École Doctorale des Sciences Économiques, Juridiques, Politiques et de Gestion
Centre d'Etudes et de Recherches sur le Développement International (CERDI)
Université Clermont Auvergne, CNRS, IRD, CERDI, F-63000 Clermont-Ferrand, France

Natural resources and development
THREE ESSAYS

Thèse Présentée et soutenue publiquement le 17 décembre 2020
pour l'obtention du titre de Docteur *és* Sciences Economiques
par

Mamadou Tanou BALDE

Sous la direction de:
M. Samuel GUERINEAU et M. Bertrand LAPORTE

Membres du jury

Dramane COULIBALY	Professeur, Université Lumière Lyon 2	Rapporteur
Claire MAINGUY	Maître de conférences-HDR, Université de Strasbourg	Rapporteur
Patrick PLANE	Directeur de recherches, Université Clermont Auvergne	Suffragant
Albert ZEUFACK	Economiste en chef, Banque Mondiale, Afrique	Suffragant
Samuel GUERINEAU	Maître de conférences-HDR, Université Clermont Auvergne	Directeur thèse
Bertrand LAPORTE	Maître de conférences-HDR, Université Clermont Auvergne	Directeur thèse

À baba et Nen Kaou.

Remerciements

C'est avec beaucoup de soulagement et d'émotions que j'achève la rédaction de cette thèse. Elle ne saurait être rédigée sans les divers soutiens scientifiques et sociaux que j'ai reçus. A ce titre, j'adresse dans un premier temps mes remerciements à mes deux encadrants M. Samuel Guernieau et M. Bertrand Laporte pour leurs conseils dans la réalisation de cette thèse et aussi pendant mon année de master finances publiques. La thèse a commencé à prendre forme pendant cette année avec une vocation pour les économies riche en ressources naturelles.

Aussi, je tiens à exprimer ma gratitude et mes remerciements aux membres du jury de thèse en l'occurence M. Dramane COULIBALY, Mme Claire MAINGUY, M. Patrick PLANE et M. Albert ZEUFACK pour avoir bien voulu évaluer le présent travail de recherche. Mes remerciements s'adressent également à mes responsables, amis et collègues de la Banque Mondiale qui durant le Fellowship m'ont soutenu et permis de co-écrire le chapitre 4. Je veux citer Jim, Moussa, Woubet, Alexis, Alexandre, Pierre, Hannah, Mohammed, Maximillien, Amma, Marie et Désiree mais aussi tous les autres collègues dans le bureau du chef économiste.

Ma reconnaissance va aussi à tous mes amis du CERDI, Carine, Claire, Maimouna, Jules et tous les doctorants que j'ai eu à rencontrer durant les années de thèse, aux professeurs ainsi qu'à toute l'administration sans laquelle la rédaction de cette thèse n'aurait pas pu aboutir.

Je suis aussi profondément reconnaissant envers mes amis Aladji, Maimouna, Magasse, Colin, Ricardo, Tahir et tous les autres pour leurs soutiens et reconfort tout au long de ces années de thèse. Enfin, je tiens à remercier les membres de ma famille, Nènè ainsi que mes oncles et tantes, tonton Fodé, Tante Ramatou, tante Ciré et Kaou Gadiri pour l'éducation, tout l'amour, et le soutien qu'ils m'ont apporté tout au long de mes années études. Je n'oublie pas également mes frères et soeurs Ko Cellou, Djadjenabou, Salimatou, Binta et tous les autres. Sachez que ces mots ne sauraient justement retranscrire toute ma reconnaissance.

Résumé

Tirer profit de la dotation en ressources naturelles pour accélérer la croissance et créer des emplois dans les pays subsahariens riches en ressources naturelles est un défi majeur pour sortir des millions d'Africains de la pauvreté. Plus de la moitié des pays d'Afrique subsaharienne sont dépendent de leurs ressources naturelles (26 sur 48 pays). En outre, d'ici 2030, 64% des pauvres du monde résideront dans des pays subsahariens riches en ressources, contre 12% dans les années 2000.

La présente thèse propose trois études empiriques qui étudient la relation entre les ressources naturelles et le développement. Nous examinons le rôle des politiques économiques dans chaque phase du processus allant du développement des projets d'extraction de ressources naturelles à la transformation des revenus provenant de l'extraction en développement durable. Nous contribuons également au débat sur la transformation structurelle et l'emploi en explorant l'impact des ressources naturelles sur la dynamique de l'emploi en Afrique subsaharienne.

Le premier essai contribue à la littérature en montrant que le décideur politique peut, par la fiscalité, conduire le propriétaire de la mine dans un plan d'extraction conforme au programme de développement des ressources du gouvernement. Nous utilisons l'analyse de survie pour la première fois dans la littérature pour étudier l'impact de la fiscalité sur le délai entre la découverte et la production, et relevons son impact significatif dans l'explication du retard de développement. Nos résultats suggèrent que lorsque le régime fiscal a un impôt sur les sociétés égal ou inférieur à 25% et une redevance égale ou inférieure à 2%, le délai entre la découverte et la production est raccourci et, en revanche, s'allonge lorsque l'impôt sur les sociétés est supérieur à 35% et la redevance supérieure à 5%. Plus important encore, nous constatons que les régimes fiscaux progressifs permettent aux pays de mobiliser davantage de ressources lorsque les conditions économiques sont favorables et favorisent le développement rapide des découvertes.

Le deuxième essai, à l'instar du premier, met l'accent sur le rôle des décideurs politiques dans la promotion d'un développement économique durable. Nous réexaminons la relation entre les dépenses publiques et la croissance dans

23 pays d'Afrique subsaharienne riches en ressources. En utilisant un modèle de panel à transition douce (PSTR), nous montrons qu'au-delà de 22,4%, les dépenses publiques deviennent néfastes pour la croissance. Aussi, nous avons également remarqué dans notre étude que les dépenses courantes comme les dépenses en capital génèrent de la croissance jusqu'à un certain seuil. Au-delà de 22,4%, les dépenses publiques évincent le secteur privé, créent des déséquilibres externes et un ralentissement économique. En outre, nous fournissons des preuves empiriques que les rentes des ressources naturelles sont une bénédiction si elles sont correctement gérées.

La dernière partie de la thèse se concentre sur les effets causaux des exportations de ressources naturelles sur la dynamique de l'emploi et la transformation structurelle dans les pays d'Afrique subsaharienne. Le troisième essai montre que l'augmentation des exportations de ressources conduit à un déplacement de la part de l'emploi de l'agriculture vers les secteurs non agricoles. Nous fournissons des preuves empiriques que les ressources naturelles ont un impact positif et significatif sur la part de l'emploi dans le secteur manufacturier. Néanmoins, il en profite moins par rapport au secteur des services. De plus, nous avons constaté que les revenus issus du secteur extractif augmentaient la part de l'emploi du secteur public dans l'emploi total. Dans le même ordre d'idées, nous montrons que les exportations de ressources sont associées à une augmentation de la masse salariale publique à la fois en proportion de la croissance économique et des dépenses publiques totales.

Mots clés: Politique budgétaire, Choix inter-temporel, Politique des ressources naturelles, Analyse de survie, Dépenses publiques, Consommation des administrations publiques, Investissement public, Croissance économique, Malédiction des ressources, Secteur manufacturier, Secteur public, Transformation structurelle, Pays en développement, Afrique subsaharienne.

Summary

Leveraging natural resource endowment to accelerate growth and jobs in Sub-Saharan African natural resource-rich countries is a key challenge to lift millions of African out of poverty. More than half of sub-Saharan African countries are resource-dependent (26 out of 48 countries). Moreover, by 2030, 64 percent of the world's poor will reside in sub-Saharan resource rich-countries, compared to 12% in 2000.

The present dissertation provides three empirical studies that investigate the relationship between natural resources and development. We examine the role of policy in each part of the process ranging from the initial development of resource projects to turning revenues stemming from the extraction into sustainable development. We also contribute to the debate on structural transformation and jobs by exploring the impact of natural resources on labor dynamics in sub-Sahara Africa.

The first essay contributes to the literature by showing that policymakers can, through taxation, lead the mine-owner in an extraction path in line with government resource development agendas. For the first time in the literature, we use survival analysis to study the impact of taxation on the lead time from discovery to production and highlight its significant role in explaining the development delay. Our findings suggest that when the fiscal regime has a corporate income tax equal or below 25% and a royalty equal to or below 2%, the time from discovery to production is shortened and, in contrast, lengthen when the corporate income tax is beyond 35% and royalty beyond 5%. Most importantly, we found that progressive fiscal regimes allow countries to mobilize greater resources when economic conditions are favorable and foster the development of discoveries.

As for the first one, the second essay focuses on the role of policymaker in promoting lasting economic development. We re-examine the relationship between government expenditures and growth in 23 Sub-Saharan African resource-rich countries. Using a panel smooth transition regression model, we find that beyond 22.4%, public expenditures become harmful for growth. Our findings also suggest that current expenditures, as for capital expenditures, generate growth until a certain threshold. Beyond 22.4%, government expenditures crowd-out the private sector, create external imbalances and economic downturn. Furthermore, we provide empirical evidence that natural resource rents are a blessing if appropriately managed.

The latest part of the dissertation focuses on the causal effects of natural resource exports on labor dynamics and structural transformation in sub-Saharan African countries. The third essay documents that increasing resource exports lead to a shift in employment share from agriculture to non-agricultural sectors. We provide empirical evidence that natural resources positively and significantly impact the share of employment in the manufacturing sector. Nevertheless, it benefits less compared to the service sector. Moreover, we found that resource windfalls increase the employment share of the public sector in total employment. Relatedly, resource exports are associated with increasing public wage bills both as a share of the growing economy and total government expenditures.

Keywords: Fiscal policy, Inter-temporal firm choice, Resources policy, Survival analysis, Public spending, Government consumption, Public Investment, Economic Growth, Resource curse, Manufacturing sector, Public sector, Structural transformation, Developing countries, sub-Saharan Africa.

List of Acronyms

ADI:	Africa Development Indicators
AfDB:	African Development Bank
AOF:	French West Africa
AEF:	French Equatorial Africa
ASEAN:	Association of Southeast Asian Nations
BoE:	Bank of England
DRC:	Democratic Republic of the Congo
FERDI:	Fondation pour les Études et Recherches sur le Développement International
GDP:	Gross Domestic Product
ICTD:	International Centre for Tax and Development
ICRG:	International Country Risk Guide
ILO:	International Labour Organization
IMF:	International Monetary Fund
LME:	London Metal Exchange
OGS:	Overseas Geological Survey, or British Geological Survey
PSTR:	Panel Smooth Transition Regression Models
PTR:	Panel Threshold Regression model
UN:	United Nations
UNCTAD:	United Nations Conference on Trade and Development
USGS:	United States Geological Survey
WAEMU:	West African Economic and Monetary Union
WAMZ:	West African Monetary Zone
WDI:	World Development Indicators
WEO:	World Economic Outlook
WGI:	Worldwide Governance Indicators

Contents

List of Figures

List of Tables

Chapter 1

General Introduction

Contents

General Introduction

Harnessing natural resource endowment in Sub-Saharan African natural resource-rich countries is a key challenge to lift millions of African out of poverty. As a matter of fact, more than half of sub-Saharan African countries are resource-dependent (26 out of 48 countries) compared to 15 before the boom in 2004. Moreover, by 2030, 64 percent of the world's poor will reside in sub-Saharan resource rich-countries, compared to 12% in 2000 (Cust and Zeufack, 2020). For instance, more than 150 million poor citizens are expected to live in two of Africa's resource-rich countries - Nigeria and The Democratic Republic of Congo - accounting for half of Africa's poor citizens (Kristofer Hamel and Hofer, 2019).

1.1 Natural resources and economic growth: are sub-Saharan African resource-rich countries cursed?

Evidence suggests that sub-Saharan African resource-rich countries missed a huge opportunity during the last commodity boom (Cust and Zeufack, 2020). The resource sector, which has been the primary driving source of economic growth for many African countries, particularly between 2003 and 2014, has not allowed them to have a significant growth rate than non-resource rich African economies. Most of these Sub-Saharan Africa resource-rich countries failed to transform the boom in natural-resource extraction and exports into sustainable growth and reduce poverty.[1] The growth rate slumped after the boom in 2014, from an average of around 5.7% to 2.9%, and let many countries - such as Congo, Mozambique, Zambia, with significant to unsustainable public debt.

This missed opportunity is even more stabbing in a COVID-19 context, where sub-Saharan African countries face heightened macro-fiscal challenges

[1] The poverty increases in 12 out of 19 Sub-Saharan resource-rich countries with poverty data available. Nonetheless, it decreases in countries such as Ghana and Uganda (Cust and Zeufack, 2020).

and, at the same time, need fiscal space to save lives and implement a countercyclical policy to sustain growth.

Numerous authors have investigated the relationship between natural resource endowment and economic growth. The literature is known as the "'resource curse"' hypothesis, and the so-called "'Dutch disease,"' which is one of the channels of transmission, is also well documented.[2] However, their findings are far from being conclusive except for studies focusing on developing countries, particularly in sub-Saharan African countries. The adverse effects of natural resources on economic growth appear quite often Badeeb, Lean, and Clark (2017). More recently, the paper by Henri (2019) documents that the negative relationship between natural resources exports and economic growth is still a reality in African countries.

Theoretically, Bruno and Sachs (1982) calibrate a theoretical dynamic model and show that natural resource discoveries reduce the long-run production of the manufacturing sector. In the same period, the so-called resource curse has also been investigated by Corden and Neary (1982); Corden (1984). Their model suggests that a boom in the energy sector reduces the output of the manufacturing sector unambiguously and leads to de-industrialization.

A few years later, in their seminal empirical study, Sachs and Warner (1995) findings suggest that mineral and fuel production have a negative impact on economic growth. Focusing on African economies, Sachs and Warner (1997) identify the dependence on natural resources as one of the sources of slow growth in African economies. These authors and the following Papyrakis and Gerlagh (2004), Harding and Venables (2016) argue that the resource boom leads to an increase in the inflation, real exchange rates, macroeconomic volatility and, therefore, to a decrease in the competitiveness of the non-resource sector.

However, this large pessimistic view documented by several authors is challenged by growing studies pointing out the endogeneity of resource exports (Badeeb, Lean, and Clark, 2017; Cassidy, 2018). They argue that the level of production, resource exports, and reserves is endogenous to institutions (Van der Ploeg and Poelhekke, 2010; Cust and Harding, 2020).

[2]We focus only on the most prominent economic channel of transmission. Other channels of transmission include volatility, rent-seeking, political institution quality (see Badeeb, Lean, and Clark (2017); Van der Ploeg (2011) for a broader literature review.

For instance, Brunnschweiler and Bulte (2008), after addressing the endogeneity issue, show that the so-called resource curse hypothesis is a "'red herring"' and suggest that it is even inappropriate to talk about the "'curse of resources"'. Nevertheless, the recent paper by Henri (2019) documents that the negative impact on economic growth is still a reality in African countries. All the more so, his identification strategy is subject to discussion since he uses the lagged value of endogenous variables as instruments and does not include years dummies and country fixed effects.

1.2 Natural resources and development: What is the role of policies?

1.2.1 Natural resources, institutions, and development

Natural resource discoveries increase expectations of better economic outcomes - growth, jobs, government revenues. These expectations are even higher in countries with weaker institutions. A recent study by Cust and Mensah (2020) shows that following resource discoveries, citizen expectations about better economic conditions and living standards rise by 35 and 52 percent, respectively.

Institutions are determinant in natural resource management. Natural resources on their own or by undermining institutions' quality and government expenditures, impede economic growth (Mehlum, Moene, and Torvik, 2006; Lundgren, Thomas, and York, 2013). Several papers document a positive impact of natural resources on growth when we take into account the quality of institutions (Papyrakis and Gerlagh, 2004; El Anshasy and Katsaiti, 2013). Their findings are in line with the study by Cust and Mihalyi (2017). They show that growth disappointment is higher in countries with weak institutions. A recent study by Lashitew and Werker (2020) suggests that the impact depends on whether or not the country is resource-dependent or has abundant resources. They document that resource dependence has a stronger negative indirect effect through its negative impact on institutional quality, while resource abundance generally has a direct positive impact on developmental outcomes.

1.2.2 Natural resources, fiscal policy, and economic growth: What do we know?

1.2.2.1 Natural resources and tax policies

Despite being criticized for being unfavorable to African governments, relatively little is known about mineral resource rent sharing in Africa and taxation regimes impact on government revenues Laporte and De Quatrebarbes (2015). A recent study by Mihalyi and Scurfield (2020) documents disappointing outcomes in several sub-Saharan African petroleum producing countries regarding government revenues stemming from the extractive sector. Their findings suggest that among the 12 sub-Saharan African countries that made their first major petroleum discoveries during the last commodity boom, all of them experienced at least revenues or timeline, or discovery disappointment.[3] Thus, the lead time from discovery to production was 73% longer than initially expected, and the initially estimated revenues before the production were 63% lower.

Several African countries have experienced a boom in the mining sector, but their revenues stemming from the extraction did not increase substantially during the boom. While, the profits of the biggest transnational mining companies located in sub-Saharan Africa were increasing by 20%, on average (Lombe and Mwakcheya, 2017). Also, between 2002 and 2008, natural resource rents have been multiplied by 2.3, while government tax revenues stemming from the exploitation of natural resources increased by only 1.5 (Laporte and De Quatrebarbes, 2015). Moreover, in certain countries such as Zambia, the disparity is huge. Government resource revenues remain steady [at around 2.3% of GDP, on average] between 2000 and 2011, while resource rents were multiplied, during the same period, by 2.81 (from 5.53% in 2000 to 15.55% of GDP).

These disappointing outcomes led to a series of contracts renegotiation. For instance, countries such as Congo (DRC), Guinea, Tanzania, and Zambia have renegotiated or call for the renegotiation of their mining contracts. Between 2010 and 2019, 24 countries have introduced new fiscal regimes to make the most out of their endowment. These unintended consequences may come

[3] 4 out of 12 countries did not come into production. The discoveries were not commercially viable.

from the misunderstanding of the role of fiscal regimes in attracting investors. To foster the development of their resources, many developing countries were in a fiscal race to bottom to attract foreign direct investment in the mining sector (Akabzaa, 2004; Sachs, Toledano, Mandelbaum, and Otto, 2012).

To attract investors and develop their endowments, developing countries - particularly sub-Saharan African countries - have been adopting lenient fiscal regimes for years [particularly from 1992 to 2005] (Campbell, Akabzaa, and Butler, 2004; McPherson, 2008). In certain countries, the fiscal regime became even more favorable to the resource sector than other industries (Boadway and Flatters, 1993).

The liberalization of the sector attracted FDI and increased the development of the sector significantly, particularly in Western and Central Africa. For instance, the number of operating gold mines was multiplied by 3 to 4 between 1995 and 2015 (USGS).[4] If these numbers allow us to gauge the role of the liberalization, few are known about the contribution of fiscal regimes in helping developing countries foster the development of their endowments. The impact of these fiscal regimes reforms is not well documented in the literature and is a source of debate Haselip and Hilson (2005); Tilton (2004); Curtis and Lissu (2008); Campbell (2009).

It emerges from the debate on the effects of taxation on mineral development that almost all fiscal instruments impact the life cycle of mineral projects, except the rents tax. According to the type of tax instruments implemented, such as royalties, corporate income tax, government equity, and its level, the effects can be significant for the profitability of mineral projects (Conrad and Hool, 1981, 1984; Heaps and Helliwell, 1985).

If there are a lot of theoretical and country case studies establishing a link between the underdevelopment of the resource sector in developing countries-especially in sub-Saharan countries - and their fiscal regimes, empirical studies on the impact of taxation on mineral sector development both for a single country and a panel of countries are lacking. As far as we know, we do not find any empirical studies on the effects of taxation on the length of time between the discovery and development of industrial mineral projects in developing countries.

[4]Foreign mining companies hold, on average, 80 to 100 percent of these mines.

1.2.2.2 Natural resources, government expenditures, and economic growth

Governments by deciding how much of the windfalls to transfer to the population for consumption and how much to retain for investment in infrastructures, education, and health, influence economic growth Ghura, Pattillo, et al. (2012); Araujo, Li, Poplawski-Ribeiro, and Zanna (2013). For instance, by increasing infrastructure and human capital investments, which are seen as an anti-curse, governments can counteract the resource curse.

In the literature, fiscal policies are not generally at the heart of the econometric investigation for most of the studies focusing on the resource curse, and the limited studies in the context of the resource curse are even more contradictory than the classical literature on economic growth (Arezki, Gylfason, and Sy, 2012; James, 2015). Also, most of the studies generally focus on the contribution of institutions, ignoring that government expenditures are one the most important connection between the resource sector and the rest of the economy.

For example, the study by Atkinson and Hamilton (2003) shows a negative impact of natural resources on economic growth despite controlling for institutions. The study shows the positive effects of natural resource rents when interacting with public capital expenditures and negative impacts when interacting with government consumption expenditures. Going further, Brunnschweiler (2008) shows that natural resources have no adverse incidence on growth through institutions but, on the contrary, promote economic development.

There is a vast literature on government expenditures and their effects on Sub-Saharan Africa's economic development. Nevertheless, the debates are far from being conclusive (Havranek, Horvath, and Zeynalov, 2016). For neo-classics, only innovation and population growth have a positive incidence on economic growth, and any other factor is a source of economic distortion. Endogenous growth theories lead by Barro and Sala-i Martin (1992); Barro (1996), in contrast, argue that government expenditures are an engine of growth.

Empirically, since Barro and Sala-i Martin (1992); Barro (1996), and even before Solow (1956), numbers of researchers have explored the role of public spending in fostering economic development. However, the empirical findings are mixed. Public expenditures are viewed both as an engine of growth and factor of distortions.

Furthermore, the few studies that have explored the issue, particularly in Sub-Saharan Africa, do not focus on the contribution of each component of public expenditures because of data limitation (Ojo and Oshikoya, 1995; El Anshasy and Katsaiti, 2013; Damette and Seghir, 2018).

1.3 Natural resources, jobs, and structural transformation

Jobs creation is an essential issue in sub-Saharan African countries. Governments and local communities, especially in sub-Saharan Africa, expect the resource sector to create jobs (Dietsche, 2020). These expectations about local employment motivated the successive fiscal reforms initiated in the nineties (Campbell, Akabzaa, and Butler, 2004).[5] More importantly, according to Abdychev, Alonso, Alper, Desruelle, Kothari, Liu, Perinet, Rehman, Schimmelpfennig, and Sharma (2018), sub-Saharan African countries will have to add 20 million jobs a year - or 1.67 million jobs per month - to keep up with the rise of the working-age population.

There is an ongoing debate on structural transformation and industrialization in Africa. Labor reallocation from low-productivity activities (agriculture) to high-productivity activities (manufacturing) is a critical determinant of development (McMillan, Rodrik, and Verduzco-Gallo, 2014). Nonetheless, evidence suggests that African countries have been experiencing, since the eighties, a "'premature de-industrialization"' (McMillan, Rodrik, and Verduzco-Gallo, 2014; Rodrik, 2016).

Warner (2015) suggests that investigating the resource curse hypothesis in terms of the whole economy is circular. The total GDP will increase during resource booms since it is a component of the economy. The critical question is the impact of natural resource windfalls on the non-resource sector. Evidence

[5] Also, an examination of mining law in sub-Saharan resource-rich countries suggests that, except for Mauritania, all other resource-rich countries have a provision regarding local employment.

suggests that the non-resource sector growth in sub-Saharan resource-rich countries was not significantly higher than non-resource rich African countries (Cust and Zeufack, 2020). Also, Ross (2019) findings suggest that African countries also have the poorest diversification record mostly because of the Dutch disease.

On the one hand, the past boom in natural resource exports led to a disappointing outcome in terms of employment in the private sector (Filmer and Fox, 2014; Fox, Thomas, and Haines, 2017). On the other hand, the resource sector, which employs few people, is found to impede the development of the manufacturing sector and slows down the structural transformation. Several studies have explored the relationship between natural resources and other sectors of the economy, mainly the tradable sector - manufacturing. The study by Harding and Venables (2016) shows that resource exports have a negative impact on non-resource exports, particularly manufacturing exports. Their findings are in line with the results by Ismail (2010).

Despite the importance of this issue for resource-rich developing countries, it is surprising that little research has been conducted on the relationship between natural resource windfalls and sectoral employment and even less focusing on sub-Saharan African countries.

1.4 The value-added of this thesis

This thesis investigates three main issues related to natural resources and economic development, particularly in sub-Saharan African countries. The first essay (chapter2) focuses on the impact of taxation on the lead time from discovery to starting mineral production in developing countries. Evidence suggests that sub-Saharan African resource-rich countries missed a huge opportunity during the last commodity boom. Contrary to most of the literature assessing the role of policies and the impact of natural resources on different outcomes ex-post, the chapter investigates the role of policies before the starting of the mineral production and exports. The underlying hypothesis of this chapter is that a part of the explanation of these missing opportunities may come from the design of the fiscal regime. A tightened fiscal regime may indeed increase the length of time between the discovery and the development.

In contrast, a low tax regime might accelerate development but will not allow the country to mobilize significant revenues to finance the development.

If there are a lot of theoretical and country case studies establishing a link between the underdevelopment of the mineral sector in developing countries - especially in sub-Saharan countries - and their fiscal regimes, empirical studies on the impact of taxation on mineral development both for a single country and a panel of countries are lacking. As far as we know, we do not find any empirical studies on the effects of taxation on the length of time between the discovery and development of industrial mineral projects in developing countries.

In this first essay, I investigate the effects of fiscal regimes on mineral industries development by focusing on one of the most critical parts of the life cycle of projects for developing countries: the beginning of the extraction and exports of mineral resources. Indeed, the beginning of the extraction means for developing countries, all else equal, higher revenues, more employment, and, subsequently, growth.

To do so, we perform both non-parametric *(Kaplan-Meir estimate)*, parametric *(Weibull)*, and semi-parametric model *(Cox model)* on a sample of 188 gold mines closed or under production, covering 24 gold-rich developing countries in Sub-Saharan Africa, Latin-America, and Asia. We define a set of variables to capture the level of taxation (Low, intermediary, and high), and the nature of the fiscal regime (progressivity) applied in each gold mine and introduced a set of economical, geological, and institutional co-variates to capture the heterogeneity across countries and gold mines.

The three main contributions of this chapter are as follows. First, to the best of our knowledge, we provide the first empirical evidence of the impacts of taxation on the lead time from discovery to production. Second, our paper contributes to the ongoing debate by showing that a progressive fiscal regime can get as positive results as a low tax regime and, therefore, could be a reasonable tradeoff for developing and particularly low-income countries. It may allow countries to get more revenues, and at the same time, reduce the tax incidence on the development lag. Third, we contribute to the literature by reducing the lack of empirical studies in the literature related to natural resource extraction determinants. Besides, we complement previous studies by documenting the significant contribution of prices and geology in explaining the heterogeneity of the length of time from discovery to extraction.

The second essay (chapter 3) of this thesis is a natural continuation to the second one since it explores the role of government expenditures in sub-Saharan African resource-rich countries. Following Collier (2007), we argue that to lift millions of sub-Saharan out of poverty, public expenditures management is central. More precisely, we assume as for Van den Bremer and Van der Ploeg (2012), Ghura, Pattillo, et al. (2012), Araujo, Li, Poplawski-Ribeiro, and Zanna (2013) that policymakers by determining how much and how to spend could speed up the development of their countries and benefit from their natural resource endowment.

The third chapter joins the two pieces of literature, rehabilitates and demarcates the role of government in Sub-Saharan Africa resource-rich countries. Basically, it re-estimates the impact of government expenditures on economic growth in 23 Sub-Saharan Africa resource-rich countries through a nonlinear approach. In order to take into account the whole non-linearities identified in the literature by Barro (2004) and heterogeneity across countries and over time, we use the Panel Smooth Transition Regression model (PSTR) developed by González, Teräsvirta, and Dijk (2005).

The study contributes to the literature by giving a striking confirmation that government expenditures are an engine of growth, and natural resource rents are blessing if appropriately managed. Both the current expenditures and public investments have a positive impact on growth when the level of spending is less than 22.4% of the GDP. Beyond this threshold, government expenditures become progressively harmful to economic growth. Government consumption and investment become less efficient and impact growth negatively. Private investments are crowded-out and escalate external imbalances.

Our third main empirical result contributes to the literature on the resource curse hypothesis in sub-Saharan African countries. It shows that natural resource rents are positively and significantly associated with economic development when government expenditures are moderated. They become detrimental only beyond the threshold.

These findings are significant as they show that natural resource windfalls on their own have not a systematic negative impact on growth. It depends on how the government manages it. By deciding to inject totally or partially or to sterilize their revenues stemming from the extraction of their resources policymakers, could change the resource curse story in Africa thus far.

The fourth and final essay of this thesis attempts to increase the understanding of the relationship between natural resources and other sectors of the economy, mainly the trade sector - manufacturing -, and public sector using sectoral employment. Three main reasons motivated this investigation. The first one is related to the fact that job creation is an essential issue in sub-Saharan African countries.

The second reason is related to the ongoing debate on structural transformation, de-industrialization, and, more specifically, the "'Dutch Disease"' hypothesis.

The third reason is to bridge the gap in the "'Dutch disease"' hypothesis literature by exploring new approaches and improving the methodology. On the one hand, the common characteristic of most of these studies exploring the crowding-out effects of windfalls on the traded sector is their utilization of the value-added of the traded sector or exports as a proxy for the manufacturing sector. The reallocation of labor across sectors in the economy, which may result from the resource boom, is not at the heart of the studies in the literature. On the other hand, a growing number of papers using the withing-country variation to address the endogeneity bias of natural resources endowment provide evidence challenging conventional views on the dutch disease (Michaels, 2011; Allcott and Keniston, 2017).[6] To date, we are aware of any studies focusing on sub-Saharan African countries that have exploited this methodology to re-investigate the relationship between natural resource exports and other outcomes.

Thus, to address the concerns about the potential endogeneity of natural resources endowment, we perform our estimates using an instrumental variables approach. Following Cassidy (2018) and Allcott and Keniston (2017), we will not use the annual production data or the current reserves. They might be endogenous as well (Cust and Harding, 2020). Instead, we build

[6] See Cust and Poelhekke (2015) for an extensive survey of the literature.

on the work by Acemoglu, Finkelstein, and Notowidigdo (2013), Dube and Vargas (2013), Carreri and Dube (2016), and Caselli and Tesei (2016) to instrument our primary variable of interest using colonial-era data. We exploit the historical level of natural resource exports during colonization and times series variation in commodity prices between 1991 and 2018.

Following the literature using the within-country strategy to analyze the resource curse, we argue that during the colonization era, sub-Saharan African countries were subject to colonial administration in units called French West Africa (AOF), French Equatorial Africa (AEF), and British Empire[7]. For example, the production before independence was reported for certain products as belonging to these regions instead of one country. In other words, Guinea, Ivory Coast, Upper Volta (former Burkina-Faso), Mali, Senegal were defined as "‘states"’ belonging to one big federation called AOF.

Hence, we assume that the institutional differences between these countries (in the regions) were small since they were in the same European administrations. Accordingly, any spurious relationship between natural resource exports during this period and the labor dynamics between 1991 and 2018 is not an overwhelming concern for identification (Michaels, 2011).

We contribute to the literature by providing empirical evidence on the causal effects of natural resource exports on labor dynamics and structural transformation in sub-Saharan African countries. Our findings suggest that natural resource endowments have significant positive effects on public sector employment and public wages. These positive effects become weak once we focus on the narrowest sense of the public sector.[8] Furthermore, our results show that once we address the endogeneity issue, natural resource exports have a positive impact on manufacturing employment and non-agricultural employment. Finally, we complement the literature on the "‘Dutch disease"’ hypothesis by using new data on colonial-era production and providing striking evidence on the no crowding-out effects of natural resource windfalls

[7]French West Africa or "‘Afrique Occidentale Française"’ (AOF) was a federation of 8 french colonies from 1895 to 1960. The capital of the federation was Dakar.
The French Equatorial Africa called (AEF) "‘Afrique Equatoriale Française"’ was a federation of 5 sub-Saharan countries with a common Governor-General. The capital of the federation was Brazzaville.

[8]Public sector employment including only public administration, defense, and compulsory social security as defined by ILO (section O).

on manufacturing employment in sub-Saharan Africa. Although the service sector benefits more from the boom and the share of employment in agriculture decreases.

The remainder of the thesis is organized as follows. The following chapters 2, 3, and 4 contain the three essays of the dissertation. In chapter 5, I provide a general conclusion of this thesis.

Chapter 2

A brief history of time: taxation and mineral production in developing countries

Contents

Abstract

This chapter investigates the impact of taxation on the lead time from discovery to production by estimating duration models. Using a dataset of 188 gold mines, covering 24 developing countries from 1950 to 2017, both parametric *(Weibull)*, semi-parametric model *(Cox model)*, and non-parametric *(Kaplan-Meir estimate)* are applied to determine the role of taxation. The study contributes to the literature by documenting that according to the level of corporate income tax, royalty, and the nature of the fiscal regime used by a country to capture its share of the revenues stemming from the mineral extraction, the first gold pour takes place sooner or later particularly when the corporate income tax is greater than 35% and the royalty rate above 5%. Most importantly, the findings show that a progressive mineral regime can shorten the length of time as a low-tax regime. Lastly, the results suggest also that a thriving economic environment at the time of discovery and the geological quality of the deposit play a critical role in encouraging investors to come into production earlier.

Keywords: Fiscal policy, Intertemporal firm choice, Resource policy, Survival analysis.

JEL Classification: C41, D25, H32, Q38

2.1 Introduction

For several decades, developing countries have been trying to foster the development of their mineral resources. They count on their mineral resource projects to mobilize more significant revenues and mainly to spur the growth of their economies (Otto, 1992b, 1997; Mitchell, 2009).

By liberalizing the resource sector in the middle of the eighties and adopting an increasingly lenient fiscal regime, particularly from 1992, they were willing to stimulate the growth of the industry (Campbell, Akabzaa, and Butler, 2004; McPherson, 2008). In some countries, by doing so, the fiscal regime became, over the years, more favorable to resource industries than other sectors (Boadway and Flatters, 1993). Worse, Akabzaa (2004) and Sachs, Toledano, Mandelbaum, and Otto (2012) think that many countries were in a fiscal race to bottom to attract foreign direct investment.

The impact of the successive reforms of their fiscal regimes on the development of the mineral sector is not well documented in the literature and continue to be a source of debate (Haselip and Hilson, 2005; Tilton, 2004; Curtis and Lissu, 2008; Campbell, 2009).

It emerges from the debate on the effects of taxation on mineral development that almost all fiscal instruments impact mineral projects' life cycle, except the rents tax. According to the type of tax instruments implemented, such as royalties, corporate income tax, government equity, and its level, the effects can be significant for the profitability of mineral projects (Conrad and Hool, 1981, 1984; Heaps and Helliwell, 1985). By affecting the return of the project, "'the fiscal regime influence therefore many aspects of investor's plan of exploitation, including the scope of exploration and discovery, the timing and scale of initial development, the rate of production and decline, the timing and scale of enhanced recovery operations, the overall resource recovery factor, and the timing of final abandonment"' (Smith, 2013).

If many theoretical studies establish a link between the underdevelopment of the mineral sector in developing countries, especially in sub-Saharan countries, and their fiscal regimes, empirical studies on the impact of taxation on mineral development both for a single country and a panel of countries are lacking. As far as we know, we do not find any empirical studies on the effects of taxation on the length of time between the discovery and development of industrial mineral projects in developing countries.

In a context with a considerable uncertainty where we have an increasing number of adjourned or postponed mineral projects Shaukat Khan, Nguyen, Ohnsorge, and Schodde (2016), add to the increase of the number of countries competing to attract foreign companies Otto, Andrews, Cawood, Doggett, Guj, Stermole, Stermole, and Tilton (2006), several governments could be attempted to reform, again and again, their fiscal regime or worse to give special incentives, such as specific conventions, to some enterprises to invite them to come on stream sooner. This unreasonable temptation to give up revenues can be explained by the lack of understanding of their fiscal regime's impact by policymakers in developing countries. Therefore, it is crucial to undertake this analysis to improve the understanding of regulation's role, especially tax policies (Daniel, Keen, and McPherson, 2010; Russell, Shapiro, and Vining, 2010).

This paper aims to investigate the effects of government fiscal regimes on mineral industries development by focusing on one of the most critical parts of the life cycle of projects for developing countries: the beginning of the extraction and exports of mineral resources. Indeed, the beginning of the extraction means for developing countries, all else equal, higher revenues, more employment, and, subsequently, economic growth.

For this purpose, we perform both non-parametric *(Kaplan-Meir estimate)*, parametric *(Weibull)*, and semi-parametric model *(Cox model)* on a sample of 188 gold mines closed or under production, covering 24 gold-rich developing countries in Sub-Saharan Africa, Latin-America, and Asia[1]. We define a set of variables to capture the level of taxation (Low, intermediary and high) and the nature of the fiscal regime (progressivity) applied in each gold mine and introduced a set of economical, geological, and institutional covariates to capture the heterogeneity across countries and gold mines.

Our results are robust and suggest that the fiscal regime used by a country to get a part of the revenue stemming from the extraction of its natural resource endowment plays a significant role in determining whether or not the industrial extraction will take place earlier.

The three main contributions of this paper are as follows. First, to the best

[1] See Table 2.1 for the list of countries.

of our knowledge, we provide the first empirical evidence of the impact of taxation on the lead time from discovery to the beginning of production. Second, our paper contributes to the ongoing debate by showing that a progressive fiscal regime can get as positive results as a low tax regime and, therefore, could be a reasonable tradeoff. It may allow countries to get more revenues, and at the same time, reduce the tax incidence on the development lag. Third, we contribute to the literature by reducing the lack of empirical studies in the literature related to natural resource extraction determinants. We complement the previous studies by showing empirically the significant contribution of prices and geology in explaining the heterogeneity of the length of time from discovery to extraction.

The rest of the paper is organized as follows. Section 3.2 provides a review of previous studies. Section 4.2 summarizes the data and paves the way for empirical analysis. The following section 2.4 provides a description of the methodology and empirical specifications employed in the investigation. In section 4.4, we discuss the results and challenge their robustness. Section 4.5 concludes and gives some takeaways drawn from our key findings.

2.2 Review of previous studies

Hotelling (1931), in his seminal work, brings to light that taxation has an incidence on the schedule and rate of production, and therefore policymakers can, through taxation, lead the mine-owner in an extraction path in line with the government resource development agendas.

On the same research agenda, focusing on the heterogeneous quality and endogenous reserve, then on the inter-temporal extraction of mineral resources, Conrad and Hool (1981, 1984) show that the variability of the tax rate (both profit tax and royalty) has a different incidence on the extraction pattern compared to the fixed-rate tax. Even profit taxes, which are ordinarily neutral, will affect the extraction rate and grade selection. Profit taxes are determined in that case by the level of profits, and consequently, the inter-temporally grade allocation is a function of the profits as well as the discounted prices.

For instance, later periods' reallocation is more remarkable under constant-rate tax (unit-based royalty or ad valorem royalty), and the recovery is lower than under variable-rate taxation. These authors also find that per-unit royalties on output lead to reallocation from present to future while property taxes shift the extraction from future to present. Finally, their results suggest that even if they impact the economic reserves, ad valorem royalty tax incidence is not uniform either over time or across mineral. It depends both on the path of discounted mineral prices and the growth rate of prices compared to the rate of interest. Heaps and Helliwell (1985) going further show that taxation impacts the pace of mineral exploration, and royalties reduce the rate of extraction even if it rises at the same rhythm as the interest rate.

Boadway and Flatters (1993), followed by Baunsgaard (2001) and, more recently, Hogan and Goldsworthy (2010) and Laporte and Rota-Graziosi (2015), provide a comprehensive review of the impact of different mineral tax instruments implemented in developing countries and the evolution of their fiscal regime. They reach the same result regarding the effects of profit taxes and royalties on the path of mining development.

These authors, as Kumar (1991) and Otto, Andrews, Cawood, Doggett, Guj, Stermole, Stermole, and Tilton (2006), acknowledge the importance of mineral royalties for developing countries, especially for low-income countries, given the scarcity of government funding, but warn against their adverse consequences on the size of economically recoverable reserves and the choice of mining extraction profile. The empirical findings by Gajigo, Mutambatsere, and Ndiaye (2012) suggest, for instance, that a modest increase in royalty rates will not profoundly impact the profitability of 29 African gold mines. Furthermore, they also observe a comeback of free state participation in the mineral regime for economic and non-economic reasons and stress the possible conflict of interest. They also warn against the impact on project return in case of free participation. It may discourage investment, particularly when there are high sunk costs. Considering governments' free share, Forster and Bills (2003) in their appraisal show through a gold "mine type" model that a project would produce a 27% higher return to the shareholders if conducted in Tanzania than if it was in Burkina-Faso[2]. They also added that the recent acceleration of gold mine development in Tanzania would not have occurred

[2]The government was entitled to get 10% free equity in the capital of mining companies in Burkina-Faso, zero in Tanzania.

without establishing an attractive mining code for foreign investors in 2003.

We can not keep our study separate from studies investigating the impact of taxation on foreign direct investment in the mining sector. Due to their weak private sector, governments in developing countries struggle to develop their natural resources' endowment. They need to attract foreign investors who have the expertise and are able to mobilize the capital necessary for the development of their mining project (Kumar, 1990; Otto, 2006; Laporte and De Quatrebarbes, 2015).

Otto (1992a, 2002) perform a global survey on one hundred mineral companies about the significant corporate determinants for mineral investment in countries. The results show that the method and level of tax levies, the ability to predetermine tax liability, and the stability of fiscal regimes were very important or important for mining projects for the totality of the respondents. While, tax allowances, such as the availability of tax holidays, accelerated depreciation, and reinvestment credit, were judged not very important by respectively more than 25%, 12%, and 31% of the respondents. In the following years, Maponga and Maxwell (2001) and UNCTAD (2005) show statistically that policy reforms have increased the inflows of foreign direct investment in mineral sectors in Africa.

In their analysis of the features of a competitive fiscal regime for foreign investors, Shimutwikeni (2011), by comparing Namibia and Botswana, reach the same conclusion; the progressivity of the profit taxation and the range of tax allowances allow these countries to be attractive for foreign investment in mining. Nevertheless, they suggest that these two countries' competitiveness depends mostly on political, legal, and fiscal regimes. Using the same approach in different countries, Saidu (2007), through a comparison between Niger and Indonesia's fiscal regimes, finds that the latter country attracts more investment, and he concludes that an attractive mining tax regime is not sufficient to attract and sustain investment.

Tole and Koop (2010) carried out an empirical analysis on 700 gold mines and find that gold mining companies are attracted to regions close to their head office and have a low level of corruption, a transparent and stable environment for doing business.

Lastly, Curtis, Gemell, and Sykes (2015) perform a financial model of Gold

Mine Returns in five South American and five African countries and compare these results to industry perceptions of mineral taxation regime. They find that there is a potential negative correlation between the Average Effective Tax Rate (AETR) and the rankings of Policy Perception[3] and not on the country rankings of overall Investment Attractiveness as compiled by the Fraser Institute. The low AETR is associated with a good perception of mineral policy by foreign investors only for Guyana, Mali, Peru, Tanzania, Burkina-Faso, and Chile. However, despite the low level of taxation in certain countries, they did not find any correlation between the AETR and the attractiveness indicators. They suggested that it is due to other problems like mineral ownership, tenure security, and institutional factors. Cust and Harding (2020) findings highligh the importance of institution for attracting investment in natural resource exploration, primarily in the oil sector, while Asiedu and Lien (2011) mitigate it and show that it depends on the size of the natural resources in the total of exports both for oil and mineral.

Finally, our work is also related to the literature on the effects of taxation on industrialization. It is essential to note that well before using taxation instruments to regulate the mineral sector, several countries had opted for the direct control of their resources in order to industrialize their economies. Nevertheless, because of the financial and technical difficulties encountered, particularly in sub-Saharan countries, they shifted their policies and allowed foreign ownership. Boadway and Flatters (1993) suggest that the tax system could help achieve particular industrial policy objectives. Brewer, Bergevin, and Dunlop (1989) suggest that taxation is an industrial policy tool, even if the country does not have an explicit industrial policy. The study by Russell, Shapiro, and Vining (2010) argues that industry and country-specific policy measures can be more relevant in explaining the industry evolution heterogeneity. They support their idea and show empirically that Canadian specific regulatory punctuations, mainly fiscal reforms, have shaped their mining industry's evolution.

We can not wrap up this literature review before running through the literature on the determinant of the development lag of natural resources. According to Favero, Hashem Pesaran, and Sharma (1994), oil prices are the most

[3] Rankings of Policy Perception as compiled by the Fraser Institute 2015.

important determinant of resource project development decisions in contrast to the geological heterogeneity across oil fields. They do not have a significant impact on triggering the process of irreversible investment. However, in the mining sector, the findings by Shaukat Khan, Nguyen, Ohnsorge, and Schodde (2016) suggest that higher commodity (Gold and Copper) prices do not have on their own a significant role, while sound macroeconomic policy and good quality of governance can shorten the lead time to production. However, they show that an upswing in Copper prices at the time of discovery accelerates the development. The study by Favero, Hashem Pesaran, and Sharma (1994) shows that the delay period is not significantly affected by the geological differences. Their findings are in line with those by Schodde (2014), focusing on the mining sector.

2.3 Data and descriptive statistics

In this section, we present our data, describe the construction of our dependent variable, main variables of interest, and carry out the first level of analysis.

2.3.1 Data and variables

We carry out the study with a sample of 188 gold mines closed or under production, covering 24 gold-rich developing countries in Sub-Saharan Africa, Latin-America, and Asia.[4] The choice of gold mines rather than other precious metals is motivated by the fact that the gold mining industry provides a rich information context in analyzing the firm or multinational location decisions (Tole and Koop, 2010). The selection of mines was guided by data availability and the effective starting of gold extraction during the period ranging from 1950 to 2017.

Therefore in our sample, there is no right censoring for all gold mines included in our study. We observe their failure event; in other words, the beginning of the production.

Our data have been gathered from different sources, mainly from the MinEx consulting database for the geological data, the FERDI (Foundation for Studies and Research on International Development) tax legislation in

[4] See Table 2.1 for the list of countries.

the gold-mining sector database developed by Laporte, De Quatrebarbes, and Bouterige (2016) and in the exhaustive review of legal and fiscal frameworks for exploration and mining conducted by Naito, Williams, Remy, and World Bank Group. (2001) for the fiscal data. We use the United States Geological Survey (USGS) reports from 1994 to 2014 and other reports to complete our database, both geological and fiscal data. The World Development Indicators (WDI) and the Bank of England (BoE) database for the economic data and other sources such as policy IV for institutional data.

Dependent variable: Our primary dependent variable is the "'period of time"' between the discovery of the gold mine and its reserves extraction. We measured our dependent variable as the difference between the year of starting gold production and the year of discovery. It is noted t and is expressed in years.

Variables of interest: We use three kinds of measures to assess the singularity of each fiscal regime. First, we generate a set of dummies variables (taxregim1 to taxregim4) according to the level of the two main components of fiscal regimes (corporate income tax and royalty). We define $taxregim1$ as equals one if minimum corporate income tax is equal to or below 25% and minimum royalty is less than 2%; $taxregim2$ equals one if minimum corporate income tax ranges from 25% to 35% and minimum royalty is greater than 2% and less 5%; $taxregim3$ equals one if the minimum corporate income tax is greater than 35% and minimum royalty is higher than 5%, and taxregim4 for all other fiscal regimes not fitting with the three previous tax bracket. Then, we focus on the three "'clear fiscal regimes"' taxregim1 to taxregim3 and call them, respectively, low-tax regime, intermediate-tax regime, and high-tax regime.

Second, we focus on the type of fiscal regime by generating a dummy variable $tprofitbase$. Following that, the tax regime is exclusively based on profit (corporate income tax), the $tprofitbase1$ equals one or zero otherwise. We then relieve the constraint and introduce countries with profit-based royalty and generate a second variable $tprofitbase2$.

Third, we introduce a dummy variable $taxflex$ to consider the variability of the tax regime. $Taxflex$ is set to be equal to one if the corporate income tax rate or the royalty is determined according to a certain price threshold or any profit threshold.

These three indicators $tprofitbase1$, $tprofitbase2$, and $taxflex$ will allow us to tackle the critical issue of progressivity in natural resource taxation and examine its role in accelerating the development of an industrial gold project. As governments' revenues are linked to the profitability of the gold project, a shorter span of time both for high profitable mines and marginal projects could be expected.

Other covariates: The rest of our covariates is divided into three categories. It includes economical, geological, and institutional variables. They have been chosen to capture gold mine's individual heterogeneity at the national level and across countries.

First, we include geological variables. They are critical determinants in the process of triggering the initial irreversible investment in natural resource projects. The first variable related to mines' geology is the quantity of gold (in millions of troy ounces) in the deposit. We note it $Pmrqtymoz$. The second geological variable, $Goldgrade$, allows us to measure the grade and, consequently, assess the impact of the gold deposit quality on time to starting production. We also use a variable, to sum up all these preceding geological characteristics and take into account the cost extraction profile of each gold mine. We call the variable *Depverpro (deposit very profitable)*. The *Depverpro* equals one if the deposit is large and has a low cost of extraction, "'low-cost mine,"' and zero otherwise.

As suggested in the literature, a deposit's geological quality is a critical but not sufficient determinant of the extraction of its resources. For this reason, we introduce the variable $Price$, which is the price of one troy ounce gold at the London metal exchange (LME) the year before the discovery. A high level of gold prices increases projects' feasibility and, accordingly, is a key trigger for gold project developments (Schodde, 2014). Furthermore, to capture the dynamic effect of prices on investors' anticipation, we add two "'price-related"' variables. The first one is the price standard deviation $Pricesd$. It allows us to capture price volatility during the three years preceding the mine discovery. We assume that price uncertainties increase commercial risks and can consequently slow down gold extraction projects' development. The second one *priceup* has a positive impact on investors' anticipation and, therefore, can foster projects' development. We define *Priceup* as a dummy variable. It is equal to one if gold prices were increasing during the five years preceding the year of discovery and zero otherwise.

To take into account the heterogeneity across countries, such as the political environment and the level of infrastructure development, we add to our covariates the following variables. The variable *Polity* from the policy IV dataset ranging from -10 (strongly autocratic country) to $+10$ (strongly democratic country) to capture the country's institutional quality where the mine is located. Beyond geological and commercial risks, a gold extraction project faces high political risk degrees, especially the time consistency compared to other sectors, because of the substantial sunk costs involved in the extraction project development (Baunsgaard, 2001). All else equal, fearing that the government confiscates or changes the tax system after making the initial irreversible investment, a mining company can decide to postpone the development of a given extraction project even if the project is profitable at the time of discovery. The situation is even worse in low-income countries, where governments' credibility is weak (Collier, 2010b). Furthermore, the relation between politics and the exploitation of natural resource deposits is not in one direction. The discovery of a huge natural resource asset can also affect politics and generally deepen the political problem (Collier, 2010a).

In this study, we use the variable polity to assess the effects of the political environment on time to starting gold production. Relatedly, we will only be interested in the situation prevailing before the discovery to avoid the reversal causality (Shaukat Khan, Nguyen, Ohnsorge, and Schodde, 2016). For this purpose, we use the score before the discovery of the gold deposit. Infrastructures play an important role in the time delay between discovery and development. The energy cost or the accessibility to the gold mine, particularly when there is no electricity, is determinant. Due to the lack of data on the quality of infrastructures, such as energy costs, access to electricity, or asphalt road covering the period of our study (1950-2017), we assume as Tole and Koop (2010) and Canning (2001) before, that the quality of telecommunication systems of a country would reflect the quality of its infrastructures in general. The last one adds that the telephone (telecommunication) is a better measure of infrastructure stock. Nonetheless, he raises the concern that paved roads and total roads are not fairly complete datasets, particularly for the period ranging from 1950 to 1990, and may not be a good proxy given the large variation of quality. Therefore we use *Fixedphone* as a proxy for infrastructures. The proxy is measured as the percentage of fixed telephone subscriptions per 100 people. In the same logic, we lastly introduce three dummies to capture the heterogeneity across the three mains developing region $Africa$, *Asia*, and *Latinam* for South-America.

2.3.2 Descriptive statistics

Table 2.1 reports the summary statistics of the data used in our study. It shows that the span of time between the gold mine discovery and the effective commencement of the production in our sample is, on average, higher than ten years during the period ranging from 1950 to 2017. The development lag was even more pronounced before 1975, and after the liberalization in the nineties, it falls progressively. The time to starting gold production was equal to 13.59 (15.89 in Africa and 16.75 in Asia)[5] in the seventies and since 2005, for instance, is about 6.5 years on average and even less in Latin America. The lead time to starting gold production is, on average, 5.42 years in this region.

Thus, due to the singularity of duration data, the largess of the skewness, the average is not relevant. Therefore we will use the Kaplan-Meier estimator to get the median, and it will provide us an interesting summary of the data. Even more, it will allow us to shed light on the specific impact of taxation on the lead time to production before performing the multivariate analysis.

We can see in Table 2 that the median is very different from the average. Half of the gold mines get into production after eight years. When we stratify our sample in groups according to the level or nature of the fiscal regime prevailing at the time of the discovery, we can observe a huge heterogeneity across durations.

As a matter of fact, in a country where the corporate income tax is equal to or below 25% and the royalty equal to or below 2% ($Low-taxregime$), the probability of starting gold extraction in a new gold mine sooner is greater

[5] See Table 1 for more details.

Table 2.1: List of mines by country and statistics

	Country	Observations	Percent	Survival time							
				Mean	25%	50%	75%	Min	Max	Skewness	Kurtosis
1	– Argentina	5	2.66	10.4	8	9	10	5	20	1.08	2.81
2	– Botswana	1	0.53	6	-	-		-	-	-	-
3	– Brazil	32	17.02	5.66	1	3.5	10.5	1	17	0.6	1.88
4	– Burkina Faso	9	4.79	14.78	9	13	19	7	27	0.67	2.01
5	– Chile	11	5.85	9.91	2	7	13	1	33	1.38	4.07
6	– Colombia	1	0.53	11	-	-	-	-	-	-	-
7	– Congo (DRC)	2	1.06	12	10	12	14	10	14	0	1
8	– Cote d'Ivoire	5	2.66	15.6	8	14	17	7	32	0.91	2.47
9	– Ghana	11	5.85	8.09	4	7	12	3	16	0.52	2.08
10	– Guinea	3	1.6	9.33	5	6	17	5	17	0.69	1.5
11	– Indonesia	9	4.79	9.44	7	8	13	5	17	0.66	2.08
12	– Laos	2	1.06	13	11	13	15	11	15	0	1
13	– Liberia	2	1.06	12.5	8	12.5	17	8	17	0	1
14	– Mali	13	6.91	11.69	6	10	20	2	23	0.32	1.56
15	– Mauritania	1	0.53	11	-	-		-	-	-	-
16	– Mexico	20	10.64	11.35	7	11	16	2	20	0.05	1.89
17	– Namibia	2	1.06	10	4	10	16	4	16	0	1
18	– Niger	1	0.53	15	-	-	-	-	-	-	-
19	– Papua New Guinea	7	3.72	13.43	7	10	22	6	24	0.52	1.69
20	– Peru	12	6.38	8.25	2	6	15.5	1	19	0.38	1.54
21	– Philippines	11	5.85	10.82	1	2	16	1	48	1.58	4.39
22	– Senegal	1	0.53	28	-	-	-	-	-	-	-
23	– South Africa	20	10.64	12.15	7.5	10	14.5	4	35	1.65	5.21
24	– Tanzania	7	3.72	9.43	5	8	13	4	21	1.19	3.21
	Total	188	100	10.29	5	8.5	14	1	48	1.36	6.11
	Region										
1	– Africa	78	41.49	11.77	7	10	15	2	35	1.14	3.91
2	– Asia	29	43.09	11.17	5	8	15	1	48	1.9	7.51
3	– Latin America	81	15.43	8.54	3	8	13	1	33	0.81	3.66

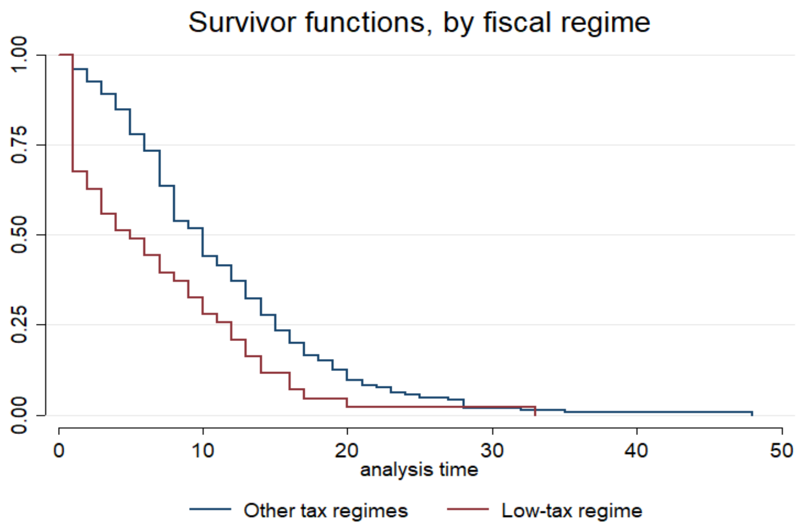
Notes: This table reports the list of mines by country and the associated statistics of the observed survival time. Source: author's elaboration on data from Minex Consulting, USGS.

than all other fiscal regimes. More than 51% of gold mines discovered in these countries experienced their first gold production after five years, while more than 51% of gold mine located in other fiscal jurisdictions do not achieve their first gold pour after nine years.

The time to starting gold production is, in contrast, lengthen when the corporate income tax is higher than 35% and the royalty rate higher than 5% ($High - taxregime$), as we can see in figure 2.4. None of the gold mines located in these countries poured their first gold after six years, while about 35% of other gold mines located in countries where the fiscal regime is more favorable get into production in the meantime.

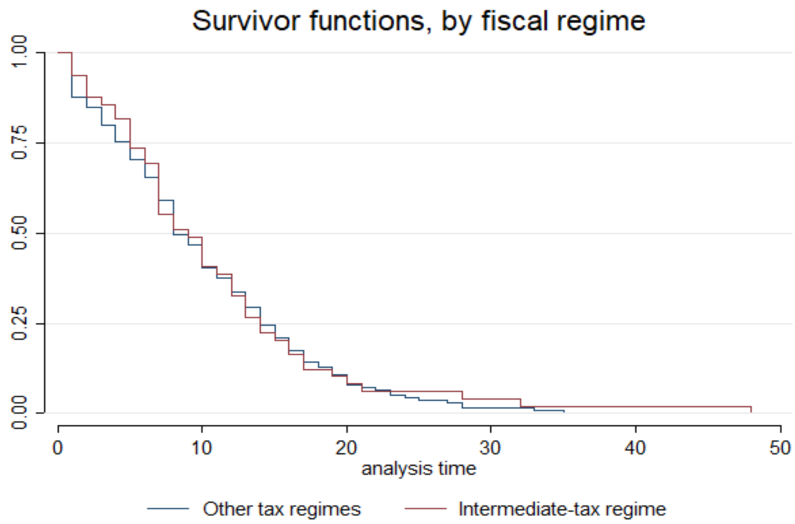
The time lag between the discovery and the beginning of the extraction does not depend only on the taxation level. We can observe through Figures 2 and 3 that the shapes of profit base taxation and variable tax regime do not merge with the other fiscal regimes. In addition to the above graphs, Tables 5 and 6 show that countries where the corporate income tax and royalty rate are variables see their gold mine discoveries getting into production sooner

Figure 2.1: Kaplan-Meier estimates of time duration by Tax regime (Low-tax regime)



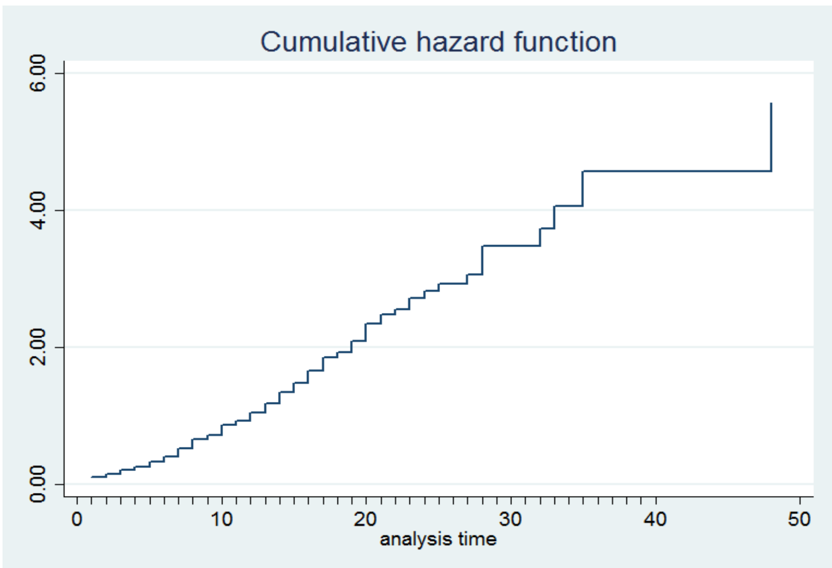
Notes: This figure provides a graphical illustration of the large difference in the survival time distribution between the "'Low-tax regime"' and the other types of regimes. Author's elaboration on data from Minex Consulting, USGS, FERDI tax database on gold.

Figure 2.2: Kaplan-Meier estimates of time duration by Tax regime (Intermediate-tax regime)



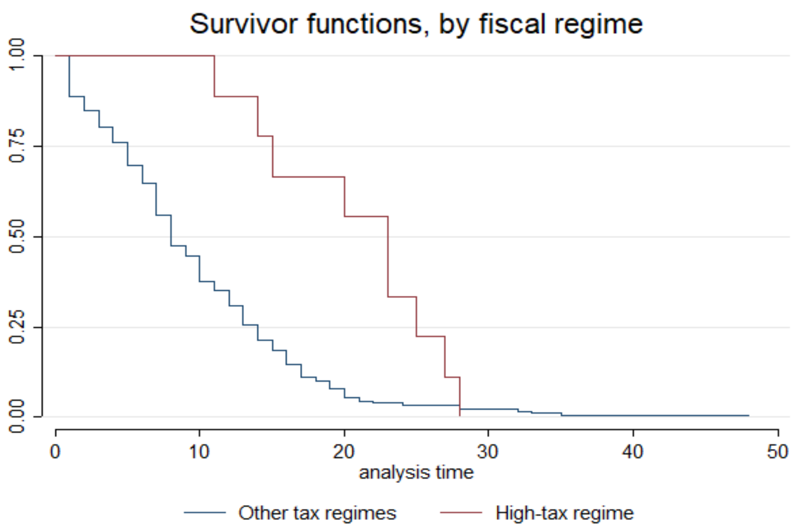
Notes: Author's elaboration on data from Minex Consulting, USGS, FERDI tax database on gold. This figure provides a graphical illustration of the weak difference in the survival time distribution between the "'Intermediate-tax regime"' and the other types of tax regimes.

Figure 2.3: Cumulative Hazard function



Notes: Author's elaboration on data from Minex Consulting, USGS. This figure shows that the probability of starting a new gold mine deposit extraction is low at the time of discovery and increases afterward.

Figure 2.4: Kaplan-Meier estimates of time duration by Tax regime (High-tax regime)



Notes: Author's elaboration on data from Minex Consulting, USGS, FERDI tax database on gold. This figure reports the stratified KM survivor function curve. The graph provides a graphical illustration of the large difference in the survival time distribution between the "'High-tax regime"' and the other types of regimes.

compared to other countries. Only 60% of new gold discoveries remain untapped in variable-tax rate jurisdiction countries after six years against more than 70% for constant fixed-rate tax regimes.

When we perform a log-rank test, the differences across durations from the discovery of new gold deposits and the beginning of the extraction are statistically significant both for $taxregime1$, $taxregime3$, and $Flextax$, respectively at 1% for the first two variables and 5% for the last one.

Thus, if for countries where the $taxregim1$, $taxregim3$, and $Flextax$ are in force at the time of the discovery, we can see a clear distinction between their survival time distribution; it is not the case in countries where the $taxregim2$, $Tprofitbase1$ or $Tprofitbase2$ are in force. The graphs, log-rank test, and Wilcoxon (Breslow) test in tables 5 and 6 do not allow us to identify significant differences across their survivor functions.

To definitely determine the role of taxation on industrial mineral development, we will perform in the following section an empirical analysis to take into account the impact of other covariates such as mine or country characteristics in the time to starting gold production.

2.4 Methodology and empirical specification

2.4.1 Methodology

To empirically appraise this relation, we assume that all else equal, if country-specific policies impact the lead time between the discovery and the initial development as suggested in the literature Tole and Koop (2010), Shaukat Khan, Nguyen, Ohnsorge, and Schodde (2016) among others, the national mining taxation can therefore explain the time delay recorded by some gold mine projects. For this purpose, we carry out a fully parametric analysis to investigate this relation. Furthermore, to make sure that our model is convenient for our data, we perform a set of background analysis. Firstly, we argue that once a mine is discovered in a given country, the discovered resource's extraction probability is, all else equal, set to be growing over the years. Therefore, we will assume that the shape of the hazard form is monotonic. Accordingly, we can use both the *Gompertz* or *Weibull* models to estimate the coefficients. To do so, we perform estimates with the two models and four others (Exponential, Log-Normal, Log-Logistic, Generalized Gamma) and compare their statistics, mainly the AIC. The AIC criterion for all equations suggests that the Weibull model fits the data adequately (see table 7). We will then, consequently, perform a Weibull model. Our model is specified as follows:

$$h(t, X) = h_0(t)\exp(\beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + ... + \beta_k X_k) \tag{2.1}$$

Where $h(t, X)$ is the hazard or the probability of starting gold production at the time t. X is a set of K variables introduced to take into account the differences between the mines and countries. The β_k coefficients, called hazard ratio, appraise each covariate's impact on the hazard rate, in other words, on the probability of developing the gold production. A hazard ratio greater than one indicates that the rise of a covariate will lead to an increase of the event hazard (decrease of the survival length), while a hazard ratio below one will lead to a reduction of the event probability (an increase of the survival time). The baseline hazard is noted $h_0(t)$. It is the value of hazard when all the coefficients β_k of the K variables are equal to zero. It also gives us information about the shape of the hazard function. When we rewrite the specification (2.1), we obtain the factor parameter.

$$h(t, X) = \alpha t^{\alpha - 1}\exp(\beta_k X) \tag{2.2}$$

When the parameter α is higher than one ($\alpha > 1$), the probability of starting gold production rises monotonically and reversely when the factor α is less than one.

2.4.2 Empirical specification

Our baseline model derives from the theoretical model developed by Favero, Hashem Pesaran, and Sharma (1994). We introduced progressively four variables, the three sets of tax regimes *(taxregim1, taxregim2, taxregim3)*; *depverpro* to capture both the grade, the quantity of gold and facility of extraction, and prices.

The duration model can be written as follows:

$$h(t|taxregim, X) = h_0(t)\exp(\beta_0+\sum_{i=1}^{3}\beta_i Taxregim_i+\beta_4 Ggrade+\beta_5 Depverpro$$
$$+ \beta_6 Reserveoz + \beta_7 Price + \beta_8 Priceup + \beta_9 Pricesd) \quad (2.3)$$

We add successively to our baseline model 2.3 a set of covariates and get the underneath equation :

$$h(t|taxregim, X) = h_0(t)\exp(\beta_0+\sum_{i=1}^{3}\beta_i Taxregim_i+\beta_4 Tprofitbase+\beta_5 Flextax$$
$$+ \beta_6 Ggrade + \beta_7 Depverpro + \beta_8 Reserveoz + \beta_9 Pmrqtymoz$$
$$+ \beta_{10} Priceup + \beta_{11} Price + \beta_{12} Price_s d + \beta_{13} Polity$$
$$+ \beta_{14} Fixedphone + \beta_{15} Africa + \beta_{16} Asia) \quad (2.4)$$

Where $\beta_i Taxregim_i$, $\beta_4 Tprofitbase$, $\beta_5 Flextax$ are the variables of interest and their coefficients; $\beta' X_k$ a set of covariates explaining potentially the time lag between the time to starting gold production.

2.5 Results and robustness

Tables 2.2 and 2.3 present the results of our estimates from our Weibull model. The first set of equations (1 to 7) in table 2.2 includes only the structural covariates (geological and economical), and the following equations include the rest of the covariates progressively.

2.5.1 Time to starting mineral production: does the taxation matter?

As we assume intuitively initially, the overall result stemming from our estimates, is that the probability of starting the extraction of gold discoveries increases over time. The statistic $ln(p)$ below each equation is statistically significant at 1%, and the value of p is above one. It implies that the hazard is increasing monotonically, and consequently, the *Weibull* parametric model is appropriate for modeling our data.

These findings suggest that according to the level and the nature of tax instruments used by a country to get a share of their resources, the fiscal regime has an incidence on the lead time to the production of a new gold mine. The hazard ratio for countries with a corporate income tax equal or below 25% and a royalty not exceeding 2% is always statistically significant and greater than one in all our estimates. It implies that in these low-tax jurisdictions, gold mines discovered will get into production sooner.

In contrast, when the mining corporate income tax rate is greater than 35%, and the royalty rate beyond 5%, the probability that the gold mines discovered remain untapped is more likely. The hazard ratio is largely below 1 (around 0.4) for all our estimates.

The variability of tax regime seems to spark initial investments in developing discoveries sooner and, as much as the low-tax regime $Taxregim1$. As we can see them in columns 7, 8, and 9 the development is more likely to happen when the deposit has been discovered in a country where the level of tax change according to a particular economic criterion, such as the price or the level of profit.

Moreover, this study document that differences in the survival time distribution between gold mines are also explained by differences in the nature of fiscal regimes in force in each mine and country. A more progressive fiscal regime incites investors to start the extraction of discoveries sooner. The variable $Tprofitbase$ has a hazard ratio above the threshold one, suggesting that a profit base fiscal regime shortens the lead time from discovery to production. The coefficient becomes significant, particularly when we take into account countries levying a profit-based royalty on gold production, such as Ghana.

2.5.2 The role of geology and economic environment

The results also suggest that the time to starting gold production depends on the geological characteristics of the mine and the economic conditions prevailing at the time of discovery. Thus as indicated in the literature, when a substantial potential and low-cost extraction deposit of gold is discovered,

Table 2.2: Time to starting gold production: Hazard ratio from Weibull Model

	Equations						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Taxregim1	1.562**	1.838**	1.484**	1.684***	-	-	-
	(0.284)	(0.449)	(0.265)	(0.301)	-	-	-
Taxregim3	0.435**	0.292***	0.416***	0.464**	-	-	0.332***
	(0.151)	(0.112)	(0.144)	(0.161)	-	-	(0.132)
Tprofitbase1	-	-	-	-	1.223	-	-
	-	-	-	-	(0.253)	-	-
Tprofitbase2	-	-	-	-	-	1.511**	-
	-	-	-	-	-	(0.301)	-
Flextax	-	-	-	-	-	-	1.506**
	-	-	-	-	-	-	(0.318)
Depverpro	1.175*	1.244**	-	1.193**	1.190*	-	-
	(0.101)	(0.130)	-	(0.103)	(0.122)	-	-
Goldgrade	-	1.050***	-	-	1.050**	1.054***	1.058***
	-	(0.020)	-	-	(0.020)	(0.021)	(0.020)
Goldreserve	-	-	0.999	-	-	-	-
	-	-	(0.007)	-	-	-	-
Priceup	-	-	-	1.725**	-	-	-
	-	-	-	(0.456)	-	-	-
Price_us	1.001**	1.001*	1.001**	-	1.003***	1.003***	1.002***
	(0.000)	(0.001)	(0.000)	-	(0.001)	(0.001)	(0.001)
Price_sd3	-	-	-	-	0.993***	0.992***	0.994*
	-	-	-	-	(0.003)	(0.003)	(0.003)
Constant	0.0201***	0.007***	0.023***	0.025***	0.006***	0.006***	0.006***
	(0.000)	(0.003)	(0.007)	(0.007)	(0.003)	(0.003)	(0.003)
/Ln_p	0.370***	0.574***	0.361***	0.367***	0.536***	0.536***	0.578***
	(0.057)	(0.071)	(0.057)	(0.056)	(0.072)	(0.072)	(0.072)
p	1.448	1.776	1.435	1.443	1.709	1.709	1.783
N	188	124	188	188	124	124	124

Notes : (*), (**), (***) denote significance at respectively 10%, 5% and 1%. Robust standard errors are in parentheses. Taxregim2 "'the intermediarytax regime"', is the variable of reference for the dummy variable Taxregim. Source: author's elaboration on data from Minex Consulting, USGS.

all else equal, the initial development of the mine occurs sooner. The coefficients of variables *Depverpro*, *Goldgrade*, and slightly *Goldreserve* confirm these findings and allow us to conclude that the geological characteristics are determinant on the lead time to starting production.

Our findings also show that on their own, except the *Goldgrade*, and the *Depverpro*, the impacts of *Goldreserve* are positive but not statistically significant. Columns 1, 2, and 3 in table 2.2 suggest that the reserve quantity is not determinant without introducing the resource's grade. For example, a deposit with a million troy ounces gold with a low grade could lead indeed to a high cost of extraction and processing, and therefore may be less profitable for an investor. The profitability may be even more affected if it is a deep mine. Furthermore, we notice that the coefficients of the variable *Depverpro* are higher than the hazard ratio of the variables *Goldgrade*, and even more for the covariate *Goldreserve*. This allows us to say that the geological quality of the deposit and its low-cost extraction profile are more determinants than the quantity on its own.

Similarly, as we can see in each column, the coefficients of the variable *Price* are higher than one and significant at 1%. The role of prices in triggering the irreversible investment in a gold mine is even more perceptible when we introduce the variable *Priceup*. These findings suggest that when a gold mine is discovered in a thriving economic context for mining investors, it is more likely that it starts production earlier. The hazard ratios of the variable *Priceup*, as we can see them in columns 4, 10, and 11, are significant and are, on average, higher than the variable $Taxregim1$, suggesting that prices foster more the lead time to starting extraction than the low taxation fiscal regime. We find, in contrast to Shaukat Khan, Nguyen, Ohnsorge, and Schodde (2016), that increasing prices at the time of discovery accelerates the development of a gold mine project.[6] Our results are in line with the findings by Favero, Hashem Pesaran, and Sharma (1994). On the contrary, the uncertainty of gold prices postpones the development of gold mine discoveries. The hazard ratios are significant and slightly below one for the volatility and more than one for the variable *price*.

Despite the importance of institutions and infrastructures in the process

[6]However, they found that the price has a significant impact when interacted with copper mine size.

Table 2.3: Time to starting gold production: Hazard ratio from Weibull Model (2)

	Equations					
	(8)	(9)	(10)	(11)	(12)	(13)
Taxregim1	-	-	1.470*	1.536**	2.069***	-
	-	-	(0.336)	(0.297)	(0.532)	-
Taxregim3	-	-	0.480**	0.452**	0.375**	0.503*
	-	-	(0.178)	(0.164)	(0.151)	(0.190)
Flextax	1.57***	1.598**	-	-	-	1.542***
	(0.276)	(0.343)	-	-	-	(0.266)
Depverpro	1.20**	-	1.201**	1.183**	1.214*	1.189*
	(0.103)	-	(0.106)	(0.102)	(0.126)	(0.112)
Goldgrade	-	1.047**	-	-	1.061***	-
	-	(0.020)	-	-	(0.020)	-
Goldreserve	-	-	-	-	-	0.995
	-	-	-	-	-	(0.109)
Priceup	1.549	-	1.765**	1.602*	-	-
	(0.445)	-	(0.480)	(0.444)	-	-
Price_us	1.001**	1.001**	-	1.001*	1.002***	1.001***
	(0.000)	(0.001)	-	(0.000)	(0.001)	(0.000)
Price_sd3	-	-	-	-	0.994*	-
	-	-	-	-	(0.003)	-
Polity2	1.000	1.018	1.001	1.003	0.998	1.001
	(0.014)	(0.018)	(0.016)	(0.016)	(0.021)	(0.016)
Fixedphone	-	-	0.999	1.003	1.019	0.988
	-	-	(0.24)	(0.020)	(0.031)	(0.024)
Africa	0.627***	0.666**	1.063	-	-	-
	(0.106)	(0.136)	(0.243)	-	-	-
Latinam	-	-	1.265	-	-	1.444*
	-	-	(0.366)	-	-	(0.301)
Asia	0.783	-	-	0.912	-	1.039
	(0.177)	-	-	(0.201)	-	(0.247)
Constant	0.019***	0.008***	0.022***	0.019***	0.005***	0.014
	(0.006)	(0.004)	(0.007)	(0.006)	(0.002)	(0.005)
/ln_p	0.387***	0.538***	0.372***	0.384***	0.608***	0.393***
	(0.058)	(0.072)	(0.057)	(0.57)	(0.072)	(0.058)
p	1.473	1.713	1.451	1.468	1.837	1.482
N	188	124	188	188	124	188

Notes : (*), (**), (***) denote significance at respectively 10%, 5% and 1%. Robust standard errors are in parentheses. Taxregim2 the intermediary-tax regime is the variable of reference for the dummy variable Taxregim. Source: author's elaboration on data from Minex Consulting, USGS.

of developing a mineral project, we find a weak impact on the lead time to production.

This can be explained by the fact that investors may turn a blind eye to the political situation, or even worse, take advantage of the current political situation for their profits. Moreover, for infrastructures, the mine area can look like an enclave, as documented by several studies. Investors use, in many cases, a helicopter or a jet to carry gold mines production.

Lastly, we find mixed results about the contribution of regional specificity on the lead time to production. Our findings suggest that being discovered in Africa increases the probability of being an untapped deposit. Hazard ratios are significant at 1% and are about 0.6, largely below one, implying that being discovered in Africa lengthen the delay before the development. In contrast, as we can see in column 13, gold mines found in *Latinamerica* are more likely to come out of the ground earlier. The probability is significant at 10%. Concerning *Asia*, the results are mixed and weak.

2.5.3 Alternative estimation using a Cox proportional hazard model

To assess our results' robustness, we will not set any shape to the probability of starting gold production in a given field. One may assume that the shape of the hazard form is non-monotonic. Accordingly, it may be assumed that the probability of developing a gold mine project increases in the following months after the discovery and fall after that and vice-versa. Therefore, we will perform a cox proportional hazards model. This model allows us to re-estimate the preceding model without assuming any particular statistical distribution. The estimate of the relationship between the probability of starting gold production and our covariates without defining any shape is written as follow:

$$h(t|taxregim, X) = h_0(t)\exp(\beta_0 + \sum_{i=1}^{3} \beta_i Taxregim_i + \beta_4 Ggrade + \beta_5 Depverpro + \beta_6 Reserveoz + \beta_7 Price + \beta_8 Priceup + \beta_9 Pricesd) \quad (2.5)$$

The main equations are re-estimated, and as the previous estimates, we picked up four variables in our dataset. It includes the three sets of tax regimes *(taxregim1, taxregim2, taxregim3)*; *depverpro*to capture the impact of grade, quantity of gold, and ease of extraction and prices. Then, we add successively to our baseline model a set of covariates and get the underneath equation:

$$\begin{aligned} h(t|taxregim, X) = h_0(t)\exp(\beta_0+\sum_{i=1}^{3}\beta_i Taxregim_i+\beta_4 Tprofitbase+\beta_5 Flextax \\ + \beta_6 Ggrade + \beta_7 Depverpro + \beta_8 Reserveoz + \beta_9 Pmrqtymoz \\ + \beta_{10} Priceup + \beta_{11} Price + \beta_{12} Price_s d + \beta_{13} Polity \\ + \beta_{14} Fixedphone + \beta_{15} Africa + \beta_{16} Asia) \end{aligned} \quad (2.6)$$

Where $h(t|taxregim, X)$ is the probability of starting gold production, t is the time lag between the gold mine discovery and the actual start of the production; $h_0(t)$ is the baseline hazard, which is the probability of starting gold production when all the coefficients of the covariates equal zero. $\beta_i Taxregim_i$, $\beta_4 Tprofitbase$, $\beta_5 Flextax$ denote the variable of interest and their coefficients; and $\beta' X_k$ a set of our covariates, which may help us to explain the time lag between the time to starting gold production. To facilitate the interpretation, we will keep the coefficients in the hazard ratio ($\exp^{b_i}$). Thus a coefficient higher than one implies that the first gold pour will come sooner and vice versa.

Table 2.4 presents the results of the estimates without assuming any shape of the baseline hazard function. While the coefficients are less significant in some instances, our mains findings remain consistent even though the Cox-model is not fitted to our data.

2.6 Conclusion

This chapter analyzes the impact of taxation on time to starting industrial mineral project development in developing countries. Using a sample of 188 gold mines discovered in 24 gold-rich developing countries from 1950 to 2018, we contribute to the literature by determining empirically through a survival

Table 2.4: Time to starting gold production: Hazard ratio from semi-parametric Cox-model

	Equations						
	(1b)	(2b)	(3b)	(4b)	(5b)	(6b)	(7b)
Taxregim1	1.543**	1.842**	1.462**	1.645***	-	-	-
	(0.282)	(0.454)	(0.261)	(0.295)	-	-	-
Taxregim3	0.429**	0.262***	0.410**	0.450**	-	-	0.303***
	(0.151)	(0.105)	(0.144)	(0.158)	-	-	(0.126)
Tprofitbase1	-	-	-	-	1.245	-	-
	-	-	-	-	(0.261)	-	-
Tprofitbase2	-	-	-	-	-	1.515**	-
	-	-	-	-	-	(0.0307)	-
Flextax	-	-	-	-	-	-	1.577**
	-	-	-	-	-	-	(0.341)
Depverpro	1.177*	1.256**	-	1.186***	1.196	-	-
	(0.102)	(0.134)	-	(0.102)	(0.123)	-	-
Goldgrade	-	1.043**	-	-	1.045**	1.050***	1.055***
	-	(0.020)	-	-	(0.020)	(0.021)	(0.020)
Goldreserve	-	-	0.999	-	-	-	-
	-	-	(0.007)	-	-	-	-
Priceup	-	-	-	1.631*	-	-	-
	-	-	-	(0.431)	-	-	-
Price	1.001*	1.001*	1.001*	-	1.003***	1.003	1.003***
	(0.000)	(0.001)	(0.000)	-	(0.001)	(0.001)	(0.001)
Pricesd	-	-	-	-	0.992***	0.992***	0.994**
	-	-	-	-	(0.003)	(0.003)	(0.003)
N	188	124	188	188	124	124	124

Notes: This table is a re-estimation of table 2.2 using a semi-parametric Cox-model. (*), (**), (***) denote significance at respectively 10%, 5% and 1%. Robust standard errors are in parentheses. Taxregim2, "‘the intermediary-tax regime"’ is the variable of reference for the dummy variable Taxregim. Source: author’s elaboration on data from Minex Consulting, USGS.

model analysis, the impact of taxation on the lead time to production.

As suggested by the theoretical literature, we document that taxation can either foster the development of gold mine projects when the country fiscal regime has a corporate income tax equal to or below 25% and a royalty equal to or below 2%, or slow down the development when the corporate income tax and the royalty rate are respectively higher than 35% and 5%. Most importantly, our research results also show that progressive fiscal regimes, especially variable tax regimes and profit base taxation, are very favorable to the first extraction of new gold deposits. Overall, all else equal, the more progressive the fiscal regime is, the sooner the extraction will occur.

Another significant evidence is the importance of the economic environment and geological characteristics in inciting mining investors to trigger gold mine projects' development earlier. These findings are consistent with the literature and suggest that a thriving economic environment, such as increasing gold prices at the time of the discovery, abundant reserves, and low-cost extraction, leads to an earlier effective beginning of the production.

Furthermore, the study emphasizes the dilemma faced by developing countries. Getting a fair share of the mineral rent and accelerating the mineral potential development, which is underdeveloped in many low-income countries. Many developing countries have a tendency, mainly during the decline in commodity prices, to give up a part of their revenues to reduce mineral projects' development duration. Relatedly, during the cyclical upswing, they desperately attempt to reform the tax regime to get a fair share of their resources.

In light of our findings, we can guard policymaker, particularly in low-income countries, against the fiscal regime "'High-tax regime"', given the risk of having an untapped mine is more likely. For the second one, the "'low-tax regime"', even if it may allow countries to quickly develop their discoveries, it undermines revenue mobilization from the natural resource sector.

Finally, the only practical and non-hostile fiscal policy implication of our findings is progressivity. A more progressive fiscal regime based on profits or involving a part of royalties and variability can conciliate both getting a fair share of revenues stemming from the exploitation of deposits and fostering their resource projects' development.

Another takeaway from our investigation is that patience could be a virtue. Trying to foster the development at all costs, particularly for mines with great potential, will not permit a country to benefit from its endowment (Curtis and Lissu, 2008).

Accepting a certain delay, and using other policy instruments other than taxes, such as the political environment or infrastructures, could help developing resource-rich countries get a fair share of their resources.

Chapter 3

Public spending and growth in Sub-Saharan African natural resource-rich countries

Contents

Abstract

This chapter re-examines the impact of government expenditures on growth in 23 Sub-Saharan resource-rich countries from 1995 to 2016. It put public spending at the heart of the investigation of the resource curse in this region. The panel smooth transition regression ($PSTR$) results, reassert, and demarcate governments' role in sub-Saharan resource-rich countries. The study contributes to the literature by showing empirically that public spending is an engine of growth. Current expenditures and public investments positively impact growth when the expenditure level is less than 22.4% of the GDP. Beyond this threshold, government expenditures become progressively harmful to economic growth. Government consumption and investment expenditures become less efficient and impact growth negatively. Private investments are crowded-out, external imbalances escalate and are detrimental to economic growth. Moreover, the study documents that natural resource rents are a blessing if appropriately managed. Natural resource rents are positively and significantly associated with economic development when government spending is moderated.

Keywords: Public spending, government consumption, public investments, economic growth, resource curse, sub-Saharan Africa.

JEL classification: E620, O470, Q320, Q330.

3.1 Introduction

Reversing the resource curse in Sub-Saharan African natural resource-rich countries is a key challenge to lift millions of African out of poverty. Natural resource wealth is one of the assets that could be used for that purpose (Davis and Tilton, 2005, 2008; Venables, 2016). The role of public expenditures management in this process is central (Collier, 2007). By determining how much to spend, policymakers could speed up the economic growth of their countries and make the windfall a blessing (Van den Bremer and Van der Ploeg, 2012; Ghura, Pattillo, et al., 2012; Araujo, Li, Poplawski-Ribeiro, and Zanna, 2013).

There is a vast literature on government expenditures and their effects on Sub-Saharan Africa's economic growth. Nevertheless, the debates are far from being conclusive (Havranek, Horvath, and Zeynalov, 2016). For neo-classics, only innovation and population growth have a positive incidence on economic growth, and any other factor is a source of economic distortion. Endogenous growth theories literature led by Barro and Sala-i Martin (1992); Barro (1996), in contrast, argue that public spending is an engine of growth.

Empirically, since Barro and Sala-i Martin (1992); Barro (1996), and even before Solow (1956), numbers of researchers have explored the role of public spending in fostering economic development. The empirical findings are mixed. Public expenditures are viewed both as an engine of growth and a factor of distortions.

When it comes to the literature on the impact of natural resource exports on development, the findings are almost unanimous. The negative association between resource rents and growth appears quite often in studies focusing on sub-Saharan African countries. The recent study by Henri (2019) shows that the resource curse is still a reality in Africa. The results show that natural resource rents undermine institutions and lead to low physical and human capital accumulation. Despite having spent more revenues, Sub-Saharan African resource-rich countries tend to grow slowly compared to non-resource-rich Sub-Saharan African countries. These findings tend to reinforce the view that public spending is a source of distortion, and resource exports are harmful to the economy, particularly for the non-resource sector (Davis and Tilton, 2005, 2008; Lundgren, Thomas, and York, 2013). However, empirical evidence of the role of fiscal policy is still lacking.

The findings by Sachs and Warner (1995) and Lundgren, Thomas, and York (2013), suggest that natural resources on their own or by undermining the quality of institutions and government expenditures impede economic development. While the study by Mehlum, Moene, and Torvik (2006) documents that natural resource exports have a positive impact on growth when we take into account the quality of institutions, investment, and openness (Papyrakis and Gerlagh, 2004; El Anshasy and Katsaiti, 2013).

Nevertheless, Atkinson and Hamilton (2003) show a negative impact despite, including institution variables and other covariates. Relatedly, their study shows the positive effects of natural resource rents when interacting with public capital expenditures and negative impacts when interacting with government consumption expenditures. Going further, Brunnschweiler (2008) shows that natural resource exports have no adverse incidence on growth through institutions, but on the contrary, promote economic development.

Fiscal policies are not generally at the heart of the econometric investigation for most of the studies investigating the resource curse hypothesis. Moreover, the limited studies on fiscal linkages that have been carried out in the resource curse context are even more contradictory than the classical literature on economic growth (Arezki, Gylfason, and Sy, 2012; James, 2015). The general findings on the impact of government expenditures on growth are negative or insignificant. For example, the study by El Anshasy and Katsaiti (2013) argues that it will not worth looking at the role of government size in trying to understand the resource curse. They generally focus on institutions' contributions, ignoring that government expenditures are among the most critical connections between the resource sector and the rest of the economy. Governments receive most of the revenues stemming from the extraction of natural resources in sub-Saharan African countries and spend them in other non-related resource sectors[1].

Furthermore, the few studies that have explored the issue, particularly in Sub-Saharan African countries, do not focus on the contribution of each component of public expenditures because of data limitation (Ojo and Oshikoya, 1995; El Anshasy and Katsaiti, 2013; Damette and Seghir, 2018).

[1]Extractive companies are detained mostly by foreign companies in sub-Saharan Africa

In this chapter, we join two literature pieces, rehabilitate and demarcate the role of government in Sub-Saharan African resource-rich countries. The study re-estimates the impact of government expenditures on economic growth in 23 Sub-Saharan African resource-rich countries through a non-linear approach. To take into account the non-linearities identified in the literature Barro (2004) and heterogeneity across countries and over time, we use the Panel Smooth Transition Regression model (PSTR) developed by González, Teräsvirta, and Dijk (2005).

This essay contributes to the literature by giving a striking confirmation that government expenditures are an engine of growth, and natural resource windfalls are a blessing if appropriately managed. Public capital, as well as, current expenditures have a positive impact on growth when the expenditure level is below 22.4% of the GDP. Beyond this threshold, government expenditures become progressively harmful to development. Government consumption expenditures and public investment become less efficient and impact growth negatively. Private investments are crowded-out and external imbalances escalate.

Our third main empirical result contributes to the literature on the resource curse hypothesis in sub-Saharan African countries. The findings suggest that natural resource rents are positively and significantly associated with economic growth when government spending is moderated. They become detrimental only beyond the threshold.

These findings are significant as they show that natural resource windfalls on their own have not a systematic negative impact on growth. It depends on how governments manage them. By deciding to inject totally, partially, or sterilize their revenues stemming from the extraction of their resources, African governments could change Africa's resource curse story.

The remainder of this chapter is organized as follows. In section 3.2, we provide a review of the related literature. Section 4.2 describes the data used for our estimates. The following section 3.4, provides the methodology and empirical specifications carried out in the analysis. In section 4.4, we discuss the results. Section 3.6 concludes and gives some policy implications drawn from our key findings.

3.2 Public Spending, resource rents, and growth in Sub-Saharan Africa: What do we know so far?

This chapter is related to two empirical pieces of literature. The first one is the general literature on the effects of public expenditures on growth, and the second one is drawn from the literature on the impact of natural resource exports on growth. The findings of these studies are conflicting. Nonetheless, they could be split into two categories. On the one hand, we have studies documenting that public spending and resource exports promote economic growth and diversification. On the other hand, findings suggesting that government expenditures and natural resource exports impede economic growth.

3.2.1 Public spending, resource rents as a factor of distortion

Numbers of economists, particularly neo-classics, question the role of public spending as a growth engine. Population growth and innovation are the most critical determinants of growth in this literature. Empirical findings are still conflicting. For example, Barro and Sala-i Martin (1990); Barro (1996) found using an endogenous economic growth model that public expenditures can raise the growth rate. However, when empirical analyzes are performed on 98 countries in the period between 1960-1985, the results show that government consumption expenditures are adversely related to the growth rate and insignificantly to the share of public investment.

Focusing on Latin American countries, Chamorro-Narvaez (2012) documents that neither government capital nor current expenditures impact the per capita economic growth rate between 1975-2000. Worse, Devarajan, Swaroop, and Zou (1996) found that even public investments, contrary to the general view, have a negative impact on per capita growth in 43 developing countries. He concludes by saying that when used in excess, public investments could become unproductive. Based on 19 Sub-Saharan African countries Ndambiri, Ritho, Ng ang a, Kubowon, Mairura, Nyangweso, Muiruri, and Cherotwo (2012), empirical findings suggest that government expenditures lead to negative economic growth. These findings aline with the previous study by Ojo and Oshikoya (1995), focusing on 17 African countries. The study by Arzelier (1998) also indicates a negative impact of public spending on Non-resource GDP and argues that it came from the crowding-out of the private sector.[2]

Natural resource-rich countries perform poorly because of the resource rents, on their own, or by undermining institutions (Sachs and Warner, 1995; Arzelier, 1998; Badeeb, Lean, and Clark, 2017). Worse more recently, Apergis and Katsaiti (2018) show that fossil energy resources exacerbate poverty. In Africa, the study by Henri (2019) indicates that the natural resource curse is still a reality in Africa. Natural resource endowment undermines institutions.

Only a few numbers of authors investigated the role of public expenditure directly. Authors argue that public expenditures already have a negative impact on growth, and so will be the impact on resource-rich countries. Government expenditures, particularly government consumption, are viewed as a transmission channel of the resource curse (Atkinson and Hamilton, 2003; Ghura, Pattillo, et al., 2012).

Investments and Human capital are also documented as a channel of transmission of the resource curse. Gylfason and Zoega (2006) and, more recently, by Cockx and Francken (2016) document that natural resources influence investments, education, and economic growth adversely. These findings are in line with the results by Henri (2019). His study shows that natural resource rents lead to a low level of physical and human capital accumulations. Nevertheless, even if Arezki, Gylfason, and Sy (2012) found a significant negative effect of resource windfalls on the Non-resource GDP, their results show that the negative impact is not through government spending. Carmignani and Chowdhury (2010) findings show that natural resource exports impede only the economic development of Sub-Saharan African countries and no other regions. Moreover, regarding the role of institutions, the paper by Eregha and Mesagan (2016) indicates that institutional quality insignificantly enhanced per-capita income growth, and the quality of institutions in these countries would not be able to reverse the resource curse in African oil-producing countries.

[2]The study focuses on two sub-Saharan African countries (Cameroon and Nigeria).

3.2.2 Public spending, resource rents: significant contributors to growth

In the endogenous growth theories literature, government expenditures are complementary to private investments. They improve productivity, and consequently, the return to capital. Kormendi and Meguire (1985), in a sample of forty-seven countries, confirm the neoclassical growth theory and indicate that investment has significant effects on economic growth. However, they find no evidence that the ratio of government consumption adversely affects economic growth. These results have been corroborated by Bose, Haque, and Osborn (2007), as they also show that capital expenditures are positively and significantly associated with economic growth. Nonetheless, they do not see a significant impact of current expenditures on growth.

Empirical results by Aschauer (1989) show that government investments play a critical role in determining productivity and, relatedly, economic growth. Using data from 43 developing countries, Devarajan, Swaroop, and Zou (1996) show that an increase in the share of current expenditures has positive and statistically significant growth effects. Focusing on the West African Economic and Monetary Union, Nubukpo (2007), using an error correction model, shows that government expenditures have a positive impact only in Senegal and Togo. Nevertheless, when disaggregated, public investments seem to have a positive effect on economic growth.

Nubukpo (2007), in addition to other authors, such as Barro (2004), justify the literature's inconclusive character by the existence of highly non-linearities in the relationship between growth and some variables. The effects of government expenditures could be conditioned by its level, macroeconomic stability, the natural resource rents. Many authors investigate the relationship between growth and public spending by taking into account these non-linearities. For example, the study by Thanh (2015) modifies Chen and Lee (2005) empirical model and shows through a panel smooth transition regression model that government spending in ASEAN countries impact the growth positively until 25.69%.[3] Beyond this threshold, economic growth declines by 0.2%.

Focusing on the same region, Hok, Jariyapan, Buddhawongsa, and Tan-

[3] Association of South-East Asian Nations (ASEAN) Brunei, Cambodia, Indonesia, Laos, Malaysia, the Philippines, Singapore, Thailand, and Vietnam.

suchat (2014) one year earlier and using mean group (MG) and pooled mean group (PMG) show that the reversal impact on economic growth comes when the government size exceeds 28.5%. For their part, Asimakopoulos, Karavias, et al. (2015) carried out an empirical analysis using the Generalized Method of Moments (GMM) and found that the optimal size was around 19.12% for developing countries. Gastonfils and Desir (2014), using methods developed by Hansen (1999) for non-dynamic panels with individual-specific fixed effects, found that the rollover threshold was around 24% for Congo (DRC). In Congo DRC's neighboring countries (CEMAC), Fouopi Djiogap (2014) found 33% and 48.5% respectively for government consumption and public investment.[4]

Numerous economists have challenged conventional views on the resource curse hypothesis. They argue that natural resources could spur the development or slow down economic growth, depending on the quality of institutions (Mehlum, Moene, and Torvik, 2006). Natural resource exports have a positive direct effect on the level of income (Bravo-Ortega and De Gregorio, 2005) and economic growth (Brunnschweiler, 2008). Moreover, even if they are harmful to economic growth, human capital beneficial effects could outweigh the negative impact of natural resource abundance (Bravo-Ortega and De Gregorio, 2005). Another group of authors documents that natural resource exports negatively impact growth if considered in isolation, but become positive when introducing institutional variables, openness, and human capital (Papyrakis and Gerlagh, 2004; El Anshasy and Katsaiti, 2013).

The study by Oyinlola, Adeniyi, and Raheem (2015) shows that the unique abundance of resources is not sufficient for the economic development in natural resource-rich countries located in Africa. The overall institutional interaction with resources matters for growth. Nevertheless, they do not find a positive individual effect of institutions on growth. It is also striking that in their studies, they considered Morocco, Tunisia, Burundi, Benin, Comoros as resource-rich countries while they do not include Guinea, Mali, Mauritania, Tanzania as resource-rich countries. James (2015) investigates further and suggests an alternative explanation. He justifies merely the slow growth rate in resource-rich economies by the fact that the decline of the resource-sector is

[4] Central African Economic and Monetary Community (CEMAC): Cameroon, Central African Republic, Chad, Equatorial Guinea, Gabon, Republic of the Congo.

disproportionately reflected in resource-dependent countries. He added that it is just a statistical mirage. Thus, his findings show that the resource sector positively influences the non-resource sector, particularly in highly resource-dependent countries.

Damette and Seghir (2018) show that when oil income exceeds 837$ per capita, it negatively affects government effectiveness. Besides, public expenditures appear to be the channel of transmission of the resource curse. Conversely, the results by Karimu, Adu, Marbuah, Mensah, and Amuakwa-Mensah (2017) suggest that greater natural resource rents positively impact growth as it leads to more public capital spending. Besides, the study by Arezki, Gylfason, and Sy (2012) documents that resource windfalls impede the development of the non-resource sector's GDP but not through government spending.

3.3 Data

Our empirical study is based on a sample of 23 Sub-Saharan African resource-rich countries.[5] The study period has been defined to prevent estimation errors with the PSTR model, mainly when the panel is unbalanced (Hansen, 1999). Accordingly, our dataset ranges from 1995 to 2016.

Countries in the sample have been chosen according to two main selection criteria - the availability of data and the endowment of the Sub-Saharan African country in natural resources. Following Ghura, Pattillo, et al. (2012), we consider a country as resource-rich when natural resources represent at least 20 percent of their total exports or 20 percent of their revenue.

The data have been gathered from The World Bank's World development indicators *(WDI)*, the IMF's World Economic Outlook *(WEO)*, the United Nations database *(UN database)*, the United Nations Conference on Trade and Development *(UNCTADstat)*. Institutional data have been collected from the World Bank's World Governance Indicators *(WGI)*, International Country Risk Guide *(ICRG)*. Furthermore, we complete the database using the African Development Bank database and IMF country reports.

[5] see Table 8 for the list of countries in the sample.

Lastly, it is essential to emphasize that we use 5-years averages[6] to avoid stationarity, multicollinearity issues. We also lagged the transition variable from one period. It may also help us capture the impacts of some variables for which the effects appear more in the middle and long run.

Table 3.1: Descriptive statistics

Variable	Obs.	Mean	Std. Dev.	Min	Max
Per capita Growth	92	0.023002	0.042388	-0.1390057	0.226306
Pubspend	92	3.111966	0.377196	1.72681	4.060816
Govivt	91	1.75952	0.743582	-1.628097	3.426529
Govcons	92	2.542661	0.506051	1.13253	3.575716
Inflation	92	1.901552	1.085104	-0.3772611	6.362443
Privateivt	92	2.215385	0.730258	-0.6689907	3.887435
Initialincome	88	23.18905	1.309153	19.43786	26.6069
Rents	92	2.472064	1.051966	-1.525149	4.490501
Rentscapita	88	9.712201	1.500244	5.514118	13.61826
Minrents	92	0.755154	0.972734	0	3.627942
Oilrents	66	1.681715	1.541847	0	4.436854
Primschool	87	4.443994	0.289998	3.394354	4.968164
Adofertility	92	4.825245	0.363696	3.613739	5.39673
Labor	92	15.21271	1.30894	12.14918	17.78297
Termstrade	91	4.770588	0.331465	3.763448	5.575622
Currentaccount	92	-5.367474	11.40986	-68.9796	15.7514
Goveffect	92	-0.7320389	0.599621	-1.764072	0.839066
Civilengage	92	0.26087	0.441515	0	1

Notes: This table provides summary statistics of our data. All variables except for *currentaccount*, *Civilengage*, *Goeffect* are in log. Log transformation for variables *Minrents* and *Oilrents* are conducted using the formula ln(1 + x). *Civilengage* is a dummy variable that takes value one if the country experiences a riot after the election and zero otherwise.

3.4 Methodology

Evidence on the effects of government expenditures on growth is inconclusive and even counter-intuitive, particularly for studies focusing on sub-Saharan resource-rich countries. The lack of agreement in the empirical literature originates mostly from the models used. They do not allow coefficients to change.

[6]Except for the last year time-period which ranges from 2010 to 2016

Moreover, many estimates do not control for essential growth determinants, such as the initial level of income (Havranek, Horvath, and Zeynalov, 2016).

To fill this gap in the literature, we assume in this study that government expenditures and natural resource windfalls could both have positive and negative impacts according to their level. Accordingly, to empirically appraise this non-linear relationship, we use a panel smooth transition model (PSTR) developed by Gonzalez, Teräsvirta, Van Dijk, and Yang (2017).

This model is suitable for our study on the effects of public spending on economic growth. In addition to considering the heterogeneity across countries and the time variability, it allows us to estimate the conditioned effects parameters of government expenditures, natural resource rents on growth. It can also reduce potential endogeneity bias (Fouquau, 2008; Lopez-Villavicencio and Mignon, 2011). Moreover, as Yu and Phillips (2018) suggested, we can identify the threshold effect parameters without the need for instrumentation.

3.4.1 Empirical strategy

3.4.1.1 Empirical specifications

To specify our PSTR, we follow the sequence of tests suggested by González, Teräsvirta, and Dijk (2005); Gonzalez, Teräsvirta, Van Dijk, and Yang (2017). The first stage of our specification is to make sure, as we assume in our study, that the relationship between government expenditures and growth is non-linear, and therefore the PSTR is appropriate. To do so, we carry out a test of linearity against the PSTR model with at least one transition function. Once the results suggest the presence of non-linearities, we will have to define the number of transition functions, estimate our PSTR model, and evaluate its fitness.

Total Government spending is the transition variable in all our estimates. Since public spending is also an explanatory variable or a part of the explanatory variable *(government investment and consumption)*, we lagged the variable to avoid simultaneity issue (Colletaz and Hurlin, 2006; Fouquau, Hurlin, and Rabaud, 2008). Moreover, including total public spending as an explanatory variable will allow us to avoid the omission bias or misspecification. One may argue that the threshold effect comes from this omission.

The general empirical model can be written as follows:

$$y_{it} = \mu_i + \beta_0' x_{it} + \sum_{j=1}^{r} \beta_j' x_{it} g(q_{it}^{(j)}; \gamma_j, c_j) + u_{it} \tag{3.1}$$

Where y_{it}, the GDP growth per capita is our dependent variable. We define y_{it} as the difference between the natural logarithm of GDP per capita in t and $t-1$ for each country i. X_{it} a set of covariates drawn from the endogenous growth theory. μ_i represents individual fixed-effects and u_{it} the errors. Lastly, $g(q_{it}^{(j)}; \gamma_j, c_j)$ is defined as the transition function and written as follows:

$$g(q_{it}; \gamma, c) = \left(1 + exp\left(-\gamma \prod_{j=1}^{m} (q_{it} - c_j\right)\right)^{-1} \tag{3.2}$$

The transition function is a logistic function with m dimensions, continuous, and bounded between 0 and 1. It relies on the transition variable q_{it}, the slope of the transition function noted γ_j, and finally, on the location parameter, denotes c_j. The parameters are define for γ as greater than 0 and for the slope as following : $c_1 < c_2 < .... < c_m$.

When $m = 1$, there is only one transition function with two extreme regimes determined by the level of q_{it}. The coefficients β_0 change smoothly from the low regime to the high one $\beta_0+\beta_1$. The smoothness of the function is determined by γ. Given that parameters β_0 and β_1 are only estimated for extreme regimes, it is difficult to interpret the values. We will then, as suggested in the literature by Colletaz and Hurlin (2006) and Fouquau (2008), focus on their sign.

The model becomes a Hansen (1999) PTR *(Panel Threshold Regression)* when γ approaches infinity. The PSTR turns into a three-regime threshold model when m is higher than one. Furthermore, it changes into a linear panel regression model with fixed-effects when the γ tends toward zero, whatever the value of m.

Given that we want to determine the conditioned effects of government expenditures on growth, we implicitly apply for one threshold function. Besides this economic reason, we perform some background analysis to ensure that the expenditure level is sufficient to capture all non-linearities.

The first set of equations derives from the literature, has a single transition function ($r = 1$).

They are written as follows :

$$y_{it} = \mu_i + \beta_0' x_{it} + \beta_1' x_{it} g(q_{it}; \gamma, c) + u_{it} \tag{3.3}$$

To examine the impact of government consumption and investments on economic growth, we disaggregated total government expenditures in the previous model as follows:

$$y_{it} = \mu_i + \beta_0' x_{it} + \beta_1' x_{it} g(q_{it}; \gamma, c) + u_{it} \tag{3.4}$$

3.4.2 Tests on PSTR models

3.4.2.1 Non-linearity tests

Given that PSTR models are designed for assessing non-linearities, testing the linearity is the first stage before carrying out any estimation using these models. Otherwise, it could lead to unidentified models.

As suggested by González, Teräsvirta, and Dijk (2005); Gonzalez, Teräsvirta, Van Dijk, and Yang (2017), we test the linearity hypothesis (H_0: $\gamma = 0$) in the PSTR model[7]. Because of the unidentified nuisance parameters in the PSTR model, and to circumvent the identification problem, $g(q_{it}; \gamma, c)$ have been replaced by its first-order Taylor expansion around $\gamma = 0$. The equation is 3.1, now written as follows:

$$y_{it} = \mu_i + \beta_1'^{*} x_{it} + \beta_2'^{*} x_{it} q_{it} + ... + \beta_m'^{*} x_{it} q_{it}^{m} + u_{i\,t}^{*} \tag{3.5}$$

The presence of non-linearities can be tested using these two tests (LM and LM_F tests). The last test is the most suitable and used in the literature. The null hypothesis in model 3.1 is equivalent to testing henceforth H_0: $\beta_2^{*} = ... = \beta_m'^{*} = 0$.

$$LM = \frac{TN(SCR_0 - SCR_1)}{SCR_0} \tag{3.6}$$

$LM \longmapsto \chi^2\ (mk)$ k represents the number of explanatory variables.

[7] We could carry out this linearity test also with H_0: $\beta = 0$

$$LM_F = \frac{\frac{(SCR_0 - SCR_1)}{mk}}{\frac{SCR_0}{TN - N - mk}} \tag{3.7}$$

$LM_F \longmapsto \mathcal{F}\left[mk, TN - m - mk\right]$
Where SCR_0 is the sum of squared residuals under H_0, and SCR_1 the sum of squared residuals when estimating equation 3.6.

3.4.2.2 Residual non-linearity tests

After having rejected the linearity hypothesis and determined the transition variable, we will now settle the number of transition functions r. To do so, we perform a non-remaining linearity test. This test aims to make sure that a model with two-regimes captures the whole non-linearities. This model is rejected when $\tau\alpha$ (with τ between 0 and 1). Another model with $r + 1$ is estimated until the acceptance of the non-remaining linearity. τ[8] have to be smaller to avoid numerous extreme regimes.

3.5 Results

In this section, we present our PSTR specifications tests and empirical estimate results. We will first focus on the total impact of public spending on growth, and then we will shed light on the effects of public capital and current expenditures.

It should be recalled that the values of coefficients β_0 and β_1 are difficult to interpret. Therefore, we will be interested only in the signs of the parameters, the slope of the transition function γ_j, and finally, on the location parameter or threshold c_j. These parameters and coefficients will show how government expenditures behave according to whether they are above or below the threshold.

[8] González, Teräsvirta, and Dijk (2005) considers $\tau = 0.5$.

3.5.1 The Effects of government expenditures and natural resource rents on economic growth

The non-linear relationship between total government expenditures and growth is confirmed for all our estimates. Table 3.3 reports the significant results of the LM and LM_F tests. The findings suggest that there is at least one transition function r=1. These tests of no-remaining linearity do not allow us to reject the null hypothesis H_0: r=1. We can conclude that a PSTR model with one transition function and two extreme regimes is sufficient to capture the heterogeneity present in the relationship between government expenditures and growth.

Tables 3.4 and 3.5 contain the results of our seven estimates. They show that we have a PSTR model with two extreme regimes. A parameter γ around 8 implies that the transition from the low regime to the high regime takes place gradually. The threshold noted c_j is between 22.33% and 22.42%. It represents the turnaround point.

The empirical results from each of our seven estimates suggest that total government expenditures positively impact economic growth when government expenditures do not exceed 22.42% of the GDP. Their positive effects on the economy disappear progressively to slow down the economy beyond this threshold. Governments' quality of policy formulation and implementation are challenged in this context.

Our variable $GovEffect$ is negatively and significantly associated with economic growth in the high regime while it was an engine of growth in the low one. Also, a high level of public spending is associated with a weak government ability to implement sound macroeconomics policy. A government decision to increase its spending, particularly during the commodity boom, may indeed result from political pressures or merely mismanagement to build white elephant projects for political gains. Another significant drawback arising out of the high public spending level is that they crowd-out the private sector. While the private sector's contribution was positive and significant at one percent in the low regime, it turns to become adversely associated with economic growth in the high extreme regime.

A high level of public spending has severe adverse effects on governments' ability to appropriately manage their natural resource endowment. Our results suggest that the impact of natural resource rents seems to be conditional to the level of government expenditures. Coefficient signs of *Rents* and *RentsCapita* are both positive and significant when government spending is moderated. These findings suggest, on the contrary to the conventional view that natural resource rents boost growth. Even when we disaggregated the rents into two categories, mining rents, and oil rents, we found a positive and significant impact on growth. Their positive effects disappear progressively to impact the economy negatively when the government expenditures exceed the threshold.

In the first regime, the effects of inflation on growth are mixed. In the literature, the effects of inflation on growth depend on its level and countries' development status. For instance, the recent findings by Mavikela, Mhaka, and Phiri (2018) show that inflation impacts negatively (low level) and positively (high level) growth in Ghana, while in South-Africa the effects are positive at a low level and harmful for a high level of inflation.

The papers by Ndoricimpa, Osoro, and Kidane (2016); Ndoricimpa (2017) suggest that the effects are positive below 6.7%, but they do not find significant impacts of inflation in WAEMU and WAMZ[9]. While the PSTR findings by Lopez-Villavicencio and Mignon (2011) show that this is valid only for developed countries, and in developing countries, inflation exerts a negative impact regardless of its level. In this study, we show that in the high extreme regime, when government spending exceeds the threshold, inflation is detrimental for economic development. The coefficients are almost all negative and significant at 5%.

Human capital is an essential determinant of growth. We use three variables to capture its effects. We find that the total labor impacts the growth positively regardless of the regime. Nevertheless, primary school enrollment is negatively associated with growth. This counter-intuitive result could be explained by the fact that this variable captures the "'quantity"' of education and not the quality (Barro, 2004). To capture the quality of the education system, we introduce adolescent fertility. A sound education system may lead to a decrease in the fertility rate because of schooling.

One additional harsh consequence of the high level of public spending is related to the adverse effects on external sustainability. Mismanagement

[9]The estimated threshold in the West African Economic and Monetary Union is 1.03%, and 8.15% in the West African Monetary Zone

of government revenues could lead to abrupt external adjustments (Ghura, Pattillo, et al., 2012; Araujo, Li, Poplawski-Ribeiro, and Zanna, 2013). Our empirical results suggest that the external sector is negatively associated with economic prosperity in high extreme regimes. External imbalances following the high level of public spending slow down the economy.

Moreover, our results show that an increase in terms of trade does not lead directly to a slow down of economic growth. In the low regime, when government spending is moderated, an increase in terms of trade contributes positively to the development of Sub-Saharan African Countries. An increase in terms of trade stemming from the boom in commodities could be used to improve productivity significantly by purchasing more technological goods, for instance. For each unit of exports, the country can import more goods.

Also, the role of civil society in natural resource-rich countries is determinant. On the one hand, civil society engagement could sustain sub-Saharan countries development by scrutinizing how governments spend revenues stemming from the resource sector, but at the same time, it could be harmful, particularly when civil society can force governments to undertake unsustainable macroeconomic policies or build white elephants (Collier, 2007; Collier and Hoeffler, 2008). In columns C, D, F, and G, we can see that civil society engagement positively affects economic development when the government level of spending does not exceed 22.40%. Nevertheless, in the high regime, it slows down the economy. In a context of higher inflation, a reduction in private investments, and deterioration of the external sector, when civil society is engaged, it leads to social unrest, and therefore, impact the growth negatively.

Lastly, our findings are in line with the neoclassical conditional convergence hypothesis(Solow, 1956; Barro and Sala-i Martin, 1992; Barro, 2004). We found in all our estimates that per capita growth is inversely related to its initial level of income per capita. These results are strongly consistent and significant across the seven specifications.

Table 3.2: Linearity and no remaining non-linearity tests

		A	B	C	D
		Linearity Tests			
$H_0 : r = 0$	Wald (LM):	27.277 (0.001)***	26.76 (0.002)***	29.518 (0.001)***	27.737 (0.002)***
or	Fisher (LMF):	2.743 (0.012)**	2.663 (0.014)**	2.735 (0.010)***	2.477 (0.019)**
$H_1 : r = 1$	LRT (LRT):	33.674 (0.000)***	32.878 (0.000)***	37.226 (0.000)***	34.391 (0.000)***
		Tests of no remaining non-linearity			
$H_0 : r = 1$	Wald (LM):	15.976 (0.067)*	16.631 (0.055)*	26.576 (0.003)***	24.214 (0.007)***
or	Fisher (LMF):	0.785 (0.632)	0.826 (0.598)	1.265 (0.303)	1.101 (0.400)
$H_1 : r = 2$	LRT (LRT):	17.905 (0.036)**	18.736 (0.028)**	32.598 (0.000)***	29.072 (0.001)***

Notes: This table provides the results of our linearity and no-remaining non-linearity tests for the first set of estimates. The first test examines the null hypothesis that the model is linear. If rejected, the following no remaining non-linearity test examines the null hypothesis that a PSTR model with one Threshold Variable ($r = 1$) is optimal. The p-values are reported below each statistic and are in parentheses.

Table 3.3: Linearity and no remaining non-linearity tests 2

		E	F	G
		Linearity Tests		
$H_0 : r = 0$	Wald (LM):	30.988 (0.001)***	32.33 (0.001)***	31.175 (0.001)***
or	Fisher (LMF):	2.633 (0.012)**	2.533 (0.013)**	2.659 (0.011)**
$H_1 : r = 1$	LRT (LRT):	39.648 (0.000)***	41.927 (0.000)***	39.961 (0.000)***
		Tests of no remaining non-linearity		
$H_0 : r = 1$	Wald (LM):	23.557 (0.015)**	30.312 (0.003)***	30.658 (0.001)***
or	Fisher (LMF):	0.841 (0.604)	0.974 (0.506)	1.263 (0.310)
$H_1 : r = 1$	LRT (LRT):	28.119 (0.003)***	38.524 (0.000)***	39.098 (0.000)***

Notes: This table provides the results of our linearity and no-remaining non-linearity tests for the first set of estimates. The first test examines the null hypothesis that the model is linear. If rejected, the following no remaining non-linearity test examines the null hypothesis that a PSTR model with one Threshold Variable ($r = 1$) is optimal. The p-values are reported below each statistic and are in parentheses.

Table 3.4: Main Panel Smooth Transition Regression Results 1

	A		B		C		D	
Threshold c_j	22.3744		22.3684		22.4205		22.3648	
Slope γ	8.2373		8.1573		5.1244		8.3475	
Coefficients	β_0	β_1	β_0	β_1	β_0	β_1	β_0	β_1
Pubspend	0.0305***	-0.0183	0.0303***	-0.0179	0.0379***	-0.0126	0.0405***	-0.0347*
	(0.0078)	(0.0172)	(0.0079)	(0.0178)	(0.0085)	(0.0166)	(0.0092)	(0.0211)
Inflation	-0.0075***	0.0007	-0.007***	0.0001	-0.0008	-0.0041	-0.0041	-0.002
	(0.0024)	(0.0042)	(0.0023)	(0.0041)	(0.0026)	(0.0047)	(0.0029)	(0.0044)
PrivateInv	0.0494***	-0.0431***	0.0482***	-0.0421***	0.0552***	-0.0498**	0.0555***	-0.051***
	(0.0156)	(0.0149)	(0.0161)	(0.0152)	(0.0149)	(0.015)	(0.0158)	(0.0154)
InitialIncome	-0.0685***	-0.032***	-0.0754***	-0.0269***	-0.0671***	-0.0361***	-0.0785***	-0.0223***
	(0.0058)	(0.0053)	(0.007)	(0.0078)	(0.0056)	(0.0054)	(0.0072)	(0.0084)
Rents	0.0097	-0.0056	–	–	0.0128*	-0.0077	–	–
	'(0.0089)	(0.0089)	–	–	(0.0083)	(0.009)	–	–
RentsCapita	–	–	0.0091	-0.0056	–	–	0.0138*	-0.0103
	–	–	(0.0076)	-0.0073	–	–	(0.0073)	(0.0075)
Minrents	–	–	–	–	–	–	–	–
	–	–	–	–	–	–	–	–
OilRents	–	–	–	–	–	–	–	–
	–	–	–	–	–	–	–	–
TBSP	-0.0661***	0.0634***	-0.067***	0.0649***	-0.0816***	0.1005***	-0.0939***	0.0909***
	(0.0244)	(0.0216)	(0.0246)	(0.0219)	(0.025)	(0.0274)	(0.028)	(0.0252)
Adofertility	–	–	–	–	0.0833***	-0.0416***	–	–
	–	–	–	–	(0.0276)	(0.0143)	–	–
Labor	0.0796***	0.0414***	0.0869***	0.0359***	0.1129***	0.0475***	0.0927***	0.0301***
	(0.0187)	(0.0067)	(0.02)	(0.0103)	(0.0177)	(0.0072)	(0.02)	(0.0107)
TermsTrade	0.0142	-0.0084	0.0133	-0.0085	–	–	0.0113	-0.0101
	(0.0169)	(0.0169)	(0.0169)	(0.0169)	–	–	(0.0179)	(0.0178)
GovEffect	0.0242**	-0.0289**	0.0234**	-0.0286**	0.0245*	-0.0405***	0.0294***	-0.0341****
	(0.0105)	(0.0127)	(0.0098)	(0.012)	(0.0131)	(0.0143)	(0.0111)	(0.0135)
Civilengage	–	–	–	–	0.0193***	-0.0216**	0.0149**	-0.01
	–	–	–	–	(0.0057)	(0.0086)	(0.0065)	(0.0074)
AIC Criterion	-8.511		-8.512		-8.66		-8.537	
BIC Criterion	-7.963		-7.964		-8.057		-7.934	

Notes: This table shows the results of our *PSTR* estimates of the impact of public spending on growth in sub-Saharan African natural resource-rich countries. The dependent variable in all our regressions is the per capita growth. The estimated slope parameter of the transition function and the estimated location parameters are respectively γ and c_j. *, **, *** denote significance at respectively, 10%, 5% and 1%. Standard Errors of estimated slope parameters corrected for heteroskedasticity are in parentheses. Source: author's calculations.

3.5.2 The Effects of Government consumption and investments on economic growth

In this subsection, we disaggregated government spending into two categories to investigate the influence of current and public capital expenditures on growth.

Table 3.3 examines the null hypothesis that the relationship between government expenditures and economic growth is linear. The linearity test reported in the first part of Table 3.3 allows us to reject the null hypothesis, while the test of no-remaining linearity in the second part of Table 3.3 does not negate the sufficiency of a model with one transition function (r=1) with two extreme regimes. Thus, as for the last set of equations, one transition function with two extreme regimes is sufficient.

The empirical results of our estimates are reported in Table 3.6. The turnaround point remains around 22.3% of the GDP, and the slope of the transition function γ_j is still close to $zero$ than $infinity$. It suggests that when the threshold is exceeded, the reversal of government expenditures' beneficial effect on growth occurs smoothly.

The conventional view regarding current government expenditures in the literature is that they are very harmful to economic growth and explain much of the resource curse (Atkinson and Hamilton, 2003).

In contrast to the conventional view, our results show that current expenditures are an engine of growth when government expenditures are moderated. This result is strongly consistent and significant at one percent across all specifications. Also, our findings are in line with common findings when public spending surpasses the threshold. They adversely affect economic growth. Nevertheless, the effects on the high regime are weak as they are significant at 15%.

Another striking confirmation is the role of public investments in economic growth. Our results indicate that public capital expenditures have positive and significant effects on growth in the low regime. This beneficial effect on growth declines smoothly to become detrimental for the growth when government expenditures exceed the threshold. Even investments that are generally viewed as a driver of growth become counterproductive and harmful for economic growth (Devarajan, Swaroop, and Zou, 1996).

Table 3.5: Main Panel Smooth Transition Regression Results 2

	E		F		G	
Threshold c_j	22.3408		22.3971		22.4033	
Slope γ	5.5435		5.0676		6.3363	
Coefficients	β_0	β_1	β_0	β_1	β_0	β_1
Pubspend	0.0202***	0.0039	0.0321***	0.0052	0.032***	-0.0031
	(0.0074)	(0.0143)	(0.0056)	(0.0154)	(0.006)	(0.0161)
Inflation	0.0006	-0.0058*	0.0059**	-0.0104***	0.0013	-0.0071***
	(0.0025)	(0.0036)	(0.0025)	(0.0034)	(0.003)	(0.0035)
PrivateInv	0.0142	-0.0127	0.0297***	-0.0315***	0.0221**	-0.0253**
	(0.012)	(0.0127)	(0.0092)	(0.0103)	(0.0099)	(0.0106)
InitialIncome	-0.0598***	-0.0386***	-0.0686***	-0.0385***	-0.0691***	-0.0379***
	(0.0048)	(0.0044)	(0.0041)	(0.0049)	(0.0046)	(0.0049)
Minrents	0.0141**	-0.0095	0.0056	0.0028	0.0068	0.0005
	(0.0062)	(0.0087)	(0.0053)	(0.0084)	(0.0062)	(0.0073)
OilRents	0.0296***	-0.0162***	0.0282***	-0.0142***	0.0304***	-0.0107**
	(0.0064)	(0.0058)	(0.0054)	(0.0048)	(0.0057)	(0.0045)
TBSP	-0.0623***	0.0734***	-0.0845***	0.0868***	-0.0804***	0.047***
	(0.0199)	(0.0204)	(0.0174)	(0.0156)	(0.0215)	(0.0149)
Adofertility	0.0585**	-0.0332**	0.093***	-0.0394***	–	–
	(0.0236)	(0.0148)	(0.0203)	(0.0131)	–	–
Labor	0.0944***	0.0564***	0.1419***	0.0567***	0.1152***	0.0513***
	(0.0243)	(0.0057)	(0.0211)	(0.005)	(0.0171)	(0.0055)
TermsTrade	0.0275**	-0.0339**	0.022**	-0.0324***	0.013	-0.016
	(0.0134)	(0.0149)	(0.0101)	(0.0115)	(0.0131)	(0.0134)
GovEffect	0.0698***	-0.0741***	0.0755***	-0.0783***	0.0748***	-0.0539***
	(0.0124)	(0.0147)	(0.0099)	(0.011)	(0.0119)	(0.0112)
Civilengagement	–	–	0.021***	-0.0342***	0.0159***	-0.0271***
	–	–	(0.0048)	(0.0077)	(0.0051)	(0.0075)
AIC Criterion	-8.798		-9.049		-8.886	
BIC Criterion	-8.14		-8.336		-8.228	

Notes: This table shows the results of our *PSTR* estimates of the impact of public spending on growth in sub-Saharan African natural resource-rich countries. The dependent variable in all our regressions is the per capita growth. The estimated slope parameter of the transition function and the estimated location parameters are respectively γ and c_j. *, **, *** denote significance at respectively, 10%, 5% and 1%. Standard Errors of estimated slope parameters corrected for heteroskedasticity are in parentheses. Source: author's calculations.

The other covariates' effects on growth remain the same as those findings reported in subsection 3.5.1.

Table 3.6: Disaggregated Panel Smooth Transition Regression Results

	P		Q		R		S		T	
Threshold c_j	22.3477		22.3398		22.3303		21.5765		22.3839	
Slope γ	9.5658		8.42		7.7894		1.317		6.1666	
Coefficients	β_0	β_1	β_0	β_1	β_0	β_1	β_0	β_1	β_0	β_1
GovIvt	0.0091	-0.0113	0.0104	-0.0114	0.0088	-0.0102	0.0241***	-0.0268***	0.008	-0.0141**
	(0.0072)	(0.0084)	(0.0072)	(0.0084)	(0.0073)	(0.0085)	(0.0083)	(0.0083)	(0.0061)	(0.0067)
GovCons	0.0344***	-0.0188	0.032***	-0.0163	0.0328***	-0.015	0.0402***	-0.004	0.03***	0.0028
	(0.0064)	(0.0163)	(0.0071)	(0.0165)	(0.0074)	(0.0165)	(0.0085)	(0.0163)	(0.0049)	(0.0139)
Inflation	-0.0028	-0.0034	-0.0019	-0.0039	-0.0016	-0.0037	0.0045	-0.0128**	0.0061**	-0.0095**
	(0.0033)	(0.0051)	(0.0033)	(0.0052)	(0.0033)	(0.0052)	(0.0038)	(0.0062)	(0.003)	(0.0043)
PrivateIvt	0.0365***	-0.0301***	0.0372***	-0.0298***	0.0347***	-0.0285***	0.0507***	-0.0334***	0.0146	-0.0145
	(0.0118)	(0.0112)	(0.012)	(0.0113)	(0.0119)	(0.0112)	(0.0108)	(0.0125)	(0.0101)	(0.0108)
InitialIncome	-0.0581***	-0.0341***	-0.0567***	-0.035***	-0.0692***	-0.0246***	-0.0626***	-0.04***	-0.0675***	-0.034***
	(0.0053)	(0.0047)	(0.0053)	(0.0046)	(0.0072)	(0.0079)	(0.0072)	(0.0052)	(0.0049)	(0.0041)
Rents	0.0192***	-0.0144*	0.0173**	-0.0124	–	–	0.0169**	-0.0122	–	–
	(0.0072)	(0.0081)	(0.0072)	(0.0086)	–	–	(0.007)	(0.0086)	–	–
RentsCapita	–	–	–	–	0.0167***	-0.0116	–	–	–	–
	–	–	–	–	(0.0061)	(0.0073)	–	–	–	–
MinRents	–	–	–	–	–	–	–	–	0.0019	0.0021
	–	–	–	–	–	–	–	–	(0.0057)	(0.0085)
OilRents	–	–	–	–	–	–	–	–	0.0267***	-0.0092**
	–	–	–	–	–	–	–	–	(0.0053)	(0.0043)
TBSP	-0.0613***	0.0659***	-0.06***	0.073***	-0.0609***	0.0746***	-0.0939***	0.1258***	-0.0562***	0.0384*
	(0.0194)	(0.0203)	(0.0201)	(0.0223)	(0.0201)	(0.0228)	(0.0161)	(0.0306)	(0.0177)	(0.0197)
AdoFertility			0.0186	-0.0107	0.0151	-0.0096	0.0301	-0.0135	0.0215	-0.0041
			(0.0248)	(0.0116)	(0.0255)	(0.0118)	(0.0323)	(0.02)	(0.0184)	(0.0129)
Labor	0.0556***	0.0457***	0.0575**	0.0483***	0.0692***	0.036***	0.083***	0.0394***	0.1347***	0.0443***
	(0.0189)	(0.008)	(0.0245)	(0.0079)	(0.0247)	(0.0107)	(0.0208)	(0.0089)	(0.0209)	(0.0055)
TermsTrade	0.0242*	-0.0121	0.0251*	-0.0146	0.0235*	-0.0131			–	–
	(0.0146)	(0.017)	(0.0144)	(0.0169)	(0.0138)	(0.0162)			–	–
CurrentAccount	–	–	–	–	–	–	0.0005	0.0011*	0.0003	0.0002
	–	–	–	–	–	–	(0.0004)	(0.0006)	(0.0002)	(0.0005)
GovEffect	0.0162	-0.0263*	0.0155	-0.0299**	0.0143	-0.0288**	0.0105	-0.0306**	0.0568***	-0.0375***
	(0.0117)	(0.0137)	(0.0117)	(0.0145)	(0.0106)	(0.0137)	(0.0098)	(0.0137)	(0.0113)	(0.0106)
CivilEngage	–	–	–	–	–	–			0.0142***	-0.0304***
	–	–	–	–	–	–			(0.0042)	(0.0074)
AIC Criterion	-8.722		-8.657		-8.67		-8.653		-9.002	
BIC Criterion	-8.119		-7.999		-8.012		-7.995		-8.234	

Notes: This table shows the results of our desegregated $PSTR$ estimates of the impact of public spending on growth in sub-Saharan African natural resource-rich countries. The dependent variable in all our regressions is the per capita growth. The estimated slope parameter of the transition function and the estimated location parameters are respectively γ and c_j. *, **, *** denote significance at respectively 10%, 5% and 1%. Standard Errors of estimated slope parameters corrected for heteroskedasticity are in parentheses. Source: author's calculations.

Table 3.7: PSTR tests

		Linearity Tests				
$H_0 : r = 0$	*Wald (LM)*:	35.25 (0.000)	35.644 (0.000)	35.02 (0.000)	38.875 (0.000)	42.982 (0.000)
or	*Fisher (LMF)*:	3.715 (0.001)	3.369 (0.002)	3.261 (0.003)	3.986 (0.001)	3.985 (0.000)
$H_1 : r = 1$	*LRT (LRT)*:	47.133 (0.000)	47.862 (0.000)	46.709 (0.000)	54.126 (0.000)	62.904 (0.000)
		Tests of no remaining non-linearity				
$H0 : r = 1$	*Wald (LM)*:	17.946 (0.056)	26.311 (0.006)	27.189 (0.004)	13.192 (0.281)	36.879 (0.000)
or	*Fisher (LMF)*:	0.729 (0.690)	0.991 (0.485)	1.042 (0.447)	0.395 (0.943)	1.061 (0.452)
$H_1 : r = 2$	*LRT (LRT)*:	20.432 (0.025)	32.194 (0.001)	33.539 (0.000)	14.47 (0.208)	50.198 (0.000)

Notes: This table provides the results of our linearity and no-remaining non-linearity tests for the first set of estimates. The first test examines the null hypothesis that the model is linear. If rejected, the following test examines the null hypothesis that a PSTR model with one Threshold Variable ($r = 1$) is optimal. The p-values are reported below each statistic and are in parentheses.

3.6 Conclusion

This chapter re-examines the relationship between government expenditures and growth in 23 Sub-Saharan natural resource-rich countries from 1995 to 2016. It questions the role of fiscal policy in the natural resource curse hypothesis. To achieve this goal, we carried out an empirical analysis using a PSTR developed by González, Teräsvirta, and Dijk (2005); Gonzalez, Teräsvirta, Van Dijk, and Yang (2017). We find significant effects of public spending on economic growth. Government expenditures boost the economy. Nevertheless, this beneficial effect is conditional to the expenditure level. In other words, public spending has a positive impact on growth below 22.4% and adverse effects beyond.

For completeness, we disaggregated government expenditures and estimated the impact of current and public capital expenditures. Our results indicate that government consumption, as well as public investments, have positive impacts on growth when they are moderated, and adverse effects when they exceed this threshold. On the contrary to the findings by Atkinson and Hamilton (2003), we show that government consumption expenditures exert a positive influence on economic growth, and public investments could be as harmful as current expenditures for the economy.

Another significant contribution is related to the literature on the resource curse. Our empirical research results suggest that natural resource rents are positively associated with economic development when government spending is moderated. They become detrimental only beyond the threshold. What matters most is the macro-fiscal management of the windfalls and not the level of rents.

Moreover, our results suggest that moderate public spending promotes growth in these countries. In the low regime, the contribution of the private sector and the external sector to economic growth are positive. In contrast, higher government expenditures are detrimental to these sectors. They crowd-out the private sector, create external imbalances, and finally lead to an economic downturn.

Accordingly, our results reassert and demarcate the role of government in sub-Saharan resource-rich countries. The implications of our findings for policy are twofold. Overall, these findings provide evidence that the resource curse is a consequence of poor public expenditures policies.

First, the threshold and its adverse effects when it is exceeded highlight, even more, the importance of savings in natural resource-rich countries. Any additional public spending beyond this threshold leads to macroeconomic distortion, is counterproductive, and is negatively associated with growth. It would be better to save for later periods and conjure the resource curse.

Second, the study shows that current expenditures have a positive impact on growth, as well as public capital expenditures. They play a critical role in the economy. We often forget that enforcing contracts, protecting property, operations, and maintenance of infrastructures are both considered as current expenditures and, therefore, may have higher returns than capital expenditures (Devarajan, Swaroop, and Zou, 1996). It is the excess that leads to the resource curse.

Chapter 4

Windfalls and Labor Dynamics in Sub-Saharan Africa

Contents

Abstract

This fourth chapter investigates the causal effects of natural resource exports on labor dynamics and structural transformation in Sub-Saharan African countries. It uses for the first time the historical level of natural resource extraction during the colonization period to overcome the endogeneity issue of natural resource exports. The results show that resource windfalls increase the employment share of the public sector in total employment. Relatedly, the resource exports are associated with an increase in public wage bills as a share of the growing economy and as a share of total government expenditures. Moreover, the paper provides empirical evidence that natural resources have a positive and significant impact on the share of employment in the manufacturing sector. Nevertheless, it benefits less compared with the service sector. Finally, the results show that increasing resource exports lead to a shift in employment share from agriculture to non-agricultural sectors.

JEL codes: J21, J45, O14, O55, Q32, Q38

Keywords: Dutch disease, Labor Force and Employment structure, Manufacturing and services Industries, Public sector labor markets, Structural transformation

4.1 Introduction

Sub-Saharan Africa has experienced a boom in natural-resource extraction and exports these last three decades, especially between 2003 and 2014. The natural resource sector became, over the years, the primary driving source of economic growth Institute (2010); Bank (2013). The development of the sector has been supported by governments and international organizations. The expectations about substantial local employment and its spillovers into other sectors of the economy explain the successive fiscal regime reforms implemented in several Sub-Saharan African countries Campbell, Akabzaa, and Butler (2004).

However, this rapid growth has not led to a substantial increase in the creation of private-sector wage employment (Filmer and Fox, 2014; Fox, Thomas, and Haines, 2017). On the contrary, the number of those employed in public sector wage jobs has increased, and the share of public wage jobs is still more significant than the private sector (Fox and Thomas, 2016). In the traded sector, the employment share in manufacturing has been shrinking. Findings by McMillan, Rodrik, and Verduzco-Gallo (2014) and Rodrik (2016) suggest that African countries have been experiencing, since the 1980s, a ”‘premature de-industrialization.”’

The study is related to the ongoing debate on de-industrialization, and more specifically, to the Dutch disease hypothesis, one of the channels of transmission of the resource curse. Bruno and Sachs (1982) calibrate a theoretical dynamic model and show that natural resource discovery reduces the long-run production of the manufacturing sector. In the same period, the hypothesis has also been analyzed theoretically by Corden and Neary (1982); Corden (1984). Their model suggests that a boom in the energy sector reduces the output of the manufacturing sector unambiguously and leads to de-industrialization.

Empirically, several authors have investigated the relationship between natural resource exports and the traded sector, although the debate is far from being conclusive. The paper by Harding and Venables (2016) addressing the endogeneity of natural resource exports documents the negative relationship between natural resource windfalls and non-resource exports, particularly manufacturing exports.[1] Their results suggest that a $1 increase in resource exports will lead to a reduction of non-resource exports by 74 cents. They argue that the resource export boom leads to an increase in inflation, real exchange rates, macroeconomic volatility, and therefore, to a decrease in the competitiveness of the non-resource sector. Ismail (2010), focusing on oil-exporting countries, documents a contraction of manufacturing output following oil booms. The contraction is even more significant in countries with more open markets to foreign investment.

The common characteristic of most of these studies exploring the crowding out effects of windfalls on the traded sector is their utilization of the value-added of the traded sector or exports as a proxy for the manufacturing sector. The reallocation of labor across sectors in the economy, which may result from the resource boom, is not at the heart of the studies in the literature. Moreover, despite the importance of the extractive sector and the issue of structural transformation for developing countries, it is surprising that little research has been conducted on the relationship between natural resource windfalls and sectoral employment in developing countries and even less focusing on Sub-Saharan African countries.[2] Most of the studies focus on the impact of oil prices on employment levels in developed countries.

In their paper, McMillan, Rodrik, and Verduzco-Gallo (2014) emphasized the importance of labor reallocation from low-productivity activities (agriculture) to high-productivity activities (manufacturing) as a critical determinant of development. The results of their empirical work suggest that natural resources endowment impedes the process of structural transformation. They argue that the natural resources sector does not generate much employment and, at the same time, could hamper the manufacturing sector. Hence, they conclude that African countries are at a disadvantage compared to Asian countries, given that these latter countries are well endowed with labor but not natural resources.

Indeed, labor dynamics may arise from two sources. Corden and Neary (1982); Corden (1984), in their "'Dutch disease"' theory, named them the

[1]Following Bazzi and Blattman (2014), they use country-specific price indexes to instrument.

[2]More than half of the Sub-Saharan African countries are resource-rich. Moreover, by 2030 more than half of the poor will be in these countries

resource movement effects and the spending effects. First, the decline of the manufacturing sector because of macroeconomic issues or merely higher demand for employment in the natural resources sector (resource movement effects) may push workers out of the traded sector into unemployment or the non-traded sector. Second, employment could also be shifted to the non-traded sector because of the boom in natural resource exports. The increase of national income is positively associated with the demand for services (spending effects). Government and other non-traded sectors may want to increase public wages or employ more people in response to higher demand for public services or non-traded goods and services (Stefanski, 2015). Given the low level of employment in the natural resource sector, we could expect this latter effect to be more significant in Sub-Saharan African countries. In addition to the response to a demand for public services, the increase of the share of public sector employment in resource-rich countries may also be explained by the attempt of the policymakers to share the windfalls through public jobs.

Bjornland (1998), investigating the effects of North Sea oil, shows that manufacturing sector unemployment increases in response to an increase in production and prices in the United Kingdom but decreases in Norway. Exploring the impact of a decline in oil prices on private jobs flows in the United States, Herrera, Karaki, and Rangaraju (2017) results suggest that a drop in oil prices leads to reallocation of jobs from the mining sector towards the manufacturing, construction, and services sectors. Besides, their findings show that a sudden decrease in oil prices impacts private employment positively but slows down the pace of job reallocation across sectors. More recently, the findings by Michieka and Gearhart (2019) suggest that oil prices do not have a significant impact on employment in the manufacturing and service sectors at the state level in top oil-producing counties in the United States.

The paper by Stefanski (2015) makes a significant contribution toward bridging the gap in the empirical literature. His theoretical and empirical findings suggest that the variation in endowments of natural resources has a significant impact on the sectoral employment structure. Resource sector development leads to a reallocation of labor from the manufacturing sector to the non-trade sectors of services and government such as law enforcement, defense, and infrastructure. Nevertheless, because of data limitations, the study focuses mostly on developed countries (only three Sub-Saharan African countries are included) and does not address the endogeneity issue. He defined, following Sachs and Warner (1997) and Kuralbayeva and Stefanski (2013), natural resource wealth as the ratio of natural resource exports to GDP and assumed that the variable is exogenous.

These results are in line with the more recent findings by Fox, Thomas, and Haines (2017). By comparing statistically Sub-Saharan African countries to Asian countries, they reach the same conclusion. The mining sector explains the slow rate of employment transformation in Sub-Saharan African natural resource-rich countries. Natural resources also impact the labor supply. The willingness to work in highly paid employment in the natural resources sector or the public sector affects their education and their employability in the non-resource private sector (Filmer and Fox, 2014).

Studies using the within-country variation to address the endogeneity bias of natural resources endowment provide evidence challenging the conventional thinking on the "'Dutch disease"' hypothesis.[3] For instance, Black, McKinnish, and Sanders (2005), taking advantage of a substantial exogenous shock in the labor market in four local economies in the United States, show that a boom in the natural resource sector has modest employment spillovers into the local economic sectors. Moreover, their results suggest that natural resource export booms do not have a negative impact on the traded goods sector.

Michaels (2011) exploiting geological differences in oil abundance in the Southern United States shows that oil abundance increases local employment per square kilometer in the mining and manufacturing sectors over the long run. He argues that oil-rich counties have better infrastructure and higher real incomes. Hence, they attract more workers and increase their long-term productivity. These findings are corroborated by the study by Allcott and Keniston (2017). Their results show that there is no evidence for a Dutch disease mechanism in the United States. On the contrary, their results suggest that natural resource booms increase employment in the manufacturing sector. While Caselli and Michaels (2013), using the same approach in Brazil, found that the boom in the oil sector has a negative impact on manufacturing and a positive one on the service sector only if the production occurs onshore.

[3]See Cust and Poelhekke (2015) for an extensive survey of the literature.

The effects are weak if it is offshore production. Their results also suggest a modest expansion in public employment.

The objective of this paper is to identify the causal relationship between natural resource windfalls and sectoral employment dynamics in Sub-Saharan Africa. In particular, we question the impact of natural resource boom and bust on labor reallocation. Do natural resource exports increase or decrease the share of manufacturing, public employment, and public wage bills or more widely the share of non-resource private sector employment in the total employment?

We contribute to the literature by providing empirical evidence on the causal effects of natural resource exports on labor dynamics and structural transformation in Sub-Saharan African countries. Our findings suggest that natural resource endowments have significant positive effects on public sector employment and public wages. These positive effects become weak once we focus on the narrowest sense of the public sector.[4] Furthermore, our results show that once we address the endogeneity issue, natural resource exports have a positive impact on manufacturing employment and non-agricultural employment. Finally, we complement the literature on the Dutch disease hypothesis by using new data on colonial-era production and providing striking evidence on the no crowding-out effects of natural resource windfalls on manufacturing employment in Sub-Saharan Africa. Although the service sector benefits more from the boom and the share of employment in agriculture decreases.

The remainder of the paper proceeds as follows. In the following Section 4.2, we describe the data and provide a summary of facts in labor dynamics in Sub-Saharan Africa. In section 4.3, we discuss our identification strategy and describe our empirical specifications. We present and discuss the estimation results in section 4.4. Section 4.5 contains our conclusion.

[4] Public sector employment including only public administration, defense, and compulsory social security as defined by ILO (section O)

4.2 Data and descriptive statistics

In this section, we discuss the data used in the study. We provide information about our sample and pave the way for our empirical analysis using descriptive statistics.

4.2.1 Data

Our dependent variables data on employment by sector are from the International Labour Organization (ILO). As for our explanatory variables, we use the UNCTAD data for resource exports, the IMF's primary commodity prices dataset, and the USGS data for commodity prices, the natural resources production database from the UK's Overseas Geological Survey (OGS), the World Bank's World Development Indicators (WDI), the IMF's World Economic Outlook (WEO) and the IMF's dataset on public finance. The dataset ranges from 1991 to 2018 and covers 46 Sub-Saharan African countries. Table 4.1 shows the descriptive statistics. The list of countries included in the study is reported in table 10.

Following Ghura, Pattillo, et al. (2012), we consider a country as resource-rich when natural resource exports represent at least 20 percent of its total exports or 20 percent of its revenue.

4.2.2 Sectoral employment dynamics in Sub-Saharan countries:

Figure 4.1 presents the evolution of employment in the natural resources sector in Sub-Saharan African countries. It shows that the natural resources sector employs few people compared to other sectors of the economy, especially in oil-producing countries. Furthermore, we can see in figure 4.1 that the oil-sector is less labor-intensive than the mining sector. The employment share in the extractive sector is, on average, 2.3 % and 1.2 % of the total employment, respectively, for the mining sector and the oil sector. This graph provides striking confirmation of the limited number of employees in the natural resources sector.

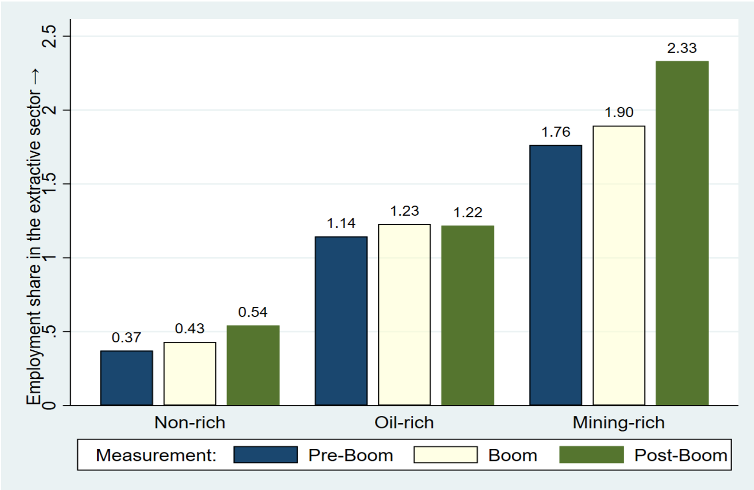
Even during the boom, the share of employment in the resource sector does

Table 4.1: Summary Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
% employed in manufacturing	1,288	7.29	4.98	0.38	31.33
% employed in agriculture	1,288	53.99	21.08	4.60	92.56
% employed in service	1,288	33.82	15.18	5.28	71.93
% employed in construction	1,288	3.43	2.87	0.05	14.41
% employed in mining	1,288	1.04	1.31	0.00	11.50
% employed in government sector	1,288	3.01	3.02	0.14	17.41
% employed in public sector	1,288	12.63	7.59	2.61	37.47
Public wage bills (%non-res)	740	1.78	0.71	-1.25	3.41
Public wage bills (%GDP)	814	1.78	0.55	-0.59	3.08
Resource export	976	1.33	1.96	-6.16	4.66
Rescolprice	980	10.94	8.20	0.00	23.98
Oil price	1,288	3.61	0.68	2.34	4.66
Commodity index	1196	4.47	0.48	3.76	5.28
Latitude	1,204	0.14	0.08	0.00	0.33
French Colony	1,288	0.37	0.48	0.00	1.00
Ethnic fractionalization	1,148	0.70	0.19	0.18	0.95
Education attainment (65+ years)	1,128	2.70	2.19	0.11	12.38
Population	1,043	1.87	1.51	-2.14	5.19

Notes: This table provides summary statistics of our data. The public sector includes activities of a governmental nature. It includes public administration, justice, education, defense, compulsory social security, human health, and social work activities. While the government sector includes only public administration, defense, and compulsory social security. Public wage, Resource export, oil prices, commodity prices index, and population variables are in log.

Figure 4.1: Evolution of employment in the extractive sector



Notes: This figure provides an overview of the evolution of the share of employment in the extractive sector in Sub-Saharan countries from 1991 to 2018. The sample period is divided into three main periods. The Pre-Boom ranges from 1991 to 2003, the Boom period ranges from 2004 to 2014, and the Post-Boom period ranges from 2015-2018. See Figure 9 in the appendix for a clear view of price dynamics. Author's elaboration on data from ILO.

not exceed 2.5% of the total employment in the economy.[5] In oil-producing countries, the employment share in the resource sector remains almost the same during the whole period. Although, in mining-rich countries, the dynamic was different. The employment share grew by more than 32% ranging from 1.76% to 2.33%.

The public employment share and manufacturing share had a different evolution. On average, for resource-rich countries, the share of public employment increases while, on the other hand, the manufacturing employment remains steady over the years.

Employment in the public sector: Figure 5 summarizes the evolution of the share of employment in the public sector, and figure 4.5 shows the evolution of the share of employment in the manufacturing sector. These graphs suggest that Sub-Saharan African resource-rich countries employ relatively more workers in the public sector and fewer workers in the manufacturing sector. This difference remains over the years.

[5]The Boom period ranges from 2004 to 2014. See Figure9 in the appendix for the Pre-Boom, Boom, and Post-Boom definitions.

When compared to the non-resource rich countries, the share of employment in the public sector in resource-rich countries seems to follow the same path. Although, when focusing on the share of employment in the public sector (in the narrowest sense),[6] we notice that overall, natural resource-rich countries employ more workers in the public sector compared to the non-resource rich countries.

Summarizing the sample across the intensity of resources as defined by Ghura, Pattillo, et al. (2012) masks substantial differences in the evolution of employment across the sector in each country. Indeed, when disaggregated according to the type of resources or across countries, the differences are more revealing.

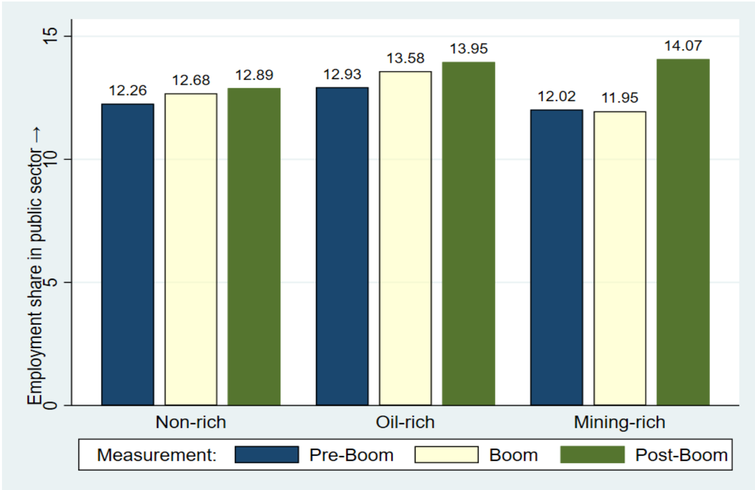
The share of public employment in mining countries has experienced the most noticeable evolution. These countries have registered a substantial increase in the share of the economy's labor employed in the public sector (see Figure 4.2). Non-resource rich countries public sector employment experienced an increase over the years, but it was less significant than in oil-rich countries. The share of public sector employment increased respectively by more than 17% in mining-rich countries, almost 8% in oil-rich countries, and 5% in non-resource-rich countries.

The evolution of public wages bills corroborated evidence of the employment dynamics in the public sector. We can see in figure 4.3 that the share of the public wage bills both in terms of the share in the total government expenditures and non-resource GDP has increased significantly. Furthermore, we can observe an increase in the share of public wage bills in the total government expenditures in resource-rich countries, particularly in mining-rich countries. The share of public wage bills remains constant and even slightly decreases in non-rich countries (see figure 8).

Manufacturing employment: Figure 4.5 provides an examination of trends in the share of employment in the traded sector in resource-rich countries. We notice that the employment share in the manufacturing sector has steadily fallen for all Sub-Saharan African countries. Although the share of employment in the manufacturing sector is still lower compared to non-

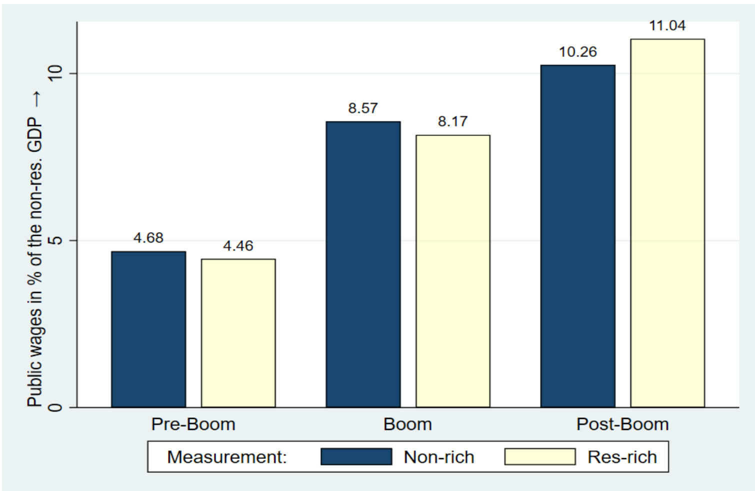
[6] Public sector employment including only public administration, defense, and compulsory social security as defined by ILO (section O)

Figure 4.2: Evolution of employment in the Government



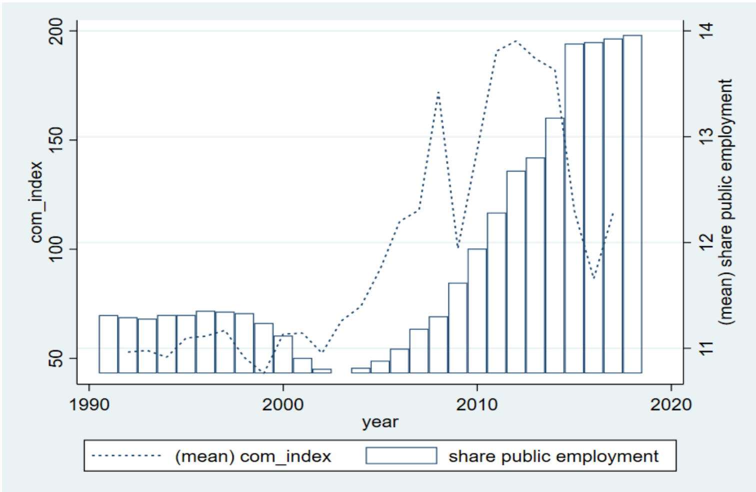
*Notes:*This figure provides an overview of the evolution of employment in the public sector in the top ten resource-rich Sub-Saharan countries compared to the bottom ten exporters. The Pre-Boom ranges from 1991 to 2003, the Boom period ranges from 2004 to 2014, and the Post-Boom period ranges from 2015-2018. See Figure9 in the appendix for a clear view of price dynamics. Author's elaboration on data from ILO.

Figure 4.3: Evolution of the public wage bills in % of non-resource GDP



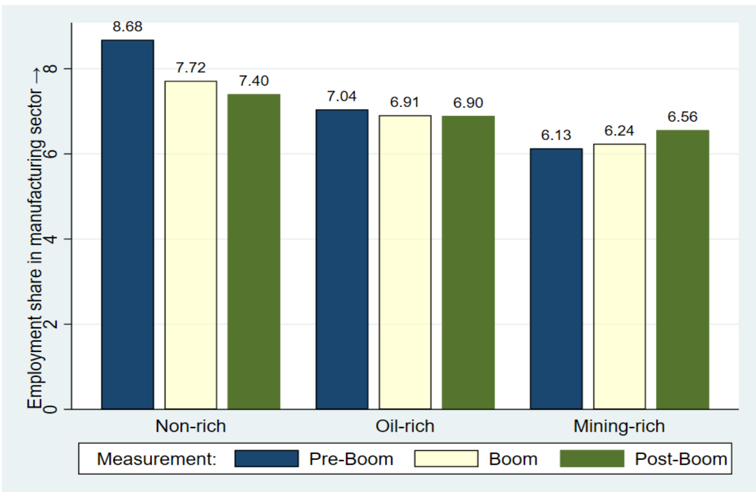
Notes: This figure shows the evolution of the public wage bills in percent of the share of the non-resource GDP in Sub-Saharan. The non-resource GDP is defined as the part of the economy outside of the resource sector. The sample period is divided into three main periods. The Pre-Boom ranges from 1991 to 2003, the Boom period ranges from 2004 to 2014, and the Post-Boom period ranges from 2015-2018. See Figure 9 in the appendix for a clear view of price dynamics. Author's elaboration on data from IMF, UN dataset.

Figure 4.4: Evolution of the share of employment in the government sector



Notes: This figure shows the evolution of the share of employment in the public sector, along with the commodities prices in Sub-Saharan mining-rich countries. The variable "'Com. Index"' is the global price index of all commodities. The sample period is divided into three main periods. The Pre-Boom ranges from 1991 to 2003, the Boom period ranges from 2004 to 2014, and the Post-Boom period ranges from 2015-2018. See Figure9 in the appendix for a clear view of price dynamics. Author's elaboration on data from ILO, IMF.

Figure 4.5: Evolution of the share of employment in the manufacturing sector



Notes: This figure provides an overview of the evolution of the share of employment in the manufacturing sector in Sub-Saharan countries. The sample period is divided into three main periods. The Pre-Boom ranges from 1991 to 2003, the Boom period ranges from 2004 to 2014, and the Post-Boom period ranges from 2015-2018. See Figure 9 in the appendix for a clear view of price dynamics. Author's elaboration on data from ILO resource rich countries, Sub-Saharan African resource-rich countries have resisted more than the non-resource rich ones. The difference narrowed down over the years, ranging from more than 2.1% before the boom to 0.70% after the boom.

Indeed, in the 1990s, the share of employment in this traded-sector was less significant in resource-rich countries compared to the non-resource-rich countries. However, the employment share remains constant in resource-rich countries (around 6.5%) while it has been shrinking in other non-resource rich countries. It ranged from 8.68% of total employment in the 1990s to 7.4% after the boom.

Furthermore, when disaggregated according to the type of resource extracted, we can see in figure 6 and 4.7 that the share of employment in the manufacturing sector in oil-rich countries was higher than in mining-rich countries in the 1990s. Over the years, the difference narrowed down to become almost the same, mainly because of the increase of manufacturing employment in mining-rich countries.

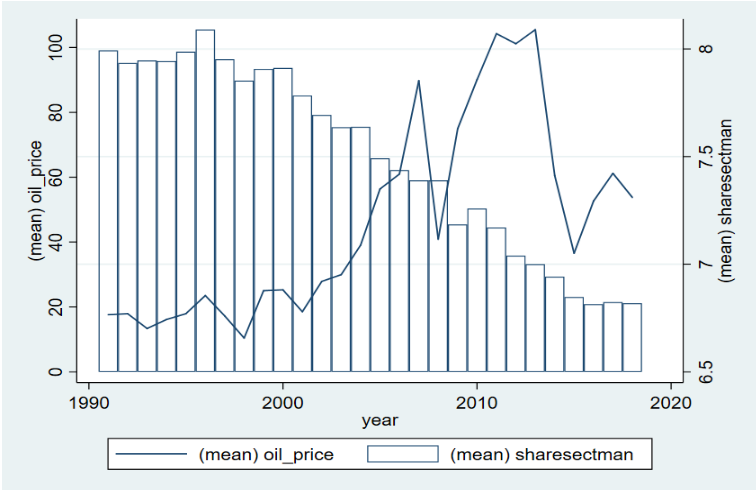
This summary of facts does not allow us to establish a causal relationship between the evolution of sectoral employment and natural resource exports. Nevertheless, these graphs question the findings in the literature regarding the role of natural resources in slowing down or even reversing the process of structural transformation (McMillan, Rodrik, and Verduzco-Gallo, 2014; Stefanski, 2015). They also suggest a positive relationship between natural resource exports and public sector employment.

In the following section, we take into account the impact of other covariates and investigate the relationship between natural resource exports and sectoral employment dynamics using empirical analysis.

4.3 Methodology

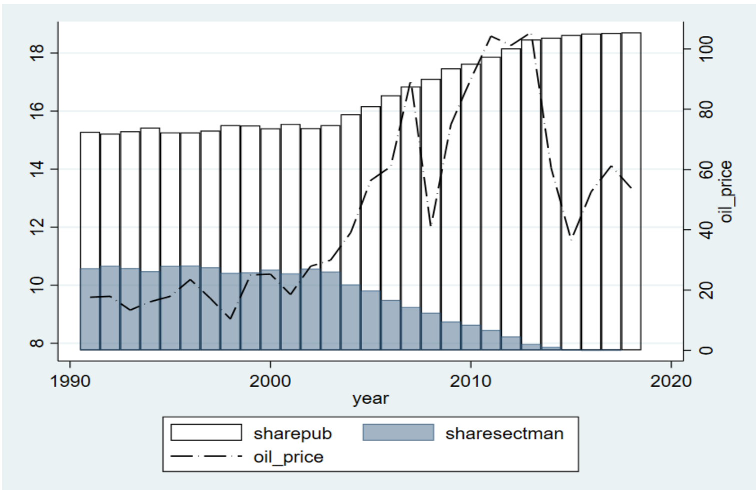
In this section, we explain how we address the endogeneity bias identified in the literature and how we establish the causal relationship between natural resource exports and sectoral employment.

Figure 4.6: Evolution of employment share in the manufacturing sector 2



Notes: This figure provides the evolution of the share of employment in the manufacturing sector along with the oil prices in Sub-Saharan oil-rich countries. The sample period is divided into three main periods. The Pre-Boom ranges from 1991 to 2003, the Boom period ranges from 2004 to 2014, and the Post-Boom period ranges from 2015-2018. See Figure 9 in the appendix for a clear view of price dynamics. Author's elaboration on data from ILO.

Figure 4.7: Evolution of sectoral employment in Nigeria



Notes: This figure provides the evolution of the share of employment in the manufacturing sector and the public sector, along with the oil prices in Nigeria. The sample period is divided into three main periods. The Pre-Boom ranges from 1991 to 2003, the Boom period ranges from 2004 to 2014, and the Post-Boom period ranges from 2015-2018. Author's elaboration on data from ILO.

4.3.1 Identification strategy:

To properly assess the causal relationship between natural resource windfalls and labor dynamics, we have to overcome the most critical challenge identified in the literature, the endogeneity issue. Indeed, they could both be linked to some unobserved factors not picked up by our control variables. In addition, natural resource exploration and exports are endogenous to institutions Cust and Harding (2020). Besides, the government may be willing to increase the resource exports in order to create more jobs in the economy, for instance, or merely to balance the increase of public wage bills.

Then, to address the concerns about the potential endogeneity of natural resources endowment, we perform our estimates using the instrumental variables approach. Following Cassidy (2018) and Allcott and Keniston (2017), we will not use the annual production data or the current reserves. They might be endogenous as well (Cust and Harding, 2020). Instead, we build on the work by Acemoglu, Finkelstein, and Notowidigdo (2013), Dube and Vargas (2013), Carreri and Dube (2016), and Caselli and Tesei (2016) to instrument our primary variable of interest using colonial-era data. We exploit the historical level of natural resource exports during colonization and times series variation in commodity prices between 1991 and 2018. In specific terms, the instrument is defined as the interaction between the production of the country's major natural resource exports during colonization and the commodity prices.

In contrast to other studies using the time-invariant measure of resource abundance (the initial level or the mean of the production) to instrument the resource windfalls, our time-invariant measures of natural resource windfalls and commodity prices are assumed to be exogenous for the following interrelated reasons.

These Sub-Saharan African countries were not independent. Therefore, we could argue that the development and extraction of the natural resources in these countries during this period was based on a combination of geological conditions and external factors to these "'new independent countries."'

Following the literature using the within-country strategy to analyze the resource curse, we argue that during the colonization era, Sub-Saharan African countries were subject to colonial administration in units called French West

Africa (AOF), French Equatorial Africa (AEF), and British Empire.[7] For instance, the production before independence was reported for certain products as belonging to these regions instead of one country. In other words, Guinea, Côte d'Ivoire, Burkina-Faso, Mali, and Senegal were defined as ”‘states”’ belonging to one big federation called AOF.

Hence, we assume that the institutional differences between these countries (in the regions) were small since they were in the same European administrations. Accordingly, any spurious relationship between natural resource exports during this period and the labor dynamics between 1991 and 2018 is not an overwhelming concern for identification (Michaels, 2011).

4.3.2 Empirical specification:

To overcome the potential endogeneity bias of natural resource exports, we estimate the following equations using the IV-2SLS method;

The first stage estimate is given by :

$$\widehat{Rexp_{it}} = \alpha_i + \gamma_t + \beta_1 Rexp_{col} * ResPrice_{zt} + \sum_{j=2}^{5} \beta_j X_{it} + \varepsilon_{it} \tag{4.1}$$

Second stage :

$$\delta SE_{it} = \alpha_i + \gamma_t + \beta_1 \widehat{Rexp_{it}} + \sum_{j=2}^{5} \beta_j X_{it} + \varepsilon_{it} \tag{4.2}$$

Where α_i represents country fixed effects, it allows us to control for country-specific and time-invariant factors, while γ_t our time-period dummies allow us to control for common shocks.

Our primary variable of interest denoted $Rexp_{it}$ is the value of natural resources exports by country i in year t. The variable SE_{it} our dependent variable is defined as the share of the sectoral employment in economy i and

[7]French West Africa or ”‘Afrique Occidentale Française”’ (AOF) was a federation of 8 french colonies from 1895 to 1960. The capital of the federation was Dakar.
The French Equatorial Africa called (AEF) ”‘Afrique Equatoriale Française”’ was a federation of 5 Sub-Saharan African countries with a common Governor-General. The capital of the federation was Brazzaville.

year t. It includes the share of manufacturing employment, public employment, service sector, construction, and mining. Our instrumental variable $Rexp_{col} * ResPrice_{zt}$ defined as an interaction between natural resource exports during the colonization period and the price of a commodity z in year t; $\beta_j X_{it}$ is a set of control variables, including education attainment (65+ years), population, the latitude of the country, the degree of ethnic fractionalization.

4.4 Results

As suggested in the literature, our results show that the natural resources sector does not create substantial employment. A 10 percent increase in resource exports will cause the share of employment in the sector to rise, on average, by only 0.064 percentage point. As we can see, the direct contribution of the resource sector employment in explaining the change in sectoral employment structure is modest. Nevertheless, the impact in other parts of the economy and the sectoral employment structure is significant, as we can see in the following sub-sections.

4.4.1 Natural resource sector and public sector

The first two columns of Tables 4.2 and 4.3 present the results of our estimates using OLS. They suggest that natural resource exports have a positive impact on the share of employment and public wage bills. Although, the positive relationship became weak once we introduce years dummies and country fixed effects, or when we focus on the narrowest sense of the public sector, in other words, the government sector.

These results do not allow us to establish a robust causal relationship between natural resource exports and labor dynamics. Natural resource endowment, as suggested in the literature, is endogenous to institutions. Also, the endogeneity may arise as a result of reverse causality. Employment in the public sector could have an impact on resource exports. For instance, the government could decide to increase the resource exports to satisfy the job demands of a growing population, public services demand, or merely to enforce an agreement with union demands for higher wages. Given the endogeneity bias, we the use instrumental variables approach to correct for this bias.

Columns 2 and 4 in Tables 4.2 and 4.3 summarize the results of our estimates using an instrumental variables approach. Overall, our instruments are strong. The first-stage F statistic for weak instruments is greater than 10 and hence, allows us to reject the null hypothesis. The exogeneity of our instruments is tested using the Sargan overidentification restriction test. This test allows us to conclude that our instrumented variables are exogenous in all our estimates.

The coefficients of our estimates suggest that natural resource windfalls have a positive and significant incidence on the share of employment in the public sector. Nevertheless, the incidence is not significant when we focus on employment in the government sector. A 10% increase in natural resource windfalls will increase the share of employment in the public sector by 0.08 percentage points.

When it comes to their impacts on public wage bills, our results are significant at 10 percent and suggest that a boom in natural resource exports induces more change in the government public wage bills than the share of employment in the public sector. The government wage bills in constant U.S. dollars increase by more than 2.5%, following a 10 percent increase in government windfalls.

4.4.2 Dutch disease in Africa: is it a reality?

We have seen in the previous sub-section that natural resource exports increase the size of public sector employment in resource-rich countries. In this subsection, we will investigate their incidence on the share of employment in the agriculture, manufacturing, mining, and service sectors.

4.4.2.1 Do natural resource windfalls crowd out the manufacturing sector?

Natural resources endowment is viewed as one of the leading causes of the slow growth in Sub-Saharan African countries. Several studies documented the negative relationship between resource windfalls and manufacturing output.

The first part of Table 4.5 contains the results of our estimates of the causal effects of natural resource windfalls on manufacturing employment. In contrast to the prevailing view when it comes to the impact of natural resource

Table 4.2: Share of employment in the public sector

	(1)	(2)	(3)	(4)
	ols		2sls	
The dependent variable is : public sector employment				
LnResexp	0.00173***	0.00116	0.0074***	0.0084**
	(0.0006)	(0.0007)	(0.0025)	(0.004)
Country fixed effects	Yes	Yes	Yes	Yes
Year dummies	No	Yes	No	Yes
Observations	822	822	658	658
R-squared	0.95	0.951	0.931	0.93
F statistic	–	–	37.85	15.67
Resexp exog.	–	–	0.332	0.156
The dependent variable is : government sector employment				
Resexp	4.12e-05	2.13e-05	0.000057	0.00023
	(0.00016)	(0.0002)	(0.0061)	(0.001)
Country fixed effects	No	Yes	No	Yes
Year dummies	No	Yes	No	Yes
Observations	822	822	658	658
R-squared	0.978	0.979	0.954	0.954
F statistic	–	–	37.85	15.67
Resexp exog.	–	–	0.492	0.322

Notes: This table reports the results of our estimates of the effects of natural resource exports on the share of employment in the public sector. The public sector includes activities of a governmental nature. It includes public administration, justice, education, defense, compulsory social security, human health, and social work activities. While the government sector includes only public administration, defense, and compulsory social security. All specifications include country fixed effects and year dummies, the degree of ethnic fractionalization, French colony dummy, latitude, education attainment (65+ years), population. The IV estimates use the level of production during the colonization period and prices. We use the Kleibergen and Paap (2006) F statistic to test our instrument. A statistic below 10 implies a weak instrument. *Resexpexog.* represents our overidentification restriction test using the Sargan test. Robust standard errors in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively.

Table 4.3: Public Wage bills

	(1)	(2)	(3)	(4)
	ols		2sls	
The dependent variable is : Public Wage bills (US dollars)				
LnResexp	0.0617***	0.0866***	0.101**	0.257***
	(0.0125)	(0.0135)	(0.048)	(0.048)
Country fixed effects	Yes	Yes	Yes	Yes
Year dummies	No	Yes	No	Yes
Observations	670	670	523	523
R-squared	0.735	0.962	0.961	0.959
F statistic	–	–	30.22	33.03
Resexp exog.	–	–	0.591	0.671
The dependent variable is : Public Wage bills (%GDP)				
LnResexp	0.0617***	0.0622***	0.003	0.089**
	(0.0125)	(0.0131)	(0.046)	(0.043)
Country fixed effects	Yes	Yes	Yes	Yes
Year dummies	No	Yes	No	Yes
Observations	670	670	523	523
R-squared	0.735	0.749	0.718	0.747
F statistic	–	–	30.22	33.03
Resexp exog.	–	–	0.351	0.746

Notes: This table reports the results of our estimates of the effects of natural resource exports on public wage bills. All specifications include country fixed effects and year dummies, per capita GDP, the degree of ethnic fractionalization, French colony dummy, latitude, education attainment (65+ years), population. The IV estimates use the level of production during the colonization period and prices. We use the Kleibergen and Paap (2006) F statistic to test our instrument. A statistic below 10 implies a weak instrument. *Resexpexog.* represents our overidentification restriction test using the Sargan test. Robust standard errors in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively.

exports on the manufacturing sector, our instrumental variable approach results show that natural resource exports have a positive and significant impact on the share of employment in the manufacturing sector. Our first stage F statistic is beyond 15, and our over-identification Sargan test is beyond 10% for all our estimates. It suggests that our instruments for resource exports are strong and exogenous. A 10% increase in natural resource exports is followed by a positive change in the share of employment in the manufacturing sector by 0.2 percentage points. The estimates are significant at 1%.

4.4.2.2 Do natural resource windfalls crowd out the agriculture sector and increase employment in services?

Table 4.4 reports the results of our estimates of the effects of natural resource windfalls on the share of employment in the agriculture and service sectors. Our coefficients are significant for all our estimates and suggest that a natural resource boom leads to a substantial decline in the share of employment in the agriculture sector. The share of employment in the sector decreases by almost 0.6 percentage points when the resource exports increase by 10%.

When it comes to the impacts of natural resources on services, our results are significant at 1% and are in line with the findings in the literature. A growing resource sector is associated with a substantial increase in the share of employment in the service sector. The share of employment in the service sector increases substantially and represents almost half of the shift in employment in the agriculture sector. A 10% increase in resource exports causes an increase in the share of employment in the service sector by 0.28 percentage points. The share of employment in the construction sector also increases by 0.04 percentage points after a 10% increase in resource windfalls.

Overall, our results show that the booming sector does not lead to the destruction of employment in the manufacturing sector, but, on the contrary, it increases the share of employment in this trade sector. Nevertheless, even though its share increases, it remains lower when compared to the services.

Table 4.4: Share of Agriculture and Service sectors employment

	(1)	(2)	(3)	(4)
	ols		2sls	
The dependent variable is: Agriculture				
LnResexp	-0.0132***	-0.0106***	-0.047***	-0.0599***
	(0.00154)	(0.00158)	(0.0066)	(0.0115)
Country fixed effects	Yes	Yes	Yes	Yes
Year dummies	No	Yes	No	Yes
Observations	822	822	658	658
R-squared	0.963	0.966	0.947	0.934
F statistic	–	–	37.845	15.665
Resexp exog.	–	–	0.438	0.9
The dependent variable is: Services				
LnResexp	0.00684***	0.00545***	0.023***	0.0284***
	(0.00105)	(0.00109)	(0.004)	(0.007)
Country fixed effects	Yes	Yes	Yes	Yes
Year dummies	No	Yes	No	Yes
Observations	822	822	658	658
R-squared	0.967	0.968	0.958	0.954
F statistic	–	–	37.85	15.67
Resexp exog.	–	–	0.988	0.63

Notes: This table reports the results of our estimates of the effects of natural resource exports on the share of employment in the agriculture and service sectors. All specifications include country fixed effects and year dummies, French colony dummy, latitude, the degree of ethnic fractionalization, education attainment (65+ years), population. The IV estimates use the level of production during the colonization period and prices. We use the Kleibergen and Paap (2006) F statistic to test our instrument. A statistic below 10 implies a weak instrument. *Resexpexog.* represents our overidentification restriction test using the Sargan test. Robust standard errors in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively.

Table 4.5: Share of Manufacturing and Construction sector employment

	(1)	(2)	(3)	(4)
	ols		2sls	
The dependent variable is: Manufacturing				
LnResexp	0.00366***	0.00308***	0.013***	0.021***
	(0.000446)	(0.000463)	(0.002)	(0.004)
Country fixed effects	Yes	Yes	Yes	Yes
Year dummies	No	Yes	No	Yes
Observations	822	822	658	658
R-squared	0.950	0.952	0.94	0.9
F statistic	–	–	37.84	15.67
Resexp exog.	–	–	0.003	0.1041
The dependent variable is: Construction				
LnResexp	0.001***	0.0007***	0.004***	0.004***
	(0.0002)	(0.0002)	(0.0008)	(0.001)
Country fixed effects	Yes	Yes	Yes	Yes
Year dummies	No	Yes	No	Yes
Observations	822	822	658	658
R-squared	0.949	0.952	0.932	0.936
F statistic	–	–	37.85	15.67
Resexp exog.	–	–	0.841	0.707

Notes: This table reports the results of our estimates of the effects of natural resource exports on the share of employment in the manufacturing and construction sectors. All specifications include country fixed effects and year dummies, French colony, latitude, the degree of ethnic fractionalization, education attainment (65+ years), population. The IV estimates use the level of production during the colonization period and prices. We use the Kleibergen and Paap (2006) F statistic to test our instrument. A statistic below 10 implies a weak instrument. *Resexpexog.* represents our overidentification restriction test using the Sargan test. Robust standard errors in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively.

4.5 Conclusion

In this paper, we investigate the impact of natural resource exports on structural transformation in 46 Sub-Saharan African countries between 1991 and 2018. We exploit for the first time the colonial level of production to overcome the endogeneity issue and carry out a two-stage least squares model. Once we address the endogeneity issue, our results suggest that natural resource exports have, contrary to the conventional view, positive and significant effects on the share of manufacturing employment and the non-agricultural employment in the economy such as services, construction, and mining. As suggested in the literature, our findings show that resource windfalls have a positive and significant incidence on the employment share of the public sector in total employment. Nevertheless, our estimations suggest that when we consider the public sector in the narrowest sense, in other words, the public administration, defense, and social security, we find no significant effects of natural resource exports. Focusing on the same sector, we provide evidence that natural resource exports impact positively public wage bills. In addition, we noticed that following a resource boom, the government tends to increase public wage bills significantly compared to increasing public employment. Finally, we contribute to the literature by providing evidence that natural resource exports shift employment from the agriculture sector towards the non-agriculture sector.

Chapter 5

General Conclusion

General Conclusion

This thesis investigated the relationship between natural resources and development in developing countries, with a particular focus on sub-Saharan resource-rich countries. Evidence suggests that natural resource endowments have not allowed sub-Saharan African countries to spur lasting economic growth. To increase the understanding of the role of policy in explaining these disappointing outcomes, this dissertation explores the role of fiscal policies and reinvestigates the "'Dutch disease"' hypothesis using new approaches. The thesis consists of three essays.

In the first essay (chapter 2), we analyze the impact of taxation on the lead time from discovery to starting industrial mineral project development in developing countries and provide new insights into the existing literature. The chapter contributes to the literature by determining empirically through a survival analysis model, the impact of taxation on the lead time to production.

Using a sample of 188 gold mines located in 24 gold-rich developing countries from 1950 to 2018, the essay documents that taxation can either foster the development of gold mine projects when the country fiscal regime has a corporate income tax equal to or below 25% and a royalty equal to or below 2%, or slow down the development when the corporate income tax and the royalty rate are respectively higher than 35% and 5%. The more tighten the fiscal regime is, the more likely the timeline disappointment will be. Worse, it could have a significant impact on exploration spending.

The study also documents that the type of fiscal regime is determinant in explaining the development lag differences between discoveries. Thus, the findings show that variable tax regimes and profit-based tax systems are very favorable to the first extraction of a gold deposit. Overall, all else equal, the more progressive the fiscal regime is, the sooner the extraction will occur.

Fiscal instruments are not the only determinant triggers of the discoveries development. The evidence shows that a thriving economic environment, such as an increase in gold prices, abundant reserves, and low-cost extraction, lead to an earlier beginning of the production.

Developing countries, particularly sub-Saharan African countries' expectations about their resource discoveries, are huge. They might be tented to implement stricter fiscal regimes to get a fair share of the revenues stemming from the extraction of their endowments. Accordingly, they face a high risk of timeline disappointment, or in the worse scenario, the discovery could remain untapped, particularly in a post-COVID era. On the other hand, they can give up revenues to shorten the duration of the development of their discoveries. In that case, they will not get the needed revenues to invest in their infrastructures and human capital development to spur lasting economic growth. In that case, government revenue and growth disappointments are high.

The guidance we can draw, in light of our findings when it comes to fiscal policy recommendations to resource-rich countries, is that the progressivity should be the rule. A more progressive fiscal regime based on profit or involving a part of variability can conciliate both getting a fair share of the revenues stemming from the exploitation of resources and fostering the development of discoveries.

Another takeaway from our investigation is that patience could be a virtue. Trying to foster the development at all costs, particularly for mines with great potential, will not permit a country to benefit from its endowment (Curtis and Lissu, 2008).

Accepting a certain delay, and using other policy instruments other than tax policies, such as the political environment or infrastructure, could help countries to get a fair share of their resources and make the best out of their endowments. While they are not statistically significant, they are at least beyond one in most of our estimates. That gives us reason to believe that a good political environment and infrastructures can foster the extraction.

The second essay/chapter 3, questions the role of policies, especially fiscal policies, in explaining natural resource curse or blessing. The investigation focuses on the relationship between government expenditures and growth in 23 Sub-Saharan natural resource-rich countries from 1995 to 2016. We carried out an empirical analysis using a PSTR developed by González, Teräsvirta, and Dijk (2005); Gonzalez, Teräsvirta, Van Dijk, and Yang (2017).

Chapter 3 documents that the beneficial effects of natural resource exports and government expenditures on economic growth are conditional to the level of spending. Thus, public spending spur economic growth when they do not exceed 22.4% and slow down to impact the economy negatively when they are beyond this threshold.

In the literature, government consumption expenditures are viewed as pro-curse, while investments in infrastructures and education, for instance, are viewed as counter-curse and promote lasting economic growth. In this chapter, we investigate the impact of the two main components of government expenditures - current and capital expenditures. The study documents, on the contrary to the conventional thinking, that both government consumption and public investment expenditures have a positive and significant impact on growth when they are moderated and negative when they exceed a certain threshold. Thus, public investments could be as harmful as current expenditures for the economy if they are not moderated.

More specifically, our findings show that in the low regime (*when government expenditures are below* 22.4%), the private sector and external sector contributions to economic growth are positive. While in the higher regime (*when government expenditures are beyond* 22.4%), our findings are consistent with the "'Dutch disease"' hypothesis. The boom in natural resource exports and government expenditure crowd-out the private sector, create external imbalances, and finally lead to an economic downturn.

This second essay contributes to the public expenditure policy design by providing empirical evidence that high public expenditures lead to a low rate of growth. In another world, the excess leads to the resource curse. The first lesson we can draw from these findings is that the resource curse is a consequence of poor public expenditure policies, and consequently, savings.

Accordingly, beyond the threshold, government expenditures become pro-curse, and, therefore, the windfalls should be saved for later periods. These savings could have allowed them to face more easily the collapse in global commodity prices following the COVID-19 pandemic since they will have the fiscal-space needed to face the increase in expenditure to respond to the spread of the virus and financing gap.

The latest essay, or Chapter 4, analyzes the impact of natural resource exports on different parts of the economy - non-resource sector (manufacturing, service, agriculture, and construction) and the resource sector. We investigate whether or not natural resource endowments impede structural transformation using a different approach. The analysis is done through the job lens instead of value-added as most of the literature. Also, to overcome the endogeneity issue identified in the literature, we use the colonial level of production.

The study documents that natural resources do not impede structural transformation. The boom in natural resource exports does not translate into a collapse in the share of employment in the manufacturing sector. Our findings suggest, on the contrary, that resource endowments have positive and significant effects on the share of manufacturing employment. Overall, natural resource exports shift employment from the agricultural sector towards the non-agriculture sector. The positive effects are not only limited to employment in the mining sector, but it reaches the whole non-agricultural sector. The share of employment increases in the services, and construction, as well.

When it comes to government employment policy response - employment and wages- following a boom in natural resource exports. Chapter 4 documents that resource windfalls have a positive and significant incidence on the employment share of the public sector in total employment. Besides, our evidence shows that sub-Saharan African governments increase public wage bills significantly compared to public employment. Moreover, our findings suggest that the positive effects of resource exports on public sector employment become weak when we consider the public sector in the narrowest sense, in other words, the public administration, defense, and social security.

Appendices

Appendix Chapter 2

Table 1: Descriptive statistics by period

		1950'–1975	1975'–1990	1990'–2005	2005'–2018
Total sample					
	–Observations	29	65	80	14
	–Mean	13.59	9.57	10.35	6.43
	–Min	1	1	2	1
	–Max	48	33	21	12
	–25%	7	3	7	3
	–50%	10	7	10	6.5
	–75%	20	14	21	10
By Region					
– Africa					
	–Observations	18	13	40	7
	–Mean	15.89	12.69	10.38	7.43
	–Min	4	3	3	2
	–Max	35	28	21	12
	–25%	8	5	7	5
	–50%	13.5	7	10	8
	–75%	23	21	14	10
– Asia					
	–Observations	4	16	9	-
	–Mean	16.75	10.75	9.44	-
	–Min	1	1	2	-
	–Max	48	28	17	-
	–25%	1.5	5	7	-
	–50%	9	9	8	-
	–75%	32	14.5	13	-
– Latin America					
	–Observations	7	36	31	7
	–Mean	5.86	7.92	10.58	5.42
	–Min	1	1	2	1
	–Max	19	33	20	11
	–25%	1	1	6	1
	–50%	2	6	10	6
	–75%	19	12.5	15	10

Notes: This table shows the difference in the length of time from the discovery to starting industrial mineral production between regions and periods. Source: author's elaboration on data from Minex Consulting, USGS.

Table 2: KM survival estimation

Time	Total mine	Start	Survivor Function	Std. Error	[95% Conf.	Int.]
1	188	20	0.8936	0.0225	0.84	0.93
2	168	7	0.8564	0.0256	0.7976	0.8992
3	161	8	0.8138	0.0284	0.7504	0.8626
4	153	8	0.7713	0.0306	0.7044	0.8249
5	145	11	0.7128	0.033	0.6423	0.7718
6	134	9	0.6649	0.0344	0.5925	0.7274
7	125	16	0.5798	0.036	0.5059	0.6466
8	109	15	0.5	0.0365	0.4266	0.5689
9	94	5	0.4734	0.0364	0.4006	0.5427
10	89	13	0.4043	0.0358	0.3339	0.4734
11	76	5	0.3777	0.0354	0.3086	0.4464
12	71	8	0.3351	0.0344	0.2686	0.4028
13	63	9	0.2872	0.033	0.2244	0.3529
14	54	9	0.2394	0.0311	0.1811	0.3023
15	45	6	0.2074	0.0296	0.1528	0.268
16	39	7	0.1702	0.0274	0.1205	0.2273
17	32	6	0.1383	0.0252	0.0935	0.1917
18	26	2	0.1277	0.0243	0.0847	0.1797
19	24	4	0.1064	0.0225	0.0675	0.1553
20	20	5	0.0798	0.0198	0.0467	0.1241
21	15	2	0.0691	0.0185	0.0387	0.1113
22	13	1	0.0638	0.0178	0.0348	0.1049
23	12	2	0.0532	0.0164	0.0272	0.0917
24	10	1	0.0479	0.0156	0.0236	0.0851
25	9	1	0.0426	0.0147	0.02	0.0783
27	8	1	0.0372	0.0138	0.0165	0.0715
28	7	3	0.0213	0.0105	0.0071	0.0501
32	4	1	0.016	0.0091	0.0044	0.0427
33	3	1	0.0106	0.0075	0.0021	0.0349
35	2	1	0.0053	0.0053	0.0005	0.0272
48	1	1	0	–	–	–

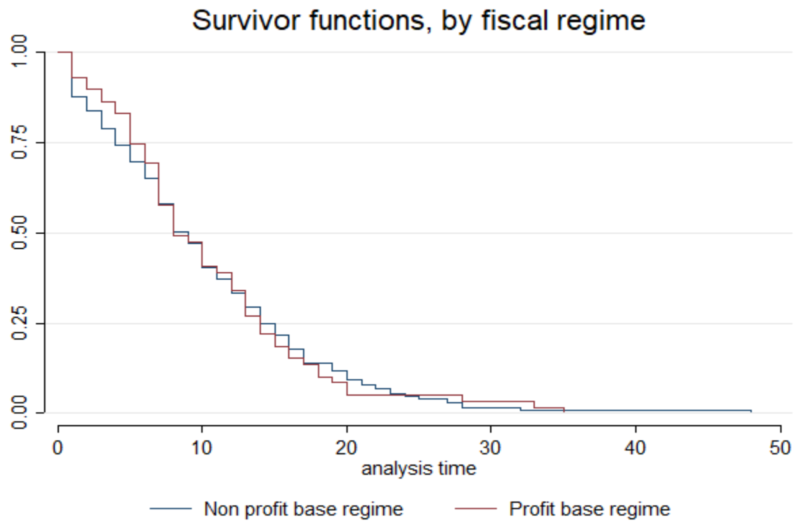
Notes: The Kaplan-Meier survivor function estimates non-parametrically the probability of remaining in the ground for a new gold mine discovery beyond the year t. Source: author's elaboration on data from Minex Consulting, USGS.

Table 3: Time to starting gold production: Hazard ratio from semi-parametric Cox-model (2)

	Equations					
	(8b)	(9b)	(10b)	(11b)	(12b)	(13b)
Taxregim1	-	-	1.476*	1.520**	2.116***	-
	-	-	(0.338)	(0.295)	(0.554)	-
Taxregim3	-	-	0.466**	0.446**	0.339***	0.489*
	-	-	(0.174)	(0.164)	(0.142)	(0.187)
Flextax	1.551***	1.696**	-	-	-	1.509**
	(0.274)	(0.364)	-	-	-	(0.264)
Depverpro	1.196**	-	1.194**	1.183*	1.225*	1.192*
	(0.104)	-	(0.105)	(0.103)	(0.129)	(0.110)
Goldgrade	-	1.044**	-	-	1.060***	-
	-	(0.021)	-	-	(0.020)	-
Goldreserve	-	-	-	-	-	0.995
	-	-	-	-	-	(0.008)
Priceup	1.477	-	1.666*	1.532	-	-
	(0.423)	-	(0.453)	(0.424)	-	-
Price	1.001**	1.001**	-	1.001*	1.002	1.001*
	(0.000)	(0.001)	-	(0.000)	(0.001)	(0.000)
Pricesd	-	-	-	-	0.993*	-
	-	-	-	-	(0.003)	-
Policy2	1.001	1.024	1.004	1.003	1.002	1.000
	(0.014)	(0.018)	(0.016)	(0.016)	(0.021)	(0.016)
Fixedphone	-	-	1.001	1.004	1.018	0.991
	-	-	(0.024)	(0.020)	(0.031)	(0.024)
Africa	0.64	0.702**	1.035	-	-	-
	(0.109)	(0.144)	(0.239)	-	-	-
Latinam	-	-	1.187	-	-	1.399
	-	-	(0.347)	-	-	(0.292)
Asia	0.805	-	-	0.934	-	1.043
	(0.185)	-	-	(0.210)	-	(0.251)
N	188	124	188	188	124	188

Notes: This table is a re-estimation of table 2.3 using a semi-parametric Cox-model. (*), (**), (***) denote significance at respectively 10%, 5% and 1%. Robust standard errors are in parentheses. Taxregim2 "'the intermediarytax regime"' is the variable of reference for the dummy variable Taxregim. Source: author's elaboration on data from Minex Consulting, USGS.

Figure 1: Kaplan-Meier estimates of time duration by Tax regime (Profit base fiscal regime)



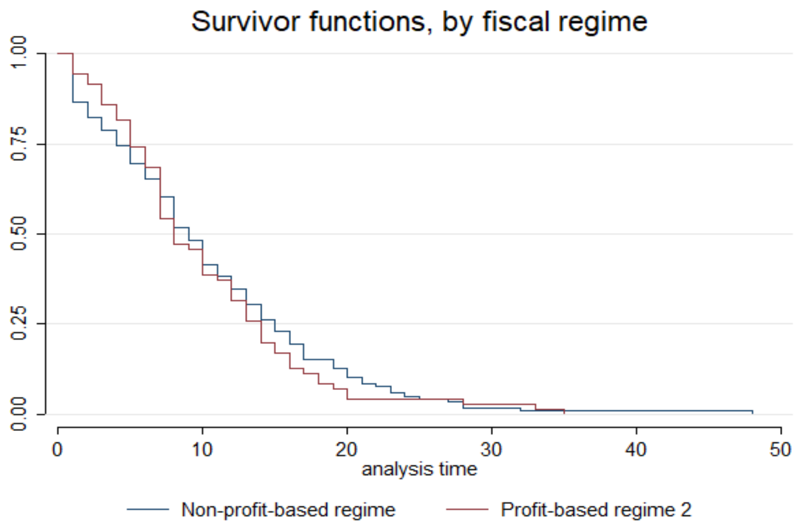
Notes: Author's elaboration on data from Minex Consulting, USGS, FERDI tax database on gold. This figure provides a graphical illustration of the mixed and weak difference in the survival time distribution between the "'Profit base fiscal regime"' and the other types of regimes.

Table 4: Summary Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
taxregim1	188	0.229	0.421	0	1
taxregim2	188	0.261	0.440	0	1
taxregim3	188	0.048	0.214	0	1
pmr_qtymoz	188	7.356	11.233	0.902	93.191
HeadGradeP t	124	4.565	4.982	0	27.74
tprofitbase	188	0.314	0.465	0	1
tprofitbase2	188	0.372	0.485	0	1
rentable	188	0.654	0.885	0	2
pg4	188	0.085	0.280	0	1
price_us	188	344.788	185.175	34.628	1225.46
price_sd3	188	43.928	45.395	0.00026	168.48
polity2	188	0.665	5.793	-9	9
fixed_phone	188	3.954	4.873	0.01	24.43001

Notes: This table provides summary statistics of our data. Author's elaboration on data from Minex Consulting, USGS, FERDI mining tax database.

Figure 2: Kaplan-Meier estimates of time duration by Tax regime (Profit base fiscal regime 2)



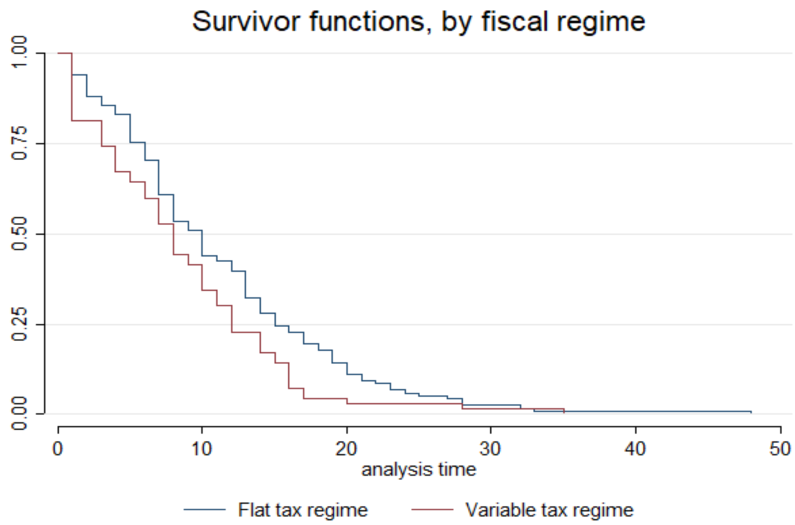
Notes: This graph as, the last one shows the Kaplan-Meier survivor function curve evolution. We observe in contrast to the Tprofitbase1 more distinctly the difference in the survival time distribution between the Tprofitbase2 and the other types of regime. Author's elaboration on data from Minex Consulting, USGS, FERDI tax database on gold.

Table 5: Survivor Function by fiscal regime

Survival times (years)	Survivor Function by fiscal regime					
	Other regimes	Low tax regime	Other regimes	Intermediate-tax	Other regimes	High-tax
1	0.9586	0.6744	0.8777	0.9388	0.8883	1
6	0.731	0.4419	0.6547	0.6939	0.648	1
11	0.4138	0.2558	0.3741	0.3878	0.352	0.8889
16	0.2	0.0698	0.1727	0.1633	0.1453	0.6667
21	0.0828	0.0233	0.0719	0.0612	0.0447	0.5556
26	0.0483	0.0233	0.036	0.0612	0.0335	0.2222
31	0.0207	0.0233	0.0144	0.0408	0.0223	–
36	0.0069	–	–	0.0204	0.0056	–
41	0.0069	–	–	0.0204	0.0056	–
46	0.0069	–	–	0.0204	0.0056	–
51	–	–	–	–	–	–
Observations	145	43	139	49	179	9
Log-rank test (χ^2)	9.91 ***		0.13		9.25***	
Wilcoxon test (χ^2)	17.08 ***		0.06		11.27***	

Notes: This table reports the difference in survival time between the different groups. The log-rank test and Wilcoxon test allow us to reinforce our visual impression of the distinction between the curve. The null hypothesis is that there no difference between the survival. Otherwise the probability of starting gold extraction after the discovery is the same in all fiscal jurisdictions. (*), (**), (***) denote significance at respectively 10%, 5% and 1%. Source: Author's elaboration on data from Minex Consulting, USGS, FERDI mining tax database.

Figure 3: Kaplan-Meier estimates of time duration by Tax regime (Variable tax regime)



Notes: This stratified graph shows the Kaplan-Meier survivor function curve evolution of "'Flextax"' and the other types of regime. We observe that there is a clear distinction in the survival time distribution between the progressive fiscal regime and the other types of regime, which are regressive (Flat tax). Author's elaboration on data from Minex Consulting, USGS, FERDI mining tax database.

Table 6: Survivor Function by fiscal regime (2)

Survival times (years)	Survivor Function by fiscal regime: Non-profit base	Profit base 1	Non-profit base	Profit base 2	Constant tax	Variable-tax
1	0.876	0.9322	0.8644	0.9429	0.9407	0.8143
6	0.6512	0.6949	0.6525	0.6857	0.7034	0.6
11	0.3721	0.3898	0.3814	0.3714	0.4237	0.3
16	0.1783	0.1525	0.1949	0.1286	0.2288	0.0714
21	0.0775	0.0508	0.0847	0.0429	0.0932	0.0286
26	0.0388	0.0508	0.0424	0.0429	0.0508	0.0286
31	0.0155	0.0339	0.0169	0.0286	0.0254	0.0143
36	0.0078	–	0.0085	–	0.0085	–
41	0.0078	–	0.0085	–	0.0085	–
46	0.0078	–	0.0085	–	0.0085	–
51	–	–	–	–	–	–
Observations	129	59	118	70	110	78
Log-rank test (χ^2)	0.00		0.3		5.36**	
Wilcoxon test (χ^2)	0.08		0.01		5.37**	

Notes: This table reports the difference in survival time between the different groups. The log-rank test and Wilcoxon tests allow us to reinforce our visual impression of the distinction between the curve. The null hypothesis is that there no difference between the survival. Otherwise the probability of starting gold extraction after the discovery is the same in all fiscal jurisdictions. (*), (**), (***) denote significance at respectively 10%, 5% and 1%. Source: Author's elaboration on data from Minex Consulting, USGS, FERDI mining tax database.

Table 7: AIC and BIC values for each model

	Model					
	exponential	weibull	gompertz	lognormal	loglogistic	gamma
Obs	188	188	188	188	188	188
AIC	509.2258	472.9019	479.6959	482.7057	488.0621	474.39
BIC	548.0631	514.9756	521.7697	524.7795	530.1358	519.7002
Obs	124	124	124	124	124	124
AIC	319.5866	263.2692	265.0596	278.3956	279.4282	264.3391
BIC	353.43	299.9329	301.7233	315.0593	316.0918	303.823

Notes: This table presents the Akaike's Information Criterion (AIC) and his alternative Bayesian information criterion (BIC). A lower AIC or BIC corresponds to better-fitting models. Source: Author's elaboration on data from Minex Consulting, USGS, FERDI mining tax database.

Appendix Chapter 3

Table 8: List of Sub-Saharan African natural resource-rich countries

	Country	Type of Nat. resources	Primary export	Nat. res. exports	Total Resource revenue
1	Angola	Oil	100	99.91	77.57
2	Botswana	Diamonds	92.42	90.31	37.31
3	Burkina-Faso	Gold	95.06	66.33	14.29
4	Cameroon	Oil	91.50	49.15	27.49
5	Chad	Oil	98.74	92.39	59.58
6	Congo, Dem. Rep.	Minerals & Oil	94.33	91.09	–
7	Congo, Rep.	Oil	87.62	83.33	75.96
8	Cote d'Ivoire	Oil & Gas	83.55	26.33	6.99*
9	Equatorial Guinea	Oil	94.07	93.39	86.44
10	Gabon	Oil	94.90	79.84	50.31
11	Ghana	Gold & Oil	92.31	57.62	10.86
12	Guinea	Bauxite & Gold	94.56	79.27	19.97
13	Mali	Gold	91.32	73.34	11.33
14	Mauritania	Iron Ore & Gold	95.26	66.09	27.10
15	Mozambique	Gas & Bauxite	93.45	71.95	
16	Namibia	Diamonds & copper	78.54	51.84	5.25
17	Niger	Uranium	60.12	42.21	17.47
18	Nigeria	Oil	97.86	93.69	65.54
19	Sierra Leone	Diamonds	84.16	70.95	8.41
20	South Africa	Mining products	56.41	44.83	–
21	Sudan	Oil	98.25	86.20	33.99
22	Tanzania	Gold & precious stones	85.37	47.96	–
23	Zambia	Copper & Gold	87.77	74.61	16.21

Notes: This table provides the list of Sub-Saharan African natural resource-rich countries included in our study. I estimate it using the data from the *UNCTAD* database and the Government Revenue Dataset 2017 developed by *ICTD*, *UNU*, *WIDER*, *GRD*. The primary exports, and natural resource exports are in percent of total export. The total resource revenue is expressed as a percentage of the total government revenue. All the data are calculated over the period 2010 to 2016.

Appendix Chapter 4

Table 9: List of Sub-Saharan African countries

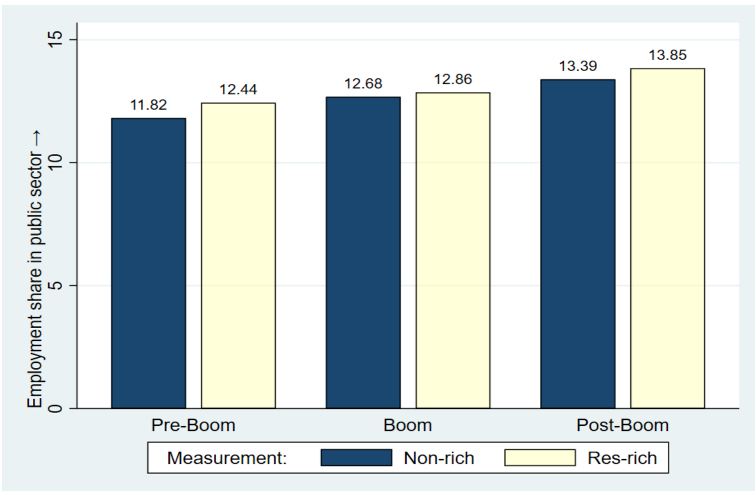
	Country	Type of Nat. resources	Res. exp. (%GDP)	Res. exp. (%tot. exports)	Res. rev (%GDP)	Res. rev (%Gov. rev)
1	Angola	Oil	43.86	99.83	32.64	75.86
2	Nigeria	Oil & Gas	17.48	95.60	8.35	65.49
3	Chad	Oil	27.12	93.11	11.52	53.54
4	Equatorial Guinea	Oil	52.18	91.17	22.71	84.79
5	Congo, D.R.	Cobalt	18.60	90.53	–	–
6	Botswana	Diamonds	38.43	88.67	13.70	37.83
7	Sudan	Gold	7.05	88.32	5.12	32.51
8	Gabon	Bauxite	39.90	82.25	13.77	51.15
9	Guinea	Bauxite	20.87	81.60	3.54	24.24
10	Congo	Oil	53.10	80.92	31.19	75.56
11	Zambia	Copper	26.18	74.85	2.73	15.18
12	Mozambique	Coak	20.15	71.22	–	–
13	Mali	Gold	13.32	68.47	1.71	9.66
14	Sierra Leone	Iron ore	14.73	65.00	0.91	6.04
15	Burkina Faso	Gold	13.33	63.87	2.47	11.41
16	Mauritania	Iron ore	25.75	62.59	6.91	25.57
17	Ghana	Gold	14.57	57.69	1.83	10.25
18	Namibia	Diamonds	17.98	51.72	1.73	5.57
19	Cameroon	Oil	6.64	49.43	4.71	26.58
20	Rwanda	–	4.32	49.32	0.00	0.00
21	Tanzania	Gold	5.34	46.93	–	–
22	Togo	Phosphate	12.75	45.28	–	–
23	South Africa	Gold	11.20	43.63	–	–
24	Benin	–	8.61	42.22	–	–
25	Niger	Uranium	7.31	41.77	2.66	12.60
26	Burundi	–	1.93	41.70	–	–
27	Liberia	Iron ore	5.21	39.35	1.75	5.99
28	Zimbabwe	Gold	8.13	39.03	1.13	4.61
29	Senegal	Phosphate	5.25	37.51	0.33	1.43
30	Eritrea	–	5.10	34.76	–	–
31	Madagascar	–	5.78	29.69	–	–
32	Côte d'Ivoire	Oil & Gas	9.93	25.48	1.15	6.31
33	Lesotho	Diamonds	8.32	22.74	–	–
34	Gambia	–	1.07	12.33	–	–
35	Ethiopia	–	0.60	10.45	0.00	0.00
36	Cape Verde	–	0.34	10.16	–	–
37	Kenya	–	1.05	10.00	–	–
38	Sao Tome and P.	–	0.21	4.87	0.76	2.22
39	Guinea-Bissau	–	0.91	4.76	–	–
40	Mauritius	–	0.99	4.57	0.00	0.00
41	Eswatini	Coal	1.93	4.54	–	–
42	Malawi	–	0.66	3.66	–	–
43	Comoros	–	0.07	2.98	–	–
44	Somalia	–	0.37	–	–	–
45	South Sudan	Oil	–	–	17.37	–
46	Djibouti	–	2.03	–	–	–

Notes: This table provides the list of Sub-Saharan African natural resource-rich and non resource-rich included in our study. We estimate it using the data from *UNCTAD* database and the Government Revenue Dataset 2018 developed by *ICTD*, *UNU*, *WIDER*, *GRD*. *Res.exp.*(%*GDP*), *Res.exp.*(%*tot.exp*) represent the natural resource exports as a share of *GDP* and total merchandise exports, respectively. *Res.rev*(%*GDP*) and *Res.rev*(%*Gov.rev.*) represent the government revenue stemming from the extraction of the resources as a percentage of *GDP* and total government revenue, respectively. The type of resource indicates the principal resource exported by the country. All the data are calculated over the period 2010 to 2018.

Table 10: Variables definition

Variable	Definition
Dependent variable	
shareagr	The share of employment in the agriculture sector
sharesecman	The share of employment in the manufacturing sector
sharepub	The share of employment in the public sector
sharepub2	The share of employment in the government sector
wage	The public wages bills in US dollars
wage$_g dp$	The public wages bills as a percentage of the GDP
Variables of interest	
lnresexp_gdp	The logarithm of the natural resource exports
lnrescolprice	Interacted the level of production before the independence and the commodity prices between 1991 and 2018
lnoil_price	The logarithm of the oil prices
lncomindex	The logarithm of the commodity prices index. The commodity index is defined as the global price index of all commodities.
Covariates	
Frcol	Dummy equaling one if the country was a french colony and zero otherwise
fe_etfra	Is an indicator of ethnic fractionalization from the "The Quality of Government Dataset".
edu65plus	Measure the level of education of the population (65+ years)
latitude	Measure the latitude of the country
lnpop	Is the logarithm of the population

Figure 4: Evolution of employment in the public sector



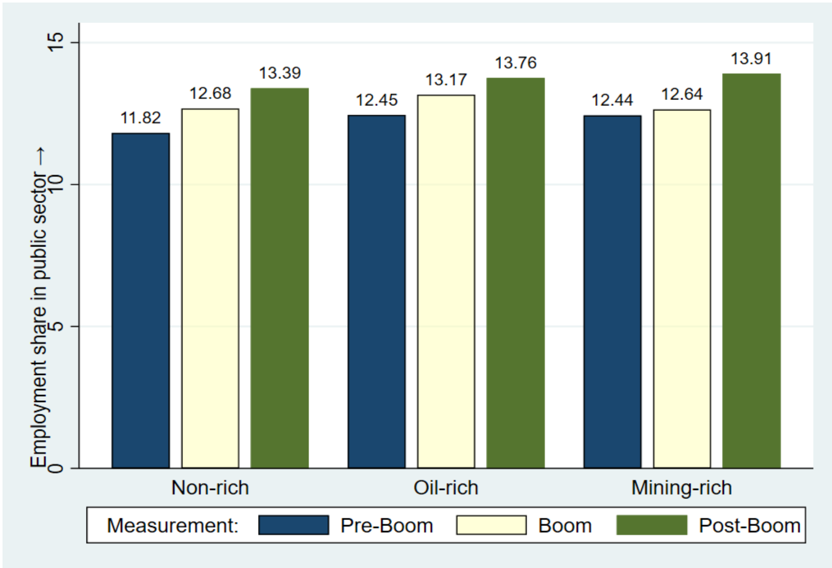
Notes: This figure provides an overview of the evolution of employment in the public sector in sub-Saharan countries. The sample period is divided into three main periods. The Pre-Boom ranges from 1991 to 2003, the Boom period ranges from 2004 to 2014, and the Post-Boom period ranges from 2015-2018. See Figure9 in the appendix for a clear view of price dynamics. Author's elaboration on data from ILO.

Table 11: Share of mining and industry sector employment

	(1)	(2)	(3)	(4)
	ols		2sls	
The dependent variable is: Industry (Broad sect)				
LnResexp	0.00640***	0.00518***	0.024***	0.031***
	(0.000680)	(0.000695)	(0.003)	(0.006)
Country fixed effects	Yes	Yes	Yes	Yes
Year dummies	No	Yes	No	Yes
Observations	822	822	658	658
R-squared	0.937	0.942	0.905	0.87
F statistic	–	–	37.85	15.67
Resexp exog.	–	–	0.1056	0.394
The dependent variable is: Mining				
LnResexp	0.00170***	0.00136***	0.0058***	0.0064***
	(0.000244)	(0.000254)	(0.001)	(0.002)
Country fixed effects	Yes	Yes	Yes	Yes
Year dummies	No	Yes	No	Yes
Observations	822	822	658	658
R-squared	0.747	0.758	0.671	0.663
F statistic	–	–	37.85	15.665
Resexp exog.	–	–	0.627	0.414

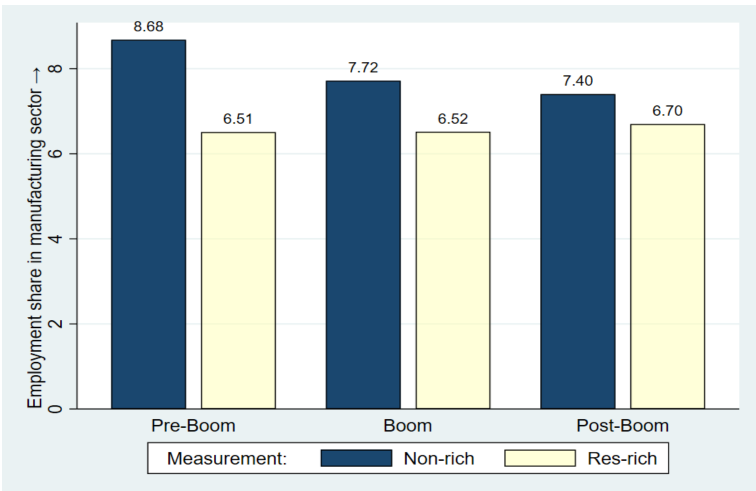
Notes: This table reports the results of our estimates of the effects of natural resource exports on the share of employment in the mining and industry sectors. All specifications include country fixed effects and year dummies, French colony dummy, latitude, the degree of ethnic fractionalization, education attainment (65+ years), population. The IV estimates use the level of production during the colonization period and prices. We use the Kleibergen and Paap (2006) F statistic to test our instrument. A statistic below 10 implies a weak instrument. *Resexpexog.* represents our overidentification restriction test using the Sargan test. Robust standard errors in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively.

Figure 5: Evolution of the share of employment in the public sector



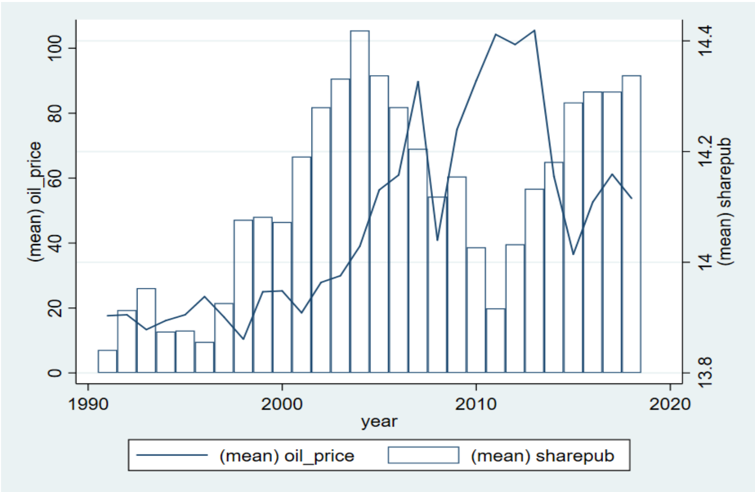
Notes: This figure provides an overview of the evolution of the share of employment in the public sector. The sample period is divided into three main periods. The Pre-Boom ranges from 1991 to 2003, the Boom period ranges from 2004 to 2014, and the Post-Boom period ranges from 2015-2018. See Figure 9 in the appendix for a clear view of price dynamics. Author's elaboration on data from ILO.

Figure 6: Evolution of the share of employment in the manufacturing sector



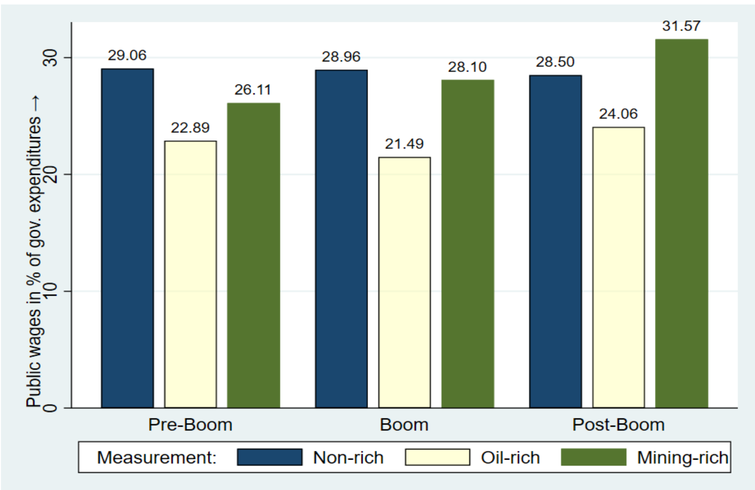
Notes: This figure provides the evolution of the share of employment in the manufacturing sector in the resource-rich and non-resource-rich countries. The sample period is divided into three main periods. The Pre-Boom ranges from 1991 to 2003, the Boom period ranges from 2004 to 2014, and the Post-Boom period ranges from 2015-2018. See Figure9 in the appendix for a clear view of price dynamics. Author's elaboration on data from ILO.

Figure 7: Evolution of the share of employment in the public sector



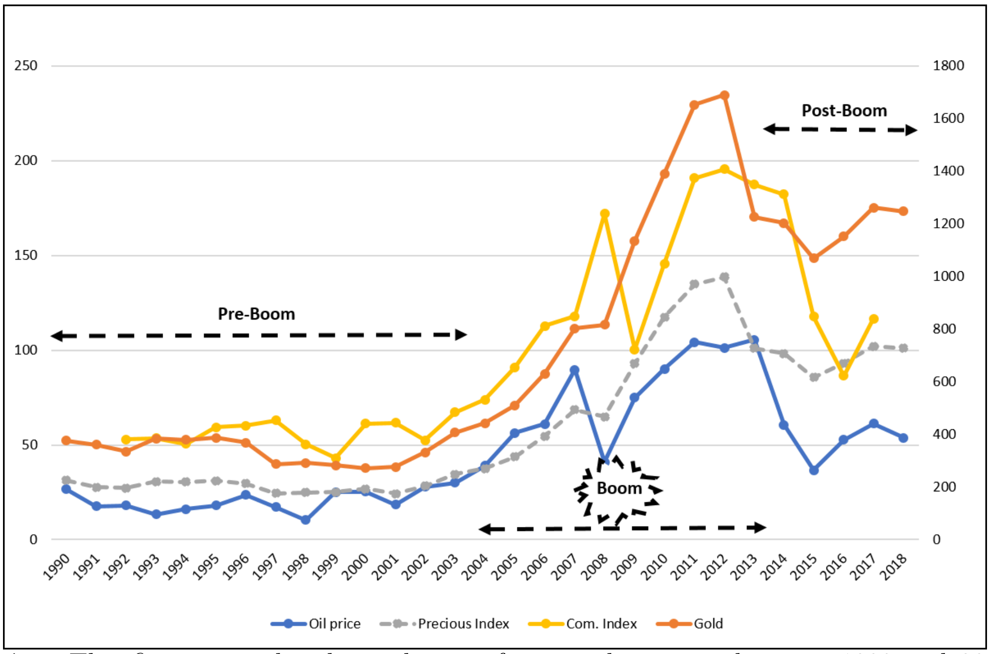
Notes: This figure provides the evolution of employment in the public sector, along with the oil prices in oil-rich countries. The sample period is divided into three main periods. The Pre-Boom ranges from 1991 to 2003, the Boom period ranges from 2004 to 2014, and the Post-Boom period ranges from 2015-2018. See Figure9 in the appendix for a clear view of price dynamics. Author's elaboration on data from ILO.

Figure 8: Evolution of the public wage bills in % of total government expenditures



Notes: This figure shows the evolution of the public wage bills in percent of the share of the total government expenditures in sub-Saharan. The sample period is divided into three main periods. The Pre-Boom ranges from 1991 to 2003, the Boom period ranges from 2004 to 2014, and the Post-Boom period ranges from 2015-2018. See Figure9 in the appendix for a clear view of price dynamics. Author's elaboration on data from IMF.

Figure 9: Evolution of commodity prices



Notes: This figure provides the evolution of commodity prices between 1990 and 2018. The price dynamics are divided into three main periods. The Pre-Boom ranges from 1991 to 2003, the Boom period ranges from 2004 to 2014, and the Post-Boom period ranges from 2015-2018. The variable "'Com. Index"' is the global price index of all commodities. The variable Precious Index includes Gold, Silver, Palladium, and Platinum price Indices. Author's elaboration on data from IMF commodity prices, Federal Reserve Bank of St. Louis, USGS.

Bibliography

Abdychev, A., C. Alonso, E. Alper, D. Desruelle, S. Kothari, Y. Liu, M. Perinet, S. Rehman, A. Schimmelpfennig, and P. Sharma (2018): "The Future of Work in Sub-Saharan Africa," IMF Departmental Papers / Policy Papers 18/18, International Monetary Fund.

Acemoglu, D., A. Finkelstein, and M. J. Notowidigdo (2013): "Income and health spending: Evidence from oil price shocks," *Review of Economics and Statistics*, 95(4), 1079–1095.

Akabzaa, T. (2004): "African mining codes a race to the bottom," *African Agenda*, 7(2), 62–63.

Allcott, H., and D. Keniston (2017): "Dutch Disease or Agglomeration ? The Local Economic Effects of Natural Resource Booms in Modern America," *The Review of Economic Studies*, 85(2), 695 731.

Apergis, N., and M.-S. Katsaiti (2018): "Poverty and the resource curse: Evidence from a global panel of countries," *Research in Economics*, 72(2), 211 – 223.

Araujo, J. D., G. B. Li, M. Poplawski-Ribeiro, and L.-F. Zanna (2013): *Current account norms in natural resource rich and capital scarce economies*, no. 13-80. International Monetary Fund.

Arezki, R., T. Gylfason, and A. Sy (2012): "Beyond the curse: policies to harness the power of natural resources," *AfricaGrowth Agenda*, pp. 12–14.

Arzelier, M.-P. (1998): "Dépenses publiques, ressources naturelles et croissance sectorielle: une comparaison Afrique-Asie," *Revue économique*, 49(1), 119–137.

Aschauer, D. A. (1989): "Is public expenditure productive?," *Journal of monetary economics*, 23(2), 177–200.

Asiedu, E., and D. Lien (2011): "Democracy, foreign direct investment and natural resources," *Journal of International Economics*, 84(1), 99–111.

Asimakopoulos, S., Y. Karavias, et al. (2015): "The impact of government size on economic growth: a threshold analysis," Discussion paper.

Atkinson, G., and K. Hamilton (2003): "Savings, growth and the resource curse hypothesis," *World development*, 31(11), 1793–1807.

Badeeb, R. A., H. H. Lean, and J. Clark (2017): "The evolution of the natural resource curse thesis: A critical literature survey," *Resources Policy*, 51, 123–134.

Bank, W. (2013): "Africa s pulse: An analysis of issues shaping Africa s economic future," .

Barro, R. J. (1996): "Determinants of economic growth: a cross-country empirical study," Discussion paper, National Bureau of Economic Research.

——— (2004): "Sala-i Martin X (2004) Economic Growth," *Second Editions, Mc-Grow-Hill, New York*.

Barro, R. J., and X. Sala-i Martin (1990): "Public finance in models of economic growth," Discussion paper, National Bureau of Economic Research.

——— (1992): "Convergence," *Journal of political Economy*, pp. 223–251.

Baunsgaard, M. T. (2001): *A Primeron Mineral Taxation*, no. 1-139. International Monetary Fund.

Bazzi, S., and C. Blattman (2014): "Economic Shocks and Conflict: Evidence from Commodity Prices," *American Economic Journal: Macroeconomics*, 6(4), 1–38.

Bjornland, H. (1998): "The Economic Effects of North Sea Oil on the Manufacturing Sector," *Scottish Journal of Political Economy*, 45(5), 553–585.

Black, D., T. McKinnish, and S. Sanders (2005): "The Economic Impact Of The Coal Boom And Bust," *Economic Journal*, 115(503), 449–476.

Boadway, R. W., and F. Flatters (1993): *The taxation of natural resources: principles and policy issues*, vol. 1210. World Bank Publications.

Bose, N., M. E. Haque, and D. R. Osborn (2007): "Public Expenditure and Economic growth: A disaggregated analysis for developing countries*," *The Manchester School*, 75(5), 533–556.

Bravo-Ortega, C., and J. De Gregorio (2005): "The relative richness of the poor? Natural resources, human capital, and economic growth," *Natural Resources, Human Capital, and Economic Growth (January 2005). World Bank Policy Research Working Paper*, (3484).

Brewer, K., G. Bergevin, and R. Dunlop (1989): "Fiscal systems," *Resources Policy*, 15(2), 131–148.

Brunnschweiler, C. N. (2008): "Cursing the blessings? Natural resource abundance, institutions, and economic growth," *World development*, 36(3), 399–419.

Brunnschweiler, C. N., and E. H. Bulte (2008): "The resource curse revisited and revised: A tale of paradoxes and red herrings," *Journal of Environmental Economics and Management*, 55(3), 248 – 264.

Bruno, M., and J. Sachs (1982): "Energy and Resource Allocation: A Dynamic Model of the "Dutch Disease"," Working Paper 852, National Bureau of Economic Research.

Campbell, B. (2009): *Mining in Africa: regulation and development.* IDRC.

Campbell, B. K., T. M. Akabzaa, and P. Butler (2004): "Enjeux des nouvelles réglementations minières en Afrique," .

Canning, D. (2001): "World Bank: A database of world infrastructure stocks, 1950-95," *World Bank, Washington, DC.*

Carmignani, F., and A. Chowdhury (2010): "Why are natural resources a curse in Africa, but not elsewhere?," Discussion Papers Series 406, University of Queensland, School of Economics.

Carreri, M., and O. Dube (2016): "Do Natural Resources Influence Who Comes to Power, and How?," Discussion paper.

Caselli, F., and G. Michaels (2013): "Do oil windfalls improve living standards? Evidence from Brazil," *American Economic Journal: Applied Economics*, 5(1), 208–38.

Caselli, F., and A. Tesei (2016): "Resource Windfalls, Political Regimes, and Political Stability," *The Review of Economics and Statistics*, 98(3), 573–590.

Cassidy, T. (2018): "The Long-Run Effects of Oil Wealth on Development: Evidence from Petroleum Geology," Discussion paper.

Chamorro-Narvaez, R. (2012): "The Composition of Government Spending and Economic Growth in Developing Countries: The Case of Latin America," *OIDA International Journal of Sustainable Development*, 5(6), 39–50.

Chen, S.-T., and C.-C. Lee (2005): "Government size and economic growth in Taiwan: A threshold regression approach," *Journal of Policy Modeling*, 27(9), 1051–1066.

Cockx, L., and N. Francken (2016): "Natural resources: A curse on education spending?," *Energy Policy*, 92(C), 394–408.

Colletaz, G., and C. Hurlin (2006): "Threshold effects of the public capital productivity: an international panel smooth transition approach," .

Collier, P. (2007): "Managing commodity booms: lessons of international experience.," .

——— (2010a): "The political economy of natural resources," *social research*, 77(4), 1105–1132.

——— (2010b): "Principles of resource taxation for low-income countries," *The taxation of petroleum and minerals: Principles, Problems and Practice*, 24, 75.

Collier, P., and A. Hoeffler (2008): "Testing the Neocon Agenda: Democracy in resource-rich societies," OxCarre Working Papers 013, Oxford Centre for the Analysis of Resource Rich Economies, University of Oxford.

Conrad, R. F., and B. Hool (1981): "Resource taxation with heterogeneous quality and endogenous reserves," *Journal of Public Economics*, 16(1), 17–33.

Conrad, R. F., and R. B. Hool (1984): "Intertemporal Extraction of Mineral Resources under Variable Rate Taxes," *Land Economics*, 60(4), 319–327.

Corden, W. M. (1984): "Booming sector and Dutch disease economics: survey and consolidation," *oxford economic Papers*, 36(3), 359–380.

Corden, W. M., and J. P. Neary (1982): "Booming sector and deindustrialisation in a small open economy," *The economic journal*, 92(368), 825–848.

Curtis, M., C. Gemell, and J. P. Sykes (2015): "Evaluating the Attractiveness of Fiscal Regimes for New Gold Developments: African and South American Peer Country Comparisons," *Action Research Report*.

Curtis, M., and T. Lissu (2008): *A golden opportunity?: How Tanzania is failing to benefit from gold mining*. Chistian council of Tanzania (CCT).

Cust, J., and T. Harding (2020): "Institutions and the location of oil exploration," *Journal of the European Economic Association*, 18(3), 1321–1350.

Cust, J., and S. Poelhekke (2015): "The Local Economic Impacts of Natural Resource Extraction," *Annual Review of Resource Economics*, 7(1), 251–268.

Cust, J., and A. Zeufack (2020): "The dog that didn't bark: the missed opportunity of Africa's resource boom," Discussion paper, World Bank, The.

Cust, J. F., and J. T. Mensah (2020): "Natural Resource Discoveries, Citizen Expectations and Household Decisions," Policy Research Working Paper Series 9372, The World Bank.

Cust, J. F., and D. Mihalyi (2017): "Evidence for a presource curse ? oil discoveries, elevated expectations, and growth disappointments," Policy Research Working Paper Series 8140, The World Bank.

Damette, O., and M. Seghir (2018): "Natural resource curse in oil exporting countries: A nonlinear approach," *International Economics*.

Daniel, P., M. Keen, and C. McPherson (2010): *The taxation of petroleum and minerals: principles, problems and practice*. Routledge.

Davis, G. A., and J. E. Tilton (2005): "The resource curse," in *Natural resources forum*, vol. 29, pp. 233–242. Wiley Online Library.

——— (2008): "Why the resource curse is a concern," *Mining Engineering*, 60(4), 29–32.

Devarajan, S., V. Swaroop, and H.-f. Zou (1996): "The composition of public expenditure and economic growth," *Journal of monetary economics*, 37(2), 313–344.

Dietsche, E. (2020): "Jobs, skills and the extractive industries: a review and situation analysis," *Mineral Economics*.

Dube, O., and J. F. Vargas (2013): "Commodity Price Shocks and Civil Conflict: Evidence from Colombia," *The Review of Economic Studies*, 80(4), 1384–1421.

El Anshasy, A. A., and M.-S. Katsaiti (2013): "Natural resources and fiscal performance: Does good governance matter?," *Journal of Macroeconomics*, 37, 285–298.

Eregha, P., and E. P. Mesagan (2016): "Oil resource abundance, institutions and growth: Evidence from oil producing African countries," *Journal of Policy Modeling*, 38(3), 603 – 619, Papers presented at the International Symposium in memory of Professor Leif Johansen.

Favero, C. A., M. Hashem Pesaran, and S. Sharma (1994): “A duration model of irreversible oil investment: Theory and empirical evidence,” *Journal of Applied Econometrics*, 9(S1), S95–S112.

Filmer, D., and L. Fox (2014): *Youth employment in sub-Saharan Africa.* The World Bank.

Forster, J. J., and J. Bills (2003): “Comparison of the impact of the fiscal regime on gold projects in Tanzania and Burkina Faso,” *Applied Earth Science: Transactions of the Institutions of Mining and Metallurgy: Section B.*

Fouopi Djiogap, Constant ; Nsi Ella, P. M. N. J. e. N. E. B. (2014): “D penses publiques et croissance dans les pays de la CEMAC,” in *Colloque de l’association d’ conomie th orique et appliqu e (B nin).*

Fouquau, J. (2008): “Modèles à changements de régimes et données de panel: de la non-linéarité à l’hétérogénéité,” Ph.D. thesis, Orléans.

Fouquau, J., C. Hurlin, and I. Rabaud (2008): “The Feldstein–Horioka puzzle: a panel smooth transition regression approach,” *Economic Modelling*, 25(2), 284–299.

Fox, L., and A. Thomas (2016): “Africa’s Got Work To Do : A Diagnostic of Youth Employment Challenges in Sub-Saharan Africa,” *Journal of African Economies*, 25(1), i16 i36.

Fox, L., A. H. Thomas, and C. Haines (2017): “Structural Transformation in Employment and Productivity : What Can Africa Hope For?,” IMF Departmental Papers / Policy Papers 17/02, International Monetary Fund.

Gajigo, O., E. Mutambatsere, and G. Ndiaye (2012): “Royalty rates in African mining revisited: evidence from gold mining,” *Afr Econ Brief*, 3(6), 1–12.

Gastonfils, L. L., and A. Desir (2014): “Nonlinear effects of spending on economic growth in DR CONGO,” *Munich Personal RePEc Archive MPRA*.

Ghura, D., C. Pattillo, et al. (2012): “Macroeconomic policy frameworks for resource-rich developing countries,” *International Monetary Fund, Washington, DC.*

González, A., T. Teräsvirta, and D. v. Dijk (2005): “Panel smooth transition regression models,” Discussion paper, SSE/EFI Working Paper Series in Economics and Finance.

Gonzalez, A., T. Teräsvirta, D. Van Dijk, and Y. Yang (2017): *Panel smooth transition regression models.*

Gylfason, T., and G. Zoega (2006): “Natural resources and economic growth: The role of investment,” *The World Economy*, 29(8), 1091–1115.

Hansen, B. E. (1999): “Threshold effects in non-dynamic panels: Estimation, testing, and inference,” *Journal of Econometrics*, 93(1999), 345–368.

Harding, T., and A. J. Venables (2016): “The Implications of Natural Resource Exports for Nonresource Trade,” *IMF Economic Review*, 64(2), 268–302.

Haselip, J., and G. Hilson (2005): “Winners and losers from industry reforms in the developing world: experiences from the electricity and mining sectors,” *Resources Policy*, 30(2), 87–100.

Havranek, T., R. Horvath, and A. Zeynalov (2016): “Natural resources and economic growth: A meta-analysis,” *World Development*, 88, 134–151.

Heaps, T., and J. F. Helliwell (1985): “The taxation of natural resources,” *Handbook of public economics*, 1, 421–472.

Henri, P. A. O. (2019): “Natural resources curse: A reality in Africa,” *Resources Policy*, 63, 101406.

Herrera, A. M., M. B. Karaki, and S. K. Rangaraju (2017): “Where do jobs go when oil prices drop?,” *Energy Economics*, 64, 469 – 482.

Hogan, L., and B. Goldsworthy (2010): “International mineral taxation: experience and issues,” *The Taxation of Petroleum and Minerals*, p. 122.

Hok, L., P. Jariyapan, P. Buddhawongsa, and R. Tansuchat (2014): "Optimal Size of Government Spending: Empirical Evidence from Eight Countries in Southeast Asia," *The Empirical Econometrics and Quantitative Economics Letters Volume 3, Number 4 pp. 31 - 44.*

Hotelling, H. (1931): "The Economics of Exhaustible Resources," *Journal of Political Economy*, 39(2), 137–175.

Institute, M. G. (2010): "Lions on the move: The progress and potential of African economies," .

Ismail, K. (2010): *The Structural Manifestation of the "Dutch Disease": The Case of Oil Exporting Countries*, no. 10-103. International Monetary Fund.

James, A. (2015): "The resource curse: A statistical mirage?," *Journal of Development Economics*, 114(C), 55–63.

Karimu, A., G. Adu, G. Marbuah, J. T. Mensah, and F. Amuakwa-Mensah (2017): "Natural Resource Revenues and Public Investment in Resource-rich Economies in Sub-Saharan Africa," *Review of Development Economics*, 21(4), e107–e130.

Kormendi, R. C., and P. G. Meguire (1985): "Macroeconomic determinants of growth: cross-country evidence," *Journal of Monetary economics*, 16(2), 141–163.

Kristofer Hamel, B. T., and M. Hofer (2019): "Poverty in Africa is now falling - but not fast enough," .

Kumar, R. (1990): "Policy reform to expand mining investment in subSaharan Africa," *Resources Policy*, 16(4), 242–255.

——— (1991): "Taxation for a cyclical industry," *Resources Policy*, 17(2), 133–148.

Kuralbayeva, K., and R. Stefanski (2013): "Windfalls, structural transformation and specialization," *Journal of International Economics*, 90(2), 273–301.

Laporte, B., and C. De Quatrebarbes (2015): “What Do We Know about Mineral Resource Rent Sharing in Africa?,” *Resources Policy*, 46, 239 249.

Laporte, B., C. De Quatrebarbes, and Y. Bouterige (2016): “La fiscalité minière en Afrique: un état des lieux du secteur de l or dans 14 pays de 1980 à 2015,” Discussion Paper Document de travail P164, Ferdi.

Laporte, B., and G. Rota-Graziosi (2015): *Principles and Dilemmas in Mining Taxation*chap. 24, pp. 399–414. Financing sustainable development by addressing vulnerabilities. FERDI, Econometrica and Ferdi.

Lashitew, A. A., and E. Werker (2020): “Do natural resources help or hinder development? Resource abundance, dependence, and the role of institutions,” *Resource and Energy Economics*, 61, 101183.

Lombe, W., and B. Mwakcheya (2017): *Experience of Mining Fiscal Reform and Renegotiation of Mining contract: The case of Zambia*. Third Word Network-Africa.

Lopez-Villavicencio, A., and V. Mignon (2011): “On the impact of inflation on output growth: Does the level of inflation matter?,” *Journal of Macroeconomics*, 33(3), 455 – 464.

Lundgren, C. J., M. A. H. Thomas, and R. C. York (2013): *Boom, Bust, or Prosperity? Managing Sub-Saharan Africa s Natural Resource Wealth*. International Monetary Fund.

Maponga, O., and P. Maxwell (2001): “The fall and rise of African mining,” *Minerals and Energy-Raw Materials Report*, 16(3), 9–27.

Mavikela, N., S. Mhaka, and A. Phiri (2018): “The inflation-growth relationship in SSA inflation targeting countries,” Working Papers 1801, Department of Economics, Nelson Mandela University.

McMillan, M., D. Rodrik, and i. Verduzco-Gallo (2014): “Globalization, Structural Change, and Productivity Growth, with an Update on Africa,” *World Development*, 63(C), 11–32.

McPherson, C. (2008): "State Participation In The Natural Resource Sectors: Evolution," *Issues And Outlook, IMF*, pp. 11–13.

Mehlum, H., K. Moene, and R. Torvik (2006): "Institutions and the Resource Curse," *Economic Journal*, 116(508), 1–20.

Michaels, G. (2011): "The Long Term Consequences of Resource?Based Specialisation," *Economic Journal*, 121(551), 31–57.

Michieka, N. M., and R. S. Gearhart (2019): "Oil price dynamics and sectoral employment in the U.S.," *Economic Analysis and Policy*, 62, 140 – 149.

Mihalyi, D., and T. Scurfield (2020): "How Africa's Prospective Petroleum Producers Fell Victim to the Presource Curse?," Discussion paper, The World Bank.

Mitchell, P. (2009): "Taxation and investment issues in mining," *Advancing the EITI in the Mining Sector: A Consultation with Stakeholders, Extractive Industries Transparency Initiative, Oslo*, pp. 27–31.

Naito, K., J. P. Williams, F. Remy, and World Bank Group. (2001): *Review of legal and fiscal frameworks for exploration and mining / Koh Naito, Felix Remy, John P. Williams.* Mining Journal Books Ltd., London.

Ndambiri, H., C. Ritho, S. Ng ang a, P. Kubowon, F. Mairura, P. Nyangweso, E. Muiruri, and F. Cherotwo (2012): "Determinants of economic growth in Sub-Saharan Africa: A panel data approach," *Management*, 2(2), 18–24.

Ndoricimpa, A. (2017): "Working Paper 249 - Threshold Effects of Inflation on Economic Growth in Africa: Evidence from a Dynamic Panel Threshold Regression," Working Paper Series 2359, African Development Bank.

Ndoricimpa, A., N. Osoro, and A. Kidane (2016): "Threshold effects of inflation on economic growth in selected African regional economic communities: Evidence from a dynamic panel threshold modeling," *Applied Econometrics*, 41, 5–23.

Nubukpo, K. (2007): "Dépenses publiques et croissance des pays de l'Union économique et monétaire ouest-africaine (UEMOA)," *Afrique contemporaine*, (2), 223–250.

Ojo, O., and T. Oshikoya (1995): "Determinants of long-term growth: some African results," *Journal of African Economies*, 4(2), 163–191.

Otto, J. (1992a): "A global survey of mineral company investment preferences," *Mineral investment conditions in selected countries of the Asia-Pacific region*, pp. 330–342.

Otto, J. (2002): "A global survey of mineral company investment preferences and criteria for assessing mineral investment conditions," *Minerals investment Conditions in Selected Countries of the Asia Pacific Region*.

Otto, J., C. B. Andrews, F. Cawood, M. Doggett, P. Guj, F. Stermole, J. Stermole, and J. Tilton (2006): *Mining Royalties: A Global Study of their Impact on Investors, Government, and Civil Society*. The World Bank.

Otto, J. M. (1992b): "Criteria for Assessing Mineral Investment Conditions: Mineral Investment Conditions in Selected Countries of the Asia-Pacific Region," *United Nations, New York*.

——— (1997): "A national mineral policy as a regulatory tool," *Resources Policy*, 23(1), 1–7.

——— (2006): "The competitive position of countries seeking exploration and development investment," *SPECIAL PUBLICATION-SOCIETY OF ECONOMIC GEOLOGISTS*, 12, 109.

Oyinlola, M. A., O. A. Adeniyi, and I. D. Raheem (2015): "Natural resource abundance, institutions and economic growth in Africa," *African Journal of Economic and Sustainable Development*, 4(1), 34–48.

Papyrakis, E., and R. Gerlagh (2004): "The resource curse hypothesis and its transmission channels," *Journal of Comparative Economics*, 32(1), 181 – 193.

Rodrik, D. (2016): "Premature deindustrialization," *Journal of Economic Growth*, 21(1), 1–33.

Ross, M. L. (2019): "What do we know about export diversification in oil-producing countries?," *The Extractive Industries and Society*, 6(3), 792 – 806.

Russell, B. I., D. Shapiro, and A. R. Vining (2010): "The evolution of the Canadian mining industry: The role of regulatory punctuation," *Resources Policy*, 35(2), 90–97.

Sachs, J. D., and A. M. Warner (1995): "Natural resource abundance and economic growth," Discussion paper, National Bureau of Economic Research.

——— (1997): "Sources of slow growth in African economies," *Journal of African economies*, 6(3), 335–376.

Sachs, L., P. Toledano, J. Mandelbaum, and J. Otto (2012): "Impacts of Fiscal Reforms on Country Attractiveness: Learning From the Facts - Columbia Center on Sustainable Investment," .

Saidu, B. (2007): "How Taxes, Royalties, and Fiscal Regime Stability Affect Mining Investment: A Comparison of Niger and Indonesia," *The Journal of Structured Finance*, 13(3), 105–111.

Schodde, R. (2014): "Key issues affecting the time delay between discovery and development–Is it getting harder and longer," in *Prospectors and Developers Association of Canada (PDAC) Conference*, vol. 3.

Shaukat Khan, T., T. T. T. Nguyen, F. L. Ohnsorge, and R. Schodde (2016): "From commodity discovery to production," *World Bank Policy Research Working Paper*, (7823).

Shimutwikeni, N. S. (2011): "What is a Competitive Fiscal Regime for Foreign Investment? With Special Reference to Namibia and Botswana," *CAR CEPMLP Annual Review*, 14.

Smith, J. L. (2013): "Issues in extractive resource taxation: A review of research methods and models," *Resources Policy*, 38(3), 320–331.

Solow, R. M. (1956): "A contribution to the theory of economic growth," *The quarterly journal of economics*, 70(1), 65–94.

Stefanski, R. R. (2015): "Government Size, Misallocation and the Resource Curse," in *Commodity Prices and Macroeconomic Policy*, ed. by R. Caputo, and R. Chang, vol. 22 of *Central Banking, Analysis, and Economic Policies Book Series*, chap. 6, pp. 197–244. Central Bank of Chile.

Thanh, S. D. (2015): "Threshold effects of inflation on growth in the ASEAN-5 countries: A Panel Smooth Transition Regression approach," *Journal of Economics Finance and Administrative Science.*

Tilton, J. E. (2004): "Determining the optimal tax on mining," in *Natural Resources Forum*, vol. 28, pp. 144–149. Wiley Online Library.

Tole, L., and G. Koop (2010): "Do environmental regulations affect the location decisions of multinational gold mining firms?," *Journal of Economic Geography*, p. lbp064.

UNCTAD (2005): "Rethinking the Role of Foreign Direct Investment," Discussion paper, United Nations Conference on Trade and Development.

Van den Bremer, T. S., and F. Van der Ploeg (2012): "How to spend a windfall: Dealing with volatility and capital scarcity," Discussion paper, Oxford Centre for the Analysis of Resource Rich Economies, University of Oxford.

Van der Ploeg, F. (2011): "Natural resources: curse or blessing?," *Journal of Economic literature*, 49(2), 366–420.

Van der Ploeg, F., and S. Poelhekke (2010): "The pungent smell of red herrings : Subsoil assets, rents, volatility and the resource curse," *Journal of Environmental Economics and Management*, 60(1), 44–55.

Venables, A. J. (2016): "Using natural resources for development: why has it proven so difficult?," *Journal of Economic Perspectives*, 30(1), 161–84.

Warner, A. M. (2015): "Natural Resource Booms in the Modern Era; Is the curse still alive?," IMF Working Papers 15/237, International Monetary Fund.

Yu, P., and P. C. Phillips (2018): "Threshold regression with endogeneity," *Journal of Econometrics*, 203(1), 50 – 68.