They also established a strong non-linear, relationship between educational and income inequality. Indeed, initially, with a rise in educational inequality, a rise in income inequality is found. [27] However, the decline in educational inequality at the end of the twentieth century, also reduced income inequality. By considering the last decade of the 20^{th} century, Van Leeuwen et al. (2012) showed that by reducing educational inequality to zero, a government could achieve a decline in income inequality by no less than 81%. Munir and Kanwal (2020) examined the impact of educational inequality on income inequality in six South Asian countries (Bangladesh, India, Maldives, Nepal, Pakistan and Sri Lanka) from 1980 to 2010 by using fixed and random effects model. Their results suggested that educational inequality and average year of schooling positively and significantly affects income inequality.

In short, the impact of education inequality on income distribution have been the topic of several empirical studies. This literature used two main indices of educational inequality (dispersion of education and education Gini index), different measures of income distribution, functional forms and estimation techniques. Most of them are based on human capital theory. Earlier empirical studies employed cross-country data and have been followed by studies using panel data with large samples of countries and years. Concerning the results, it appears difficult to obtain clear predictions about the effect of educational inequality on income inequality. This literature also highlighted that some factors such as Skill Biased Technological Change, globalization and increasing returns to education could explain the rise of income inequality although the substantial reduction of education inequality. These factors may be responsible for shifts in the demand for skilled labor in a way that favours skilled workers and, in turn, increases wage inequality[28] and then income inequality.

[27] Van Leeuwen et al. (2012, p.31)
[28] Sağlam (2021, p.270)

2.4 CONCLUSION

Income inequality within developed and developing countries has increased, a phenomenon that has received considerable attention. This become today an important issue for governments and social science researchers. President Barack Obama called widening income inequality the "defining challenge of our time". The rise of income inequality could cause several harmful economic, social, and political consequences. High income inequality affect negatively economic growth and its sustainability. It is also affect growth drivers and lead to political and social tensions.

The importance of income inequality for society led researchers and other actors concerned to identify its potential causes. The human capital theory especially explained income inequality by the gap of investment in human capital. This was follow by an abundant empirical literature on the effect of education on income inequality. The availability of data on education for many countries and years contributed to generate indicators on education inequality. This contributed to extending the studies concerning the relationship between human capital and income inequality.

This chapter aims the following goals. First it surveys the economic literature to identify the mechanisms by which education inequality affect income inequality. Second it shows the main result of the empirical literature concerning the impact of education distribution on income inequality.

Concerning the channels by which education inequality could affect income distribution, this chapter identifies political economy, labor market , credit market constraint, fertility and life expectancy as the main channels by which education inequality may affect income inequality.

As for empirical literature on the relationship between education inequality and income distribution, the chapter notices that there is no consensual results. In fact, if some empirical studies conclude to a positive and significant effect of education inequality on income distribution, other studies find no significant effect. This literature also shows that some factors such as Skill Biased Technological Change, globalization and increasing returns to education could counterbalance the equalizing effect of education inequality reduction and then increase income inequality.

As policies recommendation governments should invest in access in education to reduce education inequality which may lead to lower income inequality.

They have also to develop good and democratic institutions which favor policies for poor people. Good and democratic institution are also tools to reduce education inequality.

Chapter 3

Democratic Institutions and Education Inequality

Contents

Abstract

This chapter investigates the impact of democracy on education inequality. Our theoretical framework is mainly based on median voter theorem and Sen's analysis. These theories point out the effect of democracy on redistribution policies and public goods provision. Our theoretical framework also take into account the fact that high political competition may lead governments to respond more effectively to voters' demand. Using fixed effects and Instrumental Variables estimator the chapter empirically investigates the effect of democracy on education inequality. It also studies the effect of democracy on education inequality components.

Our results show that democracy reduces education inequalities. This result is due to the positive impact of democracy on access to education. The effect of democracy on education inequality is higher in low income and Least Developed Countries (LDCs) compared to the other economic areas. The results are robust when we use other indicators of democracy.

Keywords: *Democracy, Education inequality, Illiteracy, Inequality among literates*

JEL codes: *P26, I20, I21*

3.1 INTRODUCTION

Education, essential component for human development is a factor of economic growth. The concept of education as a fundamental human right is enshrined in the International Covenant on Economic, Social, and Cultural Rights and has been proclaimed in the Universal Declaration of Human Rights (article 26) in 1948 and reaffirmed in the United Nations Convention on the Rights of the Child (UNCRC).[1]

If economic literature agrees on the role of education in economic growth and development (human capital theory), the relationships between education and political democracy are not consensual. In fact, many theoretical works in social sciences highlighted the positive effect of education on political democracy (Lipset, 1959; Kamens, 1988; Glaeser et al., 2007; Yoldaş, 2015). These studies called "the modernization theory" have been corroborated by empirical research (Barro, 1999; Glaeser et al., 2004; Balaev, 2014; Crespo-Cuaresma and Oberdabernig, 2014). But some authors (Brown, 1999; Lake and Baum, 2001; Vollmer and Ziegler, 2009; Acemoglu et al., 2015; Bittencourt, 2014) pointed out the role of institutions particularly political democracy in the expansion of education.

There is several definitions of political democracy. The definition differs between authors and between institutions. According to Schumpeter (1947) "The democratic method is that institutional arrangement for arriving at political decisions in which individuals acquire the power to decide by means of a competitive struggle for the people's vote".[2] Lipset (1959) defined democracy as a political system which supplies regular constitutional opportunities for changing the governing officials. Huntington (1991) argued that democracy is the central procedure by which leaders are selected through competitive elections by the people which they govern. These definitions are restrictive because they are limited to "electoral democracy". According to Skaaning et al. (2015) "electoral democracy" is "a regime where leaders are selected through contested elections held periodically before a broad electorate".

Other definitions of democracy are limited to "majority rule". According to Pennock (1952) "The principle of majority rule requires, at the least, that no minority shall be entitled to impose its will upon a majority. (In this sense,

[1] Torpey-Saboe (2019)
[2] Barro (1999, p.S161)

majority rule is the simple negation of minority rule.) In other words, the vote of each must be given the same weight as that of every other; otherwise, by a combination of individuals having extra votes, a minority might be able to impose its will on the majority. The principle of the majority is the principle of equality, the denial of the right of any minority to rule". In this way, Bollen (1990) defined political democracy as the extent to which the political power (ability to control the national governing system) of elite (members of a society who hold a disproportionate amount of the political power) is minimized and that of the nonelite is maximized. But democracy can not be limited to "electoral democracy" and "majority rule". It has complex demands which include in addition to voting, respect for election results, the protection of liberties and freedoms, respect for legal entitlements and the guaranteeing of free discussion.[3]

According to Sen (1999), democracy has to fulfill three essential functions. First, democracy has a intrinsic value because political freedom is a part of human freedom and exercising civil and political rights is a crucial part of individuals' lives as social beings. Political and social participation have a intrinsic value for human life and well-being. Prevent someone from participating in political life of the community is a major deprivation. It has also an instrumental value by giving more echos to people's claims and encouraging governments to take them into account.[4] Finally, democracy gives citizens an opportunity to learn from one another and helps society to form its values and priorities. Indeed, according to Sen, individuals' preferences, wishes and needs as well as social values and norms require public discussion. In this sense, democracy has a constructive function.[5]

In 1997 the Inter-Parliamentary Union adopted the Universal Declaration on Democracy. This declaration defines democracy as "a universally recognized ideal, based on values common to people everywhere regardless of cultural, political, social or economic differences. As an ideal, democracy aims to protect and, promote the dignity and fundamental rights of the individual, instil social justice and foster economic and social development. Democracy is a political system that enables people to freely choose an effective, honest,

[3] Sen (1999, p.6)
[4] Bonvin (2005, p.25)
[5] Bonvin (2005, p.25)

transparent and accountable government".[6]

As far as we know, if there is an important literature on the relationships between education and democracy, few of them have examined the links between democracy and education distribution.[7] Yet, a equitable distribution of education can improve individual productivity and promote the fight against poverty. Furthermore, education enables the wealth creation and the social protection's improvement without impoverish anyone. Consequently, an equitable distribution of education is preferable to redistribution of income or assets Thomas et al. (2001). In cases of income inequality, democracy (through political reforms like franchise extension to proportions of society with no political representation) can be viewed as strategic decisions by the political elite to prevent widespread social unrest and revolution (Acemoglu and Robinson, 2000). This democratization led to lower income inequality thanks to social reforms (transfer of income toward the poorer segments of the society and the increase in the proportion of skilled workers due to the extension of education to the masses).[8] Thus, in developing countries, democratization may be a solution to fight poverty and reduce income inequality by giving the opportunity to poor persons (who are also uneducated) to elect representatives favorable to their needs (e.g. political programs in favor of masses education).

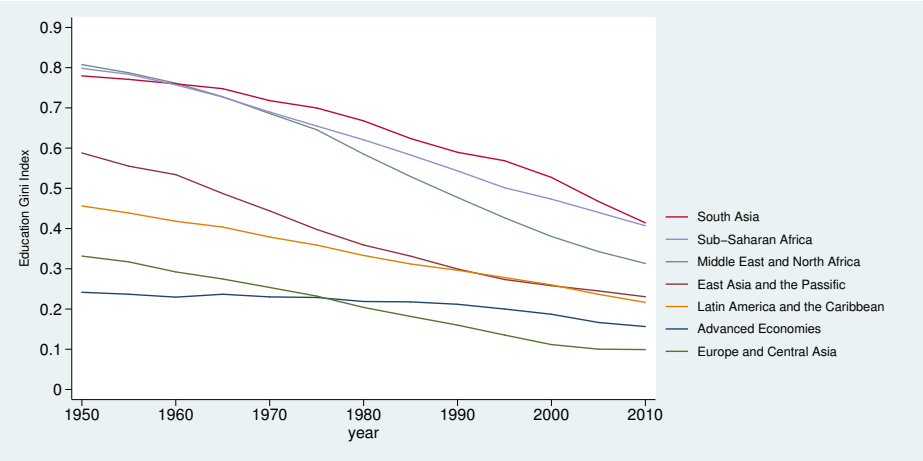
During the last decade, the availability of education data for a great number of countries and periods permitted the development of education inequality indicators (sometime called human capital inequality). Despite the decrease of these inequalities, they remain high in some parts of the world.

[6] United Nations Development Programme (2002, p.55)

[7] e.g. Castelló-Climent and Doménech (2008) study the impact of education distribution on democracy

[8] Acemoglu and Robinson (2000)

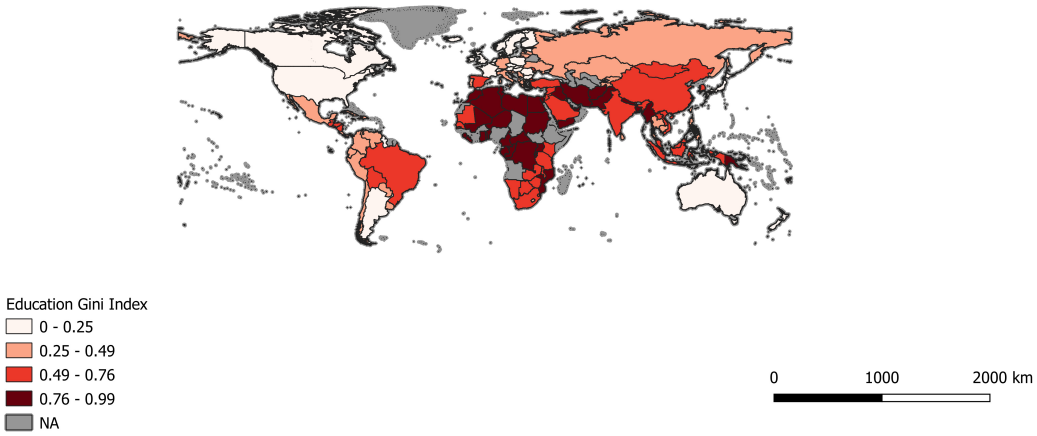
Figure 3.1: Evolution of education inequalities over the period 1950-2010



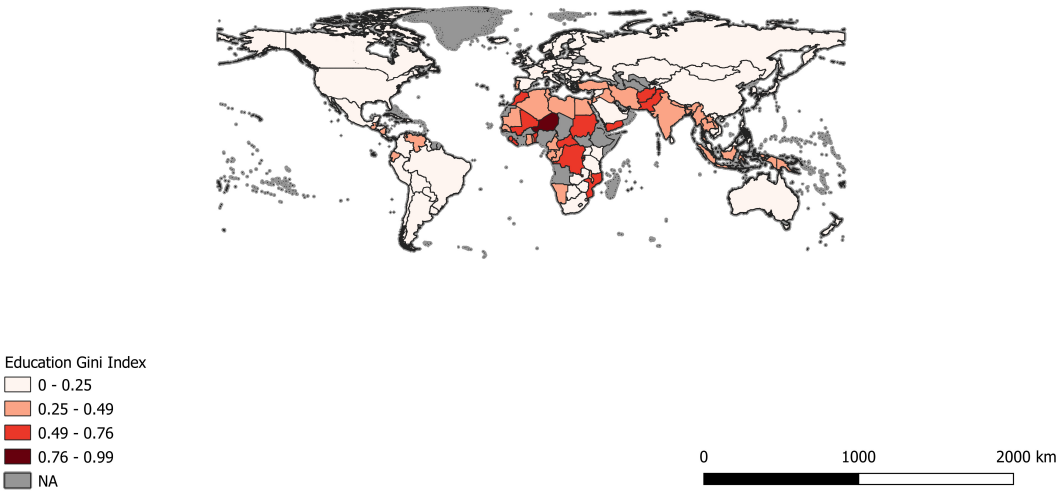
Source: author with Castelló-Climent and Doménech (2014) data set

Figure 3.2: Education inequality

(a) Education inequality in 1960



(b) Education inequality in 2010



Source: author with Castelló-Climent and Doménech (2014) data set

This chapter aims to study the impact of democracy on education inequality. We also investigate the effect of democracy on the components of education inequality (education inequality among the literates and the share of literates).

3.2 Democracy and Education: theoretical and empirical relationships

3.2.1 Theoretical relationships between democracy and education

Redistribution channel

Many theoretical works have pointed out the role of democracy in promoting education. These research are mainly based on "the median voter theorem" and Sen's analysis.

According to "the median voter theorem" (which results from New political economy analysis), the universal suffrage and the majority rule attribute to median voter a decisive role (Meltzer and Richard, 1981) in democratic countries. In fact, the "median voter" is an individual whose ideal point (favorite policy) is median (Laslier, 2003). According to the majority rule, no other policy can be preferred by the majority of voters to median ideal point. This theory assumes that each individual has a favorite policy and wishes that the chosen policy is the closest to its ideal. The higher is the gap between the average and the median income, the higher the amount of taxes and then the redistribution (transfers and public goods provision) he will decide.[9]

In authoritarian regimes, redistribution does not play a decisive role due to the exclusion of all or a substantial part of electorate in the decision process (to avoid the consequences of redistribution policies engender by democracy). Consequently, the size of public sector remains small (Boix, 2001). The large size of public sector in some authoritarian regimes is due to ideological reasons, the desire to preserve power and the increase of regime members' wealth (Glaeser et al., 2007; Vollmer and Ziegler, 2009). However, more redistribution in democracy does not mean that the redistribution is aligned with societal

[9] Vollmer and Ziegler (2009, p.9)

demands. In other words, voting is insufficient to aggregate individual preferences. Moreover, the "median voter theorem" gives a quantitative aspect of redistribution.

According to Sen (1999), democracy behind its values (intrinsic, instrumental and constructive) plays an important role in the development process. Moreover these functions give it (through its instrumental and constructive functions), a role in the formation and aggregation of values, needs and preferences and their translation into well-designed policies benefiting the society. For instance, civil and political liberties, freedom of speech, public debate and criticism permit the formation of preferences, values and access to relevant information. Consequently, a better understanding of societal needs is possible. Democratic procedures favor the transmission of these needs into the political arena where decision power is distributed among the legitimate representatives of the whole society (Vollmer and Ziegler, 2009). In other words, democratic regimes in developing countries give the ability to disadvantaged groups to get voices and be represented even if they are minority or majority. In cases of direct democracy or local democracy, they can even decide themselves. In its pursuit of political objectivity, democracy has to take the form of constructive and efficacious public reasoning (Sen and Scanlon, 2004). It is also protective because control mechanisms (free and fair elections, the compliance with the rule of law) reduce discretionary and corrupt behavior of some political leaders. It incites political and administrative leaders to be responsible and act in favor of society that they represent (Vollmer and Ziegler, 2009).

In autocratic regimes, a small elite dictates the will of upper class. This is accompanied by the repression of the political opposition and the prohibition of free expression and opinion impeding conceptualization of the general will. The state apparatus is at the service of the welfare of the ruling elite. Political measures favorable to well-being of disadvantaged people are only implemented if they strengthen their wealth (Vollmer and Ziegler, 2009)

Democracy can also promote education via political competition. Indeed, according to Eterovic and Sweet (2014) higher political competition is positively correlated to governments which respond more efficiently to the demands of their voters. Since political competition tends to promote more efficient policies, increases in political competition are likely to encourage public investment in policies with the highest social return. Given education

is acknowledged in economic literature as producing a high return, it can be considered as an efficient policy (Eterovic and Sweet, 2014). This assumption is based on spatial voting models (Downs, 1957; Lindbeck and Weibull, 1987) and pressure group models (Becker, 1983).

Several factors may militate against the redistribution effects of democracy. First, the elite i.e. the richer segments of society who stand to lose from increased redistribution can attempt to increase their de facto power (the ability to engage in collective action or use brute force or other channels such as lobbying or bribery[10] to compensate for their reduced de jure power (the type of political power allocated by political institutions such as constitutions or electoral systems[11] under democracy (Acemoglu et al., 2015). This can limit redistribution and/or the potential reduction in inequality. Second, democratization may lead to increase taxes but the resulting revenues could be used in favor of the middle class and not necessarily reduce inequality. Finally, democracy may also be associated with the opening up of new economic opportunities to a large segment of society, which can be an additional source of inequality.[12]

Property rights channel

Protection of property rights is another way through which democracy may affect education. According to Leblang (1996), "To say that an individual has a property right over something simply means—in a legal and practical sense—that an individual can say a thing belongs to him and others will act accordingly. More specifically, we say that an individual has a property right over something if he has the right to control that property, consume that property and alienate (sell) that property". Furthermore, according to North (1990), "economic rules define property rights, that is the bundle of rights over the use and the income to be derived from property and the ability to alienate an asset or a resource". Property rights help to define individual incentives (Leblang, 1996) Secure property rights are then required to encourage investment in physical and human capital.

Several reasons explain why democracy ensures property rights protection.

[10] see Acemoglu (2006, p.326)
[11] Acemoglu (2006, p.325–330)
[12] Acemoglu et al. (2015, p.1901)

First, democratic leaders have broad winning coalitions, and universal property rights protection may thus be a cheaper way for them to ensure their political survival than selective grabbing and redistribution to all their supporters (Bueno de Mesquita et al., 2003).[13] Second, the conditions that are needed to have the individual rights are exactly the same that are needed to have a lasting democracy. Democracy is not viable if individuals, including political opponents, lack the rights to free speech and to security for their property and contracts or if the rule of law is not followed even when it calls for the current administration to leave office. Thus, the same court system, independent judiciary, and respect for law and individual rights that are needed for a lasting democracy are also required for security of property and contract rights. Consequently, the only societies where individual rights to property and contract are confidently expected to last across generations are the securely democratic societies (Olson, 1993). Last, there is a higher degree of political accountability in democracies. In democratic regimes, electorates can vote out leaders they are dissatisfied with the performance of. One would expect many citizens to value a stable, universal property rights framework. Retrospective voting should then discipline democratic politicians to not grab property (Olson, 1993). Given that property rights protection promote human capital and democracy ensure property rights protection, we can support that democracy lead to greater education via secure property rights.

Although the idea that democracy delivers broad access to property rights rather than a narrow one, is well grounded, some theoretical works support that " the idea that democracy protects property rights is a recent invention, and . . . a far–fetched one" (Przeworski and Limongi, 1993). First, democracy may weaken property rights. Indeed, democratization was considered as a threat to secure private property rights in nineteenth-century industrializing Western societies. Conservatives agreed with socialists that democracy, specifically universal suffrage and the freedom to form unions, could be a tool for poor and uneducated electors to redistribute or even collectivise, the private property of wealthy industrialists and landlords (Przeworski and Limongi, 1993; Knutsen, 2011). For instance, David Ricardo argued to "deprive those of the elective franchise against whom it could be justly alleged that they

[13] See Knutsen (2011, p.167)

considered it in their interest to invade [property rights]".[14] He was prepared to extend suffrage only "to that part of them [the people] which cannot be supposed to have an interest in overturning the right to property".[15] Marx (1952) expressed the same opinion that private property and universal suffrage are incompatible. According to him, democracy inevitably "unchains the class struggle". The poor use democracy to expropriate the rich; the rich are threatened and subvert democracy, typically by "abdicating" political power to the permanently organized armed forces. As a result, either capitalism or democracy crumbles[16](Marx, 1934). Second, It is not always clear that nondemocratic regimes can not provide an environment favorable to secure property rights (Bardhan, 1999). For example, the Chinese Nationalist Party named Kuo–Min–Tang (KMT) leadership in Taiwan has provided a reasonably predictable and durable (even though corrupt) contractual environment for private business to prosper, without the procedural formalities of a democracy (Bardhan, 1999). In South Korea, the governments led by Syngman Rhee (from 1948 to 1960) and General Park Chung-Hee (from 1961 to 1979) were authoritarian. However, both regimes guaranteed private property rights (Acemoglu and Robinson, 2013). Given the contradictory debate about the impact of democracy on secure property rights we will focus our theoretical analysis on its redistributive effects.

Modernization theory

Other theoretical works (known as the modernization theory) highlighted the determining role of education in the democratic process. This theory was first promoted by Lipset (1959). In fact, Lipset studied the favorable conditions for the stability of democratic societies and highlighted the role of education in promoting democratic institutions. Thus, a better educated population increases the likelihood of a country's democratization. For example, Lipset's statistics showed that democratic countries in Europe and Latin America had the highest literacy rate (96% and 74% respectively). Furthermore, this theory supports the existence of a relationship between school enrollment and democracy. For instance countries with a low level of education (less than one

[14] Knutsen (2011, p.168)
[15] See Przeworski and Limongi (1993, p.52)
[16] Przeworski and Limongi (1993, p.52)

year) in 1960 remained authoritarian regimes during the period 1960-2000.[17]

Education can have a direct impact on democracy if we take individual behavior into account. For example, the improvement of an individual's education level increases its confidence and its support to democratic values and practices (tolerance for opposition, belief in multiparty system, attitudes toward minorities). As far as Lipset (1959) is concerned, if education is not a sufficient condition for democratization, it may be a necessary condition.

Other theoretical works corroborated Lipset's analysis and identified the channels through which education affects democracy. These principal channels are civic participation and socialization. Indeed, indoctrination in political participation is a main component of education via civic education. Thus, civic education encourages political participation by giving information and the basis to make conscientious judgments. According to Yoldaş (2015), knowledge of politics, political conscientious, and political participation are the goals of education in democratic regimes. Researches (Almond and Verba, 1963; Hyman and Wright, 1979; Nie et al., 1979)[18] highlighted the contribution of education to the "civic culture" for individuals who support democratic institutions. These studies pointed out the enduring effects of education over time (e.g. Hyman and Wright (1979)).[19] This implies that the changes caused in individuals by education are stable and hence, promotes the stability of cultural patterns in favor of democratic political systems (Kamens, 1988). Furthermore, some States' Constitution (e.g. Costa-Rica and Sweden), emphasize the role of school in promoting of citizenship and democracy. According to Glaeser et al. (2007), education increases the society support for democracy because it relies on people with participation benefits for its support.

According to socialization hypothesis, education aims to socialize individuals by teaching how to interact with others. In fact, education facilitates the exchange of information between individuals. Educated people are able to express their knowledge, to inform, to persuade, to acquire new information, to understand, and to learn (Glaeser et al., 2007) According to Bowles and Gintis (1976), schooling teaches the rules of behavior that make discussions

[17] Castelló-Climent and Doménech (2008, p.179)
[18] Kamens (1988, p.116)
[19] Kamens (1988)

more informative and less likely to degenerate into a quarrel.[20] These benefits generated by education, capture its values. Education contributes to reinforce social interactions by coordination. Indeed, the coordination requires members of a groups, abilities to explain and understand. Social interactions result from coordination. Then education socialize young individuals and political involvement is also a form of socialization.

3.2.2 Empirical relationships between democracy and education

From democracy to education

Empirical relationships between education and democracy have been the subject of an abundant literature. Thus, Brown (1999) and Gallego (2010) highlighted the positive impact of democracy on primary education (measure by primary rate enrollment).

Democracy has a positive impact on secondary education. Indeed, several studies have pointed out its role on secondary education (Lake and Baum, 2001; Acemoglu et al., 2015). Furthermore, empirical studies have identified education as a transmission channel linking democracy and growth (Tavares and Wacziarg, 2001; Baum and Lake, 2003; Gründler and Krieger, 2016; Acemoglu et al., 2019). The effect of democracy on education was also the subject of studies at regional level. In this way, Bittencourt (2014) highlighted the determining role of democracy on education (number of teachers per 100 pupils in secondary education and secondary school enrollment) in SADC (Southern African Development Community) over the period 1980-2009. His study employed Fixed Effects and Fixed Effects with Instrumental Variables[21] estimators. Eterovic and Sweet (2014) examined in a article the relationship between voting institutions (political competition), changes in the franchise (electoral participation), and education outcomes (school enrollment) in 18 Latin American countries from 1920 to 2000. They fond that that democracy has a positive effect on education enrollment and highlighted the important democratic sub-components, specifically, who votes and how. They found that an increase in political competition (from low to high) is accompanied by an

[20] Glaeser et al. (2007, p.82)
[21] to take reverse causality into account

increase in total educational enrollment of about 1.135% points of the total population. Similarly, an increase in electoral participation (from 0 participation to 50%) results in an increase in educational enrollment of approximately by 0.9% points of the total population. Their paper also point out that the enfranchisement of women led to increases in enrollment in higher education while the enfranchisement of illiterates led increased primary education enrollment.

But Lott (1999) pointed out the positive impact of totalitarianism (measure by political freedom and civil liberty) on education (current educational expenditures per capita). Mulligan et al. (2004) in an article about the difference between democracies and non-democracies in public policies, do not find evidence that democracy (democracy index of POLITY IV data) affects education spending in their sample of 142 countries between 1960 and 1990. Murtin and Wacziarg (2014) also find little evidence that democracy leads to higher education attainment in an article about the relationships between development (GDP per capita and education) and democracy over the period 1870-2000. In fact, their results revealed that the impact of democracy on education is not significant in the presence of the level of development. Moreover, they endorse the modernization theory. Dahlum and Knutsen (2017) in a study on the relationships between democracy (measure by polity2) and education quality (composite measure from Angrist et al. (2013) that aggregates both primary and secondary-level test-score performances for mathematics, reading, and science) find no clear evidence of any relationship between democracy and education quality.

Palma and Reis (2018) by using a random sample of 4600 and over individuals from military archives in Portugal shown that the authoritarian regime of Estado Novo (1933-1974) have had a positive effect on education outcome (literacy) relative to the limited impact of the democracy which preceded it. Indeed, according to this study, an individual under the regime of Estado Novo ("New State") was only about half as likely to be illiterate relative to the Republic.

From education to democracy

Several empirical research corroborated the "Modernization theory". Thus, Lipset (1959), by comparing education levels (literacy rate, enrollment rate

for primary, secondary and high education) of European and Latin American countries, found that the most democratic countries had the higher levels of education. In an article about the impact of economic development on democracy, Barro (1999) pointed out the positive effect of education (primary school attainment) on democratization. This study focused on a sample of 100 countries from 1960 to 1995 and used the Seemingly Unrelated Regression (SUR) method. This method is used when the error terms of individual equations are correlated. He also showed the negative effect of the gap between male and female primary schooling on democracy. The positive impact of education on democracy was also highlighted by Glaeser et al. (2004) in an article about the relationships between political institutions, human capital and growth.

But Acemoglu et al. (2005) noticed the fragility of these results. Indeed, they underlined that relationship is based on cross-sectional correlation and do not take into account within variations. This bias is due to omitted factors influencing both education and democracy. So, inclusion of individual fixed effects invalidates the robustness of results. They conclude that there is no evidence that countries with an increase in their education levels are likely to become democratic.

However, Acemoglu et al.'s econometric method was the subject of criticisms. First, the instruments used by Acemoglu et al. (2005) were considered weak. In fact, they used the first-difference Generalized Method of Moments (GMM) estimator. This method employs the lagged dependent variable as an instrument. But according to Blundell and Bond (1998), lagged variables are wake instruments if endogenous variables are persistent [22]. According to Castelló-Climent and Doménech (2008), education levels differ from a country to another but remain stable over time (for each country). Moreover, 36 countries in the sample of Acemoglu et al. (2005) have the same value of democracy (measured by the political right index) in 1970 and 2000. Given the persistence of the variables education and democracy, their lagged variables are weak instruments (Bobba and Coviello, 2007). Weak identification is also a criticism made against Acemoglu et al. (2005). According to Bobba and Coviello (2007), given the prospective nature of investment in human capital, education is an endogenous variable and its impact on democracy is weakly identified.

[22] Castelló-Climent and Doménech (2008, p.181)

Following these reviews, other econometric methods were used by economic literature to study the impact of education on democracy. These studies challenged the results of Acemoglu et al. (2005). So, Bobba and Coviello (2007) and Castelló-Climent and Doménech (2008) by using GMM system estimator, pointed out the positive and significant effect of education on democracy. Furthermore, Castelló-Climent and Doménech (2008) supports that a more redistribution of education (measured by the 3rd quintile of education, the Gini coefficient of education and the ratio between the top and the bottom quintile of education computed by Castelló and Doménech (2002)) promote democracy. Balaev (2014) suggests that most of determinants of democracy have a lagged effect rather than an immediate effect. For example, during high school, young adults acquire knowledge that make them active citizens. This ability leads to questioning the political institutions as well as civil and political engagement. But several years are necessary for a young adult to go through high school, reach the voting age and begin his involvement in political life. Consequently, education level in time t influences democracy in time t+n and not in time t.[23] However, the university enrollment may have in addition to delayed effects, a direct effect on democracy. The empirical results show that education produces continuous effects regardless of the timing. In other words education improves democratization in short, medium and long term. Empirical research by Crespo-Cuaresma and Oberdabernig (2014) (using a probit model) also concluded to the important role played by education (measured by educational attainment), demographic structure, and education inequalities (Gender gap and age difference in education) in the transition toward sustainable democracy.

3.3 Empirical analysis of the effects of democracy on educational inequality

3.3.1 Data and empirical method

In order to study the empirical relationship between democracy and educational inequality, we use a quinquennial unbalanced data set covering 112

[23] Balaev (2014, p.173-174)

countries (71 developing countries[24] and 41 high income countries[25]) from 1960 to 2010.

3.3.1.1 Dependent variable

Our dependent variable is the education Gini index for persons aged 15 and over. This index measures the inequality of schooling in relative term (Digdowiseiso, 2010). Gini coefficient is a measure of mean standardized deviations between all possible pairs of persons and lies in a range between zero and one. This index was computed by Castelló-Climent and Doménech (2014) and Castelló-Climent and Doménech (2021) using the educational attainment levels from Barro and Lee's(2013) data set. This source uses information from national censuses, as well as United Nations Educational, Scientific and Cultural Organization (UNESCO) data to estimate the percentage of adult population that has achieve different levels of education (Torpey-Saboe, 2019). The methodology used to construct this database consist in filling the missing observations by backward and forward extrapolation of the census data on attainment levels by age group with an appropriate lag. It also constructs new estimates of mortality rates and completion ratios by education and age group. Castelló-Climent and Doménech applied the following formula:

$$Ginih = \frac{1}{2\bar{H}} \sum_{i=0}^{3} \sum_{j=0}^{3} |\hat{x}_i - \hat{x}_j| n_i n_j \tag{3.1}$$

Where $\bar{H}$ is the average schooling years in the population aged 15 years and above, n_i and n_j are the shares of population with the respective levels of education i and j, $\hat{x}_i$ and $\hat{x}_j$ refer to the cumulative average years of schooling of each educational level. Four levels of education are considered as depicted in table3.1

The educational Gini coefficient ranges from zero to one. A value of zero indicates a perfectly equally distributed education structure (This case corresponds to a situation in which the whole population attains the same education level). In the other hand, a value of one indicates a perfect unequal distribution (In this case, one person completes for example tertiary education, while

[24] low and middle income countries according to The World Bank
[25] according to The World Bank

Table 3.1: Categories of educational attainment

level	Category	Definition
0	no schooling	Anyone who completed less than one year of primary school
1	primary education	Incomplete and complete primary
2	secondary education	Lower and upper secondary
3	tertiary education	Incomplete and complete tertiary

Source: Barro and Lee (1993, 2013)

the rest of the population does not attain any formal schooling).[26]

The education Gini index can be decomposed into a combination of two components. The first component is the education Gini coefficient among the literates such as:

$$Ginih^{LIT} = \frac{1}{2\bar{H}^{LIT}} \sum_{i=0}^{3} \sum_{j=0}^{3} |\hat{x}_i - \hat{x}_j| n_i^{LIT} n_j^{LIT} \tag{3.2}$$

where $\text{Ginih}^{\text{LIT}}$ is the educational Gini index among the literates, n_i^{LIT} the share of literates and equal to $\frac{n_i}{1-n_0}$ and $\bar{H}^{LIT}$ is the literates' average years of schooling. The second component (n_0) is the share of population with no schooling (used as a proxy of illiterates by Castelló-Climent and Doménech. This variable was taken from Barro and Lee's(2013) data set.

The Gini indexes measures the relative inequality of schooling distribution based on school attainment (which is considered as a stock variable). It capture access to education.[27] It is a quantitative output indicator. But this index does not take into account the quality of education (e.g. cognitive and performance). The education Gini index is also level-dependant, meaning that it depends on the average years of school completed (Petcu, 2014; Frankema and Bolt, 2006). This metric tends to be higher in countries where a bigger share of the population has no schooling. In effect, the gap between people who completed primary schooling and no schooling is higher than the gap the gap for people who completed secondary education but not tertiary education (Petcu, 2014). The gap is then very prominent when someone has no schooling so it makes the discrepancy bigger, thus causing a higher educational Gini, as

[26] Sauer (2016)
[27] Torpey-Saboe (2019)

that person's level of accumulated education is only 0.[28]

The first Education Gini index based on educational attainment was derived by Lopez et al. (1998) for 12 countries. The previous educational Gini index was based on school enrollment or education finance data (e.g. Rosthal (1978); Maas (1982); Sheret (1988). However, enrollment ratios are flow variables that measures access to education (Crespo-Cuaresma et al., 2013; Thomas et al., 2001). It does not capture the degree of inequality in educational outcomes, that is, in the stock of human capital (Crespo-Cuaresma et al., 2013).

The Standard deviation of schooling is also a measure of educational inequality. It was used in the earliest studies on education inequality (Ram, 1990; Birdsall and Londono, 1997; Inter-American Development Bank, 1998). and applied to test the existence of an Education Kuznets Curve. But standard deviation of schooling is only a measure of absolute dispersion. It does not provide a consistent picture of the distribution of education outcomes across individuals especially for countries with very low and high levels of average schooling (Crespo-Cuaresma et al., 2013, 2012). It does not control for differences in the mean of the distribution (Castelló and Doménech, 2002). Furthermore, according to Thomas et al. (2001), education Gini is the better measurement for the distribution of education.

3.3.1.2 Democracy variables

Polity2: Our democracy variable is the polity2 indicator from the PolityV database. This index is a combination of democracy and autocracy indicators of PolityV. This variable is a modified version of the polity variable added in order to facilitate the use of the polity regime measure in time-series analyses (Marshall and Gurr, 2020). The Democracy indicator is conceived as three essential, interdependent elements. The first is the presence of institutions and procedures through which citizens can express effective preferences about alternative policies and leaders. Second is the existence of institutionalized constraints on the exercise of power by the executive. Last, the guarantee of civil liberties to all citizens in their daily lives and in acts of political participation.

As for autocracy, it refers to following characteristics: First, the restriction

[28] Petcu (2014, p.15)

or suppression of competitive political participation. The chief executives are chosen in a regularized process of selection within the political elite, and once in office they exercise power with few institutional constraints (Marshall and Gurr, 2020; Marshall et al., 2016).

Additionally to autocracy and democracy, polity2 take into account interruption (occupation by a foreign country), interregnum (falling down of political authority) and transition (period between two political regimes that are substantially different) periods. The polity2 score ranges from -10 (strongly autocratic), to 10 (strongly democratic). and available since 1800. It captures the degree of democratization. To make the interpretation easier, we normalized the polity2 score from 0 (highly autocratic) to 1 (highly democratic) by using a Max-Min formula. Polity2 is one of the most frequently used democracy indices in current research.

Due to its broad chronological (1800-2018) and geographical scope (167 countries), polity2 Index is one of the most frequently used democracy indices in current research. It is coded on a nominal or ordinal scale. Moreover, one of the strongest advantages of the PolityV Data set is the availability of the disaggregate data. This enables the breakdown of Polity2 into its components. However, polity index presents some limits. First, the polity index seems to embrace the minimalist democracy definition (although it is a measure of political contestation) with contestation and participation.[29] This narrow concept of democracy insufficiently distinguishes between autocratic, democratic, and hybrid regimes.[30] Furthermore, according to Glaeser et al. (2004), Polity variables provide an assessment of electoral outcomes over time and not a measure of actual political constraints on government. For instance, when countries have inconsistent electoral experiences, their scores fluctuate wildly.[31] Second there is no theoretical justification given for polity weighing and aggregation rule. Indeed, each of component (e.g. competition, participation, the constraints on the exercise of power etc) variable is coded using three or more categories. However, all of the categories are not taken into account when calculating the democracy/autocracy and consequently the polity index (Boese, 2019). Last, the value "0" of polity2 can occur in three different cases. The first is the case in which country's autocracy score equals its democracy

[29] see Boese (2019)
[30] Munck and Verkuilen (2002)
[31] Glaeser et al. (2004, p.277)

score. The second is a given year of a transition period where the a country is undergoing. The last case is year in which a total collapse of central political authority occurs the country is assigned a Polity2 value of "0". The meaning behind this particular "0" is rather different from the others and it renders differences between Polity2 values impossible to interpret (Boese, 2019).

Political Rights: To check our results robustness we use Freedom House's political Rights index. This index is used in literature to measure democracy (Barro, 1999; Acemoglu et al., 2005; Castelló-Climent and Doménech, 2008). According to Gastil (1987), " Political rights are rights to participate meaningfully in the political process. In a democracy this means the right of all adults to vote and compete for public office, and for elected representatives to have a decisive vote on public policies". The political Right index takes into account electoral process, political pluralism and participation, and functioning of government (Freedom House, 2014). It ranges from 1 (the greatest degree of freedom) to 7 (smallest degree of freedom) and has been available since 1972. This index is generally supplemented in literature (e.g. Barro (1999); Acemoglu et al. (2005); Castelló-Climent and Doménech (2008)) with Political democracy index from Bollen (1980, 1990) for 1960 and 1965. The Political democracy index is the average of six indicators (Press Freedom, Freedom of Group Opposition, Government Sanctions, Fairness of Election, Executive Selection and Legislative Selection)[32]. As in economic literature, we also normalize reversed Political rights index (completed with normalized Political democracy index for 1960 and 1965 and range it from 0 (highly autocratic) to 1 (highly democratic). One of the most criticized aspects of the Freedom House data is the compilation of components by means of checklist questions without a theoretical justification (Boese, 2019). In fact, the components are not ordered by level of abstraction and the relationship between the components is not considered. According to Coppedge et al. (2011) "the high inter-correlations of the Freedom House indicators coupled with their ambiguous coding procedures suggest that these components may not be entirely independent of one another". Second, there are no clear cut answers for the checklist questions. Indeed, given the questions are formulated in a way as to capture highly subjective features, the lack of clear answers transmits this problem of subjectivity further into the data (Cheibub et al., 2010;

[32] Bollen (1980, p.376)

Boese, 2019). Last, Freedom House uses an inappropriate aggregation rule of addition - equal weighing (Boese, 2019; Gründler and Krieger, 2016). In effect, according to Boese (2019), "Assigning equal weights to each question asked/concept contained is disputable in light of their content". This aggregation rule does not capture the complementarity of the concepts participation and contestation. Furthermore, there is no theoretical justification of Freedom House aggregation strategy (Gründler and Krieger, 2016).

Support Vector Democracy Index (SVDI): we also use the Support Vector Democracy Index (SVDI) to check our results robustness. This indicator was developed by (Gründler and Krieger, 2016; Gründler and Krieger, 2018). This indicator is based on a narrow concept including political participation, political competition, and civil rights. This index was computed by using an aggregation method based on a machine learning technique called the Support Vector Machines (SVM) algorithm (Gründler and Krieger, 2016; Gründler and Krieger, 2018). SVM allows to transfer the problem of aggregation into an optimization context, estimating the most appropriate function (Gründler and Krieger, 2016; Gründler and Krieger, 2018). It aims at revealing an unknown functional relationship that link a set of input to an outcome for all observations in the sample. In contrast to conventional tools of statistical modeling such as Ordinary Least Squares (OLS) or Generalized Methods of Moments (GMM), machine learning techniques do not require prior assumptions about the shape of the functional relationship. They rather learn without being explicitly programmed (Gründler and Krieger, 2016; Gründler and Krieger, 2018). SVM has three major advantages compared to conventional aggregation techniques: first, assumptions about the functional relationship between the characteristics and the degree of democratization are not necessary. Second It allows to compute continuous and dichotomous measures without manual adjustments for any concept of democracy. Last, a distribution of indicators can be produced to provide indication of measurement uncertainty.[33] SVDI is continuous on the interval from 0 to 1 and covers 186 countries from 1960 to 2014.

V-Dem Electoral Democracy Index, Polyarchy (v2x_polyarchy): We employ this index to check our results robustness. This variable is from the Varieties of Democracy (V-Dem) database. V-Dem is a new approach to the

[33] Gründler and Krieger (2018, p.9)

conceptualization and measurement of democracy. This database is assembled by a cooperation of scholars from all over the world, co-hosted by the University of Gothenburg (Sweden) and University of Notre Dame (USA). The V-Dem database provide a multidimensional concept consisting of five distinct dimensions, with no overlapping attributes. These components are: electoral, liberal, participatory, deliberative and egalitarian (Lindberg et al., 2014; Kasuya and Mori, 2019; Boese, 2019; Coppedge et al., 2020). The electoral component of democracy embodies the core value of making rulers responsive to citizens through competition for the approval of a broad electorate during periodic elections. Lindberg et al. (2014). This index is considered fundamental to all other measures of democracy. in effect, in the V-Dem definition of democracy, the electoral dimension is circled out as the core element without which no country shall be labelled democratic (Boese, 2019). Therefore, the Electoral Democracy Index is combined with the high level indices of dimensions to create four indices of democracy (the Liberal Democracy Index, the Participatory Democracy Index, the Deliberative Democracy Index and the Egalitarian Democracy Index).[34] Furthermore, countries can have "democratic qualities" without being complete polyarchies (Coppedge et al., 2017). These reasons justify the choose of V-Dem Electoral Democracy Index, Polyarchy.

The V-Dem Electoral Democracy Index, Polyarchy, reflects the minimalist democracy definition of contestation and participation (Boese, 2019). It joins complementarity and substitutability by averaging the additive and multiplicative polyarchy indices. These indices include freedom of association, clean elections and suffrage. This index is continuous and ranges from 0 to 1. According to Boese (2019) "with the public availability of disaggregate and aggregate data, theoretical justification for the detailed aggregation rule and comprehensive spatial and temporal coverage, the V-Dem data set provides the most well-documented and well-grounded collection of democracy measures available today". The V-Dem data set is very transparent due to fact that it provides disaggregate data. It cover 202 countries and available since 1789.

An alternative dichotomous measure of democracy has been developed by some authors (Alvarez et al., 1996; Cheibub et al., 2010) who argue that a

[34] see Boese (2019)

simple dichotomy between democracy and non-democracy is the most useful empirical definition. According to these authors, democracy is a regime in which some governmental offices are filled as a consequence of contested elections. Thus, a regime is classified as a democracy if it meets the following criteria: first, The chief executive must be chosen by popular election or by a elected body. Second, the legislature must be popularly elected. Third, there must be more than one party competing in the elections. Last, an alternation in power under electoral rules identical to the ones that brought the incumbent to office must have taken place (Cheibub et al., 2010).

Boix et al. (2012), also developed a dichotomous measure of democracy based on both on contestation (the executive is directly or indirectly elected in popular elections and is responsible either directly to voters or to a legislature and the choice of legislature or the executive (if elected directly) through free and fair elections) and participation (a majority of adult men has the right to vote). The dichotomous measures of democracy enable a clear discussion of transition from and to democracy (Acemoglu, 2006). However, according to Przeworski et al. (2000), a country can not be democratic unless a political party has been observed to lose the power. This means that some countries like Botswana (since its independence) and Japan (for most of the post-second World War until the defeat of the Liberal Democratic Party) have never been democracies even though all agree that elections are free and fair, that there is free entry into politics and that the government is accountable to the people. In fact, in these countries the party in power (Botswana Democratic Party[35] and Liberal Democratic Party) have rarely lose elections.[36] The dichotomous measures of democracy also contradicts the broad consensus that cultivation of a democracy is a process which occurs over a longer period of time. Treating each country-year as equally (non)democratic neglects information about the process of democratization and results in a severe upward bias in empirical estimations (Doucouliagos and Ulubaşoğlu, 2008; Gründler and Krieger, 2016). Finally, The binary measures of democracy do not allow for a nuanced distinction between different countries (Gründler and Krieger, 2016).

[35] party in power in Botswana
[36] Acemoglu (2006, p.51)

3.3.1.3 Control variables

Other variables that we expect to have an impact on education inequality have been taken into account

The logarithm of real GDP per capita at chained PPPs in US Dollars: This variable is provide by Penn World Table (PWT) dataset. It capture relative living standards across countries and over time (Robert C. Feenstra, 2021). In effect, relatively wealthy nations are able to devote greater resources to education (then decrease education inequality) than countries with low income levels. Moreover, Thomas et al. (2001) and Mesa (2007) found a negative association between education inequality and per capita GDP.

Public spending on education: This variable measures the ratio of government expenditure on education in percentage of GDP. It is a proxy to capture the government support on education or public provision on schooling. This variable come from the World Bank's WDI and IMF[37] database. We expect that public spending on education is an equalizer of education inequality.

Income Inequality measured by Gini index from the World Income Inequality Database (WIID). This variable captures the distribution of income. Income inequality can disequalizes inequalities in education because in more unequal societies, more people cannot afford to spend on education (Vollmer and Ziegler, 2009).

Urbanization measured by urban population rate from the World Bank's WDI database may also impacts education inequality. Indeed, urbanization itself can provide a concrete agenda of development by addressing critical issues involving all aspects of economic, political and social life as well as human development (Mayer-Foulkes, 0011). Urbanization lowers the cost of education for individuals and government. In fact, it is easier to provide schools and teachers in large cities than in dispersed rural communities. Moreover, the proximity of schools to the students reduce transportation costs (Torpey-Saboe, 2019). Furthermore, The returns on education are higher in an urban society, due to greater demands for skilled labor (Glaeser and Maré, 2001; Torpey-Saboe, 2019). Last, a government may be more likely to respond to the demands of an urban population rather than a rural since an urban population is better able to overcome the collective action problem and overthrow

[37] International Monetary Fund

the regime.[38]

Gender parity in education:To capture Gender gap in education, we use the Gender Parity Index for gross enrollment ratio in primary, secondary and tertiary school. This index is the ratio of female to male enrollment. It is available for each level of schooling. These indicators come from the World Bank's WDI database. According to the literature Gender gaps in education are clearly related to the education inequality (Thomas et al., 2001; Mesa, 2007). For example according to Mesa (2007), shows that in Philippines Gender gap in education contribute to around 50% of education inequality. As these indicators capture the proportion of female enrollment, we expect a negative impact of these variables on education inequality.

3.3.2 Empirical strategy

To estimate our model, we use fixed effects model to account for individual characteristics. Accordingly, we use the following econometric equation.

$$Ginih15_{it} = \beta_0 + \beta_1 Democracy_{it} + \beta_2 X_{it} + \varepsilon_{it} \tag{3.3}$$

Where $\text{Ginih15}_{\text{it}}$ is the educational Gini index in the population aged 15 years and above, $\text{Democracy}_{\text{it}}$ is level of democracy and X_{it} is the matrix of control variables. ε_{it} denotes the error term. β_1 and β_2 refer to parameters. β_0 is a constant.

We also take into account the possibility of reverse causality. Education inequality might determine democracy as supported by the "modernization theory" (see 3.2.1) and some empirical studies (Castelló-Climent and Doménech, 2008; Crespo-Cuaresma and Oberdabernig, 2014). An other endogenous variable may also be income inequality. According to economic literature, education inequality is an important determinant of income inequality (Checchi, 2000; Földvári and van Leeuwen, 2011; Petcu, 2014). We can then also hypothesize a reverse causality concerning income inequality. For this purpose, we also estimate our econometric using Fixed effects with Instrumental Variables. As instrumental variable for democracy, we use the lag of democracy which is commonly employed in literature (Bittencourt, 2014). We also use the average level of democracy in nearby countries as an instrumental vari-

[38] Torpey-Saboe (2019, p.43)

able for the domestic level of democracy (Acemoglu et al., 2019; Gründler and Krieger, 2016; Aidt and Jensen, 2014; Dorsch and Maarek, 2019; Dahlum and Knutsen, 2017). We assume that democratization and social unrest that leads to a change of regime often occur in regional waves.[39] For example the fall of the Soviet Union spurred a wave of democratization in Eastern Europe, Central Asia, and Africa in the 1990s. This variable is computed following this formula

$$Z_{i,t}^{r_i} = \frac{1}{|R|} \sum_{j \in R} D_{j,t}^{r_i} \text{ with : } R = \{j : j \neq i, r_j = r_i\} \tag{3.4}$$

Where r_i denotes the region in which country i is located, D the domestic degree of democratization, and Z the regional (jack-knifed) degree of democratization.[40] As an instrumental variable for income inequality, we use lag of income inequality

3.4 Results Analysis

3.4.1 Stylized facts

3.4.1.1 Education inequality

Figure3.3 shows the level of education inequality by region over our study period. The following results can be drawn: South Asia has the highest level of education inequality (0.59). Education inequality is also high in Sub-Saharan Africa (0.57). East Asia and the Pacific and Latin America and the Caribbean countries have close levels of education inequality (respectively 0.32 and 0.31). Education inequality is relatively high in Middle East and North Africa (0.49). Europe and Central Asia has the lowest level of education inequality (0.17). on average the level of education inequality is relatively low (0.35).

Inequality among the literates is relatively low (between 0.12 and 0.17, see figure3.3b). Moreover, on average Latin America and the Caribbean and Middle East and North Africa have the same level of education inequality among the literates (0.17).

South Asia and Sub-Saharan Africa have the highest shares of illiterates

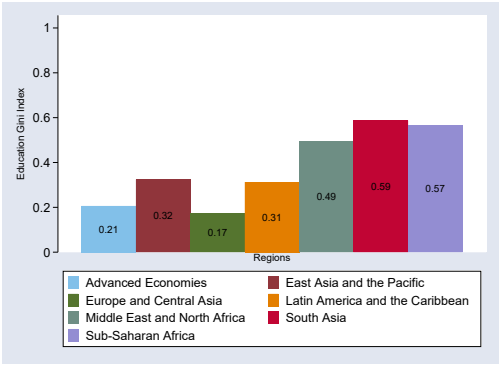
[39] Acemoglu et al. (2019)

[40] we use classification of region of (Gründler and Krieger, 2016)

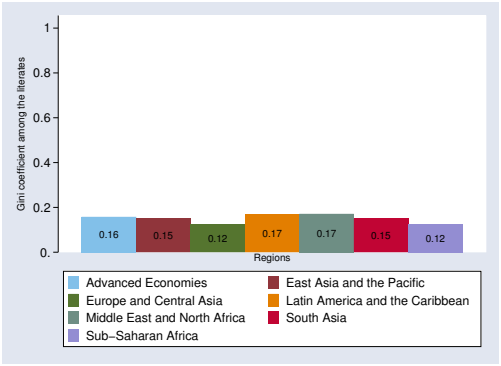
(respectively 52.21% and 51.46%). They are followed by Middle East and North Africa (39.07%) and South Asia (23.86%). Advanced Economies have the lowest share of illiterates.

Figure 3.3: Education inequalities by Region

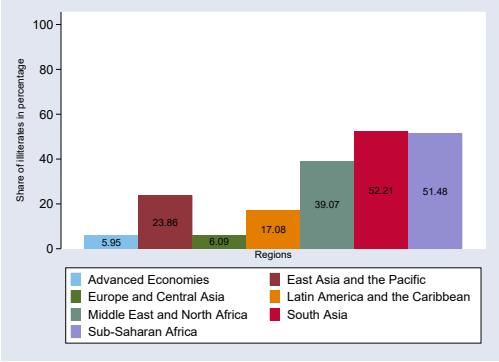
(a) Education inequality



(b) Education inequality among literates

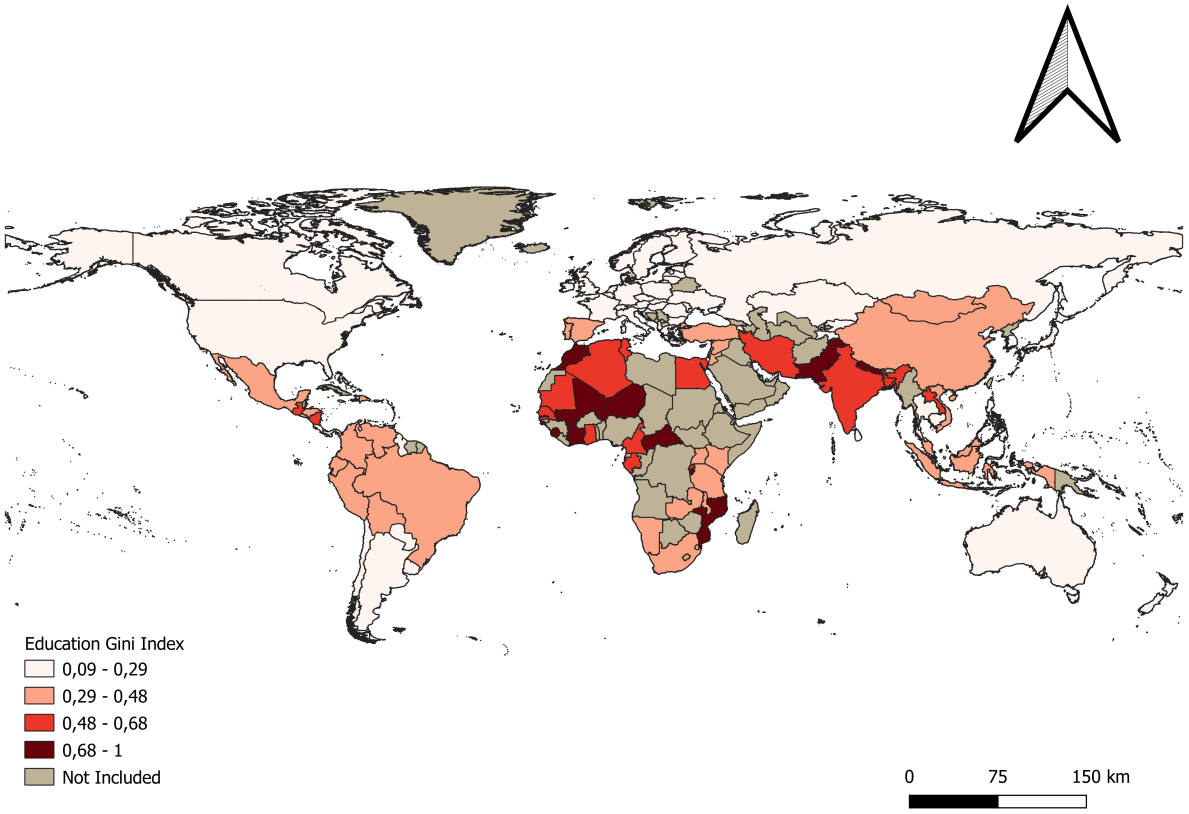


(c) Share of illiterates



Source: author

Figure 3.4: Geographical representation of education inequality over the period 1960-2010

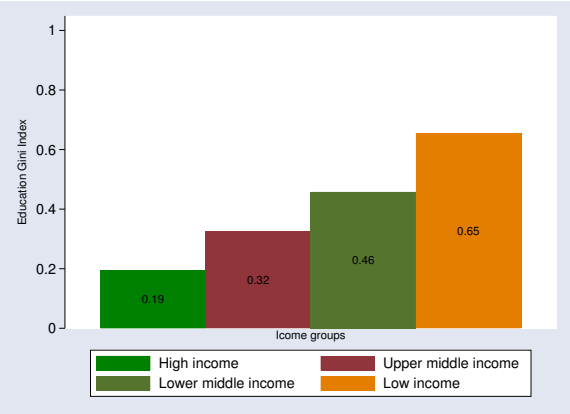


Source: author

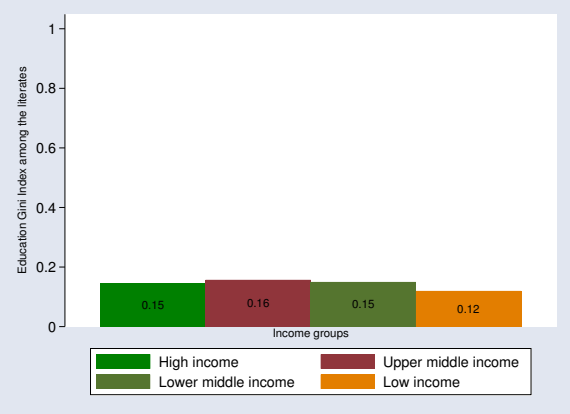
The level of education inequality and share of illiterates is linked to the level of income. In fact, high income countries have the lowest level of education inequality (and share of illiterates) and Low income countries have the highest level of education inequality (see figures 3.5a and 3.5c). Upper middle income countries have the highest level of education inequality among literates. We also notice that high income and lower middle income countries have the same level of education inequality among literates. Low income countries have the lowest level of education inequality among the literates.

Figure 3.5: Education inequalities by income level

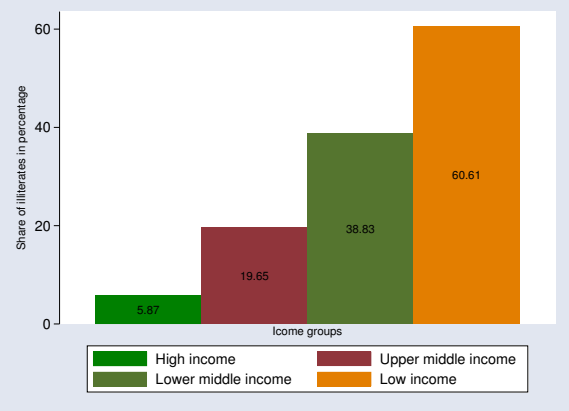
(a) Education inequality



(b) Education inequality among literates



(c) Share of illiterates



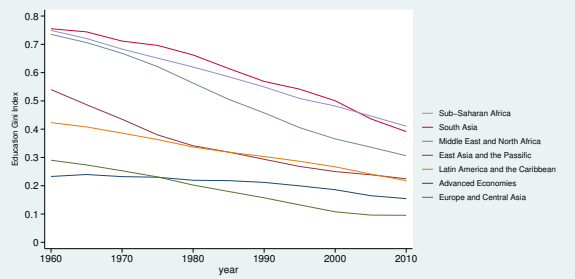
Source: author

Education inequality has greatly gone down worldwide over the study pe-

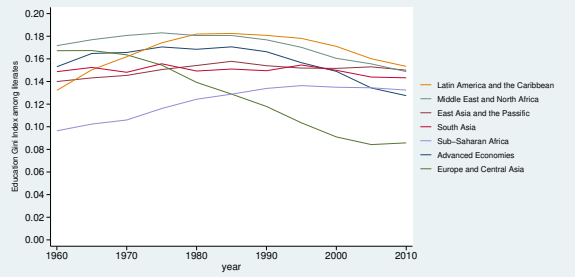
riod (see figure 3.6a). This decrease is mainly due to the spectacular decline of the share of illiterates experienced by all the regions of the world (figure 3.6c). These findings have also been highlighted by economic literature (Morrisson and Murtin, 2013; Castelló-Climent and Doménech, 2014; Castelló-Climent and Doménech, 2021). As for education inequality among the literates, it has decreased in many parts of the world, except in Sub-Saharan Africa where it rose.

Figure 3.6: Evolution of education inequalities by region

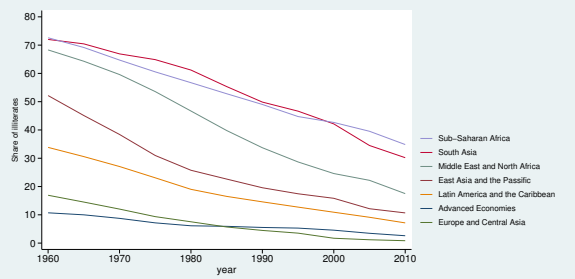
(a) Education inequality



(b) Share of illiterates



(c) Education inequality among literates



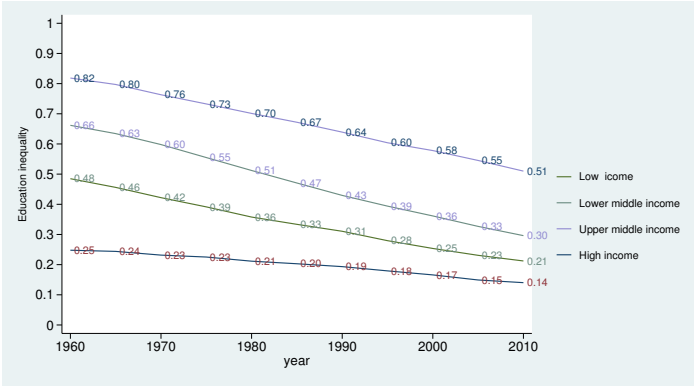
Source: author

Education inequality has deeply decreased in all income levels especially,

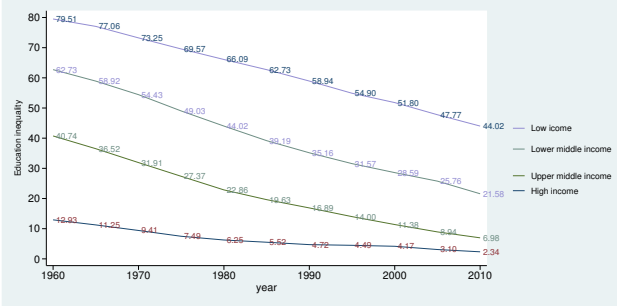
in low income countries (from 0.82 to 0.51 (see figure3.7a). This result is essentially due to improving access to education (see figure3.7b). As for education inequality among the literates, we notice that it has gone down or stable (e.g. lower middle income countries) in most of income groups except in low income countries where it has risen. This result may be due to the unequal distribution of resources. In fact, in these countries it is difficult to poor people to access to higher education because parents have not enough resources to support their children and prevent them. Consequently many student are prevent to continue their studies.

Figure 3.7: Evolution of education inequalities by income level

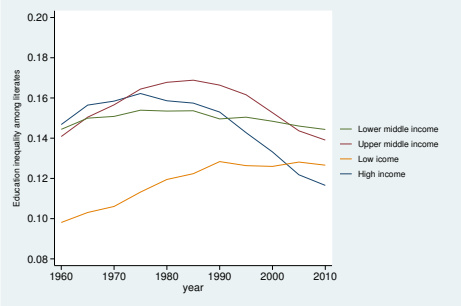
(a) Education inequality



(b) Share of illiterates



(c) Education inequality among the literates



Source: author

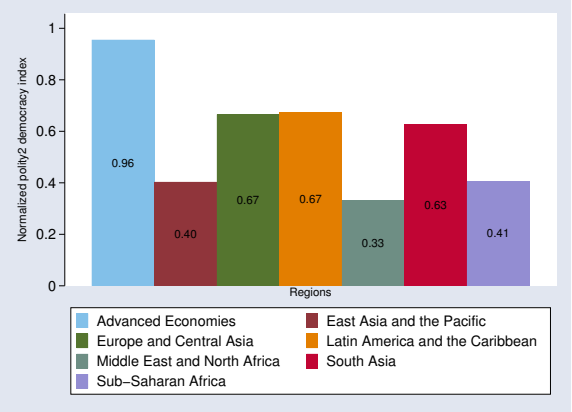
3.4.1.2 Democracy

Advanced economies have the highest level of democracy (0.96). Europe and Central Asia and Latin America and the Caribbean have the same level of democracy (0.67). The level of democracy is relatively high in south Asia

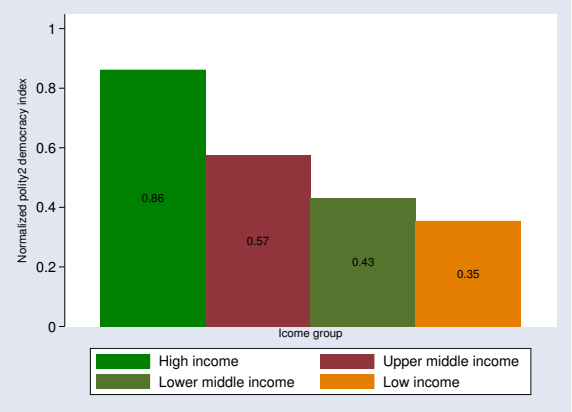
(0.62). Sub-Saharan Africa and East Asia and the Pacific have close level of democracy. Middle East and North Africa is the least democratic area. (figure3.8a). The level of democracy is also linked to the level of income (see figure3.8b). In other words, high income countries are the most democratic (0.87). and low income countries have the lowest level of democracy (0.35)

Figure 3.8: Democracy level by region and income level

(a) Democracy level by Region

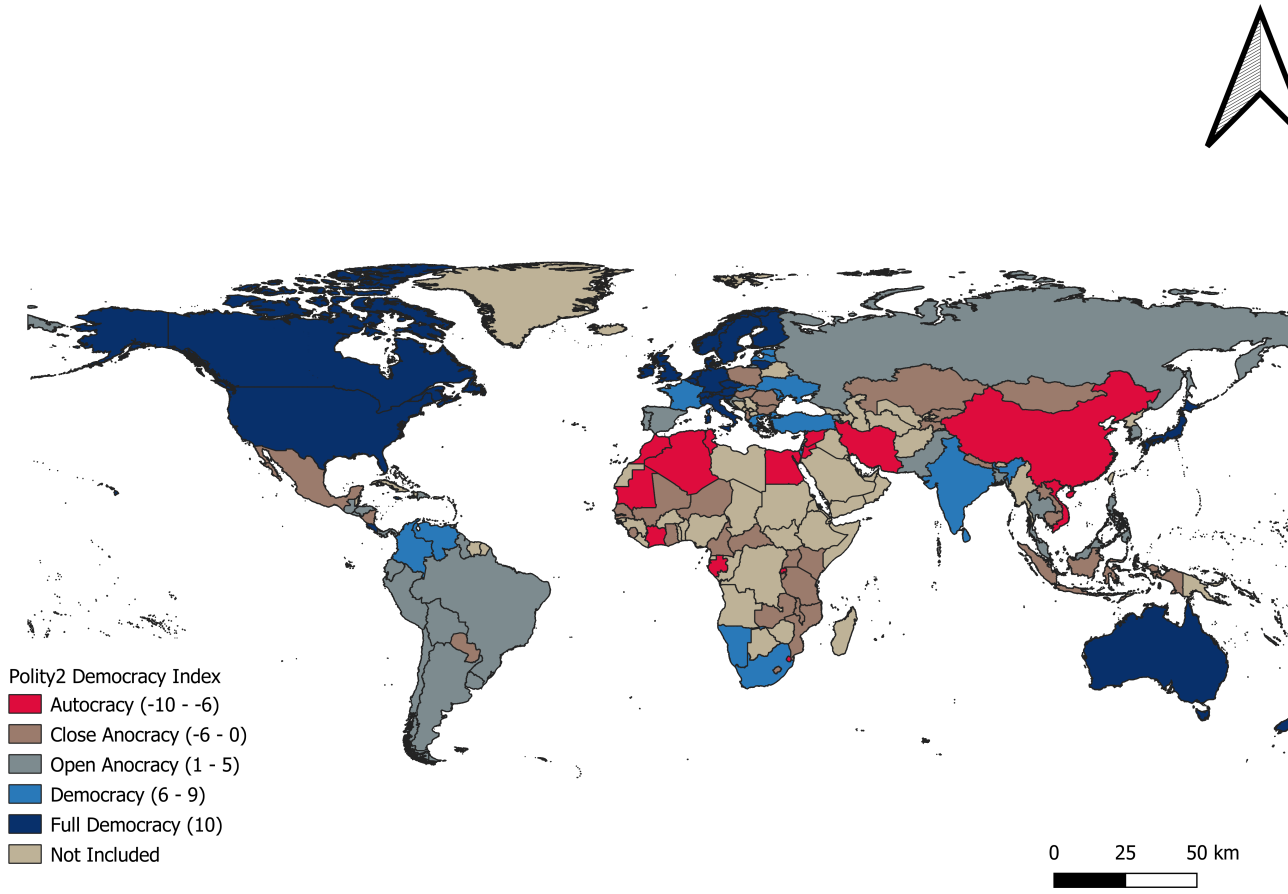


(b) [Democracy by income level



Source: author

Figure 3.9: Geographical representation of polity2 democracy index over the period 1960-2010

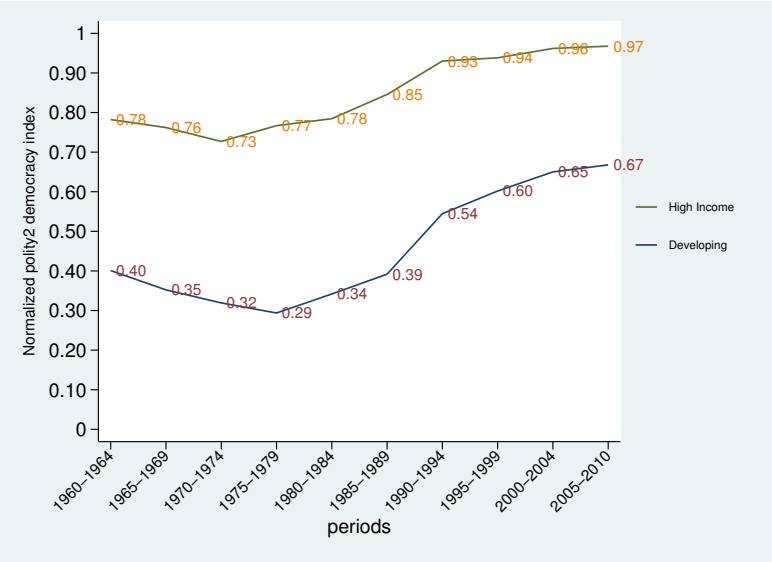


Source: author

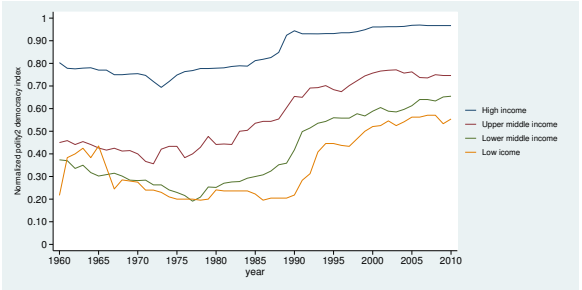
High income countries have known a drop of democracy from 1960 to 1974. However their level of democracy has improved since 1975 (figures3.10a and 3.10b). In developing countries (low and middle income countries) democracy went down from 1960 to 1979. This is due to the reduction of the level of democracy in low and lower middle income countries. (figure3.10b). However the level of democracy in developing world has improved at the begging of years 1980 due to its improvement in middle income countries (see figure3.10b). From the geographical point of view, we can observe large fluctuations of democracy in most areas of the world (see figure 3.10c).

Figure 3.10: Evolution of democracy

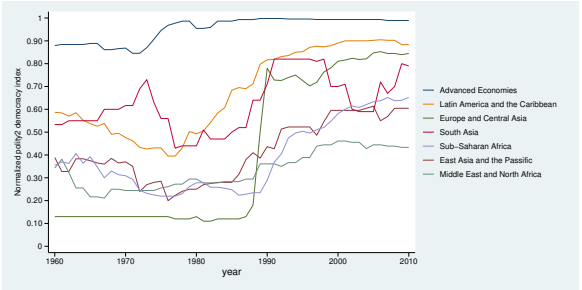
(a) High income and Developing countries



(b) [Income levels



(c) [Regional level



Source: author

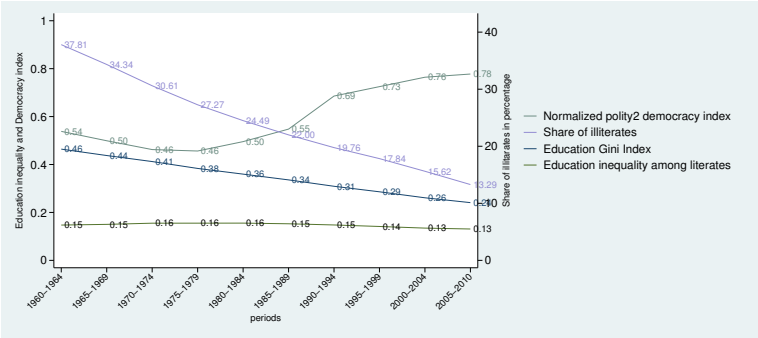
3.4.1.3 Relationship between democracy and education inequality

If we consider the evolution of democracy and education inequality over the studied period, we notice a global improvement of democracy (even if it went down between 1960 and 1974) and a reduction of education inequality (see figure3.11a). As the reduction of education inequality is mainly due to the decline of the share of illiterates, we can hypothesize that the improvement of democracy goes with a reduction of education inequality via more great access to education.

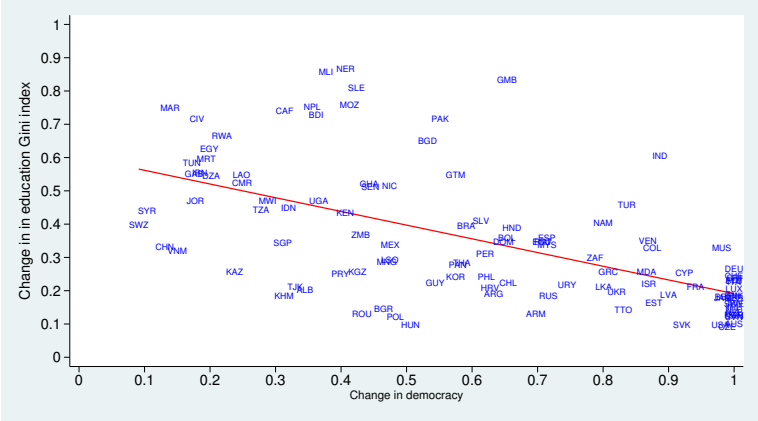
Figure 3.11b show the relationships between democracy and education inequality. From this graph, we observe a negative correlation between democracy and education inequality. In other words, countries with higher level of democracy have the lower level of education inequality and vice versa. However, we notice that some countries with low level of democracy have low level of education inequality This situation may be explained by a better access to education in these non democratic countries due to ideological (former and current communist countries)or economic (non-democratic countries may invest in education to promote economic growth and permit to the regime to keep the power) reasons. Some countries with high level of democracy have high education inequality (e.g. India). This may be explained by the large differences in access to education between different states in India. For example in 2005 over half of the poorest 7 to 16 year old in Bihar state (eastern India) had never been to school (EFA Global Monitoring Report, 2013).

Figure 3.11: Relationship between democracy and education inequality

(a) Evolution of democracy and education inequality



(b) Correlation of democracy and education inequality



Source: author

3.4.2 Empirical Result

We report in table3.2 our estimation results. from these results we can draw the following analysis: first, democracy reduces education inequality even controlling with a set of variables. GDP per capita has a negative and significant effect on education inequality except in presence of gender parity in tertiary school where its value become negligible and insignificant(column 8). Public spending on education has non significant impact on education inequality except in column 6 and 8 of table3.2. in these cases we observe that gender gap in primary and tertiary school rise the impact of public spending on education. We can hypothesize that public spending in education reduces greatly education inequality in countries where access to primary and tertiary school are favorable to women. Income inequality has a positive and significant effect on education inequality. Gender parity in primary and tertiary school have a negative and significant effect on education inequality.

Table 3.2: Estimates results of democracy on education inequality fixed effects estimator

Education Gini Index	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
Democracy	-0.151***	-0.088***	-0.084***	-0.088***	-0.051**	-0.051***	-0.049***	-0.043***
	(-7.075)	(-3.994)	(-3.856)	(-4.033)	(-2.420)	(-2.983)	(-3.115)	(-2.920)
log of GDP per capita		-0.076***	-0.074***	-0.075***	-0.035*	-0.028**	-0.028**	-0.006
		(-5.884)	(-5.634)	(-5.660)	(-1.684)	(-2.066)	(-2.103)	(-0.395)
Public spending on education			-0.404	-0.409	-0.307	-0.598*	-0.550	-0.527*
			(-0.964)	(-1.025)	(-0.800)	(-1.859)	(-1.611)	(-1.669)
Gini Income				0.190	0.211**	0.156*	0.149*	0.191**
				(1.600)	(2.095)	(1.925)	(1.858)	(2.533)
Urbanization					-0.495***	-0.304**	-0.278**	-0.273**
					(-2.895)	(-2.598)	(-2.230)	(-2.348)
Gender parity primary school						-0.503***	-0.441***	-0.431***
						(-7.119)	(-4.207)	(-4.475)
Gender parity secondary school							-0.057	-0.030
							(-0.956)	(-0.570)
Gender parity tertiary school								-0.072***
								(-4.091)
Constant	0.378***	1.020***	1.017***	0.955***	0.831***	1.180***	1.159***	0.960***
	(24.192)	(8.888)	(8.840)	(8.698)	(6.924)	(11.610)	(11.807)	(8.688)
N	410.000	410.000	410.000	410.000	410.000	410.000	410.000	410.000
N_g	107.000	107.000	107.000	107.000	107.000	107.000	107.000	107.000
r2	0.239	0.437	0.440	0.449	0.521	0.703	0.705	0.729
r2_a	0.238	0.435	0.436	0.443	0.515	0.698	0.700	0.724
r2_w	0.239	0.437	0.440	0.449	0.521	0.703	0.705	0.729
r2_b	0.261	0.452	0.456	0.483	0.396	0.578	0.590	0.629
r2_o	0.263	0.447	0.450	0.468	0.400	0.581	0.593	0.630
F	50.054	31.269	21.485	16.779	13.192	34.385	27.946	34.509

t statistics in parentheses

* p<0.1, ** p<0.05, *** p<0.01

Table3.3 reports the effect of democracy on education inequality for some economic groups. From these results we can observe that the improvement of democracy reduces education inequality in all economic areas. We can also notice that the impact of democracy on education inequality is higher in low income and Least Developed Countries (LDCs) compared to the other economic areas. We also observe that in high income countries GDP per capita reduces education inequality. In other area its effect is negligible. Public spending on education reduces education inequality in developing countries particularly in middle income countries. Income inequality increase education inequality except in high income countries where its impact is negligible. Gender parity in primary and tertiary school reduce education inequality in Developing and Middle income countries. As for Gender parity in primary school, its reduces education inequality in low income countries. In other words to reduce education inequality in low income countries policies in favor of girls education in secondary school should be implemented.

In table3.4 we report the effect of democracy on components of education inequality that is education inequality among the literates and the share of population with no schooling. As Castelló-Climent and Doménech (2014), we use the share of unschooled people to capture the share of illiterates. To study the effect of democracy on these variables, we apply our econometric model on the components of education inequality. The results show that democracy has a negative and statically significant impact on the share of illiterates for our whole sample (World), and most of economic area except in middle income countries (its effect is statistically insignificant).Concerning education inequality among the literates, the impact of democracy on this variable is negligible. In fact in for our whole sample and most of the economic areas, the effect of democracy on education inequality among the literate is non significant. Furthermore, the value of its coefficient is very low. Even in low income countries where democracy has a positive and significant effect on education inequality among the literates, the magnitude of the coefficient is very low (0.011). Based on these results we assume that the impact of democracy on education inequality is essentially captured by its effect on illiteracy.

GDP per capita has a negative and significant effect on education inequality among the literates for our whole sample. It has also a negative and

significant effect on both components of education inequality in high and low income countries. In high income countries its effect is the same for both components. In low income countries, its effects is greater on the reduction of illiteracy.

Public spending on education has a negative and significant effect on the share of illiterates in our whole sample and middle income countries. However in Least Developed countries its has a negative and significant effect on education inequality among the literates.

Income inequality has a positive and significant on the share of illiterates for our whole sample and in developing world. However in Least developing countries it has a positive and significant effect on education inequality among the literates.

Gender parity in primary school decreases the share of illiterates in our whole sample, in developing countries especially in middle income countries. In other words, better access to basic education for girls contributes to reduce the share of illiterates and then decreases education inequality. As for gender parity in secondary school, it has a negative and significant effect on share of illiterates for our whole sample, in high income, in developing and least developed countries.

Table 3.3: Estimates results of Democracy on Education inequality by economic group (fixed effects estimator)

Education Gini Index	**World**	**high income**	**Developing**	**Low income**	**Middle income**	**LDCs**
Democracy	-0.043***	-0.044**	-0.043**	-0.051*	-0.041*	-0.067**
	(-2.920)	(-2.154)	(-2.254)	(-1.855)	(-1.790)	(-2.304)
log of GDP per capita	-0.006	-0.047**	0.010	0.016	0.006	0.039
	(-0.395)	(-2.634)	(0.454)	(1.078)	(0.233)	(1.043)
Public spending on education	-0.527*	-0.238	-0.653*	-0.152	-0.872**	0.083
	(-1.669)	(-0.472)	(-1.686)	(-0.253)	(-2.010)	(0.139)
Gini Income	0.191**	0.096	0.294***	0.279*	0.313**	0.272**
	(2.533)	(0.685)	(3.571)	(1.917)	(2.493)	(2.257)
Urbanization	-0.273**	-0.007	-0.430**	-0.430**	-0.423**	-0.673**
	(-2.348)	(-0.063)	(-2.580)	(-2.273)	(-2.372)	(-2.450)
Gender parity primary school	-0.431***	0.214	-0.391***	0.052	-0.437***	-0.071
	(-4.475)	(0.836)	(-2.992)	(0.205)	(-3.139)	(-0.458)
Gender parity secondary school	-0.030	-0.022	-0.049	-0.381*	-0.018	-0.136
	(-0.570)	(-0.346)	(-0.577)	(-2.067)	(-0.212)	(-1.177)
Gender parity tertiary school	-0.072***	-0.028	-0.077***	-0.085	-0.072***	-0.106
	(-4.091)	(-1.178)	(-4.847)	(-1.734)	(-4.523)	(-1.624)
Constant	0.960***	0.504**	0.834***	0.662**	0.872***	0.469
	(8.688)	(2.163)	(5.835)	(2.935)	(5.685)	(1.654)
N	410.000	194.000	216.000	33.000	183.000	53.000
N_g	107.000	39.000	68.000	12.000	56.000	19.000
r2	0.729	0.555	0.812	0.949	0.802	0.908
r2_a	0.724	0.536	0.805	0.932	0.793	0.891
r2_w	0.729	0.555	0.812	0.949	0.802	0.908
r2_b	0.629	0.051	0.485	0.216	0.409	0.001
r2_o	0.630	0.192	0.496	0.246	0.449	0.068
F	34.509	27.227	45.930	902.389	40.875	379.393

t statistics in parentheses

* p<0.1, ** p<0.05, *** p<0.01

Table 3.4: Effect of democracy on education inequality components fixed effects estimator

	World		High Income		Developing		Low Income		Middle Income		LDCs	
	Education Gini index among literates	**Share of illiterates**	**Education Gini index among literates**	**Share of illiterates**	**Education Gini index among literates**	**Share of illiterates**	**Education Gini index among literates**	**Share of illiterates**	**Education Gini index among literates**	**Share of illiterates**	**Education Gini index among literates**	**Share of illiterates**
Democracy	0.008	-0.050***	0.012	-0.067***	0.010	-0.045*	0.017*	-0.067**	0.004	-0.042	0.009	-0.061*
	(1.235)	(-2.681)	(1.465)	(-2.818)	(0.980)	(-1.876)	(2.120)	(-2.311)	(0.360)	(-1.542)	(1.207)	(-1.871)
log of GDP per capita	-0.016***	0.005	-0.032***	-0.032*	-0.003	0.009	-0.011*	0.047*	-0.003	-0.003	-0.017	0.045
	(-2.667)	(0.320)	(-3.096)	(-1.838)	(-0.354)	(0.384)	(-1.953)	(1.849)	(-0.251)	(-0.122)	(-1.598)	(0.886)
Public spending on education	0.153	-0.680*	0.059	-0.240	0.114	-0.717	0.285	0.348	0.107	-1.111**	0.481**	0.476
	(0.899)	(-1.912)	(0.196)	(-0.585)	(0.484)	(-1.544)	(0.992)	(0.354)	(0.399)	(-2.188)	(2.379)	(0.493)
Gini Income	0.037	0.185**	0.049	0.079	0.044	0.291**	-0.037	0.291	0.080	0.318*	-0.070**	0.248
	(0.873)	(2.070)	(0.540)	(0.730)	(1.008)	(2.467)	(-1.021)	(1.457)	(1.274)	(1.900)	(-2.640)	(1.428)
Urbanization	-0.008	-0.317**	0.010	0.084	-0.031	-0.515***	-0.108	0.084	-0.022	-0.505***	0.043	-0.444
	(-0.171)	(-2.365)	(0.183)	(0.716)	(-0.381)	(-2.756)	(-1.234)	(0.240)	(-0.256)	(-2.691)	(0.613)	(-1.728)
Gender inequlity primary school	0.020	-0.434***	0.049	0.225	0.004	-0.300*	0.058	0.233	-0.016	-0.373**	0.017	0.297
	(0.602)	(-3.504)	(0.312)	(1.003)	(0.088)	(-1.885)	(0.908)	(0.620)	(-0.326)	(-2.278)	(0.603)	(1.376)
Gender inequlity secondary school	0.034	-0.118*	0.063	-0.131***	0.020	-0.150	-0.016	-0.536**	0.027	-0.103	-0.017	-0.391***
	(1.227)	(-1.969)	(1.477)	(-2.822)	(0.587)	(-1.668)	(-0.364)	(-2.235)	(0.777)	(-1.188)	(-0.871)	(-3.017)
Gender inequlity tertiary school	-0.031***	-0.056**	-0.025	0.002	-0.023**	-0.084***	0.032	-0.256**	-0.027**	-0.066***	0.028**	-0.233***
	(-2.833)	(-2.418)	(-1.394)	(0.094)	(-2.412)	(-3.439)	(1.732)	(-3.053)	(-2.620)	(-2.688)	(2.470)	(-2.910)
Constant	0.239***	0.854***	0.334**	0.252	0.151**	0.799***	0.180***	0.260	0.148**	0.902***	0.250***	0.234
	(4.630)	(6.734)	(2.224)	(1.130)	(2.298)	(5.144)	(3.119)	(0.664)	(2.186)	(5.542)	(3.278)	(0.575)
N	410.000	410.000	194.000	194.000	216.000	216.000	33.000	33.000	183.000	183.000	53.000	53.000
N_g	107.000	107.000	39.000	39.000	68.000	68.000	12.000	12.000	56.000	56.000	19.000	19.000
r2	0.279	0.698	0.449	0.420	0.117	0.804	0.574	0.912	0.141	0.809	0.606	0.883
r2_a	0.265	0.692	0.425	0.395	0.083	0.796	0.431	0.883	0.101	0.800	0.535	0.862
r2_w	0.279	0.698	0.449	0.420	0.117	0.804	0.574	0.912	0.141	0.809	0.606	0.883
r2_b	0.001	0.727	0.008	0.101	0.010	0.590	0.119	0.332	0.008	0.567	0.020	0.015
r2_o	0.006	0.722	0.088	0.228	0.008	0.593	0.278	0.342	0.014	0.581	0.025	0.136
F	4.994	28.895	7.141	16.726	1.510	51.424	51.728	3459.002	1.725	47.215	13.463	80.853

t statistics in parentheses
* p<0.1, ** p<0.05, *** p<0.01

Table3.5 provides the results of Instrumental Variable estimator (IV). The results also show that democracy has a negative and significant effect on education inequality. Income inequality has a positive but not significant in IV model (column 2 table3.5). Urbanization, gender parity in primary and tertiary school have a negative and significant effect on education inequality for both fixed effects and IV model. The p-value of Hansen J test and Sargan-Hansen test allowed to not reject the validity of our instrumental variables.

3.4.3 Robustness

To test the robustness of our results, we use other democracy indicators, respectively: Freedom House's political Rights index (complement with Political democracy index from Bollen (1980, 1990) for 1960 and 1965), the Support Vector Democracy Index (Gründler and Krieger, 2016; Gründler and Krieger, 2018) and V-Dem Electoral Democracy Index. table3.6 and table3.7 provide our robustness result respectively for fixed effects and IV estimators. Concerning our fixed effects estimators, we notice that apart from Political right index, the other democracy indexes have a negative and significant effect on education inequality. The impact of the Support Vector Democracy Index on education inequality is the highest. The effect of the control variables do not change whatever the democracy indicator.

As far as IV estimator is concerned, the effect of democracy on education inequality is negative and significant whatever the indicator. The effect of V-Dem Electoral Democracy Index on education inequality is the highest. The effect of control variables on education inequality remains the same whatever, the indicator of democracy.

Table 3.5: Estimates results of Democracy on Education inequality Instrumental variable estimator (IV)

Education Gini Index	**(1)** **Fixed effects**	**(2)** **IV**
Democracy	-0.046**	-0.062**
	(-2.496)	(-2.408)
log of GDP per capita	-0.006	-0.006
	(-0.493)	(-0.468)
Public spending on education	-0.317	-0.270
	(-1.001)	(-1.048)
Gini Income	0.152*	0.224
	(1.964)	(1.235)
Urbanization	-0.273**	-0.262***
	(-2.179)	(-2.818)
Gender inequlity primary school	-0.416***	-0.424***
	(-3.427)	(-3.937)
Gender inequlity secondary school	-0.060	-0.047
	(-0.926)	(-0.732)
Gender inequlity tertiary school	-0.074***	-0.077***
	(-3.756)	(-3.921)
Constant	0.980***	
	(11.613)	
N	313.000	291.000
N_g	103.000	81.000
r2	0.747	0.745
r2_a	0.740	0.632
r2_w	0.747	
r2_b	0.587	
r2_o	0.566	
F	25.207	44.217
Ff		
Hansen J statistic		0.588
P-value Hansen J statistic		0.443
Sargan-Hansen statistic		0.498
P-value Sargan-Hansen		0.48

t statistics in parentheses
* p<0.1, ** p<0.05, *** p<0.01

Table 3.6: Robustness check fixed effects estimator

Education Gini Index	**(1)**	**(2)**	**(3)**	**(4)**
Democracy	-0.043***			
	(-2.920)			
log of GDP per capita	-0.006	-0.004	-0.007	-0.004
	(-0.395)	(-0.251)	(-0.502)	(-0.238)
Public spending on education	-0.527*	-0.685**	-0.598*	-0.635*
	(-1.669)	(-2.033)	(-1.900)	(-1.908)
Gini Income	0.191**	0.184**	0.199***	0.180**
	(2.533)	(2.361)	(2.675)	(2.390)
Urbanization	-0.273**	-0.320***	-0.246**	-0.298**
	(-2.348)	(-2.787)	(-2.098)	(-2.521)
Gender inequlity primary school	-0.431***	-0.426***	-0.434***	-0.429***
	(-4.475)	(-4.371)	(-4.612)	(-4.493)
Gender inequlity secondary school	-0.030	-0.040	-0.027	-0.038
	(-0.570)	(-0.711)	(-0.511)	(-0.693)
Gender inequlity tertiary school	-0.072***	-0.076***	-0.070***	-0.074***
	(-4.091)	(-4.247)	(-3.885)	(-4.125)
Freedome house political right index		-0.020		
		(-1.655)		
supper vector democracy index			-0.045***	
			(-3.317)	
V-dem Electoral democracy Index				-0.036**
				(-2.049)
Constant	0.960***	0.967***	0.958***	0.958***
	(8.688)	(8.553)	(8.696)	(8.466)
N	410.000	410.000	410.000	410.000
N_g	107.000	107.000	107.000	107.000
r2	0.729	0.720	0.734	0.722
r2_a	0.724	0.714	0.729	0.717
r2_w	0.729	0.720	0.734	0.722
r2_b	0.629	0.610	0.643	0.618
r2_o	0.630	0.608	0.642	0.617
F	34.509	35.012	34.514	34.444

t statistics in parentheses

* p<0.1, ** p<0.05, *** p<0.01

Table 3.7: Robustness check IV estimator

Education Gini Index	**(1)**	**(2)**	**(3)**	**(4)**
Democracy	-0.062**			
	(-2.455)			
Gini Income	0.224	0.211	0.230	0.198
	(1.260)	(1.032)	(1.223)	(1.091)
log of GDP per capita	-0.006	-0.004	-0.006	-0.001
	(-0.477)	(-0.333)	(-0.513)	(-0.115)
Public spending on education	-0.270	-0.370	-0.367	-0.288
	(-1.068)	(-1.426)	(-1.373)	(-1.053)
Urbanization	-0.262***	-0.291***	-0.241***	-0.256***
	(-2.874)	(-2.957)	(-2.644)	(-2.754)
Gender inequlity primary school	-0.424***	-0.435***	-0.418***	-0.443***
	(-4.014)	(-3.797)	(-3.855)	(-4.178)
Gender inequlity secondary school	-0.047	-0.057	-0.046	-0.046
	(-0.747)	(-0.848)	(-0.742)	(-0.747)
Gender inequlity tertiary school	-0.077***	-0.080***	-0.076***	-0.076***
	(-3.998)	(-3.528)	(-4.029)	(-4.133)
Freedome house political right index		-0.050*		
		(-1.719)		
supper vector democracy index			-0.059***	
			(-2.603)	
V-dem Electoral democracy Index				-0.089***
				(-2.788)
N	291.000	291.000	291.000	291.000
N_g	81.000	81.000	81.000	81.000
r2	0.745	0.730	0.740	0.731
r2_a	0.632	0.612	0.626	0.612
r2_o				
F	44.217	41.759	46.603	45.506
Hansen J statistic	0.588	0.092	0.583	0.503
p-value Hansen j	0.443	0.762	0.445	0.478
Sargan-Hansen statistic	0.498	0.088	0.693	0.58
P-value Sargan-Hansen	0.48	0.7666	0.405	0.446

t statistics in parentheses

* p<0.1, ** p<0.05, *** p<0.01

3.5 CONCLUSION

Democracy and education relationships have been subjected to several theoretical and empirical studies in social sciences. But few of them were interested in the effects of democracy on the distribution of education. Yet, an equal distribution of education may lead to fight poverty and reduce income inequality. This is the reason while this chapter is focused in the impact of democracy on education inequality.

We base our theoretical framework on the median voter theorem and Sen's analysis which pointed out the effects of the redistribution policies and the importance of public goods provided by democratic regimes compared non democratic regimes. Our theoretical assumptions also support that high political competition may lead governments to respond more effectively to voters' demand.

Using a dataset on education inequality for the population aged 15 years and over and polity2 democracy index, we test empirically the effect of democracy on education inequality by using the fixed effects estimator. We also analyze the effect of democracy on education inequality components i.e share of illiterates and education inequality among the literates. We take into account the possibility of endogeneity due to reverse causality. For the purpose we use the Instrumental Variable estimator.

Our results reveal that even though the level of education inequality is very low on average, it is relatively higher in some part of the world (South Asia and Sub-Saharan Africa). Education inequality has greatly decreased due to the drop of the share of illiterates. We also notice that the level of education inequality and the level of democracy are linked to the level of income.

Concerning our empirical results, we find that democracy reduces education inequality for fixed effects and Instrumental Variables estimators. This result is mainly due to its impact on the access to education by reducing the share of illiterates. The results also show that the impact of democracy on education inequality is higher in low income and Least Developed Countries (LDCs) compared to the other economic groups. The results are robust when we use other democracy indicators.

The empirical results show that public education expenditures contribute to reducing education inequality in developing countries (fixed effects model). However, these countries face constraints on resources with high education in-

equality. How can these countries lower the unequal distribution of education with resources constraint? Are resources well used? The assessment of public expenditures a becomes crucial in this area.

Chapter 4

Public Expenditures Efficiency On Education Distribution in Developing Countries

Contents

Abstract

This fourth chapter assesses the efficiency of public expenditures in decreasing the unequal distribution of education in developing countries over the period 1980–2010. For this purpose, we use partial frontier estimator to compute output and input efficiency scores. Moreover, we analyze the determinants of education output efficiency by using Exponential Fractional Regression Models (EFRM).

The results show that on average, developing countries can reduce their education inequality by 30% without changing their public expenditures on education. Developing countries improved their output efficiency over the study period. However, their input efficiency has decreased relatively slightly since 2005. The results also show that logarithm of GDP and its square, urbanization, government stability and democracy are the main determinants of education output efficiency for both logit and Cloglog specifications.

Keywords: *Public Spending, Efficiency, Education Inequality, Partial Frontier Method, EFRM*

JEL codes: *H52, I20, C14, C25, C23*

4.1 INTRODUCTION

Education, one of the fundamental human and children rights is essential for sustainable development and for ending poverty. Economists have recognized the role played by education on economic growth and well-being. Thus, the human capital theory (Becker, 1985) has highlighted the importance of education in individual productivity. Following Becker, the endogenous growth theory (Romer, 1986, 1990; Lucas, 1988)[1] identified education as the engine of economic growth.[2]

However, neoclassical and endogenous growth theories ignored any impact of the inequitable distribution of human capital on the growth process (Sauer and Zagler, 2014). Yet, inequitable distribution of education is harmful for growth and economic development. In fact, education inequality may affect negatively economic growth via the demographic mechanisms (greater inequality in the distribution of education is related to greater fertility, lower life expectancy, and lower rates of investment in human capital) or via credit market constraints (human capital inequality coupled with credit market constraints may also negatively influence investment and growth).[3] Moreover, many empirical works (Castelló and Doménech, 2002; Castelló-Climent, 2010a,b; Checchi, 2000; Thomas et al., 2001) have highlighted the negative impact of education inequality on economic performance and poverty.

Over the last decades, education has expanded dramatically in most developing countries. In some countries, this expansion has been at historically unprecedented rates (The World Bank, 2017). This period is also characterized by the decrease of education inequality (Castelló-Climent and Doménech, 2014). However, the level of education inequality remains high in many developing countries particularly in South Asia and Sub Saharan Africa.[4]

To attain equitable distribution of education, governments can increase the level of public funding allocated to this sector or improve the efficiency of public expenditures. The increase in public expenditures, mostly funded through taxation, can create distortion in the allocation of resources and constraints economic growth. The improvement of public expenditures efficiency

[1] See Sauer and Zagler (2014)
[2] Sauer and Zagler (2012)
[3] Galor and Zeira (1993)
[4] See Castelló-Climent and Doménech (2014, p.8)

becomes crucial. According to Chan and Karim (2012), "Public spending efficiency is defined as the ability of the government to maximize its economic activities given a level of spending, or the ability of the government to minimize its spending given a level of economic activity". In other words, efficiency of a producer (non-profit or profit organizations) consists in doing a comparison between observed and optimal value of its outputs and inputs. Inputs refer to the monetary and non-monetary resources employed to produce outputs (Mandl et al., 2008). Outputs are those results that are achieved immediately after implementing an activity[5] (products); they are goods or services produced by the government. Outcomes, which can be considered as mid-term results, are the difference made by the outputs (Moreno-Enguix and Lorente Bayona, 2017). In other words, they are the final objectives to achieve and often linked to welfare or growth objectives (Mandl et al., 2008). In the case of public sector, outcomes are the goals that the government wants to achieve with the outputs.

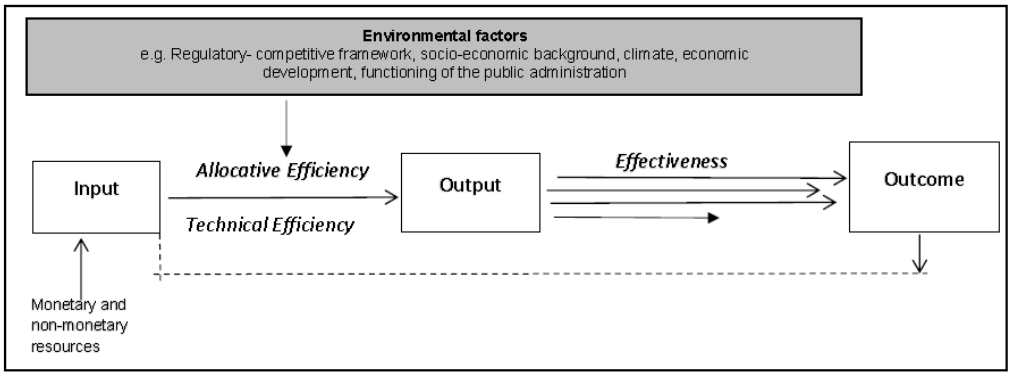
Economic efficiency has technical and allocative components. Technical efficiency is defined as the capacity and willingness of an economic unit to produce the maximum possible output from a given bundle of inputs and a technology[6] (or uses minimal inputs to produce a given level of output). It refers to the ability to avoid waste (Fried et al., 2008). Allocative efficiency is defined as the ability and willingness of an economic unit to equate its specific marginal value product with its marginal cost (Kalirajan and Shand, 1999). In other words, the allocative efficiency measures a Decision Making Unit's (DMU) success in choosing an optimal set of inputs with a given set of input prices.[7] According to Mandl et al. (2008), allocative efficiency reflects the link between the optimal combination of inputs, taking into account costs and benefits, and the output achieved. It is the ability to combine inputs and/or outputs in optimal productions in light of prevailing prices.[8] Optimal proportions satisfy the first–order conditions for the optimization problem assigned to the production unit. The measurement of allocative efficiency requires information on inputs prices and that is controversial.

Output-oriented efficiency expresses the efficiency of a DMU for a given

[5] Moreno-Enguix and Lorente Bayona (2017)
[6] Kalirajan and Shand (1999, p.149)
[7] see Daraio and Simar (2007)
[8] Fried et al. (2008, p.20)

level of inputs while on the other hand input-oriented efficiency represents the efficiency of a DMU for a given level of output. Thus, countries with low input-oriented efficiency could reduce their expenditures without lowering their performance while countries with low output-oriented efficiency might increase their performance without increasing their expenditures (Christl et al., 2018).

Figure 4.1: Conceptual framework of efficiency and effectiveness



Source: Mandl et al. (2008, p.3)

Many reasons justify the interest of economic studies and international organizations (e.g., International Monetary Fund and The World Bank) in public expenditures efficiency. First, it facilitates comparison across similar economic units, i.e., it indicates relative efficiency. Second, where measurement reveals variations in efficiency among economic units, further analysis can be undertaken to identify the factors causing such variations. Third, such analyses bear policy implications for improving efficiency (Kalirajan and Shand, 1999). In fact, studies that measure public expenditures efficiency, contribute to highlight best practices and to draw implication on public sector reforms. In a context of macroeconomic constraints (which limit countries' scope for expenditure increases) and fiscal discipline, public expenditures efficiency could be used as an indicator to evaluate the effectiveness of the public policy. Finally, improving public expenditures efficiency can improve accountability.

Many empirical studies were interested in the measurement of efficiency of public expenditures in education (Gupta and Verhoeven, 2001; Christiaensen et al., 2002; Afonso and Aubyn, 2006; Afonso et al., 2005, 2010; Herrera and Pang, 2005; Fonchamnyo and Sama, 2016; Gavurova et al., 2017). These

studies offer several techniques to measure efficiency (specifically technical efficiency) which can be classified into parametric and nonparametric. Although some of these studies were focused on the determinants of efficiency, they have given limited attention to education distribution. Thus, this chapter assesses empirically the technical efficiency of public expenditures in improving the distribution of education in developing countries. In fact, technical efficiency permits to identify opportunities for improvements in the ways resources are converted into outputs, and to identify inefficiencies in the mix of production factors. To assess the efficiency scores, we use a nonparametric partial frontier estimator especially order-m estimator which is more robust to extreme values and outliers than the previous estimators (e.g., Data Envelopment Analysis and Free Disposal Hull). This estimator also does not suffer of the curse of dimensionality shared by most nonparametric estimators. We also analyze the determinants of the output–oriented efficiency scores using fractional regression models (FRM) especially Exponential Fractional Regression Model (EFRM) which is the most natural way of modeling bounded proportional response variables.

The chapter is structured as follow. Section 4.2 reviews the literature in the efficiency of education public expenditures. Section 4.3, presents the methods used for measuring efficiency and the originality of our estimator. Section 4.4 discusses the data and results. The last section concludes.

4.2 Literature Review

Efficiency measurement has been analyzed since Adam Smith's pin factory (Daraio and Simar, 2007). The study of Koopmans (1951) and Debreu (1951) represent the first rigorous analytical approach and Farrell (1957) conducted the first empirical assessment. An significant contribution to the development of efficiency and productivity analysis has been done by Shephard's models of technology and the concept of distance functions (Shephard, 1970, 1953, 1974) [9].

In recent years there has been an increasing interest by researchers in the efficiency of education public expenditures. These studies, mostly quantitative, are relying on parametric and nonparametric approach. Thus, Clements

[9] Daraio and Simar (2007, p.16)

(2002) assessed the efficiency public expenditures on education in European Union. He applied Free Disposal Hull (FDH) method by comparing countries of European Union to the "best practices" observed in the OECD.[10] His study used expenditure per student (in purchasing parity adjusted dollar) and teacher to student ratio as input variables and international standardized test (TIMSS, Trend in International Mathematics and Science Study) as output variable. He found that 25 percent of education spending is wasteful in European Union relative to the "best practices". This result showed that educational performance could be improved without necessarily increasing educational public spending. Eugéne (2007) by using the same method assessed the efficiency of the Belgian general government in health care, education, public order and safety and general public services. He concluded that Belgian education system is more expensive but lead to better results than the European average.

FDH was also used by Gupta and Verhoeven (2001) to assess the efficiency of government expenditure on education (measured by per capita education spending in purchasing power parity (PPP)) and health[11] in 37 African countries, both in relation to each other and in comparison with countries in Asia and the Western Hemisphere. This study covered the period 1984–1995. The authors showed that on average, governments in African countries are less efficient in the provision of education (primary school enrolment, secondary school enrolment, and adult illiteracy) and health (life expectancy, infant mortality, and immunizations against measles and DPT[12]) services than countries in Asia and the Western Hemisphere. But education and health spending in Africa have become more efficient during this period. The results also suggest that improvements in educational attainment and health output in African countries require more than higher budgetary allocations.

Data Envelopment Analysis (DEA) has been extensively used to assess public expenditure on education. In this way, Kirjavainen and Loikkanen (1998) used the nonparametric DEA method to study the efficiency among 291 Finnish senior secondary schools. They also explained the degree of inefficiency (100 - efficiency score) by a statistical Tobit model. Their results showed that private schools were inefficient relative to public schools. They

[10] Organisation for Economic Co-operation and Development
[11] measured by per capita health spending in PPP
[12] Diphtheria–Pertussis–Tetanus

also highlighted that school size does not affect efficiency. Following the same methodology, Afonso and Aubyn (2006) addressed the efficiency of public expenditures on the provision of education services by comparing the output (PISA[13] Indicators) from the educational system of 25 mostly OECD countries with resources employed (teachers per student, time spent at school) during the period 2000-2002. They estimated a semi-parametric model of the education production process using a two-stage procedure. By regressing DEA output scores on nondiscretionary variables, using both Tobit and a single and double bootstrap procedure, they showed that inefficiency was strongly related to GDP per capita and adult educational attainment. Gavurova et al. (2017) employed DEA approach to compare the relative efficiency of government expenditures on secondary education in selected European countries in 2015. They found that average efficiency (output-oriented) was 0.955 and highlighted a relative high efficiency in evaluated countries.

DEA was also employed by Yogo (2015) for assessing public spending efficiency (precisely input oriented technical efficiency) in health, education and infrastructure of 77 developing countries over the period 1996–2012. He also examined the effect of ethnic diversity (fractionalization and polarization measures) on the efficiency of public spending by using a censored Tobit regression model. Two main findings have been drawn. First, barely 12% of the sample of countries under study makes an efficient use of public expenditures. Second, no matters the level of aggregation, ethnic polarization is positively associated with higher efficiency. Fonchamnyo and Sama (2016), analyzed the efficiency of public spending in the education and health sectors in three selected Central Africa countries (Cameroon, Central African Republic and Chad) applied DEA approach to compute efficiency scores. They used in a second stage panel data Tobit and fractional logit regression to determine the effect of institutional and economic factors on public expenditures efficiency on education and health sectors. They found that Cameroon is the most efficient country. Their results also indicated that budgetary and financial management impacts positively and significantly efficiency scores while corruption has a negative and significant effect.

Yotova and Stefanova (2017), in a study in assessing the efficiency of tertiary education expenditure used the DEA method. Their study covered nine

[13]Program for International Student Assessment

European Union member States from Central and Eastern Europe (Bulgaria, the Czech Republic, Estonia, Latvia, Lithuania, Hungary, Poland, Romania, and Slovenia). They employed tertiary educational attainment (age group 25-34 years), employment rate of population with tertiary education (age group 25-29 years) and population with tertiary education not at risk of poverty and social exclusion (age group 25-49) as output indicators and total expenditure on tertiary education[14] as input indicator. The authors concluded that Latvia is the most efficient country in comparative perspective in the area of the tertiary education expenditure and achieved direct and indirect output results.

Some research used both FDH and DEA methods to compute efficiency scores. Afonso and Aubyn (2004) assessed the efficiency in education and health sectors for a sample of OECD countries by applying nonparametric FDH and DEA methods. They used the performance of 15 years old in the PISA (reading, mathematics and science literacy scales) in 2000 as output indicator. As for inputs measures, they used the annual expenditures on secondary education per student in 1999. Their results suggest that the average input efficiency in education sector varies between 0.520 and 0.610, depending on method used.[15] They used the same methodology to assess efficiency in health and education in an article published in 2005. In the educational case, they employed physical input indicators (the total intended instruction time in public institutions in hours per year for the 12 to 14-years old and the number of teachers per student in public and private institutions for secondary education). As an output, they used PISA indicators. The results showed that the average input efficiency vary between 0.859 and 0.886, depending on method used.

Herrera and Pang (2005) estimated the efficiency frontiers using nine education output indicator (gross and net primary school enrolment, gross and net secondary school enrolment, literacy of youth, average years of schooling, first level complete, second level complete, and learning scores) and four health output indicators (life expectancy at birth, immunization against DPT and measles, disability-adjusted life expectancy) based on a sample of 140 countries from 1996 to 2002. In the case of education, they used public spending

[14]Total expenditure on tertiary education is calculated as the sum of public expenditure and private expenditure of households

[15]The output average efficiency varies between 0.942 (FDH) and 0.966 (DEA)

per capita on education (in constant 1995 US PPP dollars) and non-monetary factors of production such as the ratio of teachers to students. They also applied nonparametric FDH and DEA methods to compute efficiency scores and sought to identify empirical regularities that explain cross-country variation in the efficiency scores by using a Tobit panel approach. Their results showed that higher expenditure levels, larger wage bill, income inequality, HIV/AIDS and aid are negatively associated with efficiency scores. In contrast, urbanization is positively associate to efficiency score.

Moreno-Enguix and Lorente Bayona (2017) designed Public Expenditures Efficiency Indexes (PEEI), both for total expenditure and sectoral expenditures (including education), by using single synthetic indicators. These indexes were developed for 35 developed countries in 2012. The Public Expenditures Efficiency Index by sector is computed mathematically as the ratio between the sectoral public performance and government expenditure in the sector considered (in percentage of GDP). Performance on Education is a synthetic index of primary (average of two normalized scores[16]) and higher (average of two normalized scores) education. Their results showed that corruption and democracy do not influence efficiency in education. Their study follows Afonso et al. (2005) who used the same methodology to compute Public Sector Performance and Public Sector Efficiency (PSE) indicators comprising a composite and seven sub-indicators (administrative, education[17], health, public infrastructure, distribution, stability and economic performance), for 23 industrialized countries.

Parametric method was also used for evaluating efficiency public spending on education. Jayasuriya and Wodon (2003) assessed efficiency in education and health spending using a stochastic frontier estimator on a sample of 76 countries from 1990 to 1998. Per capita GDP, per capita expenditures on education and adult literacy rate employed as input variables. As for education output variable, they used net primary enrolment rate.The production frontiers can vary by region. In a second stage the authors explained efficiency by bureaucracy quality, corruption and urbanization. The results suggest large differences among countries (and among regions) in efficiency, and a substantial correlation in the efficiency measures obtained for the two

[16]Primary education enrolment rate and Quality of primary education
[17]This index contains secondary school enrolment and educational attainment indicators

indicators (education and health). An analysis of the determinants of the efficiency measures suggests that bureaucratic quality and urbanization both have strong positive impacts on efficiency while the impact of corruption is not statistically significant.

Grigoli (2014) used an hybrid approach to examine public expenditure efficiency in secondary education for emerging and developing economies. This method was designed by Wagstaff and Wang (2011). This method allows to take advantage of the strengths of DEA and SFA while avoiding their weaknesses. Grigoli's results show that education expenditure is inefficient in many emerging and developing economies, especially in Africa. He also found that reallocating expenditure to hire more teachers could improve the efficiency of public education spending where student-to-teacher ratios are high.

In short, the literature on the efficiency of public expenditure on education is based on a variety of methods to compute efficiency scores and to analyze their determinants.

4.3 Methods for Measuring Efficiency

There are two types of public spending efficiency measurement. Macro measurements which aim to evaluate the efficiency of total public spending. They attempt to measure, or rather to get some ideas of the benefits from higher public spending. Micro measurements aim at measuring the efficiency of a particular category of public spending. They attempt to determine the relationship between spending and benefits in a particular budgetary function or even sub-function (i.e., health spending or the efficiency of spending in hospitals, or spending for protection against malaria, aids, etc.)[18].

Numerous techniques have been developed to compute efficiency scores. These methods are based on the concept of efficiency frontier (productivity possibility frontier). In other words the method consist on estimating a production, cost or profit function. Efficiency scores of Decision Making Units (DMUs) are measured by their distance to an estimated production function (the frontier). A production function is a mathematical representation of the technology that transforms inputs into outputs. The two most widely used

[18] See Afonso et al. (2010)

methods are parametric (stochastic or deterministic) or non-parametric (essentially deterministic).

4.3.1 The parametric methods

The parametric approach assumes a specific functional form for the relationship between the inputs and the outputs as well as for the inefficiency term incorporated in the deviation of the observed values from the frontier (Herrera and Pang, 2005). It assumes that a function giving maximum possible output as a function of certain inputs (or minimum cost of producing that output given the prices of the inputs). This approach can be either deterministic or stochastic.

A very common parametric method is the Stochastic Frontier Analysis (SFA) approaches. There are two main estimation strategies here. The first strategy is based on a error components model which assumes that the error term has two components, one for random errors (assumed to follow a normal distribution) and one non negative represents the technical inefficiency (Aigner et al., 1977; Meeusen and van Den Broeck, 1977). Initially applied to cross-section data, the SFA was extended to panel data with Battese and Coelli (1992, 1995); Kumbhakar and Wang (2005); Kumbhakar et al. (2014) etc. The second strategy is the fixed effect approach used by Evans et al. (2000). In this method, frontier intercept[19] is represented by a constant and the non negative component of the error term are the country-specific inefficiencies. The country with the highest intercept is considered as best performer and taken as the reference country (the frontier) and the distance from this maximum, gives a measure of technical efficiency (Evans et al., 2000; Jayasuriya and Wodon, 2003).

SFA offers the possibility to find out whether the deviation of a DMU's actual output from its potential output is mainly because it did not use the best practice techniques or is due to external random factor (Kalirajan and Shand, 1999). It permits to test statistically various hypotheses concerning technology's modelling and characteristics of DMU–specific efficiency measures.[20] SFA offers flexibility in modeling various specific aspects of production such as production and marketing risk. SFA facilitates decomposition of economic

[19] constant – non-negative component of the error term
[20] Kalirajan and Shand (1999, p.168)

efficiency into technical and allocative efficiency. SFA also takes care of potential bias introduced by extreme observations (Christiaensen et al., 2002). However, it imposes a parametric structure on the production function and on the distribution of efficiency which potentially introduces other bias.

Other methods were used to estimate a frontier via resolving a linear or quadratic programming (Aigner and Chu, 1968), corrected ordinary least squares (Richmond, 1974) or maximum likelihood (Afriat, 1972). These methods are named the parametric deterministic approach or "full frontier models". This approach assumes that inefficiency is explained by all deviations from the frontier.[21] (Herrera and Pang, 2005; Fried et al., 2008). Since this method is deterministic, the results are sensitive to outliers. The main drawback of parametric method is the possibility of imposing an inappropriate structure on the technology (Hollingsworth et al., 1999).

4.3.2 Nonparametric methods

The nonparametric approach calculates the frontier directly from the data without imposing specific functional restrictions on the production technology. This approach was pioneered by Farrell (1957). This approach is generally dominated by deterministic approach and use an outer envelope that encompasses all observations is constructed. In other words, under the nonparametric approach, a–best practice frontier is constructed from the observed inputs and outputs as a piecewise linear technology (Grosskopf, 1986). In this approach the restrictions placed on the technology vary widely but can be less restrictive than those used to date in the parametric approach.

Free Disposal Hull

One common nonparametric method to establish the production frontier is the Free Disposal Hull (FDH) approach. It is defined as a piecewise linear reference technology, constructed on the basis of observed input-output combinations that satisfie the following axioms:
The first states that a semi-positive output cannot be obtained from a null input vector — thus excluding free production — and that any non-negative input results at least in a zero output. The second implies that finite in-

[21] The distance of a DMU from the frontier

puts cannot produce infinite outputs. The third (known as strong free disposability or positive monotonicity assumption) guarantees that an increase in inputs cannot result in a decrease in outputs. The fourth axiom is postulated for mathematical convenience which cannot be contradicted by any empirical observation. The last axiom implies that any reduction in outputs remains producible with the same amount of inputs. This assumption allows for variable returns to scale (De Borger et al., 1994). In this method, technical efficiency is measured as the distance between an observed production unit and the postulated production frontier (the isoquant). This method was first proposed by Deprins et al. (1984), FDH requires minimal assumptions with respect to the production technology (e.g., absence of convexity). It allows for a direct measurement of the relative efficiency of government spending among countries (Gupta and Verhoeven, 2001). From a managerial viewpoint, the major advantage of the FDH is that the resulting efficiency measures are related to an observed production unit.[22] But its main drawback is due to the partial ordering based on the vector dominance reasoning. This implies that the approach may be sensitive both to the number and distribution of the observations in the data set, and to the number of input and output dimensions considered (De Borger et al., 1994). FDH does not permit to make a distinction between random factors that may affect production (for example, rainfall in agricultural production) and actual inefficiency (Christiaensen et al., 2002). Finally the method is not robust to outliers or extreme data points.

Data Envelopment Analysis

Data Envelopment Analysis (DEA) is another common non parametric deterministic approach to estimating production frontiers. In this approach, linear programming methods are used to construct a linear envelope to bind the data (construct the frontier) relative to which efficiency measures can be calculated. In contrast to FDH, DEA assumes convexity of the production possibility set implying that linear combinations of best-observed production results lie on or below the production possibility frontier (Christiaensen et al., 2002; Herrera and Pang, 2005). According to Aragon et al. (2005), the convexity assumption is widely used in economics but is not always valid. DEA also assumes the free disposability of the production frontier. This technique,

[22] De Borger et al. (1994, p.657)

originating from Farrell's (1957) seminal work and popularized by Charnes et al. (1978) was initially born in operations research for measuring and comparing the relative efficiency of a set of DMUs.[23] DEA permits to analyse each DMU separately and to measure relative efficiency with respect to the entire set being evaluated. It also solves problems using standard techniques of linear programming (Seiford, 1996). However, DEA is sensitive to extreme values and outliers (an atypical observation or a data point outlying the cloud of data points).

Partial frontiers Methods

An alternative nonparametric estimator of the "efficiency frontier" which is more robust to extreme values, noise or outliers than the standard DEA and FDH was proposed by the literature (Cazals et al., 2002; Aragon et al., 2005; Daraio and Simar, 2005; Daouia and Ruiz-Gazen, 2006; Daouia and Simar, 2007; Daouia and Gijbels, 2011; Tauchmann, 2012; Christl et al., 2018). The underlying idea of this method is to estimate a partial frontier well inside the cloud of data points but near the upper frontier[24] (Daouia and Gijbels, 2011). Two alternatives have been used to estimate partial frontier:
The order-m estimator (or conditional order-m estimator) introduced by Cazals et al. (2002) is based on the concept of expected minimum production function (or expected maximum production function). This estimator generalizes FDH by adding a layer of randomness to the computation of efficiency scores. Rather than benchmarking a DMU by the best performing peer in the sample at hand, order-m is based on the idea of benchmarking the DMU by expected best performance in a sample of m peers[25]. In other words, the method consists to estimate a frontier of a discrete order–m $\in N^*$[26] (instead of estimating the full frontier), which increases with respect to m to achieve the efficient frontier φ when $m \rightharpoonup \infty$.[27] This estimator shares the same asymptotic properties as the FDH estimator but is less sensitive to outliers and/or extreme values (Daouia and Simar, 2007; Daouia and Ruiz-Gazen, 2006).

The quantile-frontier of order–α (or order-α estimator) suggested by

[23] Murillo-Zamorano (2004)
[24] In contrast to envelopment methods (DEA and FDH) which envelop all the data
[25] Tauchmann (2012, p.463)
[26] a set of all integers $m \geq 1$
[27] Daouia and Ruiz-Gazen (2006, p.1234–1235)

Aragon et al. (2005) is also a generalization of FDH. The idea is to replace the concept of "discrete" order–m partial frontier by a "continuous" order-α partial frontier where $\alpha \in]0, 1]$ corresponds to the level of an appropriate non standard conditional quantile frontier (Daouia and Simar, 2007). From an economic point of view, α gives the production threshold exceeded by $100(1-\alpha)\%$ all production units using less than x as inputs. The order-α estimator is fast to compute, easy to interpret and can be useful in terms of practical efficiency analysis. It does not envelop all the observed data points and has at least the same statistical properties as the order-m estimator. Moreover, according to Daouia and Ruiz-Gazen (2006) and Aragon et al. (2005) order-α has better robust property than order-m. Note that there exists a relationship between α and m[28] such that

$$\alpha(m) = \frac{1}{2}^{\frac{1}{m}} \tag{4.1}$$

Partial frontiers and related measures of efficiency show some interesting statistical properties together with several "appealing" economic features that deserve some comments (Daraio and Simar, 2007).

First, partial frontier estimators do not envelop all the data points. Consequently, these robust measures of frontiers and the related efficiency scores are less influenced and hence more robust to extreme values and outliers. This property permits to avoid one of the more important limitation of the traditional nonparametric estimators related to their deterministic nature.[29]

Second, because of their statistical properties these robust estimators do not suffer of the curse of dimensionality shared by most nonparametric estimators and by the DEA/FDH efficiency estimators (Daraio and Simar, 2007). This property is very important for empirical works since it allows to work with samples of moderate size and do not require large samples to avoid imprecise estimation (e.g., large confidence intervals).[30]

Third, and even more important is the economic interpretation of order–m measures of efficiency, and the appealing notion of order-α, in particular α measures of efficiency. Indeed, the parameter m has a dual nature. It is defined

[28] Daouia and Gijbels (2011, p.149)
[29] Daraio and Simar (2007, p.78)
[30] Daraio and Simar (2007, p.78)

as a "trimming" parameter for the robust nonparametric estimation. It also defines the level of benchmark one wants to carry out over the population of firms. Based on this nature, Daraio and Simar (2007) have proposed to to use m in its dual meaning to provide both robust estimations and a potential competitors analysis.

Given that partial frontiers methods do not impose specific functional restrictions on the production technology, are robust estimators and do not suffer from the curse of dimensionality (compared to FDH and DEA estimators), we will use partial frontier methods specially the order–m estimator to estimate our production boundary.

Note that a hybrid method to measuring efficiency was proposed by Wagstaff and Wang (2011) which blends both DEA and SFA approach. This approach allows to deal with heterogeneity across groups, as different frontiers are constructed for different groups of countries. It also uses a LOWESS (locally weighted scatter plot smoothing) method, which helps dealing with the measurement error, data outliers, and stochastic nature of the problem at hand.

4.4 Data and Results Analysis

4.4.1 Data

We use a panel dataset of 67 developing countries[31] over the period 1980 to 2010[32]. Two groups of variables are considered: those used in estimating the production frontier for education distribution and those used in the analysis for the determinants of efficiency.

4.4.1.1 Production frontier

The first group of variables includes one output (education Gini index by age and gender for persons over 15) and one input variable (Per capita education spending by the government in purchasing power parity (PPP)). The education Gini index is from Crespo-Cuaresma et al. (2012, 2013) data set. This indicator measures inequality in educational attainment by age and gender at

[31] low and middle income countries according to The World Bank
[32] see table9 page171 for the list of countries used in this chapter

the global level and captures access to education. In this paper, we use the index for both men and women. This quinquennial index covers 175 countries from 1960 to 2010. It used IISA/VID (International Institute for Applied Systems Analysis/Vienna Institute of Demography) global database of populations by age, sex, and levels of education. This IISA/VID dataset was developed by applying the demographic methodology of multi-state population projection (see Lutz and KC (2011); KC et al. (2010); Lurz and Goujon (2001)). Crespo-Cuaresma et al. (2012, 2013) computed the Gini index of education by applying the following formula:

$$GiniEC_{\alpha,s} = \frac{1}{\bar{y}_{\alpha,s}} \sum_{i=2}^{4} \sum_{j=1}^{i-1} |y_{\alpha,s,i} - y_{\alpha,s,j}| p_{\alpha,s,i} p_{\alpha,s,j} \tag{4.2}$$

Where $y_{\alpha,s,i}$ is the cumulative duration of schooling for the level of education i in the age group α with sex s and $p_{\alpha,s,i}$ is the corresponding share of the population with that level of education. $\bar{y}_{\alpha,s}$ denotes the mean value of years of schooling, given by

$$\bar{y}_{\alpha,s} = \sum_{i=1}^{n} p_{\alpha,s,i} y_{\alpha,s,i}$$

Four educational attainment levels have been considered by Crespo-Cuaresma et al. : no formal education (i = 1), primary education (i = 2), secondary education (i = 3) and tertiary education (i = 4). The education Gini coefficient is between 0 to 1. A value of 0 indicates a perfectly equally distributed education structure (this case corresponds to a situation in which the whole population attains the same education level). A value of 1 indicates a perfect unequal distribution (in this case, one person completes for example tertiary education, while the rest of the population does not attain any formal schooling).[33]

As Afonso et al. (2010), we compute the output variable ($GiniEC^{T}_{\alpha,s}$) by transforming the education Gini index as follow:

$$GiniEC^{T}_{\alpha,s} = 1 - GiniEC_{\alpha,s} \tag{4.3}$$

This transformation is used to insert increasing outputs as the desired objective, given that higher Gini coefficients imply a greater inequality.

We used Per capita education public expenditures in purchasing power

[33] Sauer (2016)

parity (PPP) as our input measure. This indicator is computed as the product of the shares of public expenditure on education in percentage of GDP[34] and real GDP per capita at chained PPPs in US Dollars[35]. We computed GDP per capita by dividing GDP by population from PWT database. In fact, expenditure-side real GDP allows comparison of relative living standards across countries and across years (Feenstra et al., 2015). Then, using per capita PPP education public expenditures permits a more accurate cross-country comparison of the domestic shadow costs of the resource allocation for education than conventional US dollar measures and GDP ratios (Gupta and Verhoeven, 2001).

Private expenditures, including activities of Non Governmental Organizations (NGOs), may also be taken into account. But these data are not available. Physical inputs such as the numbers of teachers, pupil-teacher ratio, average class size, number of instruction hours and the use and availability of computers can also be taken into account to estimate the production frontier.[36] However, these indicators are either unavailable or contain missing data for many developing countries.

4.4.1.2 Non-discretionary factors

The second group of variables are used to analysis the determinants of education output efficiency score. These variables determine the heterogeneity across countries and influence performance and efficiency. These variables are called "environmental" or non–discretionary or "exogenous" inputs. They include: *The logarithm of real GDP per capita, the square of the logarithm of real GDP per capita, Urbanization, Trade openness, Foreign Direct Investment, Financial Development, Net Official development assistance, Corruption, Government stability and Democracy.*

The logarithm of real GDP per capita: This variable aims to proxy the physical capital stock which facilitates an efficient production of public goods and services, but which may also facilitate monitoring of policy makers (Afonso et al., 2010). A higher level of public expenditures efficiency is associated with a higher level of GDP per capita. We also use the square of the

[34] from International Monetary Fund (IMF) database (World Economic Outlook and Government Financial Statistics)

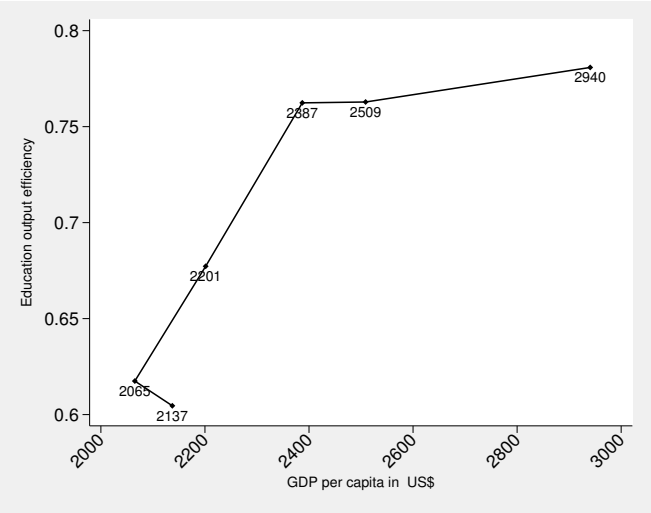
[35] from Penn World Table 9.1 (PWT 9.1) data set

[36] see Afonso and Aubyn (2006); Afonso et al. (2005)

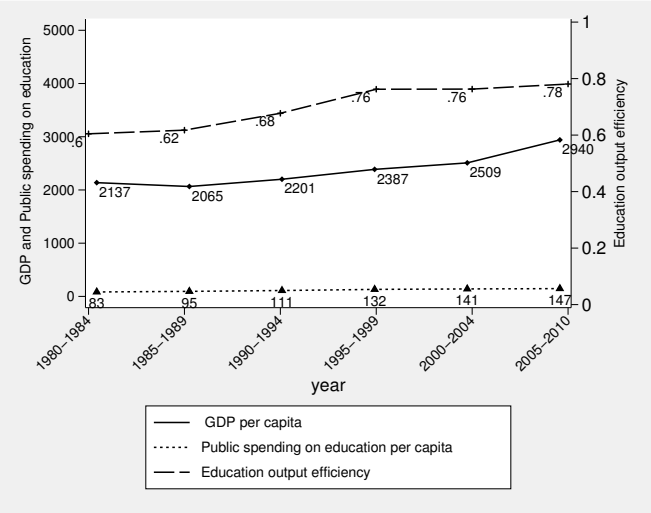
logarithm of real GDP per capita (logGDPSq). In fact, the relationship between the education output efficiency score and GDP per capita is not linear as shown by figure4.2a. We can hypothesize that a drop of GDP per capita was followed by an increasing of education efficiency score during the 1980s (see figure 4.2b). This may be due to the economic policy reforms adopted by the governments and following the Washington Consensus. In fact, these reforms include fiscal discipline and the reordering public expenditures priorities. Since 1990, we notice that improvement of education output efficiency is followed by the rise of GDP per capita.

Figure 4.2: Relationship between GDP per capita and educatin's output efficiency

(a) Education's output efficiency and GDP per capita



(b) Education output efficiency, GDP per capita and public spending on education



Source: authors

Urbanization, refers to urban population in percentage of total population. The clustering of public servants makes cheaper to provide services in urban areas. So higher degree of urbanization should result in higher efficiency (Herrera and Ouedraogo, 2018).

Trade openness (sum of exports and imports as a share of GDP): This

indicator proxies the degree of international competition over labour and capital (Afonso et al., 2010). It also measures the level of integration in the world economy. According to Hauner and Kyobe (2010), trade openness could increase public spending efficiency by increasing competitive pressure on the domestic economy, including the government, as well as increasing exposure to the outside world.[37] We expect that higher international trade compels the government to become more market oriented and hence increases government efficiency (Rayp and Van De Sijpe, 2007).

Foreign Direct Investment (FDI), net inflows (% of GDP): According to Rayp and Van De Sijpe (2007), the sign of the inflow of FDI is ambiguous. In fact, as a proxy of integration in the world economy, higher of FDI inflows may forces the government to be behave in a more free market compatible way and to comply with higher performance standards that multinational corporations expect. However according to Todaro and Smith (2003), FDI in developing countries may also be linked to rent extraction and rent sharing between the political elite and foreign corporations, leading to favouritism, corruption . . . and, ultimately, less efficiency.[38]

Financial Development Index (FD): This overall index of financial development is an aggregation of financial institutions (banks, insurance companies, mutual funds, and pension funds) and financial markets (stock and bond markets) sub-indices. This index is defined as a combination of depth (size and liquidity of markets), access (ability of individuals and companies to access financial services) and efficiency (ability of institutions to provide financial services at low cost and with sustainable revenues, and the level of activity of capital markets).[39] This index is available with annual frequency from 1980 onwards.[40] A better developed financial system could prevent the manipulation of financial system, thus putting more pressure on the government to control its budget by working in an efficient manner. Furthermore, a better–developed financial systems could make it easier to domestically finance deficits (Rayp and Van De Sijpe, 2007).

Net Official development assistance (ODA) received in percentage of Gross National Income (GNI). This variable represents disbursement flows (net of

[37] Rayp and Van De Sijpe (2007, p.370)
[38] Rayp and Van De Sijpe (2007, p.370)
[39] Cihák et al. (2012); Čihák et al. (2013); Svirydzenka (2016)
[40] It is available for 180 countries but not available for Zimbabwe

repayment of principal) that meet the Development Assistance Committee (DAC) definition of ODA. To the extent that countries do not have to incur the burden of taxation, they may not have the incentive to use resources in the most cost-effective way. Another channel through which aid-financing may affect efficiency is the volatility and unpredictability of its flows. Given that this financing source is more volatile than other types of resources (Bulíř and Hamann, 2003), it is difficult to undertake medium-term planning (Herrera and Pang, 2005). In this case we expect a negative association between aid and public expenditures efficiency.

Corruption: This variable assess corruption within the political system (Howell, 2012). A higher values of corruption index indicates a decreased prevalence of corruption. Corruption distorts the economic and financial environment, reduces the efficiency of government and business by enabling people to assume positions of power through patronage rather than ability and introduces inherent instability in the political system (Jayasuriya and Wodon, 2003). Moreover, corruption breeds waste of public funds. Higher values of corruption index indicate a decreased prevalence of corruption. In other words, low level of corruption rises public spending efficiency.

Government stability: This variable assesses both the government's ability to carry out its declared program(s), and its ability to stay in office. The risk rating assigned is the sum of three subcomponents (Government Unity, Legislative Strength and Popular Support). Each subcomponent has a maximum score of four points and a minimum score of 0 points. A score of 4 points equates to "Very Low Risk" and a score of 0 points to "Very High Risk" (Howell, 2012). The ICRG Government stability index is between 1 (the lowest level of government strength) to 12 (the highest level of government strength). Political instability can complicate consistent budgetary planning and undermine efficiency (Hauner and Kyobe, 2010). Since ICRG provides ratings for 140 countries, Corruption and Government stability are not available for some countries (Benin, Burundi, Chad, Lesotho, Mauritania, Mauritius, Nepal and Rwanda).

Democracy measured by the polity2 indicator. This index is a combination of democracy and autocracy indicators of polity IV. Additionally, to

autocracy and democracy, polity2 includes interruption[41], interregnum[42] and transition[43] periods. The polity2 score ranges from -10 (highly autocratic), to 10 (highly democratic) and is available since 1800. To make the interpretation easier, we normalized the polity2 score from 0 (highly autocratic) to 1 (highly democratic) by using a Min-Max formula. Indeed, voting is the fundamental link between citizens and politicians. A high turnout may reduce inefficiencies in public service provision through more efficient monitoring of politicians. In other words, a high turnout may give politicians incentives to implement policies that improve efficiency Borge et al. (2008).

The input and environmental variables have been averaged over 5 years periods (respectively 1980-1984, 1985-1989, 1990-1994, 1995-1999, 2000-2004 2005-2010) because the output data are quinquennial. Notice that for the second stage regression, we then use an education output efficiency score strictly lower than 1 (because the econometric estimator used does not accommodate the value 1). We then used an unbalanced dataset of 55 developing countries over the period 1980-2010. Summary statistics and sources for all variables are presented in table4.1

Table 4.1: Summary Statistics of key variables

Variable	Definition	mean	sd	min	max	N	Sources
First stage regression							
Output							
GiniEC15	Gini index of education 15 year and over	0.48	0.22	0.13	0.95	402	?? dataset
GiniEC15T	Transformed education Gini index	0.52	0.22	0.053	0.87	402	Authors computing
Input							
rgdpe_pop	Real GDP per capita at chained PPPs in US Dollars	3021	2243.5	532.7	12517.2	402	Authors computing with PWT 9.1 data
goveducgdp	Government spending on education in percentage of GDP	3.69	1.65	1.21	15	402	IMF databases
goveducgdp_ppp	Real public spending on education per capita at chained PPPs in US Dollars	118	110.7	11.8	637.6	402	Authors computing
Education efficiency							
effiEduc_output23	Education spending output Efficiency Score	0.70	0.27	0.071	1.05	402	Authors computing
effiEduc_input23	Education spending input Efficiency Score	0.51	0.35	0.071	1.65	402	Authors computing
Second stage regression							
effiEduc_output23	Education spending output Efficiency Score	0.65	0.25	0.071	1.00	301	Authors computing
logGDP	Logarithm of GDP per capita at constant 2010 US Dollars	7.36	1.05	5.21	9.41	288	Computing with World Bank WDI [44]
logGDPSq	Logarithm of real per capita GDP squared	55.3	15.5	27.2	88.6	288	Computing with World Bank WDI
Urbanrate	Urban rate	1.83	2.52	-5.28	25.8	291	World Bank WDI
Trade openness	Trade openness in percentage of GDP	0.19	0.11	0	0.62	301	World Bank WDI
FD	Financial Development	61.4	32.3	12.9	210.0	283	IMF financial development database
ODA	Net Official development assistance (ODA) received (% of GNI)	42.9	18.4	8.16	84.0	301	World Bank WDI
Corruption	Corruption	2.59	0.98	0	6	293	International Country Risk Guide (ICRG)
Government Stability	Government Stability	7.05	2.04	1	11	293	International Country Risk Guide (ICRG)
Democracy	Normalized Polity2 democracy Index	0.53	0.31	0.0100	1	299	Polity IV database

Source: Authors' calculation

[41] occupation by a foreign country
[42] falling down of political authority
[43] period between two political regimes that are substantially different

4.4.2 Empirical strategy: Exponential Fractional Regression Models

As said in subsection 4.3.2, we use partial frontier approach (or conditional efficiency model) especially, the order-m estimator to estimate our production boundary. We compute efficiency scores for output and input oriented for each period. We set the value of m equal to 23. This value permits to get the lower share of super-efficient DMUs (after stimulated many samples of m DMUs). The method authorizes DMUs to be above the production frontier (i.e., efficiency score higher than 1). We test the sensibility of the order–m estimators (effiEduc_output23 and effiEduc_input23) to other values of m, by using Pearson correlation test (non linear correlation test) and Spearman's rank correlation test. The alternative values of m are respectively 17[45] and 50.[46] In the same vein, we also test the sensibility of the order-m estimator to alternative order–α estimator. A correlation coefficient (or a rank correlation coefficient) close to one and significant means that the DMU's efficiency (or its rank) are not significantly influenced by m values or order-α estimator. The order-m estimator allows some DMUs to lie outside the efficiency frontier (super-efficient countries). Hence, unlike the other methods, the efficiency score in the order-m method can be greater than one.

In the second stage we regress the output efficiency score (effiEduc_output) on a set of exogenous variables (named environmental variables) by using Fractional Regression Models (FRMs). The bounded nature of efficiency scores and in some cases, the possibility of nontrivial probability mass accumulating at one or both boundaries imply that fractional regression models must be applied in this context. The standard linear regression model is not appropriate since it does not guarantee that the predicted values of the dependent variable are restricted to the unit interval (Ramalho et al., 2010, 2011). Moreover, given that the dependent variable is strictly bounded from above and below, it is in general unreasonable to assume that the effect of any explanatory variable is constant throughout its entire range[47]. Tobit approach is also traditionally used to estimate efficiency score. However, there are some problems with this approach. First, only in

[45] corresponding to one fourth of the sample
[46] corresponding to three fourths of the sample
[47] Ramalho et al. (2011)

the two-limit Tobit model, the predicted values of dependent variable are restricted to the unit interval. But that approach can only be applied when observations are with in both limits, which is often not the case. Second, the Tobit model is appropriate to describe censored data in the interval [0, 1] but its application to data defined only in that interval is problematic. Observations at the boundaries of a fractional variable are a natural consequence of individual choices and not of any type of censoring. Finally, the Tobit model is very stringent in terms of assumptions, requiring normality and homoskedasticity of the dependent variable, prior to censoring (Ramalho et al., 2011). Fractional regressions models were first suggested by Papke and Wooldridge (1996). This seminal paper was followed by several extensions (Ramalho et al., 2010, 2011; Ramalho and Ramalho, 2017; Ramalho et al., 2018; Ramalho, 2019). Recently, Ramalho et al. (2016, 2018) and Ramalho (2019) developed a new class of estimators based on a transformation of logit and Complementary loglog (Cloglog) fractional regression models into a form of exponential regression (EFRM) with multiplicative individual effects and time-variant heterogeneity from which six alternative GMM estimators (including four alternative GMM fixed-effects estimators) have been proposed. These estimators are robust to heterogeneity (time-variant and time-invariant) and can accommodate endogenous explanatory variables. In this paper we use the pooled fixed-effects (GMMpfe) estimator allowing explanatory variables and individual effects to be correlated.

We then use the following econometric specification:

$$y_{it} = G(x_{it}\theta + \alpha_i + \upsilon_{it}) \tag{4.4}$$

Where υ_{it} denotes time-varying unobserved heterogeneity and G is assumed to have a logit ($G(\cdot) = \frac{\exp(\cdot)}{1+\exp(\cdot)}$) or cloglog ($G(\cdot) = 1 - \exp^{-\exp(\cdot)}$) specification. y_{it} is the dependent variable and x_{it} the matrix of explanatory variables. α_i is the vector of individual-specific intercepts and θ denotes the vector of parameters. Note that the EFRM accommodates the value zero of dependent variable. However it is not defined for its upper boundary.

4.4.3 Results Analysis

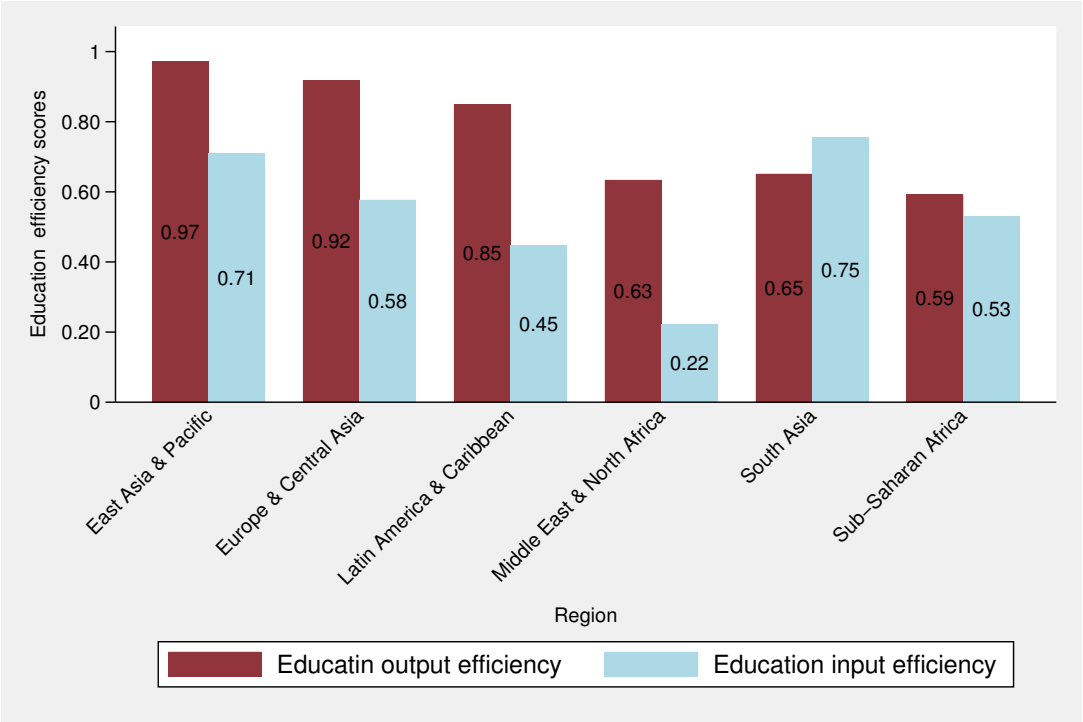
4.4.3.1 Efficiency scores

Table10 in appendix Chapter 4 (se page172) provides output and input efficiency scores for each country and each period. The analysis of efficiency scores provides the following results:

The average output technical efficiency score is relatively high (0.70). This suggests that developing countries might increase their output (then reduce their education inequality) by 30% without changing their public expenditure on education. East Asia and Pacific, Europe and central Asia and Latin America and Caribbean have the highest levels of output efficiency scores over the study period. As for Sub-Saharan Africa, its output efficiency score is the lowest (0.59). However, its input efficiency score (0.53) is higher than the average input efficiency score (0.51). Middle East and North Africa's (MENA) countries have the lowest input efficiency score (0.22). In general (except South Asia) the output efficiency score is higher than the input efficiency score[48] (see figure4.3).

[48] Herrera and Ouedraogo (2018) also find the same result

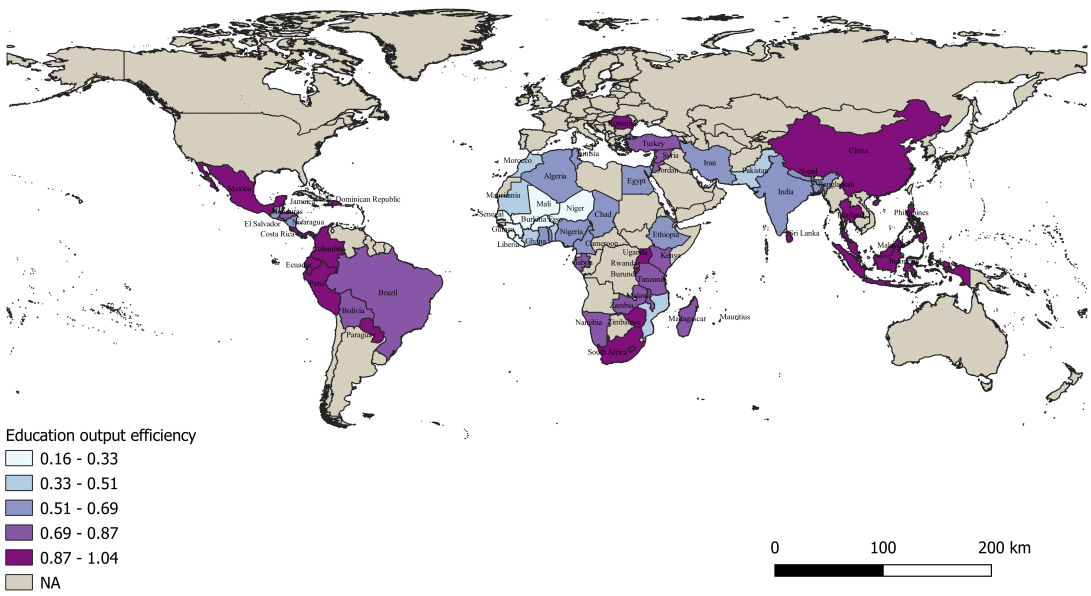
Figure 4.3: Average score of efficiency by regional sub-sample



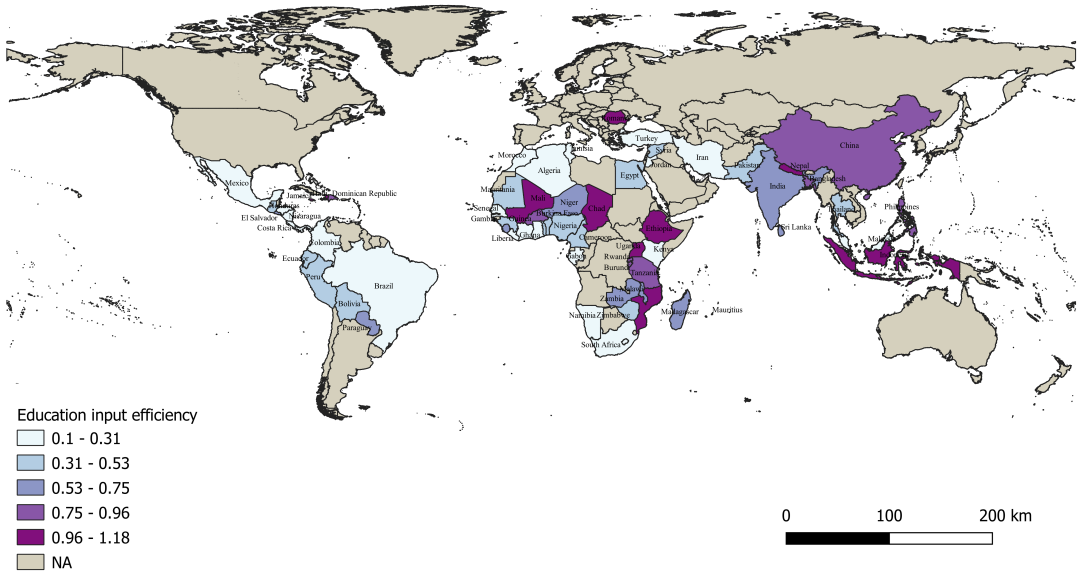
Source: authors

Figure 4.4: Geographical representation of education efficiency scores

(a) Education output efficiency



(b) Education input efficiency

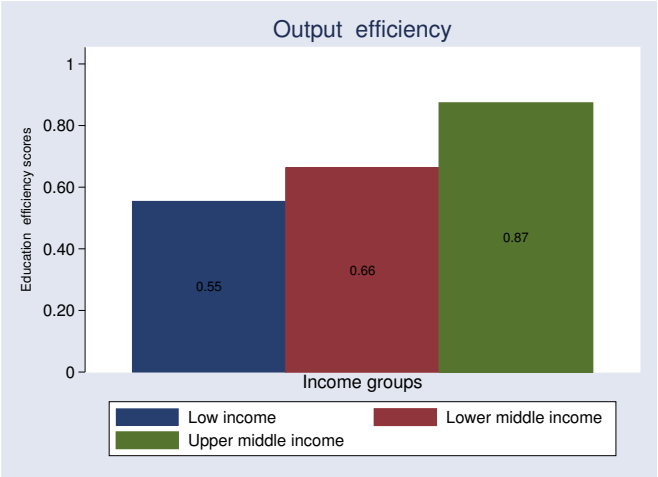


Source: author

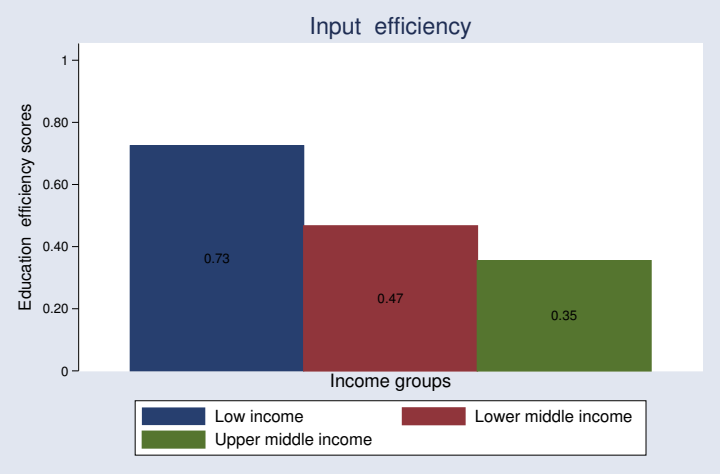
Low income countries have the lowest level of output efficiency (0.55). However, they have the highest level of input efficiency (0.73). In the same vein, upper middle income countries have the highest level of output efficiency (0.87) but the lowest level of input efficiency (0.35). Figures 4.5a and 4.5b provide the average output and input efficiency score by income group.

Figure 4.5: Average score of efficiency by income group

(a) Output Efficiency



(b) Input Efficiency



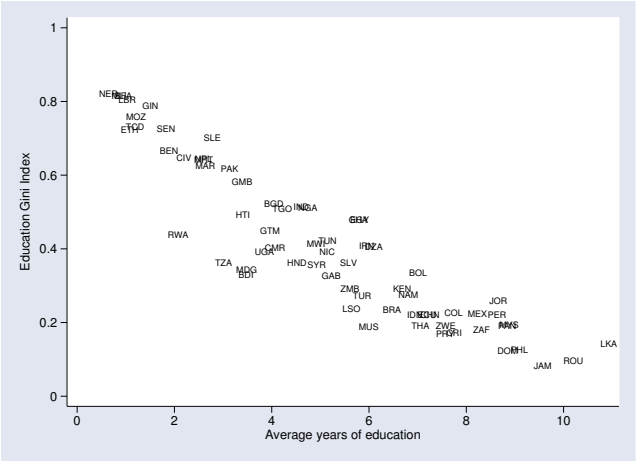
Source: author

Countries with high level of education output efficiency (e.g., Sri Lanka, Jamaica and Romania) have higher educational attainment level and better education equality. Conversely, countries with low educational attainment

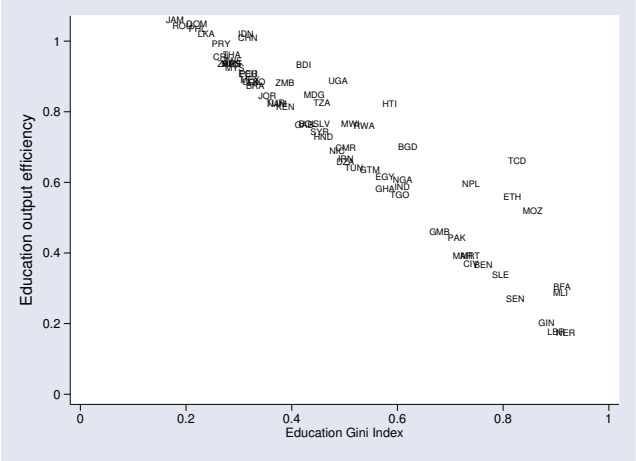
level (e.g., Guinea, Liberia and Niger) have higher education inequality and lower education output inefficiency (see figures 4.6a, 4.6b and 4.6c). Then, we can hypothesize that the level of educational attainment is linked to the level of education output efficiency.

Figure 4.6: Relation between Education output efficiency, education inequality and Education

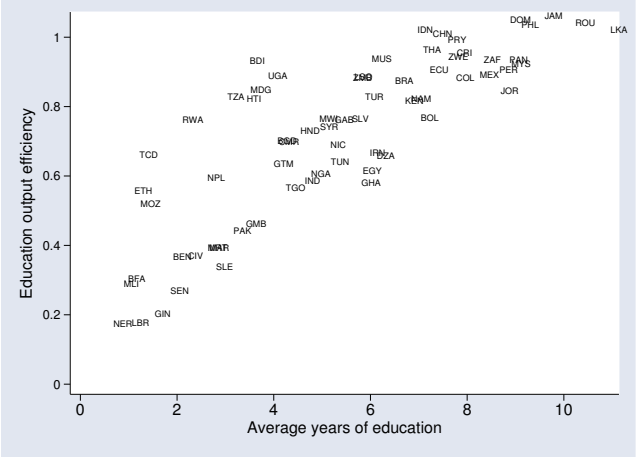
(a) Correlation: Education inequality Average year of education



(b) Correlation: Education output efficiency Education inequality



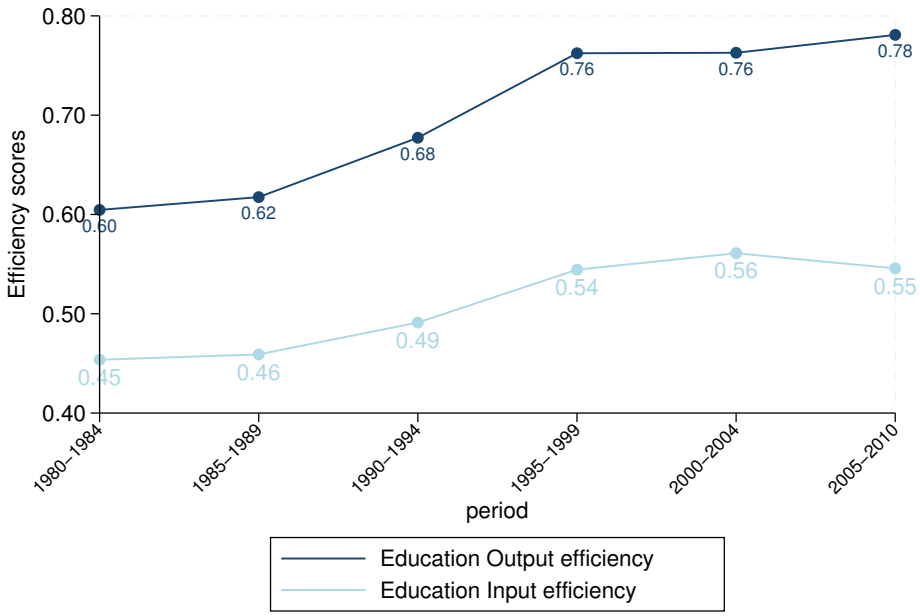
(c) Correlation: Education output efficiency Average year of education



Source: author

Table4.2 and table4.3 provide the evolution of output and input efficiency scores over the study period. The results show that the output efficiency scores have increased ((figure4.7 and table4.2). Regarding input efficiency, there is an improvement from 1980 to 2004 and a slightly decrease since 2005 (see figure4.7 and table4.3).

Figure 4.7: Evolution of Output and Input efficiency score



Source: author

Table 4.2: Evolution of efficiency scores output oriented

Periods	**mean**	**p50**	**sd**	**cv**	**min**	**max**	**p25**	**p75**	**iqr**
1980-1984	0.60	0.63	0.28	0.47	0.071	1.05	0.38	0.83	0.45
1985-1989	0.62	0.66	0.28	0.46	0.089	1.05	0.35	0.86	0.52
1990-1994	0.68	0.72	0.26	0.38	0.13	1.05	0.50	0.89	0.39
1995-1999	0.76	0.84	0.24	0.32	0.16	1.04	0.64	0.95	0.30
2000-2004	0.76	0.83	0.25	0.32	0.19	1.04	0.65	0.95	0.29
2005-2010	0.78	0.86	0.23	0.29	0.21	1.05	0.69	0.94	0.25
Total Sample	0.70	0.76	0.27	0.38	0.071	1.05	0.50	0.92	0.42
Number of observations	402								

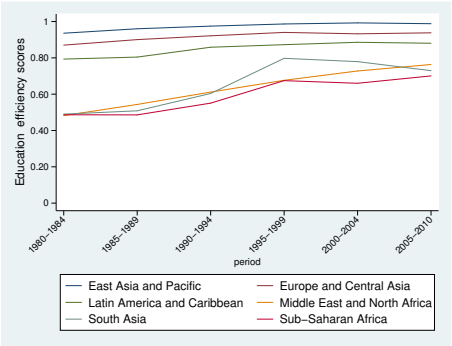
Table 4.3: Evolution of efficiency scores input oriented

Periods	mean	p50	sd	cv	min	max	p25	p75	iqr
1980-1984	0.45	0.32	0.35	0.76	0.071	1.33	0.17	0.65	0.49
1985-1989	0.46	0.34	0.35	0.75	0.076	1.45	0.16	0.68	0.51
1990-1994	0.49	0.38	0.35	0.71	0.077	1.44	0.20	0.81	0.61
1995-1999	0.54	0.40	0.37	0.68	0.083	1.25	0.22	0.95	0.73
2000-2004	0.56	0.44	0.36	0.65	0.082	1.65	0.29	0.90	0.61
2005-2010	0.55	0.50	0.34	0.62	0.093	1.48	0.25	0.79	0.54
Total Sample	0.51	0.40	0.35	0.69	0.071	1.65	0.20	0.80	0.60
Number of observations	402								

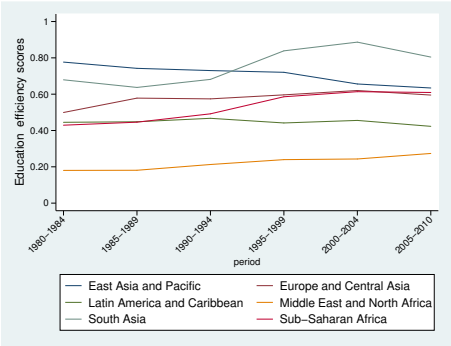
Sub-Saharan Africa, South Asia, Europe and Central Asia have improved their output efficiency scores (see figure4.8). There is also an improvement of output efficiency in lower and upper middle income countries (see figure4.9a).

Figure 4.8: Evolution of output and input efficiency by region

(a) Output Efficiency



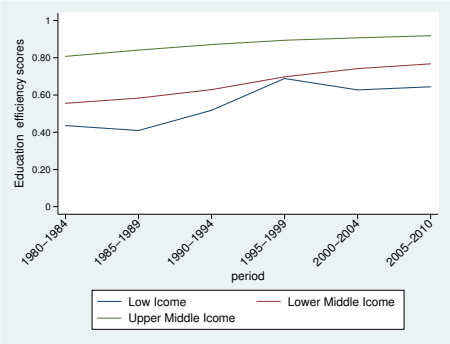
(b) Input Efficiency



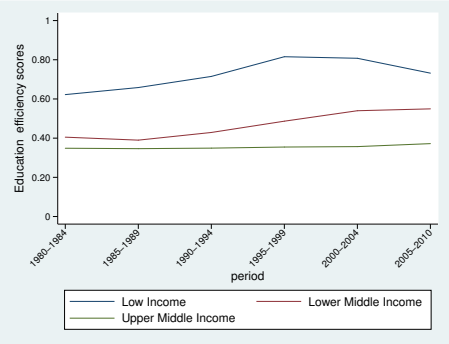
Source: author

Figure 4.9: Evolution of output and input efficiency by income group

(a) Output Efficiency



(b) Input efficiency



Source: author

The sensibility tests (Pearson and Spearman's rank correlation tests) of the order-m estimators (effiEduc_output23 and effiEduc_input23) to other value of m and to order-α estimators (EffiEducalpha_output and EffiEducalpha_input) are significant (at 1%) and close to 1 (see table4.4 and 4.5. Consequently, the output and input order-m estimators are robust (DMU's efficiency score (or its rank) are not significantly influenced by the values of m or order–α estimator).

Table 4.4: Sensibility of output efficiency score to other values of m and order–α estimator

Pearson correlation test

	effiEduc_output23	effiEduc_output17	effiEduc_output50	effialpha_output
effiEduc_output23	1.000			
effiEduc_output17	0.999*	0.999*		
effiEduc_output50	0.999*	0.999*	1.000	
effialpha_output	0.999*	0.999*	0.999*	1.000

Spearman correlation test

	effiEduc_output23	effiEduc_output17	effiEduc_output50	effialpha_output
effiEduc_output23	1.000			
effiEduc_output17	0.9994*	1.000		
effiEduc_output50	0.9991*	0.9983*	1.000	
effialpha_output	0.9975*	0.9966*	0.9985*	1.000

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

Table 4.5: Sensibility of input efficiency score to other values of m and to orderalpha estimator

Pearson correlation test

	effiEduc_input23	effiEduc_input17	effiEduc_input50	effialpha_input
effiEduc_input23	1.000			
effiEduc_input17	0.997*	1.000		
effiEduc_input50	0.991*	0.982*	1.000	
effialpha_input	0.986*	0.978*	0.991*	1.000

Spearman correlation test

	effiEduc_input23	effiEduc_input17	effiEduc_input50	effialpha_input
effiEduc_input23	1.000			
effiEduc_input17	0.9979*	1.000		
effiEduc_input50	0.9945*	0.9895*	1.000	
effialpha_input	0.9907*	0.9856*	0.9940*	1.000

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

4.4.3.2 Determinants of Education's output efficiency score

Table4.6 shows the main determinants of education spending's output efficiency for logit and CLoglog specifications. These results lead to the following remarks:
The logarithm of real GDP per capita has a positive and significant effect on public expenditures efficiency for logit and Cloglog specifications. The square of the logarithm of the real per capita GDP decreases public expenditures efficiency on education for both specifications.

Urbanization ratio, financial development, government stability and democracy impact positively and significantly public spending efficiency on education for both specifications.

Corruption has a non-significant impact on education output efficiency for both specifications. However, it lowers public expenditures efficiency on education.

Contrary to expectation, trade openness has a negative, but non-significant impact on education output efficiency. Net ODA has a negative and non-significant effect on education output efficiency.

FDI has a negative and non-significant impact on education output efficiency for logit specification but a positive and non sigificant impact for

Cloglog specification. In general, the coefficients for logit specification are higher than the coefficients for Cloglog specification (in absolute value).

Table 4.6: Determinant of education output efficiency

Variables	Logit	Cloglog
logGDP	6.222***	3.609***
	(2.047)	(0.950)
logGDPSq	-0.448***	-0.251***
	(0.139)	(0.065)
Urbanrate	0.043***	0.023***
	(0.010)	(0.006)
FD	2.874***	1.235***
	(0.912)	(0.467)
Trade	-0.103	-0.121
	(0.233)	(0.115)
ODA	-0.619	-0.141
	(0.559)	(0.351)
FDI	-0.436	0.131
	(1.394)	(0.688)
Corruption	0.016	0.013
	(0.055)	(0.041)
Government Stability	0.063***	0.045***
	(0.020)	(0.011)
Democracy	0.591***	0.362***
	(0.193)	(0.124)
Number of observations	266	266
Number of Countries	52	52

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

4.5 CONCLUSION

Developing countries are facing high education inequality with limited resources to reduce it. Thus, efficiency of public expenditures is crucial in these countries.

This paper aims two objectives: First, it assesses the efficiency of public expenditures focusing on the distribution of education considered an output measure. Second, it identifies the factors determining education output efficiency.

This chapter uses a sample of 67 developing countries to compute education output and input efficiency from 1980 to 2010. As for identifying the determinants of education output efficiency.

To estimate the efficiency scores of public expenditures on education, we use nonparametric partial frontier method especially order-m estimator. This method is more robust to extreme values or outliers than the other nonparametric estimators (specifically, FDH and DEA). To analyse the factors determining education output efficiency, the paper employs exponential Fractional Regression Model (EFRM). This econometric methodology is more appropriate for fractional variable (i.e., variables bounded by 0 and 1) such as efficiency scores.

The results show that, on average, developing countries might reduce their education inequality by 30% without changing their amount of public expenditures on education. Education output efficiency is very low in sub-Saharan Africa and low-income countries. The level of education output efficiency may be due to level of educational attainment.

Regarding education input efficiency, the results indicate that developing countries could reduce their education public expenditures by 49% to achieve the same results. Middle-East and North Africa and Upper middle income countries have the lowest level of education imput efficiency.

Developing countries have achieved significant progress in improving their education output efficiency. Their education input efficiency has been improved from 1980 to 2004 but has since 2005 decreased slightly.

From EFRM results, we finds that education output efficiency is determined economic and institutional factor. We find a nonlinear relationship between GPD per capita and education output efficiency. A high ratio of urbanization permits to provide easily education services in an efficient manner.

Good governance (government stability and democracy) lead to high efficiency. A higher level of financial development is also beneficial for education output efficiency.

Chapter 5

General Conclusion

The distribution of education is a welfare indicator that complements the traditional measure of education. It is also a measure of equal opportunity. Unequal distribution of education is detrimental to economic and social well-being. Its reduction is then a goal for governments and the international community. Although the unprecedented reduction of inequality in education due to the expansion of education access, the distribution of education is still unequal in some parts of the world, especially in South Asia and Sub-Saharan Africa.

Relying on the level of education inequality in some parts of the world and its detrimental effects on economic and social well-being, this thesis investigates three main issues related to education inequality. First, it analyzes which mechanisms link education inequality to income distribution. Second, it studies the effect of democracy on education inequality. Last, it assesses the efficiency of public expenditures in improving the reduction of education inequality in developing countries.

The first essay (Chapter2) addresses how education distribution affects income inequality. For this purpose, the Chapter reviews the theoretical and empirical literature to identify the mechanisms connecting education distribution to income inequality. It also shows the main results of empirical literature concerning the impact of education distribution on income inequality. Concerning the channels by which education inequality could affect income distribution, the Chapter identifies political economy, labor market, credit market constraint, fertility, and life expectancy as the main channels by which education inequality may affect income inequality.

Concerning the empirical relationship between education inequality and income distribution, the Chapter notices no consensual results in the literature. If some empirical studies conclude that education inequality has a positive and significant effect on income distribution, other studies find no significant impact. This literature also shows that some factors such as Skill Biased Technological Change, globalization, and increasing returns to education could counterbalance the equalizing effect of education inequality reduction and then raise income inequality.

The second essay (Chapter3) empirically investigates the impact of democracy on education inequality. It bases its theoretical framework on the "median voter theorem" and Sen's analysis, which pointed out the effect of democ-

racy on redistribution policies. It also considers the pressure generated by political competition on the effectiveness of the governments' reaction to voters' demands.

Using a dataset on education inequality for the population aged 15 years and over and polity2 democracy index, the essay tests the effect of democracy on education inequality by using the fixed effects and instrumental variables estimators. It also studies the impact of democracy on the education inequality components, i.e., the share of illiterates and education inequality among the literates. The dataset covers a sample of 112 countries from 1960 to 2010.

The results reveal that democracy reduces education inequalities. The impact of democracy on education inequality is higher in low-income and Least Developed Countries (LDC) compared to the other economic areas. This result is due to the positive effect of democracy on access to education by reducing the share of illiterates. The results also show that urbanization, gender parity in primary and tertiary schools have an equalizing impact on education inequality. The results are robust to other indices of democracy.

The last essay (Chapter4) empirically assesses the efficiency of public expenditures in improving the reduction of education inequality in developing countries. Indeed, the high level of education inequality in developing countries and the limitation of resources make necessary the improvement of public expenditures.

The Chapter aims at two goals: First, it assesses the efficiency of public expenditures focusing on the distribution of education considered an output measure. Second, it identifies the factors determining education output efficiency.

To estimate the efficiency scores of public expenditures on education, we use the nonparametric partial frontier method, especially order-m estimator. This method is more robust to extreme values or outliers than the other nonparametric estimators, i.e., Free Disposal Hull (FDH) and Data Envelopment Analysis (DEA). The Chapter employs Exponential Fractional Regression Models (EFRM) to determine the factors of education output efficiency. This econometric methodology is more appropriate for fractional variables such as efficiency scores. For this purpose, we use a sample of 67 developing countries from 1980 to 2010.

The results show that, on average, developing countries might reduce their education inequality by 30% without changing their public expenditures on education. Education output efficiency is very low in sub-Saharan Africa and low-income countries. The level of education output efficiency may be due to educational attainment. Concerning education input efficiency, the results indicate that developing countries could reduce their public expenditures on education by 49% to achieve the same results.

Developing countries have achieved significant progress in improving their education output efficiency. Their education input efficiency has increased from 1980 to 2004 but decreased slightly since 2005.

The Chapter establishes a nonlinear relationship between education output efficiency and GDP per capita from the Exponential Fractional Models. Urbanization, good institutions, and a higher level of financial development improve education output efficiency.

Bibliography

Abdelbaki, H. H. (2012). An analysis of income inequality and education inequality in bahrain. *Modern Economy*, 03(05):675–685.

Abdullah, A., Doucouliagos, H., and Manning, E. (2015). Does education reduce income inequality? a meta-regression analysis. *Journal of Economic Surveys*, 29(2):301–316.

Acemoglu, D. (2006). *Economic origins of dictatorship and democracy*. Cambridge University Press, Cambridge New York.

Acemoglu, D., Johnson, S., and Robinson, J. A. (2005). Chapter 6 institutions as a fundamental cause of long-run growth. In *Handbook of Economic Growth*, pages 385–472. Elsevier.

Acemoglu, D., Naidu, S., Restrepo, P., and Robinson, J. A. (2015). Democracy, redistribution, and inequality. In *Handbook of Income Distribution*, pages 1885–1966. Elsevier.

Acemoglu, D., Naidu, S., Restrepo, P., and Robinson, J. A. (2019). Democracy does cause growth. *Journal of Political Economy*, 127(1):47–100.

Acemoglu, D. and Robinson, J. A. (2000). Why did the west extend the franchise? democracy, inequality, and growth in historical perspective. *The Quarterly Journal of Economics*, 115(4):1167–1199.

Acemoglu, D. and Robinson, J. A. (2013). *Why Nations Fail*. Profile Books.

Afonso, A. and Aubyn, M. S. (2004). Non-parametric approaches to education and health expenditure efficiency in oecd countries. Economics Working Paper 1/2004/DE/CISEP/UECE.

Afonso, A. and Aubyn, M. S. (2006). Cross-country efficiency of secondary education provision: A semi-parametric analysis with non-discretionary inputs. *Economic Modelling*, 23(3):476–491.

Afonso, A., Schuknecht, L., and Tanzi, V. (2005). Public sector efficiency: An international comparison. *Public Choice*, 123(3-4):321–347.

Afonso, A., Schuknecht, L., and Tanzi, V. (2010). Public sector efficiency: evidence for new EU member states and emerging markets. *Applied Economics*, 42(17):2147–2164.

Afriat, S. N. (1972). Efficiency estimation of production functions. *International Economic Review*, 13(3):568–598.

Aidt, T. S. and Jensen, P. S. (2014). Workers of the world, unite! franchise extensions and the threat of revolution in europe, 1820–1938. *European Economic Review*, 72:52–75.

Aigner, D., Lovell, C. K., and Schmidt, P. (1977). Formulation and estimation of stochastic frontier production function models. *Journal of econometrics*, 6(1):21–37.

Aigner, D. J. and Chu, S.-F. (1968). On estimating the industry production function. *The American Economic Review*, 58(4):826–839.

Alesina, A. and Perotti, R. (1996). Income distribution, political instability, and investment. *European Economic Review*, 40(6):1203–1228.

Almond, G. A. and Verba, S. (1963). *The civic culture : political attitudes and democracy in five nations*. Princeton University Press, Princeton, New Jersey.

Alvaredo, F. (2018). *World inequality report 2018*. The Belknap Press of Harvard University Press, Cambridge, Massachusetts.

Alvarez, M., Cheibub, J. A., Limongi, F., and Przeworski, A. (1996). Classifying political regimes. *Studies In Comparative International Development*, 31(2):3–36.

Andreas Savvides, T. S. (2008). *Human Capital and Economic Growth*. STANFORD ECONOMICS & FINANCE.

Angrist, N., Patrinos, H. A., and Schlotter, M. (2013). An expansion of a global data set on educational quality: a focus on achievement in developing countries. Policy Research Working Paper WPS 6536.

Aragon, Y., Daouia, A., and Thomas-Agnan, C. (2005). Nonparametric frontier estimation: a conditional quantile-based approach. *Econometric Theory*, 21(02).

Arrow, K. J. (1973). Higher education as a filter. *Journal of Public Economics*, 2(3):193–216.

Balaev, M. (2014). Improving models of democracy: The example of lagged effects of economic development, education, and gender equality. *Social Science Research*, 46:169–183.

Bardhan, P. (1999). *Democracy and development: A complex relationship.*, chapter Democracy's Values, pages 93–111. Cambridge University Press.

Barro, R. (1997). *Determinants of economic growth : a cross-country empirical study*. MIT Press, Cambridge, MA.

Barro, R. J. (1991). Economic growth in a cross section of countries. *The Quarterly Journal of Economics*, 106(2):407.

Barro, R. J. (1999). Determinants of democracy. *Journal of Political Economy*, 107(S6):S158–S183.

Barro, R. J. (2001). Human capital and growth. *American Economic Review*, 91(2):12–17.

Barro, R. J. and Lee, J.-W. (1993). International comparisons of educational attainment. *Journal of Monetary Economics*, 32(3):363–394.

Barro, R. J. and Lee, J. W. (2013). A new data set of educational attainment in the world, 1950–2010. *Journal of Development Economics*, 104:184–198.

Barro, R. J. and Lee, J.-W. (2015). *Education Matters: Global Schooling Gains from the 19th to the 21st Century*. OXFORD UNIV PR.

Bastagli, F., Coady, D., Gupta, S., and Cottarelli, C. (2012). Income inequality and fiscal policy. Staff Discussion Paper 12/08, International Monetary Fund, Washington, D.C.

Battese, G. E. and Coelli, T. J. (1992). Frontier production functions, technical efficiency and panel data: with application to paddy farmers in india. *International applications of productivity and efficiency analysis*, 3(1–2):153–169.

Battese, G. E. and Coelli, T. J. (1995). A model for technical inefficiency effects in a stochastic frontier production function for panel data. *Empirical economics*, 20(2):325–332.

Baum, M. A. and Lake, D. A. (2003). The political economy of growth: democracy and human capital. *American Journal of Political Science*, 47(2):333–347.

Becker, G. (1993). *Human capital : a theoretical and empirical analysis, with special reference to education*. The University of Chicago Press, Chicago.

Becker, G. S. (1962). Investment in human capital: A theoretical analysis. *Journal of Political Economy*, 70(5):9–49.

Becker, G. S. (1983). A theory of competition among pressure groups for political influence. *The Quarterly Journal of Economics*, 98(3):371.

Becker, G. S. (1985). Human capital, effort, and the sexual division of labor. *Journal of Labor Economics*, 3(1, Part 2):S33–S58.

Becker, G. S. and Chiswick, B. R. (1966). Education and the distribution of earnings. *The American Economic Review*, 56(1/2):358–369.

Benaabdelaali, W., Hanchane, S., and Kamal, A. (2012). Chapter 13 educational inequality in the world, 1950–2010: Estimates from a new dataset. In *Research on Economic Inequality*, pages 337–366. Emerald Group Publishing Limited.

Benhabib, J. and Spiegel, M. M. (1994). The role of human capital in economic development evidence from aggregate cross-country data. *Journal of Monetary Economics*, 34(2):143–173.

Berry, C. R. and Glaeser, E. L. (2005). The divergence of human capital levels across cities. *Papers in Regional Science*, 84(3):407–444.

Bhagwati, J. (1973). Education, class structure and income equality. *World Development*, 1(5):21–36.

Birdsall, N. and Londono, J. L. (1997). Asset inequality matters: An assessment of the world bank's approach to poverty reduction. *The American Economic Review*, 67(2):32–37.

Bittencourt, M. (2014). Democracy and education: Evidence from the southern african development community. Working Papers 433.

Blundell, R. and Bond, S. (1998). Initial conditions and moment restrictions in dynamic panel data models. *Journal of Econometrics*, 87(1):115–143.

Bobba, M. and Coviello, D. (2007). Weak instruments and weak identification, in estimating the effects of education, on democracy. *Economics Letters*, 96(3):301–306.

Boese, V. A. (2019). How (not) to measure democracy. *International Area Studies Review*, 22(2):95–127.

Boix, C. (2001). Democracy, development, and the public sector. *American Journal of Political Science*, 45(1):1.

Boix, C., Miller, M., and Rosato, S. (2012). A complete data set of political regimes, 1800–2007. *Comparative Political Studies*, 46(12):1523–1554.

Bollen, K. A. (1980). Issues in the comparative measurement of political democracy. *American Sociological Review*, 45(3):370.

Bollen, K. A. (1990). Political democracy: Conceptual and measurement traps. *Studies In Comparative International Development*, 25(1):7–24.

Bonvin, J.-M. (2005). La démocratie dans l'approche d'amartya sen. *L Economie politique*, 27(3):24–37.

Borge, L.-E., Falch, T., and Tovmo, P. (2008). Public sector efficiency: the roles of political and budgetary institutions, fiscal capacity, and democratic participation. *Public Choice*, 136(3-4):475–495.

Borjas, G. (2013). *Labor economics*. McGraw-Hill, New York.

Bowles, S. and Gintis, H. (1976). *Schooling in Capitalist America: Educational Reform and the Contradictions of Economic Life*. Basic Book, New York.

Brown, D. S. (1999). Reading, writing, and regime type: Democracy' impact on primary school enrollment. *Political Research Quarterly*, 52(4):681–707.

Bueno de Mesquita, B., Smith, A., Siverson, R. M., and Morrow, J. D. (2003). *The logic of political survival*. MIT Press, Cambridge, Mass.

Bulíř, A. and Hamann, A. J. (2003). Aid volatility: an empirical assessment. *IMF Staff papers*, 50(1):64–89.

Castelló, A. and Doménech, R. (2002). Human capital inequality and economic growth: Some new evidence. *The Economic Journal*, 112(478):C187–C200.

Castelló-Climent, A. (2010a). Channels through which human capital inequality influences economic growth. *Journal of Human Capital*, 4(4):394–450.

Castelló-Climent, A. (2010b). Inequality and growth in advanced economies: an empirical investigation. *The Journal of Economic Inequality*, 8(3):293–321.

Castelló-Climent, A. and Doménech, R. (2008). Human capital inequality, life expectancy and economic growth. *The Economic Journal*, 118(528):653–677.

Castelló-Climent, A. and Doménech, R. (2014). Human capital and income inequality: Some facts and some puzzles. Working Paper 12/28, BBVA Research, Madrid, Spain.

Castelló-Climent, A. and Doménech, R. (2021). Human capital and income inequality revisited. *Education Economics*, 29(2):194–212.

Cazals, C., Florens, J.-P., and Simar, L. (2002). Nonparametric frontier estimation: a robust approach. *Journal of Econometrics*, 106(1):1–25.

Champernowne, D. G. and Cowell, F. A. (1998). *Economic Inequality and Income Distribution.Cambridge*. Cambridge University Press., [England], New York.

Chan, S.-G. and Karim, M. (2012). Public spending efficiency and political and economic factors: Evidence from selected east asian countries. *Economic Annals*, 57(193):7–23.

Charnes, A., Cooper, W. W., and Rhodes, E. (1978). Measuring the efficiency of decision making units. *European journal of operational research*, 2(6):429–444.

Checchi, D. (2000). *Does educational achievement help to explain income inequality*. UNU/WIDER, Helsinki.

Checchi, D. (2001). Education, inequality and income inequality. STICERD - Distributional Analysis Research Programme Papers 52, Suntory and Toyota International Centres for Economics and Related Disciplines, LSE.

Checchi, D. (2004). Does educational achievement help explain income inequality? In Cornia, G. A., editor, *Inequality Growth and Poverty in an Era of Liberalization and Globalization*, UNU-WIDER studies in development economics, pages 81–111. Oxford University Press.

Cheibub, J. A., Gandhi, J., and Vreeland, J. R. (2010). Democracy and dictatorship revisited. *Public Choice*, 143(1-2):67–101.

Chiswick, B. R. (1971). Earnings inequality and economic development. *The Quarterly Journal of Economics*, 85(1):21.

Chiswick, B. R. and Mincer, J. (1972). Time-series changes in personal income inequality in the united states from 1939, with projections to 1985. *Journal of Political Economy*, 80(3, Part 2):S34–S66.

Christiaensen, L., Scott, C., and Wodon, Q. (2002). Development targets and costs. Paper 12299.

Christl, M., Köppl-Turyna, M., and Kucsera, D. (2018). Public sector efficiency in europe: Long-run trends, recent developments and determinants. Working Paper 14.

Cihák, M., Demirgüç-Kunt, A., Feyen, E., and Levine, R. (2012). Benchmarking financial systems around the world. Technical report, The World Bank.

Čihák, M., Demirgüč-Kunt, A., Feyen, E., and Levine, R. (2013). Financial development in 205 economies, 1960 to 2010. Technical report, National Bureau of Economic Research.

Cleland, J. G. and van Ginneken, J. K. (1988). Maternal education and child survival in developing countries: The search for pathways of influence. *Social Science & Medicine*, 27(12):1357–1368.

Clements, B. (2002). How efficient is education spending in europe? *European Review of Economics and Finance*, 1(1):3–26.

Coady, D. and Dizioli, A. (2018). Income inequality and education revisited: persistence, endogeneity and heterogeneity. *Applied Economics*, 50(25):2747–2761.

Coppedge, M., Gerring, J., Altman, D., Bernhard, M., Fish, S., Hicken, A., Kroenig, M., Lindberg, S. I., McMann, K., Paxton, P., Semetko, H. A., Skaaning, S.-E., Staton, J., and Teorell, J. (2011). Conceptualizing and measuring democracy: A new approach. *Perspectives on Politics*, 9(2):247–267.

Coppedge, M., Gerring, J., Knutsen, C. H., Lindberg, S. I., Teorell, J., Marquardt, K. M., Medzihorsky, J., Pemstein, D., Alizada, N., Gastaldi, L., Hindle, G., von Römer, J., Tzelgov, E., ting Wang, Y., Wilson, S., Altman, D., Bernhard, M., Cornell, A., Fish, M. S., Gjerløw, H., Glynn, A., Hicken, A., McMann, K. M., Paxton, P., Seim, B., Staton, J. K., Wig, T., and Ziblatt, D. (2020). Methodology v10. *SSRN Electronic Journal*.

Coppedge, M., Gerring, J., Lindberg, S. I., Skaaning, S.-E., and Teorell, J. (2017). V-dem comparisons and contrasts with other measurement projects. *SSRN Electronic Journal*.

Corak, M. (2013). Income inequality, equality of opportunity, and intergenerational mobility. *Journal of Economic Perspectives*, 27(3):79–102.

Crespo-Cuaresma, J., K.C, S., and Sauer, P. (2012). Gini coeefficients of educational attainment: Age group specific trends in educational (in)equality. Working paper.

Crespo-Cuaresma, J., K.C., S., and Sauer, P. (2013). Age-specific education inequality, education mobility and income growth. Working Paper 6.

Crespo-Cuaresma, J. and Oberdabernig, D. A. (2014). Education and the transition to sustained democracy. Working Paper 170.

Dabla-Norris, E., Kochhar, K., Ricka, F., Suphaphiphat, N., Tsounta, E., and Tiwari, S. (2015). *Causes and consequences of income inequality : a global perspective*. International Monetary Fund,Canadian Electronic Library, Washington DC.

Dahlum, S. and Knutsen, C. H. (2017). Do democracies provide better education? revisiting the democracy–human capital link. *World Development*, 94:186–199.

Dao, M. Q. (2008). Human capital, poverty, and income distribution in developing countries. *Journal of Economic Studies*, 35(4):294–303.

Dao, M. Q. (2013). Factor endowment, human capital, and inequality in developing countries. *Journal of Economic Studies*, 40(1):98–106.

Daouia, A. and Gijbels, I. (2011). Robustness and inference in nonparametric partial frontier modeling. *Journal of Econometrics*, 161(2):147–165.

Daouia, A. and Ruiz-Gazen, A. (2006). Robust nonparametric frontier estimators: influence function and qualitative robustness. *Statistica Sinica*, 16(4):1233–1253.

Daouia, A. and Simar, L. (2007). Nonparametric efficiency analysis: A multivariate conditional quantile approach. *Journal of Econometrics*, 140(2):375–400.

Daraio, C. and Simar, L. (2005). Introducing environmental variables in nonparametric frontier models: a probabilistic approach. *Journal of productivity analysis*, 24(1):93–121.

Daraio, C. and Simar, L. (2007). *Advanced robust and nonparametric methods in efficiency analysis: Methodology and applications*. Springer Science & Business Media.

Davis, L. S. (2010). Institutional flexibility and economic growth. *Journal of Comparative Economics*, 38(3):306–320.

De Borger, B., Kerstens, K., Moesen, W., and Vanneste, J. (1994). A non-parametric free disposal hull (fdh) approach to technical efficiency: an illustration of radial and graph efficiency measures and some sensitivity results. *Swiss Journal of Economics and Statistics*, 130(4):647–667.

De Gregorio, J. and Lee, J.-W. (2002). Education and income inequality: New evidence from cross-country data. *Review of Income and Wealth*, 48(3):395–416.

De la Croix, D. and Doepke, M. (2003). Inequality and growth: Why differential fertility matters. *American Economic Review*, 93(4):1091–1113.

Debreu, G. (1951). The coefficient of resource utilization. *Econometrica: Journal of the Econometric Society*, 19(3):273–292.

Denison, E. F. (1962). *Sources of Economic Growth in the United States and alternative Before Us*. Committee for Economic Development, New York.

Deprins, D., Simar, L., and Tulkens, H. (1984). Measuring labor-efficiency in post offices. In *The Performance of Public Enterprises: Concepts and Measurement*, chapter 10, pages 243–268. North-Holland.

DeSilver, D. (2015). The many ways to measure economic inequality. Fact tank, Pew Research Center, Washington, DC.

Digdowiseiso, K. (2010). Measuring gini coefficient of education: the indonesian cases. MPRA Paper 19865.

Dorsch, M. T. and Maarek, P. (2019). Democratization and the conditional dynamics of income distribution. *American Political Science Review*, 113(2):385–404.

Doucouliagos, H. and Ulubaşoğlu, M. A. (2008). Democracy and economic growth: A meta-analysis. *American Journal of Political Science*, 52(1):61–83.

Downs, A. (1957). *An economic theory of democracy*. Harper, New York.

EFA Global Monitoring Report (2013). Wide inequalities in education. UNESCO.

Engerman, S. and Sokoloff, K. (2002). Factor endowments, inequality, and paths of development among new world economics. Technical report.

Engerman, S. L. and Sokoloff, K. L. (2005). The evolution of suffrage institutions in the new world. *The Journal of Economic History*, 65(4):891–921.

Engerman, S. L. and Sokoloff, K. L. (2009). The evolution of schooling inthe americas. In Eltis, D., Lewis, F. D., and Sokoloff, K. L., editors, *Human capital and institutions: A long run view*, chapter 4, page 93–142. Cambridge University Press,, New York.

Engerman, S. L., Sokoloff, K. L., Urquiola, M., and Acemoglu, D. (2002). Factor endowments, inequality, and paths of development among new world economies [with comments]. *Economía*, 3(1):41–109.

Eterovic, D. S. and Sweet, C. M. (2014). Democracy and education in twentieth-century latin america. *Economics & Politics*, 26(2):237–262.

Eugéne, B. (2007). The efficiency of belgian general government in an international perspective. Working Paper XXX.

Evans, D. B., Tandon, A., Murray, C. J., and Lauer, J. A. (2000). The comparative efficiency of national health systems in producing health: an analysis of 191 countries. *Geneva: World Health Organization*.

Farrell, M. J. (1957). The measurement of productive efficiency. *Journal of the Royal Statistical Society*, 120(3):253–290.

Feenstra, R. C., Inklaar, R., and Timmer, M. P. (2015). The next generation of the penn world table. *American Economic Review*, 105(10):3150–3182.

Ferreira, F. H. (2001). Education for the masses? the interaction between wealth, educational and political inequalities. *The Economics of Transition*, 9(2):533–552.

Fields, G. S. (1980). Education and income distribution in developing countries: A review of the literature.

Figueroa, A. (1996). The distributive issue in latin america. *International Social Science Journal*, 48(2):231–244.

Földvári, P. and van Leeuwen, B. (2011). Should less inequality in education lead to a more equal income distribution? *Education Economics*, 19(5):537–554.

Földvári, P. and van Leeuwen, B. (2014). Educational and income inequality in europe, ca. 1870–2000. *Cliometrica*.

Fonchamnyo, D. C. and Sama, M. C. (2016). Determinants of public spending efficiency in education and health: evidence from selected cemac countries. *Journal of Economics and Finance*, 40(1):199–210.

Frankema, E. and Bolt, J. (2006). Measuring and analysing educational inequality: The distribution of grade enrolment rates in latin america and subsaharan africa. GGDC Research Memorandum GD-86, Groningen Growth and Development Centre, University of Groningen.

Freedom House (2014). Freedom in the world 2014 methodology.

Fried, H. O., Lovell, C. K., and Schmidt, S. S. (2008). *The measurement of productive efficiency and productivity growth*. Oxford University Press.

Gallego, F. A. (2010). Historical origins of schooling: The role of democracy and political decentralization. *Review of Economics and Statistics*, 92(2):228–243.

Galor, O. and Zeira, J. (1993). Income distribution and macroeconomics. *The Review of Economic Studies*, 60(1):35.

Gastil, R. D. (1987). *Freedom in the world : political rights and civil liberties, 1986-1987*. Greenwood Press, New York.

Gavurova, B., Kocisova, K., Belas, L., and Krajcik, V. (2017). Relative efficiency of government expenditure on secondary education. *Journal of International Studies*, 10(2):329–343.

Glaeser, E. L. and Maré, D. C. (2001). Cities and skills. *Journal of Labor Economics*, 19(2):316–342.

Glaeser, E. L., Ponzetto, G. A. M., and Shleifer, A. (2007). Why does democracy need education? *Journal of Economic Growth*, 12(2):77–99.

Glaeser, E. L., Porta, R. L., de Silanes, F. L., and Shleifer, A. (2004). Do institutions cause growth? *Journal of Economic Growth*, 9(3):271–303.

Glomm, G. and Ravikumar, B. (1992). Public versus private investment in human capital: Endogenous growth and income inequality. *Journal of Political Economy*, 100(4):818–834.

Goda, T. (2016). Global trends in relative and absolute income inequality. *Ecos de economía*, 20(42):46–69.

Grigoli, F. (2014). A hybrid approach to estimating the efficiency of public spending on education in emerging and developing economies. Working Paper WP/14/19.

Gründler, K. and Krieger, T. (2016). Democracy and growth: Evidence from a machine learning indicator. *European Journal of Political Economy*, 45:85–107.

Grosskopf, S. (1986). The role of the reference technology in measuring productive efficiency. *The Economic Journal*, 96(382):499–513.

Gründler, K. and Krieger, T. (2018). Machine learning indices, political institutions, and economic development. CESifo Working Paper 6930, Munich.

Gupta, S. and Verhoeven, M. (2001). The efficiency of government expenditure: experiences from africa. *Journal of Policy Modeling*, 23(4):433–467.

Hammar, O. and Waldenström, D. (2020). Global earnings inequality, 1970–2018. *The Economic Journal*, 130(632):2526–2545.

Hanushek, E. and Wößmann, L. (2010). Education and economic growth. In Penelope Peterson, Eva Baker, B. M., editor, *International Encyclopedia of Education*, pages 245–252. Elsevier.

Hauner, D. and Kyobe, A. (2010). Determinants of government efficiency. *World Development*, 38(11):1527–1542.

Herrera, S. and Ouedraogo, A. (2018). fficiency of public spending in education, health, and infrastructure: An international benchmarking exercise. Policy Research Working Paper 8586.

Herrera, S. and Pang, G. (2005). *Efficiency of public spending in developing countries: an efficiency frontier approach*. World Bank, Poverty Reduction and Economic Management Network, Economic Policy and Debt Department.

Hollingsworth, B., Dawson, P., and Maniadakis, N. (1999). Efficiency measurement of health care: a review of non-parametric methods and applications. *Health Care Management Science*, 2(3):161–172.

Hovhannisyan, A., Castillo-Ponce, R., and Valdez, R. (2019). The determinants of income inequality: The role of education. *Scientific Annals of Economics and Business*, 66(4):451–464.

Howell, L. D. (2012). Icrg methodology.

Huntington, S. P. (1991). *The third wave: Democratization in the late twentieth century*. University of Oklahoma press.

Husted, B. W. and Salazar, J. (2020). Reducing inequalities: Toward the development of a market for income inequality. *Journal of Cleaner Production*, 245:118931.

Hyman, H. H. and Wright, C. R. (1979). *Education's lasting influence on values*. Chicago University Press, Chicago.

Inter-American Development Bank (1998). *Facing up to inequality in Latin America : economic and social progress in Latin America, 1998-1999 report*. Distributed by the Johns Hopkins University Press for the Inter-American Development Bank, Washington, D.C.

International Commission on Financing Global Education Opportunity (2016). *The learning generation: Investing in education for a changing world*. New York.

Jayasuriya, R. and Wodon, Q. (2003). Measuring and explaining country efficiency in improving health and education indicators. Paper 11183, MRPA.

Kalirajan, K. P. and Shand, R. T. (1999). Frontier production functions and technical efficiency measures. *Journal of Economic Surveys*, 13(2):149–172.

Kamens, D. H. (1988). Education and democracy: A comparative institutional analysis. *Sociology of Education*, 61(2):114.

Kasuya, Y. and Mori, K. (2019). Better regime cutoffs for continuous democracy measures. Users' Working Paper 25.

KC, S., Barakat, B., Goujon, A., Skirbekk, V., and Lutz, W. (2010). Projection of populations by level of educational attainment, age, and sex for 120 countries for 2005-2050. *Demographic Research*, 22:383–472.

Keister, L. A. (2014). The one percent. *Annual Review of Sociology*, 40(1):347–367.

Kingston, P. W., Hubbard, R., Lapp, B., Schroeder, P., and Wilson, J. (2003). Why education matters. *Sociology of Education*, 76(1):53.

Kirjavainen, T. and Loikkanen, H. A. (1998). Efficiency differences of finnish senior secondary schools: An application of DEA and tobit analysis. *Economics of Education Review*, 17(4):377–394.

Knutsen, C. H. (2011). Democracy, dictatorship and protection of property rights. *Journal of Development Studies*, 47(1):164–182.

Koopmans, T. C. (1951). An analysis of production as an efficient combination of activities. In Koopmans, T. C., editor, *Activity analysis of production and allocation*, number 13 in Monograph. Wiley, New York, cowles commission for research in economics edition.

Kumbhakar, S. C., Lien, G., and Hardaker, J. B. (2014). Technical efficiency in competing panel data models: a study of norwegian grain farming. *Journal of Productivity Analysis*, 41(2):321–337.

Kumbhakar, S. C. and Wang, H.-J. (2005). Estimation of growth convergence using a stochastic production frontier approach. *Economics Letters*, 88(3):300–305.

Lake, D. A. and Baum, M. A. (2001). The invisible hand of democracy. *Comparative Political Studies*, 34(6):587–621.

Lam, D. and Levison, D. (1992). Declining inequality in schooling in brazil and its effects on inequality in earnings. *Journal of Development Economics*, 37(1-2):199–225.

Laslier, J.-F. (2003). La "nouvelle economie politique": Analyse economique du vote. Working Paper 00242989.

Lavy, V. and Zablotsky, A. (2011). Mother's schooling and fertility under low female labor force participation: Evidence from a natural experiment. Working Papers 16856.

Leblang, D. A. (1996). Property rights, democracy and economic growth. *Political Research Quarterly*, 49(1):5–26.

Lee, J.-W. and Lee, H. (2018). Human capital and income inequality. *Journal of the Asia Pacific Economy*, 23(4):554–583.

Lim, A. S. K. and Tang, K. K. (2008). Human capital inequality and the kuznets curve. *The Developing Economies*, 46(1):26–51.

Lindbeck, A. and Weibull, J. W. (1987). Balanced-budget redistribution as the outcome of political competition. *Public Choice*, 52(3):273–297.

Lindberg, S. I., Coppedge, M., Gerring, J., and Teorell, J. (2014). V-dem: A new way to measure democracy. *Journal of Democracy*, 25(3):159–169.

Lipset, S. M. (1959). Some social requisites of democracy: Economic development and political legitimacy. *American Political Science Review*, 53(1):69–105.

Lopez, R., Thomas, V., and Wang, Y. (1998). Addressing the education puzzle: The distribution of education and economic reform. Policy Research Working Paper 2031.

Lott, J. R. J. (1999). Public schooling, indoctrination, and totalitarianism. *Journal of Political Economy*, 107(S6):S127–S157.

Loury, G. C. (1981). Intergenerational transfers and the distribution of earnings. *Econometrica*, 49(4):843–867.

Lucas, R. E. (1988). On the mechanics of economic development. *Journal of Monetary Economics*, 22(1):3–42.

Lurz, W. and Goujon, A. (2001). The world's changing human capital stock: Multi-state population projections by educational attainment. *Population and Development Review*, 27(2):323–339.

Lutz, W. and KC, S. (2011). Global human capital: Integrating education and population. *Science*, 333(6042):587–592.

Maas, J. (1982). *Distribution of primary school enrollments in Eastern Africa*. East Africa Regional Office, World Bank, Washington, D.C.

Mandl, U., Dierx, A., and Ilzkovitz, F. (2008). The effectiveness and efficiency of public spending. Working Paper 301.

Marshall, M. G., Gurr, R. T., and Jaggers, K. (2016). Political regime characteristics and transitions, 1800-2015. data set users' manual. *Center for Systemic Peace*.

Marshall, M. G. and Gurr, T. R. (2020). Political regime characteristics and transitions, 1800-2018: Dataset users' manual. *Center for Systemic Peace*.

Marx, K. (1934). The eighteenth brumaire of louisbonaparte. moscow. Progress Publishers.

Marx, K. (1952). The class struggle in france, 1848 to 1850 moscow.

Mayer-Foulkes, D. (20011). Urbanization as a fundamental cause of development. Research Paper 52.

Meeusen, W. and van Den Broeck, J. (1977). Efficiency estimation from cobb-douglas production functions with composed error. *International economic review*, 18(2):435–444.

Meltzer, A. H. and Richard, S. F. (1981). A rational theory of the size of government. *Journal of Political Economy*, 89(5):914–927.

Mesa, E. P. (2007). Measuring education inequality in the philippines. *Philippine Review of Economics*, 44(2):33–70.

Meschi, E. and Scervini, F. (2013). A new dataset on educational inequality. *Empirical Economics*, 47(2):695–716.

Mincer, J. (1958). Investment in human capital and personal income distribution. *Journal of Political Economy*, 66(4):281–302.

Mincer, J. (1970). The distribution of labor incomes: A survey with special reference to the human capital approach. *Journal of economic literature*, 8(1):1–26.

Mincer, J. A. (1974). *Schooling, experience, and earnings*. Human behavior and social institutions. National Bureau of Economic Research; distributed by Columbia University Press, New York.

Moav, O. (2005). Cheap children and the persistence of poverty. *The Economic Journal*, 115(500):88–110.

Montenegro, C. E. and Patrinos, H. A. (2021). A data set of comparable estimates of the private rate of return to schooling in the world, 1970–2014. *International Journal of Manpower*, ahead-of-print(ahead-of-print).

Moreno-Enguix, M. D. R. and Lorente Bayona, L. V. (2017). Factors affecting public expenditure efficiency in developed countries. *Politics & Policy*, 45(1):105–143.

Morrisson, C. and Murtin, F. (2013). The kuznets curve of human capital inequality: 1870-2010. *The Journal of Economic Inequality*, 11(3):283–301.

Mulligan, C. B., Gil, R., and i Martin, X. S. (2004). Do democracies have different public policies than nondemocracies? *Journal of Economic Perspectives*, 18(1):51–74.

Munck, G. L. and Verkuilen, J. (2002). Conceptualizing and measuring democracy. *Comparative Political Studies*, 35(1):5–34.

Munir, K. and Kanwal, A. (2020). Impact of educational and gender inequality on income and income inequality in south asian countries. *International Journal of Social Economics*, 47(8):1043–1062.

Murillo-Zamorano, L. R. (2004). Economic efficiency and frontier techniques. *Journal of Economic surveys*, 18(1):33–77.

Murtin, F. and Wacziarg, R. (2014). The democratic transition. *Journal of Economic Growth*, 19(2):141–181.

Nie, N. H., Verba, S., and Petrocik, J. R. (1979). *Changing american voter*. Harvard Univ Press, Cambridge, MA.

North, D. C. (1990). *Institutions, Institutional Change and Economic Performance*. Cambridge University Press.

North, D. C. (1991). Institutions. *Journal of Economic Perspectives*, 5(1):97–112.

OECD (2008). Ten steps to equity in education. Policy brief.

Olson, M. (1993). Dictatorship, democracy, and development. *American Political Science Review*, 87(3):567–576.

Ozturk, I. (2001). The role of education in economic development: A theoretical perspective. *Journal of Rural Development and Administration*, XXXIII(1):39–47.

Palma, N. and Reis, J. (2018). Can autocracy promote literacy? evidence from a cultural alignment success story. Working Paper In Economic History 127.

Papke, L. E. and Wooldridge, J. (1996). Econometric methods for fractional response variables with an application to 401 (k) plan participation rates. *Journal of Applied Econometrics*, II(6):619–632.

Park, K. H. (1996). Educational expansion and educational inequality on income distribution. *Economics of education review*, 15(1):51–58.

Pennock, J. R. (1952). Responsiveness, responsibility, and majority rule. *American Political Science Review*, 46(3):790–807.

Permani, R. (2009). The role of education in economic growth in east asia: a survey. *Asian-Pacific Economic Literature*, 23(1):1–20.

Petcu, C. (2014). Does educational inequality explain income inequality across countries? Paper 125, Honors Projects.

Piketty, T. (2014). *Capital in the Twenty-First Century*. Harvard University Press.

Prasartpornsirichoke, J. and Takahashi, Y. (2012). On the determinants of inequality in education. IDEC DP2 Series 2-16.

Przeworski, A., Alvarez, M. E., and Cheibub, J. A. (2000). *Democracy and Development: Political Institutions and Well-Being in the World, 1950 1990*. Cambridge University Press.

Przeworski, A. and Limongi, F. (1993). Political regimes and economic growth. *Journal of Economic Perspectives*, 7(3):51–69.

Ram, R. (1984). Population increase, economic growth, educational inequality, and income distribution. *Journal of Development Economics*, 14(3):419–428.

Ram, R. (1989). Can educational expansion reduce income inequality in less-developed countries? *Economics of Education Review*, 8(2):185–195.

Ram, R. (1990). Educational expansion and schooling inequality: International evidence and some implications. *The Review of Economics and Statistics*, 72(2):266.

Ramalho, E. A. and Ramalho, J. J. (2017). Moment-based estimation of nonlinear regression models with boundary outcomes and endogeneity, with applications to nonnegative and fractional responses. *Econometric Reviews*, 36(4):397–420.

Ramalho, E. A., Ramalho, J. J., and Coelho, L. M. (2016). Exponential regression of fractional-response fixed-effects models with an application to firm capital structure. *Journal of Econometric Methods*, 7(1).

Ramalho, E. A., Ramalho, J. J., and Coelho, L. M. (2018). Exponential regression of fractional-response fixed-effects models with an application to firm capital structure. *Journal of Econometric Methods*, 7(1).

Ramalho, E. A., Ramalho, J. J., and Henriques, P. D. (2010). Fractional regression models for second stage dea efficiency analyses. *Journal of Productivity Analysis*, 34(3):239–255.

Ramalho, E. A., Ramalho, J. J., and Murteira, J. M. (2011). Alternative estimating and testing empirical strategies for fractional regression models. *Journal of Economic Surveys*, 25(1):19–68.

Ramalho, J. J. S. (2019). Modeling fractional responses using r. In *Handbook of Statistics*, pages 245–279. Elsevier.

Rayp, G. and Van De Sijpe, N. (2007). Measuring and explaining government efficiency in developing countries. *The Journal of Development Studies*, 43(2):360–381.

Richmond, J. (1974). Estimating the efficiency of production. *International Economic Review*, 15(2):515–521.

Robert C. Feenstra, R. I. (2021). Penn world table 10.0.

Rodríguez-Pose, A. and Tselios, V. (2009). Education and income inequality in the regions of the european union. *Journal of Regional Science*, 49(3):411–437.

Romer, P. M. (1986). Increasing returns and long-run growth. *Journal of Political Economy*, 94(5):1002–1037.

Romer, P. M. (1987). Growth based on increasing returns due to specialization. *The American Economic Review*, 77(2):56–62.

Romer, P. M. (1990). Endogenous technological change. *Journal of Political Economy*, 98(5, Part 2):S71–S102.

Rosthal, R. A. (1978). Measures of disparity. a note. Technical report.

Roy, P. and Husain, Z. (2019). Education as a way to reducing inequality: Evidence from india. Paper 93907, MPRA.

Sağlam, B. B. (2021). Educational inequality versus income inequality: An empirical investigation. *The Economic and Social Review*, 52(3):269–299.

Sala-i-Martin, X., Doppelhofer, G., and Miller, R. I. (2004). Determinants of long-term growth: A bayesian averaging of classical estimates (BACE) approach. *American Economic Review*, 94(4):813–835.

Sauer, P. (2016). The role of age and gender in education expansion. Working Paper 4.

Sauer, P. and Zagler, M. (2012). Economic growth and the quantity and distribution of education: a survey. *Journal of Economic Surveys*, 26(5):933–951.

Sauer, P. and Zagler, M. (2014). (in)equality in education and economic development. *Review of Income and Wealth*, 60:S353–S379.

Savoia, A., Easaw, J., and McKay, A. (2010). Inequality, democracy, and institutions: A critical reviewof recent research. *World Development*, 38(2):142–154.

Schultz, T. W. (1961). Investment in human capital. *The American Economic Review*, 51(1):1–17.

Seiford, L. M. (1996). Data envelopment analysis: the evolution of the state of the art (1978–1995). *Journal of productivity analysis*, 7(2-3):99–137.

Sen, A. and Scanlon, T. (2004). What's the point of democracy? *American Academy of Arts and Sciences Bulletin*, 57(3).

Sen, A. K. (1999). Democracy as a universal value. *Journal of Democracy*, 10(3):3–17.

Shahabadi, A., , Nemati, M., Hosseinidoust, S. E., and and (2018). The effect of education on income inequality in selected islamic countries. *International Journal of Asia Pacific Studies*, 14(2):61–78.

Shapiro, J. M. (2006). Smart cities: Quality of life, productivity, and the growth effects of human capital. *Review of Economics and Statistics*, 88(2):324–335.

Shephard, R. W. (1953). *Cost and production functions*. PrincetonUniversity Press, Princeton, NJ.

Shephard, R. W. (1970). *Theory of Cost and Production Functions*. Princeton University Press, Princeton, NJ.

Shephard, R. W. (1974). *Indirect Production Functions*. Princeton University Press, Princeton, NJ.

Sheret, M. (1988). Evaluation studies equality trends and comparisons for the education system of papua new guinea. *Studies in Educational Evaluation*, 14(1):91–112,.

Skaaning, S.-E., Gerring, J., and Bartusevičius, H. (2015). A lexical index of electoral democracy. *Comparative Political Studies*, 48(12):1491–1525.

Solon, G. (1999). Intergenerational mobility in the labor market. In *Handbook of Labor Economics*, pages 1761–1800. Elsevier.

Solow, R. M. (1957). Technical change and the aggregate production function. *The Review of Economics and Statistics*, 39(3):312.

Spence, M. (1973). Job market signaling. *The Quarterly Journal of Economics*, 87(3):355.

Stiglitz, J. (2012). *The price of inequality : [how today's divided society endangers our future*. W.W. Norton & Co, New York.

Stiglitz, J. E. (1975). The theory of "screening," education, and the distribution of income. *American Economic Association*, 65(3):283–300.

Svirydzenka, K. (2016). Introducing a new broad-based index of financial development. Working Paper 16/5.

Tanzi, V. (1998). Fundamental determinants of inequality and the role of government. Working Paper WP/98/178, IMF.

Tauchmann, H. (2012). Partial frontier efficiency analysis. *The Stata Journal: Promoting communications on statistics and Stata*, 12(3):461–478.

Tavares, J. and Wacziarg, R. (2001). How democracy affects growth. *European Economic Review*, 45(8):1341–1378.

The World Bank (1993). *The East Asian miracle : economic growth and public policy*. Oxford University Press, New York, N.Y.

The World Bank (2017). *World Development Report 2018: Learning to Realize Education's Promise*. The World Bank, Washington, DC, USA.

Thomas, V., Wang, Y., and Fan, X. (2001). Measuring education inequality: Gini coefficients of education. Policy Research Working Paper 2525, The World Bank.

Tinbergen, J. (1972). The impact of education on income distribution. *Review of Income and Wealth*, 18(3):255–265.

Todaro, M. P. and Smith, S. C. (2003). *Economic development*. Addison Wesley, Boston.

Todaro, M. P. and Smith, S. C. (2012). *Economic development 11th edition*. Addison-Wesley, Boston, Mass.

Torpey-Saboe, N. (2019). *Measuring Education Inequality in Developing Countries*. Springer International Publishing.

Torraco, R. (2018). Economic inequality, educational inequity, and reduced career opportunity: A self-perpetuating cycle? *New Horizons in Adult Education and Human Resource Development*, 30(1):19–29.

Tselios, V. (2008). Income and educational inequalities in the regions of the european union: Geographical spillovers under welfare state restrictions. *Papers in Regional Science*, 87(3):403–430.

UNDP (2005). *Human Development Report 2005: International Cooperation at a Crossroads: Aid, Trade, and Security in an Unequal World*. Oxford University Press.

UNESCO (2013). Education transforms lives. programme and meeting document ED.2013/WS/25, UNESCO.

UNESCO (2016). *Global education monitoring report 2016: education for people and planet: creating sustainable futures for all*. UNITED NATIONS PUBN, Paris, France, second edition.

United Nations Development Programme (2002). *Human development report 2002 : deepening democracy in a fragmented world*. Oxford University Press, New York, N.Y.

United Nations Development Programme (2020). *Human development report 2002: Deepening democracy in a fragmented world*. Oxford University Press.

US Congressional Budget Office (2011). Trends in the distribution of household income between 1979 and 2007. US Congressional Budget Office.

Van Leeuwen, B., van Leeuwen-Li, J., and Foldvari, P. (2012). Education as a driver of income inequality in twentieth-century africa. MPRA Paper 43574, University Library of Munich, Germany.

Vollmer, S. and Ziegler, M. (2009). Political institutions and human development does democracy fulfill its 'constructive' and 'instrumental' role? Policy Research Working Paper WPS4818.

Wagstaff, A. and Wang, L. C. (2011). A hybrid approach to efficiency measurement with empirical illustrations from education and health. Working Paper 5751.

Winegarden, C. R. (1979). Schooling and income distribution: Evidence from international data. *Economica*, 46(181):83.

Wolf, A. (2004). Education and economic performance: Simplistic theories and their policy consequences. *Oxford Review of Economic Policy*, 20(2):315–333.

Yogo, T. U. (2015). Ethnic diversity and the efficiency of public spending in developing countries. Etudes et Documents 13.

Yoldaş, z. B. (2015). Civic education and learning democracy: Their importance for political participation of young people. *Procedia - Social and Behavioral Sciences*, 174:544–549.

Yotova, L. and Stefanova, K. (2017). Efficiency of tertiary education expenditure in cee countries: Data envelopment analysis. *Economic Alternatives*, (3):352–364.

Appendices

Appendix Chapter 1

Table 1: Summary statistics by Region for population aged 15 years and above

Regions	**Education Gini Index**	**Education Gini Index among the literates**	**Share of Illiterates**
Advanced Economis	0.21	0.16	7.13
East Asia and the Pacific	0.38	0.15	30.4
Europe and Centra Asia	0.21	0.13	9.48
Latin America and the Caribbean	0.34	0.16	21.6
Middle East and North Africa	0.57	0.17	49.2
South Asia	0.64	0.16	58.0
Sub-Saharan Africa	0.61	0.13	56.6
World	0.41	0.15	31.8

Table 2: Summary statistics by Region in 2010 for population aged 15 years and above

Regions	**Education Gini Index**	**Education Gini Index among the literates**	**Share of Illiterates**
Advanced Economis	0.16	0.13	2.56
East Asia and the Pacific	0.23	0.14	10.9
Europe and Centra Asia	0.099	0.089	0.95
Latin America and the Caribbean	0.22	0.15	7.35
Middle East and North Africa	0.31	0.15	18.0
South Asia	0.41	0.14	32.7
Sub-Saharan Africa	0.41	0.13	34.1
World	0.26	0.13	14.7
Number of Country	146		

Appendix Chapter 3

Table 3: Statistics by Region

Regions	**Number of Countries**	**Education ineauality**	**Education inequality among the literates**	**Share of il-literates**	**Democracy**
Advanced Economies	23	0.21	0.16	5.95	0.96
East Asia and the Passific	11	0.32	0.15	23.9	0.40
Europe and Central Asia	19	0.17	0.12	6.09	0.67
Latin America and the Caribbean	21	0.31	0.17	17.1	0.67
Middle East and North Africa	9	0.49	0.17	39.1	0.33
South Asia	5	0.59	0.15	52.2	0.63
Sub-Saharan Africa	24	0.57	0.12	51.5	0.41
World	112	0.35	0.15	24.3	0.62

Table 4: Statistics by income level

Income groups	**Number of Country**	**Education inequality**	**Education inequality among the literate**	**Share of il-literates**	**Democracy**
High income	41	0.19	0.15	5.87	0.86
Upper middle income	28	0.32	0.16	19.6	0.57
Lower middle income	31	0.46	0.15	38.8	0.43
Low income	12	0.65	0.12	60.6	0.35
World	112	0.35	0.15	24.3	0.62

Appendix Chapter 4

Table 5: Descriptive statistics of education output efficiency scores by region

Regions	**mean**	**p50**	**sd**	**cv**	**min**	**max**	**p25**	**p75**	**iqr**
East Asia & Pacific	0.97	0.99	0.046	0.047	0.91	1.02	0.95	1.00	0.057
Europe & Central Asia	0.92	0.92	0.15	0.17	0.81	1.02	0.81	1.02	0.22
Latin America & Caribbean	0.85	0.87	0.12	0.15	0.62	1.04	0.75	0.93	0.18
Middle East & North Africa	0.63	0.64	0.14	0.22	0.37	0.83	0.60	0.73	0.13
South Asia	0.65	0.58	0.22	0.33	0.42	1.00	0.57	0.68	0.11
Sub-Saharan Africa	0.59	0.62	0.26	0.43	0.16	0.93	0.35	0.82	0.47
Total Sample	0.70	0.75	0.24	0.34	0.16	1.04	0.56	0.89	0.33
Number of Country	67								

caption*Source Authors'calculation

Table 6: Descriptive statistics of education input efficiency scores by region

Regions	**mean**	**p50**	**sd**	**cv**	**min**	**max**	**p25**	**p75**	**iqr**
East Asia & Pacific	0.71	0.87	0.36	0.50	0.19	1.09	0.52	0.87	0.35
Europe & Central Asia	0.58	0.58	0.56	0.97	0.18	0.97	0.18	0.97	0.79
Latin America & Caribbean	0.45	0.34	0.33	0.74	0.096	1.18	0.20	0.62	0.42
Middle East & North Africa	0.22	0.17	0.14	0.62	0.11	0.49	0.14	0.33	0.19
South Asia	0.75	0.73	0.23	0.30	0.50	1.04	0.58	0.93	0.35
Sub-Saharan Africa	0.53	0.45	0.31	0.59	0.11	1.09	0.28	0.77	0.50
Total Sample	0.51	0.43	0.32	0.64	0.096	1.18	0.21	0.77	0.57
Number of Country	67								

Source Authors'calculation

Table 7: Descriptive statistics of education output efficiency scores by income level

Income groups	**mean**	**p50**	**sd**	**cv**	**min**	**max**	**p25**	**p75**	**iqr**
Low income	0.55	0.55	0.26	0.47	0.16	0.93	0.32	0.80	0.48
Lower middle income	0.66	0.68	0.21	0.32	0.25	1.02	0.56	0.80	0.23
Upper middle income	0.87	0.89	0.12	0.14	0.62	1.04	0.81	0.95	0.14
Total sample	0.70	0.75	0.24	0.34	0.16	1.04	0.56	0.89	0.33
Number of Country	67								

Table 8: Descriptive statistics of education output efficiency scores by income level

Income groups	mean	p50	sd	cv	min	max	p25	p75	iqr
Low income	0.73	0.77	0.30	0.42	0.27	1.18	0.44	1.01	0.57
Lower middle income	0.47	0.43	0.26	0.55	0.15	1.09	0.29	0.58	0.28
Upper middle income	0.35	0.20	0.31	0.87	0.096	1	0.16	0.52	0.37
Total sample	0.51	0.43	0.32	0.64	0.096	1.18	0.21	0.77	0.57
Number of Country	67								

Table 9: list of country used

Country for wfhich efficiency scores is computed	**region**	**Second stage regression**
Algeria	Middle East & North Africa	Algeria
Bangladesh	South Asia	Bangladesh
Benin	Sub-Saharan Africa	
Bolivia	Latin America & Caribbean	Bolivia
Brazil	Latin America & Caribbean	Brazil
Burkina Faso	Sub-Saharan Africa	Burkina Faso
Burundi	Sub-Saharan Africa	
Cameroon	Sub-Saharan Africa	Cameroon
Chad	Sub-Saharan Africa	
China	East Asia & Pacific	China
Number of Country	67	55

Country for wfhich efficiency scores is computed	**region**	**Second stage regression**
Colombia	Latin America & Caribbean	Colombia
Costa Rica	Latin America & Caribbean	Costa Rica
Cote d'Ivoire	Sub-Saharan Africa	Cote d'Ivoire
Dominican Republic	Latin America & Caribbean	
Ecuador	Latin America & Caribbean	Ecuador
Egypt	Middle East & North Africa	Egypt
El Salvador	Latin America & Caribbean	El Salvador
Ethiopia	Sub-Saharan Africa	Ethiopia
Gabon	Sub-Saharan Africa	Gabon
Gambia	Sub-Saharan Africa	Gambia
Ghana	Sub-Saharan Africa	Ghana
Guatemala	Latin America & Caribbean	Guatemala
Guinea	Sub-Saharan Africa	Guinea
Haiti	Latin America & Caribbean	Haiti
Honduras	Latin America & Caribbean	Honduras
India	South Asia	India
Indonesia	East Asia & Pacific	Indonesia
Iran (Islamic Republic of)	Middle East & North Africa	Iran (Islamic Republic of)
Jamaica	Latin America & Caribbean	
Jordan	Middle East & North Africa	Jordan
Kenya	Sub-Saharan Africa	Kenya
Lesotho	Sub-Saharan Africa	
Liberia	Sub-Saharan Africa	Liberia
Madagascar	Sub-Saharan Africa	Madagascar
Malawi	Sub-Saharan Africa	Malawi
Malaysia	East Asia & Pacific	Malaysia
Mali	Sub-Saharan Africa	Mali
Mauritania	Sub-Saharan Africa	
Mauritius	Sub-Saharan Africa	
Number of Country	67	55

Country for wfhich efficiency scores is computed	**region**	**Second stage regression**
Mexico	Latin America & Caribbean	Mexico
Morocco	Middle East & North Africa	Morocco
Mozambique	Sub-Saharan Africa	Mozambique
Namibia	Sub-Saharan Africa	Namibia
Nepal	South Asia	
Nicaragua	Latin America & Caribbean	Nicaragua
Niger	Sub-Saharan Africa	Niger
Nigeria	Sub-Saharan Africa	Nigeria
Pakistan	South Asia	Pakistan
Panama	Latin America & Caribbean	Panama
Paraguay	Latin America & Caribbean	Paraguay
Peru	Latin America & Caribbean	Peru
Philippines	East Asia & Pacific	
Romania	Europe & Central Asia	Romania
Rwanda	Sub-Saharan Africa	
Senegal	Sub-Saharan Africa	Senegal
Sierra Leone	Sub-Saharan Africa	Sierra Leone
South Africa	Sub-Saharan Africa	South Africa
Sri Lanka	South Asia	Sri Lanka
Syrian Arab Republic	Middle East & North Africa	Syrian Arab Republic
Thailand	East Asia & Pacific	Thailand
Togo	Sub-Saharan Africa	Togo
Tunisia	Middle East & North Africa	Tunisia
Turkey	Europe & Central Asia	Turkey
Uganda	Sub-Saharan Africa	Uganda
United Republic of Tanzania	Sub-Saharan Africa	United Republic of Tanzania
Zambia	Sub-Saharan Africa	Zambia
Zimbabwe	Sub-Saharan Africa	
Number of Country	67	55

Country for wfhich efficiency scores is computed	region	Second stage regression
Number of Country	67	55

Source: Authors

Table 10: Public expenditures efficiency scores

Country	ID	code	period	Output effeciency	Input effeciency
Algeria	1	DZA	1980-1984	0.45	0.13
Algeria	1	DZA	1985-1989	0.54	0.13
Algeria	1	DZA	1990-1994	0.63	0.12
Algeria	1	DZA	1995-1999	0.69	0.10
Algeria	1	DZA	2000-2004	0.75	0.10
Algeria	1	DZA	2005-2010	0.79	0.09
Bangladesh	2	BGD	1980-1984	0.49	0.82
Bangladesh	2	BGD	1985-1989	0.50	0.78
Bangladesh	2	BGD	1990-1994	0.54	0.94
Bangladesh	2	BGD	1995-1999	0.92	1.02
Bangladesh	2	BGD	2000-2004	0.91	1.03
Bangladesh	2	BGD	2005-2010	0.73	0.98
Benin	3	BEN	1980-1984	0.24	0.38
Benin	3	BEN	1985-1989	0.26	0.38
Benin	3	BEN	1990-1994	0.31	0.38
Benin	3	BEN	1995-1999	0.37	0.52
Benin	3	BEN	2000-2004	0.43	0.47
Benin	3	BEN	2005-2010	0.48	0.50
Bolivia	4	BOL	1980-1984	0.61	0.32
Bolivia	4	BOL	1985-1989	0.67	0.32
Bolivia	4	BOL	1990-1994	0.74	0.35
Bolivia	4	BOL	1995-1999	0.79	0.33
Bolivia	4	BOL	2000-2004	0.83	0.36
Bolivia	4	BOL	2005-2010	0.86	0.29
Brazil	5	BRA	1980-1984	0.80	0.30

Country	ID	code	period	Output effeciency	Input effeciency
Brazil	5	BRA	1985-1989	0.84	0.16
Brazil	5	BRA	1990-1994	0.86	0.17
Brazil	5	BRA	1995-1999	0.88	0.17
Brazil	5	BRA	2000-2004	0.89	0.25
Brazil	5	BRA	2005-2010	0.88	0.20
Burkina Faso	6	BFA	1980-1984	0.52	1.08
Burkina Faso	6	BFA	1985-1989	0.12	0.97
Burkina Faso	6	BFA	1990-1994	0.24	0.87
Burkina Faso	6	BFA	1995-1999	0.38	0.98
Burkina Faso	6	BFA	2000-2004	0.24	0.71
Burkina Faso	6	BFA	2005-2010	0.23	0.64
Burundi	7	BDI	1980-1984	0.93	0.86
Burundi	7	BDI	1985-1989	0.90	0.95
Burundi	7	BDI	1990-1994	0.88	1.00
Burundi	7	BDI	1995-1999	1.02	1.09
Burundi	7	BDI	2000-2004	0.99	1.03
Burundi	7	BDI	2005-2010	0.78	0.60
Cameroon	8	CMR	1980-1984	0.54	0.37
Cameroon	8	CMR	1985-1989	0.58	0.38
Cameroon	8	CMR	1990-1994	0.66	0.54
Cameroon	8	CMR	1995-1999	0.76	0.66
Cameroon	8	CMR	2000-2004	0.77	0.44
Cameroon	8	CMR	2005-2010	0.78	0.40
Chad	9	TCD	1980-1984	0.17	0.63
Chad	9	TCD	1985-1989	0.23	0.90
Chad	9	TCD	1990-1994	0.45	0.96
Chad	9	TCD	1995-1999	1.00	1.14
Chad	9	TCD	2000-2004	1.00	1.65

Country	ID	code	period	Output effeciency	Input effeciency
Chad	9	TCD	2005-2010	1.00	1.21
China	10	CHN	1980-1984	0.84	0.65
China	10	CHN	1985-1989	1.00	0.65
China	10	CHN	1990-1994	1.00	0.81
China	10	CHN	1995-1999	1.04	1.05
China	10	CHN	2000-2004	1.04	1.05
China	10	CHN	2005-2010	1.04	1.03
Colombia	11	COL	1980-1984	0.84	0.31
Colombia	11	COL	1985-1989	0.85	0.33
Colombia	11	COL	1990-1994	0.86	0.17
Colombia	11	COL	1995-1999	0.88	0.18
Colombia	11	COL	2000-2004	0.87	0.20
Colombia	11	COL	2005-2010	0.89	0.22
Costa Rica	12	CRI	1980-1984	0.96	0.17
Costa Rica	12	CRI	1985-1989	0.95	0.14
Costa Rica	12	CRI	1990-1994	0.95	0.17
Costa Rica	12	CRI	1995-1999	0.93	0.19
Costa Rica	12	CRI	2000-2004	0.92	0.15
Costa Rica	12	CRI	2005-2010	0.91	0.17
Cote d'Ivoire	13	CIV	1980-1984	0.24	0.12
Cote d'Ivoire	13	CIV	1985-1989	0.29	0.14
Cote d'Ivoire	13	CIV	1990-1994	0.33	0.14
Cote d'Ivoire	13	CIV	1995-1999	0.38	0.17
Cote d'Ivoire	13	CIV	2000-2004	0.41	0.26
Cote d'Ivoire	13	CIV	2005-2010	0.45	0.25
Dominican Republic	14	DOM	1980-1984	1.04	1.00
Dominican Republic	14	DOM	1985-1989	1.05	1.00
Dominican Republic	14	DOM	1990-1994	1.05	1.00

Country	ID	code	period	Output effeciency	Input effeciency
Dominican Republic	14	DOM	1995-1999	1.04	1.00
Dominican Republic	14	DOM	2000-2004	1.02	0.82
Dominican Republic	14	DOM	2005-2010	1.00	0.76
Ecuador	15	ECU	1980-1984	0.86	0.17
Ecuador	15	ECU	1985-1989	0.86	0.27
Ecuador	15	ECU	1990-1994	0.88	0.38
Ecuador	15	ECU	1995-1999	0.91	0.24
Ecuador	15	ECU	2000-2004	0.91	0.48
Ecuador	15	ECU	2005-2010	0.92	0.51
Egypt	16	EGY	1980-1984	0.44	0.48
Egypt	16	EGY	1985-1989	0.46	0.45
Egypt	16	EGY	1990-1994	0.55	0.47
Egypt	16	EGY	1995-1999	0.66	0.57
Egypt	16	EGY	2000-2004	0.71	0.49
Egypt	16	EGY	2005-2010	0.77	0.47
El Salvador	17	SLV	1980-1984	0.68	0.61
El Salvador	17	SLV	1985-1989	0.67	0.53
El Salvador	17	SLV	1990-1994	0.72	0.53
El Salvador	17	SLV	1995-1999	0.76	0.51
El Salvador	17	SLV	2000-2004	0.82	0.70
El Salvador	17	SLV	2005-2010	0.83	0.56
Ethiopia	18	ETH	1980-1984	1.00	1.21
Ethiopia	18	ETH	1985-1989	0.22	1.09
Ethiopia	18	ETH	1990-1994	0.45	1.03
Ethiopia	18	ETH	1995-1999	0.70	1.10
Ethiopia	18	ETH	2000-2004	0.44	0.93
Ethiopia	18	ETH	2005-2010	0.44	0.69
Gabon	19	GAB	1980-1984	0.57	0.17

Country	ID	code	period	Output effeciency	Input effeciency
Gabon	19	GAB	1985-1989	0.66	0.12
Gabon	19	GAB	1990-1994	0.73	0.14
Gabon	19	GAB	1995-1999	0.80	0.13
Gabon	19	GAB	2000-2004	0.83	0.14
Gabon	19	GAB	2005-2010	0.88	0.24
Gambia	20	GMB	1980-1984	0.31	0.15
Gambia	20	GMB	1985-1989	0.35	0.16
Gambia	20	GMB	1990-1994	0.40	0.22
Gambia	20	GMB	1995-1999	0.46	0.26
Gambia	20	GMB	2000-2004	0.53	0.39
Gambia	20	GMB	2005-2010	0.62	0.42
Ghana	21	GHA	1980-1984	0.46	0.12
Ghana	21	GHA	1985-1989	0.49	0.17
Ghana	21	GHA	1990-1994	0.52	0.17
Ghana	21	GHA	1995-1999	0.59	0.22
Ghana	21	GHA	2000-2004	0.64	0.29
Ghana	21	GHA	2005-2010	0.68	0.24
Guatemala	22	GTM	1980-1984	0.55	0.40
Guatemala	22	GTM	1985-1989	0.54	0.51
Guatemala	22	GTM	1990-1994	0.60	0.48
Guatemala	22	GTM	1995-1999	0.64	0.44
Guatemala	22	GTM	2000-2004	0.68	0.43
Guatemala	22	GTM	2005-2010	0.69	0.32
Guinea	23	GIN	1980-1984	0.11	0.19
Guinea	23	GIN	1985-1989	0.13	0.30
Guinea	23	GIN	1990-1994	0.18	0.40
Guinea	23	GIN	1995-1999	0.20	0.37
Guinea	23	GIN	2000-2004	0.24	0.41

Country	ID	code	period	Output effeciency	Input effeciency
Guinea	23	GIN	2005-2010	0.27	0.36
Haiti	24	HTI	1980-1984	0.49	0.94
Haiti	24	HTI	1985-1989	0.52	1.14
Haiti	24	HTI	1990-1994	1.00	1.44
Haiti	24	HTI	1995-1999	1.00	1.25
Haiti	24	HTI	2000-2004	1.00	1.23
Haiti	24	HTI	2005-2010	0.81	1.08
Honduras	25	HND	1980-1984	0.63	0.25
Honduras	25	HND	1985-1989	0.66	0.22
Honduras	25	HND	1990-1994	0.72	0.34
Honduras	25	HND	1995-1999	0.73	0.36
Honduras	25	HND	2000-2004	0.76	0.33
Honduras	25	HND	2005-2010	0.78	0.29
India	26	IND	1980-1984	0.45	0.43
India	26	IND	1985-1989	0.46	0.48
India	26	IND	1990-1994	0.50	0.45
India	26	IND	1995-1999	0.59	0.60
India	26	IND	2000-2004	0.69	0.74
India	26	IND	2005-2010	0.72	0.76
Indonesia	27	IDN	1980-1984	1.00	1.33
Indonesia	27	IDN	1985-1989	1.00	1.45
Indonesia	27	IDN	1990-1994	1.02	1.27
Indonesia	27	IDN	1995-1999	1.01	1.13
Indonesia	27	IDN	2000-2004	1.02	0.76
Indonesia	27	IDN	2005-2010	0.97	0.62
Iran (Islamic Republic of)	28	IRN	1980-1984	0.46	0.10
Iran (Islamic Republic of)	28	IRN	1985-1989	0.54	0.12
Iran (Islamic Republic of)	28	IRN	1990-1994	0.62	0.10

Country	ID	code	period	Output effeciency	Input effeciency
Iran (Islamic Republic of)	28	IRN	1995-1999	0.69	0.11
Iran (Islamic Republic of)	28	IRN	2000-2004	0.77	0.29
Iran (Islamic Republic of)	28	IRN	2005-2010	0.80	0.34
Jamaica	29	JAM	1980-1984	1.05	1.00
Jamaica	29	JAM	1985-1989	1.04	1.00
Jamaica	29	JAM	1990-1994	1.05	1.00
Jamaica	29	JAM	1995-1999	1.03	1.00
Jamaica	29	JAM	2000-2004	1.04	1.00
Jamaica	29	JAM	2005-2010	1.05	1.00
Jordan	30	JOR	1980-1984	0.68	0.08
Jordan	30	JOR	1985-1989	0.76	0.08
Jordan	30	JOR	1990-1994	0.82	0.14
Jordan	30	JOR	1995-1999	0.87	0.20
Jordan	30	JOR	2000-2004	0.90	0.17
Jordan	30	JOR	2005-2010	0.92	0.18
Kenya	31	KEN	1980-1984	0.66	0.17
Kenya	31	KEN	1985-1989	0.72	0.17
Kenya	31	KEN	1990-1994	0.78	0.25
Kenya	31	KEN	1995-1999	0.84	0.34
Kenya	31	KEN	2000-2004	0.88	0.47
Kenya	31	KEN	2005-2010	0.91	0.46
Lesotho	32	LSO	1980-1984	0.80	0.38
Lesotho	32	LSO	1985-1989	0.83	0.23
Lesotho	32	LSO	1990-1994	0.84	0.25
Lesotho	32	LSO	1995-1999	0.89	0.24
Lesotho	32	LSO	2000-2004	0.92	0.35
Lesotho	32	LSO	2005-2010	0.93	0.31
Liberia	33	LBR	1980-1984	0.10	0.13

Country	ID	code	period	Output effeciency	Input effeciency
Liberia	33	LBR	1985-1989	0.12	0.16
Liberia	33	LBR	1990-1994	0.14	0.20
Liberia	33	LBR	1995-1999	0.16	0.26
Liberia	33	LBR	2000-2004	0.19	0.39
Liberia	33	LBR	2005-2010	0.26	0.52
Madagascar	34	MDG	1980-1984	0.67	0.35
Madagascar	34	MDG	1985-1989	0.71	0.43
Madagascar	34	MDG	1990-1994	0.83	0.61
Madagascar	34	MDG	1995-1999	0.96	1.03
Madagascar	34	MDG	2000-2004	0.91	0.91
Madagascar	34	MDG	2005-2010	0.90	0.84
Malawi	35	MWI	1980-1984	0.68	0.65
Malawi	35	MWI	1985-1989	0.69	0.62
Malawi	35	MWI	1990-1994	0.70	0.64
Malawi	35	MWI	1995-1999	0.73	0.62
Malawi	35	MWI	2000-2004	0.78	0.68
Malawi	35	MWI	2005-2010	0.90	0.65
Malaysia	36	MYS	1980-1984	0.82	0.18
Malaysia	36	MYS	1985-1989	0.87	0.20
Malaysia	36	MYS	1990-1994	0.91	0.21
Malaysia	36	MYS	1995-1999	0.93	0.21
Malaysia	36	MYS	2000-2004	0.95	0.15
Malaysia	36	MYS	2005-2010	0.96	0.18
Mali	37	MLI	1980-1984	0.13	0.86
Mali	37	MLI	1985-1989	0.13	1.05
Mali	37	MLI	1990-1994	0.25	1.10
Mali	37	MLI	1995-1999	0.66	1.14
Mali	37	MLI	2000-2004	0.25	0.90

Country	ID	code	period	Output effeciency	Input effeciency
Mali	37	MLI	2005-2010	0.21	0.83
Mauritania	38	MRT	1980-1984	0.23	0.47
Mauritania	38	MRT	1985-1989	0.27	0.33
Mauritania	38	MRT	1990-1994	0.33	0.31
Mauritania	38	MRT	1995-1999	0.41	0.35
Mauritania	38	MRT	2000-2004	0.46	0.38
Mauritania	38	MRT	2005-2010	0.55	0.42
Mauritius	39	MUS	1980-1984	0.87	0.11
Mauritius	39	MUS	1985-1989	0.90	0.17
Mauritius	39	MUS	1990-1994	0.93	0.23
Mauritius	39	MUS	1995-1999	0.94	0.25
Mauritius	39	MUS	2000-2004	0.93	0.32
Mauritius	39	MUS	2005-2010	0.94	0.25
Mexico	40	MEX	1980-1984	0.83	0.11
Mexico	40	MEX	1985-1989	0.86	0.12
Mexico	40	MEX	1990-1994	0.88	0.08
Mexico	40	MEX	1995-1999	0.88	0.08
Mexico	40	MEX	2000-2004	0.89	0.08
Mexico	40	MEX	2005-2010	0.90	0.10
Morocco	41	MAR	1980-1984	0.26	0.16
Morocco	41	MAR	1985-1989	0.31	0.15
Morocco	41	MAR	1990-1994	0.35	0.18
Morocco	41	MAR	1995-1999	0.40	0.20
Morocco	41	MAR	2000-2004	0.45	0.18
Morocco	41	MAR	2005-2010	0.48	0.13
Mozambique	42	MOZ	1980-1984	0.19	0.93
Mozambique	42	MOZ	1985-1989	0.19	1.10
Mozambique	42	MOZ	1990-1994	0.37	1.02

Country	ID	code	period	Output effeciency	Input effeciency
Mozambique	42	MOZ	1995-1999	1.00	1.22
Mozambique	42	MOZ	2000-2004	0.39	0.91
Mozambique	42	MOZ	2005-2010	0.87	1.01
Namibia	43	NAM	1980-1984	0.70	0.12
Namibia	43	NAM	1985-1989	0.76	0.08
Namibia	43	NAM	1990-1994	0.80	0.09
Namibia	43	NAM	1995-1999	0.83	0.09
Namibia	43	NAM	2000-2004	0.86	0.13
Namibia	43	NAM	2005-2010	0.88	0.14
Nepal	44	NPL	1980-1984	0.25	1.07
Nepal	44	NPL	1985-1989	0.30	1.05
Nepal	44	NPL	1990-1994	0.62	1.03
Nepal	44	NPL	1995-1999	1.00	1.21
Nepal	44	NPL	2000-2004	0.70	1.07
Nepal	44	NPL	2005-2010	0.60	0.81
Nicaragua	45	NIC	1980-1984	0.60	0.08
Nicaragua	45	NIC	1985-1989	0.63	0.08
Nicaragua	45	NIC	1990-1994	0.65	0.12
Nicaragua	45	NIC	1995-1999	0.68	0.16
Nicaragua	45	NIC	2000-2004	0.72	0.21
Nicaragua	45	NIC	2005-2010	0.75	0.23
Niger	46	NER	1980-1984	0.07	0.32
Niger	46	NER	1985-1989	0.09	0.37
Niger	46	NER	1990-1994	0.13	0.49
Niger	46	NER	1995-1999	0.20	0.64
Niger	46	NER	2000-2004	0.22	0.75
Niger	46	NER	2005-2010	0.23	0.79
Nigeria	47	NGA	1980-1984	0.38	0.19

Country	ID	code	period	Output effeciency	Input effeciency
Nigeria	47	NGA	1985-1989	0.44	0.34
Nigeria	47	NGA	1990-1994	0.50	0.29
Nigeria	47	NGA	1995-1999	0.56	0.33
Nigeria	47	NGA	2000-2004	0.65	0.43
Nigeria	47	NGA	2005-2010	1.00	1.14
Pakistan	48	PAK	1980-1984	0.31	0.50
Pakistan	48	PAK	1985-1989	0.32	0.44
Pakistan	48	PAK	1990-1994	0.37	0.44
Pakistan	48	PAK	1995-1999	0.45	0.56
Pakistan	48	PAK	2000-2004	0.55	0.59
Pakistan	48	PAK	2005-2010	0.55	0.48
Panama	49	PAN	1980-1984	0.90	0.16
Panama	49	PAN	1985-1989	0.92	0.17
Panama	49	PAN	1990-1994	0.92	0.20
Panama	49	PAN	1995-1999	0.93	0.26
Panama	49	PAN	2000-2004	0.91	0.18
Panama	49	PAN	2005-2010	0.93	0.22
Paraguay	50	PRY	1980-1984	1.02	1.01
Paraguay	50	PRY	1985-1989	0.96	0.83
Paraguay	50	PRY	1990-1994	0.98	0.81
Paraguay	50	PRY	1995-1999	0.96	0.56
Paraguay	50	PRY	2000-2004	0.96	0.45
Paraguay	50	PRY	2005-2010	0.96	0.33
Peru	51	PER	1980-1984	0.82	0.29
Peru	51	PER	1985-1989	0.85	0.35
Peru	51	PER	1990-1994	0.89	0.25
Peru	51	PER	1995-1999	0.91	0.33
Peru	51	PER	2000-2004	0.93	0.43

Country	ID	code	period	Output effeciency	Input effeciency
Peru	51	PER	2005-2010	0.94	0.50
Philippines	52	PHL	1980-1984	1.03	1.00
Philippines	52	PHL	1985-1989	1.01	0.79
Philippines	52	PHL	1990-1994	1.02	0.76
Philippines	52	PHL	1995-1999	1.02	0.66
Philippines	52	PHL	2000-2004	1.02	1.00
Philippines	52	PHL	2005-2010	1.02	1.01
Romania	53	ROU	1980-1984	1.00	0.83
Romania	53	ROU	1985-1989	1.02	1.00
Romania	53	ROU	1990-1994	1.03	1.00
Romania	53	ROU	1995-1999	1.04	1.00
Romania	53	ROU	2000-2004	1.03	1.00
Romania	53	ROU	2005-2010	1.03	1.00
Rwanda	54	RWA	1980-1984	0.55	0.60
Rwanda	54	RWA	1985-1989	0.66	0.68
Rwanda	54	RWA	1990-1994	0.69	0.85
Rwanda	54	RWA	1995-1999	0.93	0.95
Rwanda	54	RWA	2000-2004	0.81	0.86
Rwanda	54	RWA	2005-2010	0.82	0.68
Senegal	55	SEN	1980-1984	0.17	0.23
Senegal	55	SEN	1985-1989	0.20	0.28
Senegal	55	SEN	1990-1994	0.23	0.32
Senegal	55	SEN	1995-1999	0.27	0.32
Senegal	55	SEN	2000-2004	0.30	0.31
Senegal	55	SEN	2005-2010	0.33	0.20
Sierra Leone	56	SLE	1980-1984	0.21	0.57
Sierra Leone	56	SLE	1985-1989	0.27	0.60
Sierra Leone	56	SLE	1990-1994	0.28	0.55

Country	ID	code	period	Output effeciency	Input effeciency
Sierra Leone	56	SLE	1995-1999	0.31	0.56
Sierra Leone	56	SLE	2000-2004	0.38	0.50
Sierra Leone	56	SLE	2005-2010	0.47	0.59
South Africa	57	ZAF	1980-1984	0.83	0.07
South Africa	57	ZAF	1985-1989	0.88	0.09
South Africa	57	ZAF	1990-1994	0.91	0.10
South Africa	57	ZAF	1995-1999	0.95	0.14
South Africa	57	ZAF	2000-2004	0.96	0.15
South Africa	57	ZAF	2005-2010	0.97	0.50
Sri Lanka	58	LKA	1980-1984	0.95	0.58
Sri Lanka	58	LKA	1985-1989	0.97	0.44
Sri Lanka	58	LKA	1990-1994	0.99	0.54
Sri Lanka	58	LKA	1995-1999	1.02	0.80
Sri Lanka	58	LKA	2000-2004	1.04	1.00
Sri Lanka	58	LKA	2005-2010	1.04	1.00
Syrian Arab Republic	59	SYR	1980-1984	0.60	0.14
Syrian Arab Republic	59	SYR	1985-1989	0.65	0.16
Syrian Arab Republic	59	SYR	1990-1994	0.71	0.35
Syrian Arab Republic	59	SYR	1995-1999	0.76	0.37
Syrian Arab Republic	59	SYR	2000-2004	0.80	0.37
Syrian Arab Republic	59	SYR	2005-2010	0.84	0.61
Thailand	60	THA	1980-1984	0.99	0.72
Thailand	60	THA	1985-1989	0.93	0.63
Thailand	60	THA	1990-1994	0.94	0.59
Thailand	60	THA	1995-1999	0.94	0.55
Thailand	60	THA	2000-2004	0.94	0.31
Thailand	60	THA	2005-2010	0.94	0.34
Togo	61	TGO	1980-1984	0.36	0.27

Country	ID	code	period	Output effeciency	Input effeciency
Togo	61	TGO	1985-1989	0.43	0.24
Togo	61	TGO	1990-1994	0.50	0.27
Togo	61	TGO	1995-1999	0.59	0.37
Togo	61	TGO	2000-2004	0.69	0.46
Togo	61	TGO	2005-2010	0.73	0.56
Tunisia	62	TUN	1980-1984	0.49	0.18
Tunisia	62	TUN	1985-1989	0.55	0.18
Tunisia	62	TUN	1990-1994	0.60	0.14
Tunisia	62	TUN	1995-1999	0.66	0.13
Tunisia	62	TUN	2000-2004	0.70	0.11
Tunisia	62	TUN	2005-2010	0.74	0.09
Turkey	63	TUR	1980-1984	0.74	0.17
Turkey	63	TUR	1985-1989	0.78	0.16
Turkey	63	TUR	1990-1994	0.81	0.15
Turkey	63	TUR	1995-1999	0.84	0.19
Turkey	63	TUR	2000-2004	0.83	0.24
Turkey	63	TUR	2005-2010	0.85	0.19
Uganda	64	UGA	1980-1984	0.72	1.16
Uganda	64	UGA	1985-1989	0.73	0.86
Uganda	64	UGA	1990-1994	0.75	1.07
Uganda	64	UGA	1995-1999	1.01	1.17
Uganda	64	UGA	2000-2004	1.00	1.12
Uganda	64	UGA	2005-2010	1.00	1.16
United Republic of Tanzania	65	TZA	1980-1984	0.65	0.47
United Republic of Tanzania	65	TZA	1985-1989	0.68	0.49
United Republic of Tanzania	65	TZA	1990-1994	0.80	0.59
United Republic of Tanzania	65	TZA	1995-1999	0.81	0.84
United Republic of Tanzania	65	TZA	2000-2004	1.00	1.18

Country	ID	code	period	Output effeciency	Input effeciency
United Republic of Tanzania	65	TZA	2005-2010	0.90	1.07
Zambia	66	ZMB	1980-1984	0.69	0.16
Zambia	66	ZMB	1985-1989	0.75	0.16
Zambia	66	ZMB	1990-1994	0.81	0.37
Zambia	66	ZMB	1995-1999	0.91	0.83
Zambia	66	ZMB	2000-2004	1.02	1.31
Zambia	66	ZMB	2005-2010	1.00	1.48
Zimbabwe	67	ZWE	1980-1984	0.82	0.23
Zimbabwe	67	ZWE	1985-1989	0.87	0.30
Zimbabwe	67	ZWE	1990-1994	0.91	0.29
Zimbabwe	67	ZWE	1995-1999	0.97	0.40
Zimbabwe	67	ZWE	2000-2004	0.99	0.41
Zimbabwe	67	ZWE	2005-2010	1.00	0.36