

UNIVERSITÉ D'ORLÉANS
ÉCOLE DOCTORALE SCIENCE DE LA SOCIÉTÉ
TERRITOIRE, ÉCONOMIE ET DROIT (SSTED)
LABORATOIRE D'ÉCONOMIE D'ORLÉANS
THÈSE

présentée par :

Arrouna KEITA

soutenue le : **17 décembre 2024**

pour obtenir le grade de : **Docteur de l'Université d'Orléans**

Discipline/ Spécialité : **Sciences Économiques**

**Natural Resources and Fiscal Policy: From Discovery to
Export**

THÈSE dirigée par :

Madame TURCU Camélia

Professeure, Université d'Orléans.

RAPPORTEURS :

Monsieur AFONSO Antonio

Professeur, Université de Lisbonne.

Monsieur DUFRENOT Gilles

Professeur, Sciences Po Aix.

JURY :

Monsieur AFONSO Antonio

Professeur, Université de Lisbonne.

Madame BADARAU Cristina

Professeure, Université de Bordeaux

Monsieur DUFRENOT Gilles

Professeur, Sciences Po Aix.

Monsieur RAULT Christophe

Professeur, Université d'Orléans (Président du Jury).

Monsieur SAADAoui Jamel

Professeur, Université Paris 8.

Monsieur TAMARIT Cecilio

Professeur, Université de Valence.

Madame TURCU Camélia

Professeure, Université d'Orléans.

Monsieur MAS APARISI Alban

Economist, OCDE, Paris (Membre Invité).

Laboratoire d'Économie d'Orléans

Faculté de Droit d'Économie et de

Gestion

Rue de Blois - BP 26739

45067 ORLÉANS Cedex 2

Tél : (33) (0)2 38 41 70 37

Fax : (33) (0)2 38 41 73 80

Arrouna KEITA

Ressources naturelles et politique budgétaire : de la découverte à l'exportation

Résumé :

Cette thèse explore l'interaction complexe entre la découverte, l'exploitation des ressources naturelles, la typologie de ces ressources, l'ouverture commerciale et les politiques budgétaires, et leur impact sur les résultats socio-économiques, notamment les inégalités de revenu et la sécurité alimentaire. Le premier chapitre analyse l'impact des découvertes de ressources naturelles sur la politique budgétaire, mettant en évidence comment l'annonce de telles découvertes influence les comportements économiques et la discipline budgétaire, en particulier dans les pays dotés d'institutions faibles. Le deuxième chapitre examine l'efficacité des dépenses publiques agricoles en Afrique subsaharienne et leur effet sur la sécurité alimentaire, en mettant l'accent sur la proportion des cultures de rente par rapport aux cultures vivrières. Le troisième chapitre étudie comment l'ouverture commerciale interagit avec les types de ressources naturelles (à source ponctuelle et diffuse) pour influencer les inégalités de revenu. Les résultats montrent que la nature des ressources joue un rôle déterminant dans la distribution des effets de l'ouverture commerciale, suggérant que l'investissement dans les ressources à source diffuse, telles que l'agriculture, pourrait favoriser la réduction des inégalités.

Mots clés : Politique budgétaire, Ressources naturelles, Inégalités de revenus, Sécurité alimentaire, Ouverture commerciale.

Natural Resources and Fiscal Policy: From Discovery to Export

Abstract :

This thesis explores the complex interaction between the discovery and exploitation of natural resources, resource typology, trade openness, and fiscal policies, and their impact on socio-economic outcomes, notably income inequality and food security. The first chapter analyzes the impact of natural resource discoveries on fiscal policy, highlighting how the announcement of such discoveries influences economic behavior and fiscal discipline, particularly in countries with weak institutions. The second chapter examines the efficiency of public agricultural expenditures in Sub-Saharan Africa and their effect on food security, emphasizing the proportion of cash crops relative to food crops. The third chapter investigates how trade openness interacts with different types of natural resources (point-source and diffuse-source) to influence income inequality. The findings show that the nature of resources plays a critical role in the distributional effects of trade openness, suggesting that investment in diffuse-source resources, such as agriculture, could help reduce inequalities.

Keywords : Fiscal policy, Natural resources, Income inequality, Food security, Trade Openness.

Laboratoire d'Économie d'Orléans
Rue de Blois - BP 26739 45067 ORLÉANS Cedex 2



L'université d'Orléans n'entend donner aucune approbation ni
improbation aux opinions émises dans les thèses ;
elles doivent être considérées comme propres
à leurs auteurs.

Remerciements

À la conclusion de cette thèse, je constate que je suis profondément transformé. J'ai acquis une grande expérience, gagné en maturité, et je ressens une grande satisfaction d'avoir mené à bien ce projet. Bien évidemment, je reconnais que la réalisation d'un projet d'une telle envergure n'aurait pas été possible sans le soutien inestimable de nombreuses personnes que je tiens à remercier sincèrement.

Je souhaite tout d'abord exprimer mes sincères remerciements à ma directrice de thèse, Camélia, pour avoir eu confiance en moi et pour m'avoir donné cette opportunité. Le chemin de la recherche n'est pas toujours aisé, surtout au début. Cependant, vous avez su m'encourager, me guider, et surtout me faire savoir lorsque je faisais du bon travail. Je vous suis reconnaissant de m'avoir accompagné tout au long de ce projet, et particulièrement pour les opportunités que vous m'avez offertes. Votre pédagogie, votre disponibilité, votre gentillesse et votre écoute ont été inestimables. Alors que ce projet touche à sa fin, je tiens à vous exprimer ma profonde gratitude et j'espère avoir l'occasion de collaborer à nouveau avec vous dans le futur.

Je tiens aussi à remercier AFONSO Antonio et DUFRENOT Gilles pour m'avoir fait l'honneur d'être rapporteurs sur cette thèse, ainsi que BADARAU Cristina, RAULT Christophe, SAADAoui Jamel et TAMARIT Cecilio d'avoir accepté de faire partie de mon jury.

Pour garantir des conditions de travail optimales, il est impératif de disposer d'une équipe de qualité. J'exprime ma sincère gratitude envers l'ensemble du personnel administratif du laboratoire d'économie d'Orléans et de l'Université d'Orléans pour leur contribution essentielle à notre travail quotidien. Je tiens à accorder une mention spéciale à Mélie Hénault, Isabelle Lecras, Pierre-Yves Pochard et Samuel Siewald.

L'une des pierres angulaires de mes années passées au LEO a été la convivialité. Je tiens à remercier l'ensemble des professeurs et maîtres de conférences du laboratoire. Merci d'avoir été constamment disponibles pour prodiguer des conseils et échanger sur divers sujets, que ce soit dans la salle de pause ou ailleurs. Un remerciement particulier à Anthony Paris et Abdoul Aziz Ndoeye, qui ont toujours été disponibles pour des discussions et des conseils. Je tiens également à remercier tous ceux avec qui j'ai eu des conversations non axées exclusivement sur la recherche, qui ont égayé mes journées et m'ont motivé à me rendre au bureau.

Une grande partie de mes remerciements s'adresse évidemment à mes camarades qui ont fait partie de mon quotidien pendant ces 4 années et demie. Je tiens à remercier l'ensemble des doctorants avec qui j'ai partagé des moments, que ce soient des moments de joie, de doute ou de colère. Sans votre soutien inestimable, tout cela aurait été bien plus difficile.

Je tiens aussi à exprimer ma gratitude envers ceux qui étaient déjà en fin de parcours, voire avaient déjà franchi la ligne d'arrivée lorsque je suis arrivé. Merci de m'avoir rassuré en me disant : "Ne t'inquiète pas, nous voyons tous le bout du tunnel", et de me l'avoir démontré. En particulier, je remercie Pauline, Inessa, Hugo, Askandarou et Wassim, qui ont été comme des boussoles pour nous, toujours disponibles et prêts à nous guider.

Je tiens à exprimer ma gratitude envers mes camarades de promotion du Master, avec qui j'ai débuté et achevé ce doctorat : Mamadou, Bienvenu, Julie et Lucien. Mamadou a toujours été le pilier qui réunissait notre groupe à la fin des cours en Master, et même plus tard pendant la thèse, il était souvent l'initiateur de nos soirées, que nous passions généralement chez lui. Avec lui, j'ai appris à lâcher prise et à profiter des bons moments sans me sentir coincé. Bien que travailleur acharné, il savait aussi nous faire oublier nos soucis et partager des moments de fête ; il est bien plus qu'un ami, il est comme un frère pour moi, et ce sentiment est réciproque. Je ne peux évoquer Mamadou sans penser à sa compagne Aïcha. Ils forment un duo indissociable, et Aïcha nous accueillait toujours avec ses plats délicieux, préparés avec fierté pour chacun de nos passages. Elle disait souvent en plaisantant que Mamadou et elle devraient m'adopter, tant ils appréciaient nos moments ensemble, ce qui était réciproque.

Bienvenu, mon compagnon du quotidien, vivait tout près de chez moi. En dehors des soirées avec Mamadou, Aïcha et les autres, c'est avec lui que j'ai partagé les mêmes joies et les mêmes difficultés. Nous avions l'habitude de marcher ensemble, de nous confier nos projets, nos soucis et nos succès, trouvant toujours le réconfort dans notre amitié. Lucien et Julie, quant à eux, nous ont rejoints au Master 2, mais c'est durant la thèse que notre complicité s'est renforcée. Julie, avec sa bienveillance et son esprit ouvert, a été comme une adorable maman pour nous tous, toujours présente et attentive. Quant à Lucien, il a été pour moi un véritable mentor en matière de connaissances techniques. Bien que plus jeune, il a su me transmettre un savoir précieux et m'a toujours offert son soutien ; nous partageons les mêmes ambitions pour l'avenir, et il a été d'une bienveillance constante tout au long de ce parcours.

Je tiens également à remercier West, qui a rejoint l'aventure en cours de route et faisait partie de la promotion suivante, mais qui est rapidement devenu un compagnon de route incontournable. Bien que de la promotion après nous, il a toujours été à mes côtés durant la thèse, un peu comme Bienvenu l'était pour moi durant le Master. Nous partagions une relation unique, remplie de rires et de moments mémorables. Avec son sens de l'humour inégalé, West savait toujours comment détendre l'atmosphère et me remonter le moral. Ses blagues et sa bonne humeur resteront parmi les souvenirs les plus joyeux de ces années de doctorat.

Au fil de la thèse, d'autres amis et collègues ont rejoint cette aventure : Vakaba, Asbath, Yacouba et Allassane. Ensemble, nous formions une seconde famille, passant des heures à débattre de tout et de rien, savourant ces discussions sans fin. Vakaba et Allassane, bien qu'ils ne soient pas doctorants, se joignaient toujours à nous le soir, et notre amitié me rappelait celle que l'on crée durant l'enfance. Ces instants partagés m'émeuvent encore aujourd'hui, et je me rends compte qu'ils feront toujours partie de mes souvenirs les plus chers.

Je tiens à remercier tout particulièrement Sébastien, dont la bienveillance et l'attention ont toujours été d'un grand réconfort pour moi. Il s'est constamment soucié de mon bien-être, avec une gentillesse et une disponibilité inégalées. Son soutien et son amitié ont été précieux tout au long de ce parcours, et je lui en suis profondément reconnaissant.

Malheureusement, je manque de place et de mots pour remercier tous les doctorants et toutes les doctorantes du laboratoire comme il se doit. Je tiens à m'excuser si j'oublie des personnes mais sachez que le LEO a été pour moi comme une seconde famille. Merci à Arnaud, Cristina, Mehdi de notre salle et Mehdi de l'autre salle, Flavien, Lin, Rabbie, Safa, Sarah, Wiem, Yanick, José, Matilda, Aynur, Sahar.

J'aimerais également souligner l'importance de mes parents, mon père Abdoulaye et ma mère Massita. Je tiens à vous exprimer ma profonde gratitude pour m'avoir toujours encouragé à aller de l'avant et jamais à renoncer. Merci d'avoir toujours eu foi en moi et de m'avoir soutenu. Sans vous, je ne serais pas là où j'en suis aujourd'hui. Vous avez toujours fait preuve d'une patience inébranlable. Je vous envoie tout mon amour, et j'espère que ce travail vous rendra fiers. Mes remerciements vont également à ma famille proche, à mes frères et sœurs Kady, Fatim, Dado, Barou, toujours intéressés par mon parcours et présents dans les moments cruciaux, ainsi qu'à mon beau-frère Ismael, qui m'a toujours encouragé et su trouver les mots justes.

Naturellement, je tiens aussi à exprimer ma gratitude envers mes amis et mes proches. Ce sont les personnes qui ont toujours vu en moi un potentiel que je ne suis pas toujours parvenu à voir moi-même. Ils n'ont jamais douté, ne serait-ce qu'une seconde, de ma capacité à mener cette thèse à son terme. Merci à Guibo, Ousman, Papis, Lasbil et Nébié.

Enfin, il reste une personne qui a tant fait pour moi autant d'un point de vue académique que personnel. Kady, tu as toujours été comme une seconde maman pour moi. Depuis que je suis tout petit, tu as veillé sur moi avec une bienveillance infinie, prenant soin de moi, de mon avenir, et me montrant le chemin vers la réussite. Mon enfance a été merveilleusement marquée par ta présence ; nous avons passé tellement de bons moments ensemble, et je me souviens encore de ces instants où nous regardions nos dessins animés préférés : *La Famille Berenstain*, *Les contes de Tiji*, *Les Trois Petites Sœurs*, *Mona le Vampire*, *Arthur*, *Pépin trois pommes* et tant d'autres. Tu m'apprenais plein de choses, et je me sentais chanceux d'avoir une sœur comme toi. Je t'aime énormément et j'espère de tout cœur qu'à l'avenir, tu pourras te libérer un peu de ton travail pour que nous puissions revivre ensemble ces moments précieux. Merci pour tout, Kady, j'espère que tu es fière de moi.

Aujourd'hui, je suis plutôt fier de moi, et c'est largement grâce à vous tous.

Contents

List of Figures	iv
List of Tables	vi
General Introduction	1
1 Natural Resource Discoveries and Fiscal Discipline	13
1.1 Introduction	13
1.2 Literature Review	15
1.3 Methodology and data	17
1.3.1 Computing the cyclical coefficient	17
1.3.2 Addressing the link between natural resource discoveries and the cyclical of fiscal policy: a Local Projections approach	18
1.3.3 Data and descriptive statistics	19
1.4 Results and interpretations	23
1.4.1 High-income countries and upper-middle income countries (HMI)	23
1.4.2 Low-income and lower-middle income countries (LMIs)	24
1.5 Robustness Tests	26
1.5.1 Different sample sizes	26
1.5.2 Different specifications	27
1.5.3 Another measure of the cyclical coefficient	27
1.6 Conclusion	28
1.7 Appendix	30
2 Public Agricultural Expenditure Efficiency and Food Security in Sub-Saharan African Countries: Cash Crops or Food Crops ?	41
2.1 Introduction	41
2.2 Literature review	44
2.2.1 <i>Public agricultural expenditure and food security</i>	44
2.2.2 <i>Cash crops production and food security</i>	44

2.3	Stylised facts	45
2.4	Empirical methodology	47
2.4.1	<i>Theoretical conception of efficiency</i>	47
2.4.2	<i>Econometric strategy</i>	48
2.5	Data and statistics	50
2.6	Results and interpretations	52
2.6.1	<i>Public agricultural expenditure efficiency scores</i>	53
2.6.2	<i>The effect of cash crops production on public agricultural expenditure efficiency</i> . .	55
2.7	Robustness tests	56
2.7.1	<i>Robustness 1 : Alternative measure of efficiency scores</i>	56
2.7.2	<i>Robustness 2 : Alternative samples</i>	57
2.7.3	<i>Robustness 3 : Alternative econometric method</i>	57
2.7.4	<i>Robustness 4 : Additional control variables</i>	58
2.7.5	<i>Robustness 5 : Revisiting the effect of the policy of increasing public agricultural expenditure on food security in light of our findings</i>	59
2.8	Conclusion and discussion	59
2.9	Appendix	61
3	Trade Openness, Natural Resources Abundance and Income Inequality	73
3.1	Introduction	73
3.2	Literature Review	76
3.3	Data and statistics	78
3.3.1	Data	78
3.3.2	Statistics	80
3.4	Methodology	84
3.5	Econometric Results	86
3.6	Robustness Tests	89
3.6.1	Robustness 1: sub-samples, relative rich VS poor in diffuse-source natural resources	89
3.6.2	Robustness 2: sub-samples, relative rich VS poor in diffuse-source natural resources, alternative measure of diffuse-source and point-source natural resources wealth . .	91
3.6.3	Robustness 3: Alternative methodology	92
3.7	Conclusion	94
3.8	Appendix	95
	General conclusion	107
	Résumé en français	125

List of Figures

1	Inequality trend	3
2	Number of acutely food-insecure people in need of emergency aid	4
3	Need of food aid at the world level	4
4	Effect of revenue volatility from natural resources	6
1.1	Distribution of computed Total Spending Cyclicity Coefficient by Country Income Level	21
1.2	Institutional Quality by group of countries	22
1.3	Fiscal rules adoption by group of countries	22
1.4	Direct effect of natural resource discoveries (equation (1.2)), at the 5% and 10% threshold.	23
1.5	Effect of natural resource discoveries in interaction with institutional quality (equation (1.3)) and fiscal rules (equation (1.4)), at the 5% and 10% threshold.	24
1.6	Direct effect of natural resource discoveries (equation (1.2)), at the 5% and 10% threshold.	25
1.7	Effect of natural resource discoveries in interaction with institutional quality (equation (1.3)) and fiscal rules (equation (1.4)), at the 5% and 10% threshold.	25
1.8	Public investment and consumption expenditure, direct effect of natural resource discoveries (equation (1.2)), at the 5% and 15% threshold.	26
1.9	Distribution of revised computed Total Spending Cyclicity Coefficient by Country Income Level	28
1.10	Distribution of computed Government Investment cyclicity coefficient by Country Income Level	34
1.11	Distribution of computed Government consumption cyclicity coefficient by Country Income Level	34
1.12	Direct effect of natural resource discoveries (equation (1.2)), at the 5% and 10% threshold.	35
1.13	Effect of natural resource discoveries in interaction with institutional quality (equation (1.3)) and fiscal rules (equation (1.4)), at the 5% and 10% threshold.	35
1.14	Public investment and consumption expenditure, direct effect of natural resource discoveries (equation (1.2)), at the 5% and 15% threshold.	36
1.15	Effect of natural resource discoveries interacting with alternative measures of institutional quality (equation (1.3)), at the 5% and 10% threshold.	36
1.16	Direct effect of natural resource discoveries (equation (1.2)), at the 5% and 10% threshold.	37

1.17	Effect of natural resource discoveries in interaction with institutional quality (equation (1.3)) and fiscal rules (equation (1.4)), at the 5% and 10% threshold.	37
1.18	Public investment and consumption expenditure, direct effect of natural resource discoveries (equation (1.2)), at the 5% and 15% threshold.	38
1.19	Direct effect of natural resource discoveries (equation (1.2)), at the 5% and 10% threshold.	38
1.20	Effect of natural resource discoveries in interaction with institutional quality (equation (1.3)) and fiscal rules (equation (1.4)), at the 5% and 10% threshold.	39
1.21	Public investment and consumption expenditure, direct effect of natural resource discoveries (equation (1.2)), at the 5% and 15% threshold.	39
2.1	Arable land (hectares) per capita in 2018	45
2.2	Prevalence of undernourishment (% of total population) in 2018	46
2.3	Change in the share of public agricultural expenditure from 2000 to 2018	46
2.4	Efficiency representation	47
2.5	Cash crops % share of harvested area in 2022	51
2.6	Cash crops % share of harvested area (Average 2000-2018)	52
2.7	Computed BTE scores: Average 2003-2017	54
2.8	Computed BTE 2 scores: Average 2003-2017	57
2.9	Computed TE scores : Average 2003-2017	61
2.10	Africa Infrastructure Development Index : Average 2003-2017	62
2.11	Fish production-to-population ratio : Average 2003-2017	63
3.1	Relationship between diffuse-source natural resources and income inequality (Average 1980-2023)	81
3.2	Relationship between point-source natural resources and income inequality (Average 1980-2023)	82
3.3	Share by commodity in total commodities export (average 1995-2018)	84
3.4	Inequality trend	95
3.5	Distribution of total natural resources share in total export (average 1988-2022)	96
3.6	Self-employment (% of total employment) and diffuse-source natural resources (Average 1990-2018)	97
3.7	Self-employment (% of total employment) and point-source natural resources (Average 1990-2018)	98
3.8	Share of total natural resources in total export (average 1995-2018)	99
3.9	Share of total natural resources in total export (1995)	100
3.10	Share of total natural resources in total export (2018)	101
3.11	Share by commodity in total commodities export (1995)	102
3.12	Share by commodity in total commodities export (2018)	103

List of Tables

1.1	Spatial and Temporal Distribution of Large Oil and Gas Deposits: DISC indicates the number of discoveries per 10-year interval (e.g. Disc1980s indicates the number of discoveries that took place in the 1980s).	20
1.2	List of low income and lower-middle income countries	30
1.3	List of high income and upper middle income countries	30
1.4	List of Countries removed from the sample	30
1.5	List and definitions of variables	33
2.1	Main results, cash crops production and PAEE	56
2.2	Sensitivity to alternative BTE scores	64
2.3	Sensitivity to alternative BTE scores and to alternative sample	64
2.4	Sensitivity to alternative methodology, alternative BTE scores and to alternative sample	65
2.5	Sensitivity to additional variables and to alternative sample	65
2.6	Sensitivity to alternative BTE scores, to additional variables and to alternative sample	66
2.7	Sensitivity to alternative methodology, alternative BTE scores, to additional variables, and to alternative sample	66
2.8	Revisiting the impact of public agricultural expenditure on food security	67
2.9	List of Variables and their Sources	69
2.10	List of Agricultural Products	70
2.11	List of countries	70
2.12	List of Countries in Robustness 5	71
2.13	Disasters associated with food shortage, crop failure or famine	71
3.1	Direct effects on income inequalities	87
3.2	Interaction effects on income inequalities : trade openness and diffuse source natural resource	88
3.3	Interaction effects on income inequalities : trade openness and point source natural resource	88
3.4	Direct effects on income inequalities: countries relatively poor in diffuse-source natural resources	90

3.5	Direct effects on income inequalities: countries relatively rich in diffuse-source natural resources	91
3.6	Direct effects on income inequalities: countries relatively poor in diffuse-source natural resources	91
3.7	Direct effects on income inequalities: countries relatively rich in diffuse-source natural resources	92
3.8	Direct and interaction effects on income inequality	93
3.9	List of Variables and their Sources	95
3.10	Classification of HS6 Codes by Natural Resource Type	103
3.11	Countries used in the sample	104

General Introduction

General Introduction

“My dear Governor: The dust storms and floods of the last few years have underscored the importance of programs to control soil erosion. I need not emphasize to you the seriousness of the problem and the desirability of our taking effective action, as a Nation and in the several States, to conserve the soil as our basic asset. The Nation that destroys its soil destroys itself.”

Franklin D. Roosevelt, Letter to all State
Governors on a Uniform Soil
Conservation Law. - February 26, 1937

One of the major challenges of our decade is the sustainable management of global natural resources to curb climate change while ensuring a just energy transition. This transition requires an in-depth understanding of the dynamics of resource-rich countries, particularly regarding their fiscal policies and the socio-economic impacts related to the discovery, exploitation, and commercialization of these resources. Indeed, these countries possess both polluting resources, such as oil and gas—still vital to the global economy—and essential resources for the energy transition, such as critical metals. Furthermore, other trade-offs emerge: renewable resources such as forests, fisheries, and agricultural land - which are vital for sustainable development and global food security - are often affected by the exploitation of fossil resources. Thus, managing all these resources relies on a complex interaction among them and understanding their socio-economic impacts in the countries that possess them.

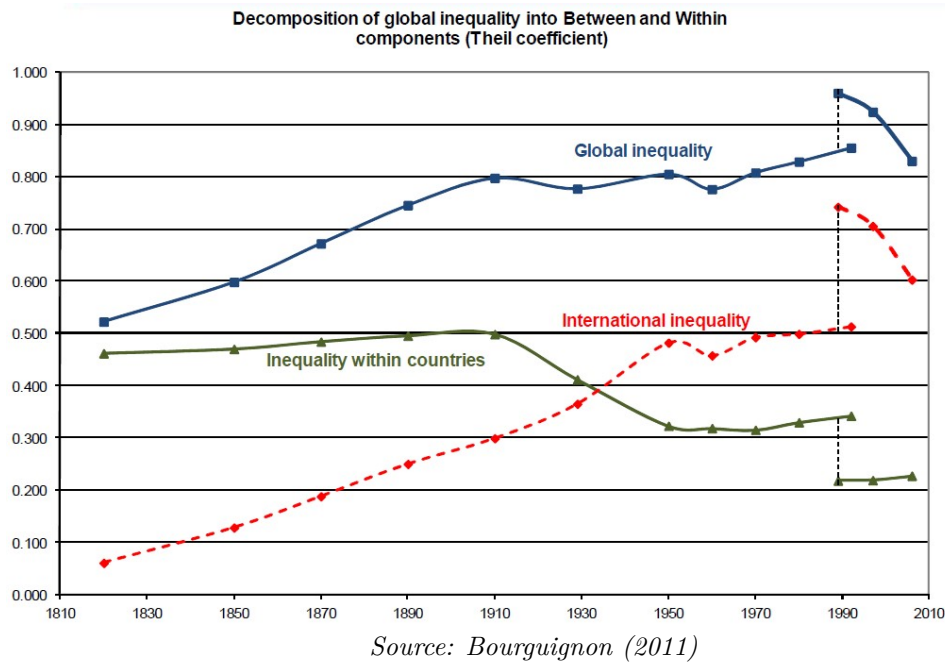
The global energy transition represents a crucial opportunity to reduce carbon emissions and address climate change. However, this transition needs to be equitable, especially for resource-rich countries, which are both essential to this transformation and vulnerable to its impacts (United Nations Environment Programme (UNEP), 2024; Organisation for Economic Co-operation and Development (OECD), 2022). These economies are often characterized by paradoxical situations: natural resource abundance can lead to prosperity but also to economic failures. In the literature on the economic performance of resource-rich

countries, largely based on the analysis of the effects of fossil and precious metal endowments, natural resource abundance has often been associated with both economic success and failure, with evidence supporting both perspectives. For instance, it has been shown that natural resources slow economic growth in resource-rich developing countries (Ploeg, 2011), limit export diversification (Ross, 2017), contribute to currency appreciation (Stokke, 2007), reduce foreign direct investment in non-resource sectors (Poelhekke and van der Ploeg, 2013), and increase income inequality (Bourguignon and Morrisson, 1990; Ross, 2001*b*; Gylfason and Zoega, 2003). Conversely, they have also been linked to positive economic effects, such as reduced public debt and low inflation (Fasano, 2002), high public spending in education (Sarraf and Jiwanji, 2001), and strong economic growth (Larsen, 2006).

However, the economic failures of resource-rich countries are particularly noted in developing economies with weak institutional quality, where poor governance and corruption prevail (Acemoglu and Robinson, 2012). This economic failure, known as the *resource curse* (Ross, 1999*a*; Humphreys, 2007; Shaffer and Ziyadov, 2011), has fueled a sense of injustice in these countries, where populations feel disadvantaged by the effects of globalization and the trade of their natural resources. These frustrations have often led to social unrest, and even military coups, as seen in Mali in 2020, Burkina Faso in 2022, and Niger in 2023 (Ross, 2001*a*; Collier and Hoeffler, 2004; Jensen and Wantchekon, 2004; Ross, 2012; Deutsche Welle, 2023).

It is important to note that globalization, in all its forms (i.e. capital flows, and trade), is often perceived as one of the underlying causes of crises, economic difficulties, and social inequalities (Stiglitz, 2002; Milanovic, 2017; Castañeda and Shemesh, 2020). For a long time, it was believed that trade liberalization would benefit all parties, as predicted by traditional international trade theory (Ricardo, 1817*a,b*; Baldwin, 1992). However, according to literature and stylized facts, reality has deviated from these expectations (Lee et al., 2020; Le et al., 2020; Antràs et al., 2017). This is clearly illustrated in Figure 1, where we can see the trends in inequalities in a context of increasing globalization.

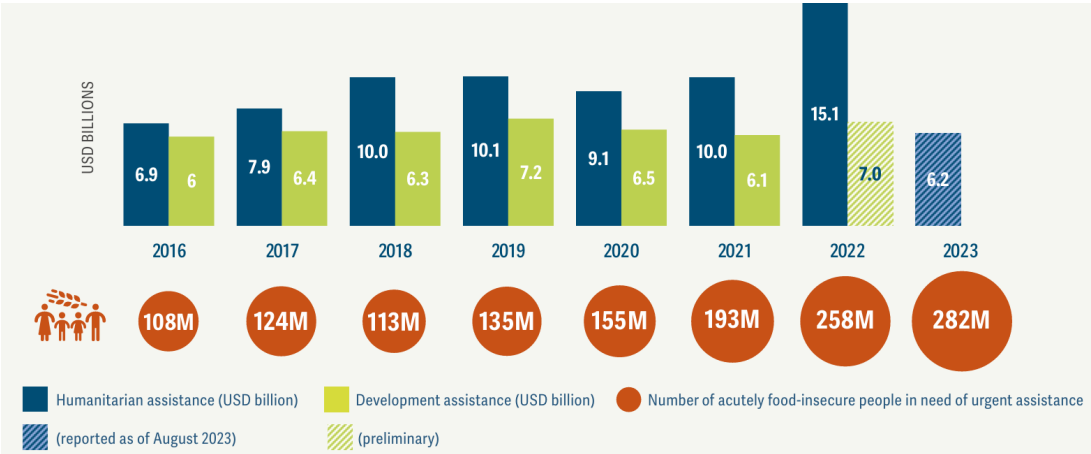
Figure 1: Inequality trend



In addition, according to OECD (2018), in recent decades, the poorest 40% of the population in many countries have benefited very little from their countries' economic development and export diversification. Thus, many resource-rich countries have fallen victim to the *resource curse* in their natural resource trade.

Beyond the *resource curse*, the exploitation of fossil resources and precious metals has devastating effects on renewable natural resources, including forests, agricultural land, and fishery ecosystems, exacerbating biodiversity loss and food insecurity (UNEP, 2022; Earthjustice, 2023). The issue of food insecurity is becoming increasingly alarming, as highlighted by recent data showing a growing number of people affected globally. The exploitation of fossil resources does not only have direct effects on food insecurity through the degradation of agricultural soils and biodiversity but also through the broader impact of climate change it triggers. The extraction and burning of fossil fuels contribute significantly to greenhouse gas emissions, which accelerate global warming and disrupt weather patterns. These climatic shifts manifest as more frequent and severe droughts, unpredictable rainfall, and other extreme weather events that undermine agricultural productivity and stability. Consequently, the capacity of local farmers to sustain crop yields diminishes, and the resilience of food systems weakens. Figure 2 underscores this point, depicting the increasing trend of people affected by acute food insecurity over recent years, emphasizing the global scale of the crisis and its links to environmental and climate-related disruptions.

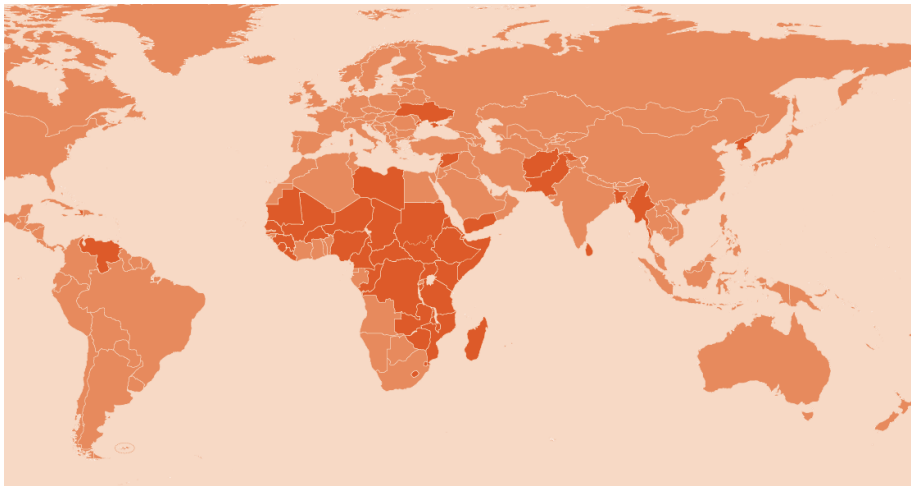
Figure 2: Number of acutely **food-insecure** people in need of emergency aid



Source: Food Security Information Network (FSIN) (2024).

These negative effects are particularly evident for populations in developing countries, particularly vulnerable ones, that are the first to suffer from these consequences (Earthjustice, 2023). These countries, already facing food insecurity issues, could see their situation worsen. This is the case, for example, in Sub-Saharan Africa, where food insecurity has been intensifying despite ongoing efforts to bolster agricultural investment. Figure 3 focuses on this region, illustrating the most vulnerable areas that face severe food insecurity (e.g. out of the 45 countries in the world in need of food aid, 33 are African). This visual emphasizes how Sub-Saharan Africa is disproportionately impacted due to its reliance on climate-sensitive agriculture and limited adaptive capacity. Addressing the dual challenge of resource exploitation and its environmental consequences is imperative to mitigating the compounding crisis of food insecurity in these affected areas.

Figure 3: Need of food aid at the world level



Source: FAO (2024).

Meanwhile, global demand for critical metals such as lithium, cobalt, and nickel is expected to triple by 2030 to meet the needs of the energy transition (UNEP, 2024). This surge in demand could in-

crease the dependence of producing countries, heightening geopolitical tensions and environmental and social challenges, such as ecosystem degradation, food security risks, human rights violations, and social conflicts.

For these resource-rich countries—many of which are among the least equipped to manage the risks and seize the opportunities of the low-carbon economy—the energy transition could, without adequate policies, significantly increase income inequality and social crises. This highlights the importance of sound fiscal policies and transparent practices to avoid repeating the mistakes associated with the *resource curse* and to ensure that the energy transition benefits everyone, including the most vulnerable populations (Dalabajan et al., 2022).

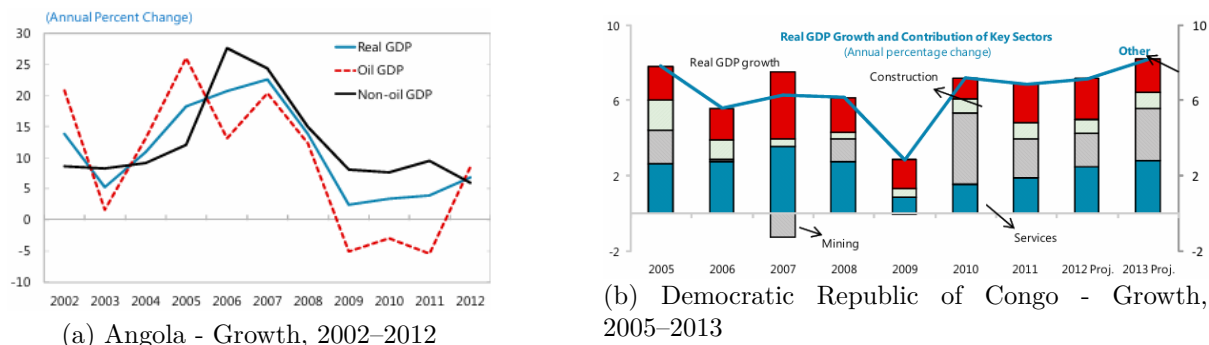
From the above, it emerges that the socio-economic outcomes of the discovery, exploitation, and commercialization of natural resources, as well as the energy transition, will heavily depend on the quality of economic and social policies, particularly the quality of the fiscal policies adopted by the affected countries. Fiscal policy is crucial, as bad budget management leads to permanent fiscal deficits, typically financed by public debt. In this context, the issue of sovereign debt sustainability arises—a challenge faced by many economies. This problem has become even more critical following recent crises, such as the Covid-19 pandemic and the war that began in Ukraine in 2022, which have weakened the fiscal capacities of many countries, resulting in increased deficits and record debt levels (UNCTAD, 2023). High levels of public debt could prevent governments from raising the necessary funds on international capital markets and making essential investments for their economic development, thereby reducing their ability to respond to future shocks. Indeed, excessive debt burdens often constrain available fiscal resources, forcing governments to prioritize debt service over key investments, such as social spending and climate resilience measures. This inability to invest could exacerbate challenges, particularly for countries vulnerable to climate shocks, increase inequality, and raise the risk of long-term social instability.

The necessity of sound fiscal policy in resource-rich countries is widely recognized as essential for economic stability and long-term sustainability (Bleaney and Halland, 2009; Gelb and Grasmann, 2010; Collier and Goderis, 2012). These countries often face significant challenges due to commodity price volatility, the finite nature of natural resources, and the risks of excessive dependence on resource revenues (Bleaney and Halland, 2009). Revenue volatility from natural resources can lead to major economic shocks, as shown by examples from Congo and Angola (Figure 4 respectively), which saw their oil revenues drop by more than half in 2009, severely impacting their public budgets (Bova et al., 2018; Fund, 2010; Arezki and Gylfason, 2011).

Well-designed fiscal policy can mitigate these fluctuations through countercyclical measures, saving during periods of high prices to stabilize public spending during price downturns (Larsen, 2006; Sarraf and Jiwaji, 2001). Prudent management reduces macroeconomic imbalances, an approach advocated by institutions such as the International Monetary Fund (IMF) (Bova et al., 2018).

This thesis proposes an integrated approach to understanding how natural resource discovery, exploitation, resource typology, trade openness, and fiscal policies interact to shape socio-economic outcomes,

Figure 4: Effect of revenue volatility from natural resources



Source: IMF Article IV consultation and post program monitoring 2012

such as income inequality and food security. The central research questions guiding this work are as follows:

- How do natural resource discoveries affect fiscal policies and economic management in resource-rich countries?
- What mechanisms underlie the relationship between public agricultural spending and food security, particularly in regions with a complex balance of cash and food crop production?
- How do trade openness and natural resources impact income inequality, and why do their effects differ between countries rich in *point-source* versus *diffuse-source* natural resources?

These questions frame the investigation presented in the three core chapters of the thesis, each addressing a specific dimension of these interactions.

The **first chapter** addresses the impact of natural resource discoveries on the fiscal policy of resource-rich countries. The discovery of new resources, such as vast oil or gas deposits, is often perceived as an economic boon for the countries involved. However, this boon can also become a curse. This curse can emerge when resource discoveries are followed by poor fiscal management. In such cases, the abundance of natural resources, instead of stimulating economic growth, ends up hindering the development of the affected countries, leading to macroeconomic imbalances, limited export diversification, and increased dependency on a single economic sector.

This chapter focuses on the anticipated effects of natural resource discoveries, particularly the economic shocks induced by the announcement of these discoveries before exploitation begins. Indeed, the announcement of new resource discoveries can create expectations of significant future revenue, influencing the behavior of economic actors and the fiscal policies of the concerned governments. These future revenue expectations can lead to fiscal indiscipline, especially in countries with weak institutions and procyclical budget management. In other words, instead of maintaining fiscal discipline, these countries tend

to increase public spending in anticipation of future revenue, thereby worsening possibly the situation of their public finances.

Norway's experience after discovering oil in the North Sea in the 1960s and 1970s highlights the economic impacts of such discoveries. Anticipating future revenue, the country reduced its savings rate, boosted investments, and incurred a current account deficit, reaching 15% of GDP in 1977 (Arezki et al., 2017). Public debt also rose to finance oil infrastructure, illustrating how economic expectations tied to resource discoveries can have significant effects well before actual revenue begins.

In this context, this chapter analyzes the impact of natural resource discoveries on fiscal policies in both low- and high-income countries, using Local Projection Models (LPM). Our study shows that in high-income countries, governments manage to maintain fiscal discipline even after significant resource discoveries. However, low-income countries tend to adopt procyclical fiscal policies, increasing public spending as early as the first year following a discovery, with differentiated effects between public consumption and public investment expenditures. The results also show that institutional quality and the presence of fiscal rules play a crucial role in moderating the effects of these discoveries on fiscal policy.

Hence, this chapter highlights the necessity for resource-rich countries to develop strong institutional frameworks and fiscal rules to effectively manage natural resources and avoid the possible trap of the *resource curse*. In resource-rich countries, weak institutions can lead to mismanagement of revenue and inefficient spending, thereby reducing the potential benefits of natural resources. Adhering to fiscal rules, such as those governing the use of resource revenues, enhances transparency and reduces the risks of mismanagement. For instance, in low- and middle-income countries, implementing fiscal rules can help moderate the tendency toward procyclical fiscal policies.

In summary, sound fiscal policy is crucial for resource-rich countries to protect against shocks, and guarantee the equitable use of resource revenues.

The **second chapter** focuses on another key consequence of natural resource management, namely food security. Indeed, in many resource-rich economies, the exploitation of resources and climate change also affect renewable natural resources, including forests, agricultural land, and fishery ecosystems, exacerbating possibly biodiversity loss and food insecurity.

This chapter examines the relationship between public agricultural spending and food security in Sub-Saharan African countries, where food insecurity has become a persistent and alarming issue. Food security, defined as consistent access to sufficient, safe, and nutritious food for a healthy and active life (Food and Agriculture Organization of the United Nations (FAO), 1996), relies on four dimensions: stability, access, availability, and biological utilization (FAO, 1996). Food security can be threatened by numerous environmental, socio-economic, and security factors, such as climate change, the COVID-19 pandemic, and recent geopolitical conflicts, notably the war in Ukraine (FAO, 2020; Campi et al., 2021; Nchanji and Lutomia, 2021). In 2023, approximately 282 million people faced acute food insecurity, requiring urgent assistance (Food Security Information Network (FSIN), 2024), with the vast majority located in Africa, particularly Sub-Saharan Africa.

The importance of this issue is reinforced by the Sustainable Development Goals (SDGs), particularly SDG 2, which aims to end hunger by 2030 (United Nations (UN), 2015). In light of this reality, African leaders and international institutions, such as the FAO and the International Fund for Agricultural Development (IFAD), have advocated for increased public spending in the agricultural sector to improve productivity, encourage diversification, and ensure nutritious food (FAO, IFAD, WFP, 2015). However, despite the efforts of African governments, including the Maputo and Malabo Declarations that committed countries to allocate at least 10% of public expenditure to agriculture, results in terms of food security remain mixed in many countries in the region (Fontan Sers and Mughal, 2019; FAO and al., 2022).

This chapter analyzes the efficiency of public agricultural expenditures (EDPA) in Sub-Saharan Africa. Mobilizing resources to finance agriculture remains a major challenge for African governments, particularly in the face of recent crises such as the COVID-19 pandemic and the war in Ukraine, which have disrupted supply chains and worsened budget imbalances in many countries. These crises have increased import bills, food subsidies, and social protection measures for vulnerable populations. They have also exacerbated budget difficulties, limiting the ability of countries to invest in their food systems and respond to future shocks (Rother et al., 2023).

This chapter seeks to answer a key question: why do public agricultural expenditures fail to ensure food security in Sub-Saharan Africa? To address this, the study examines the agricultural production structure of the region, which is divided between food crops for local consumption and cash crops primarily for export. The impact of cash crops, such as coffee, cocoa, and cotton, on food security is debated in the literature. While some studies highlight positive effects on food security (Kuma et al., 2019; Bitama et al., 2020), others report negative effects (Masanjala, 2006; Adjimoti and Kwadzo, 2018).

This chapter analyzes how the structure of agricultural production—specifically, the share of cash crops—affects the efficiency of public agricultural spending in the region. The approach involves two steps: first, it calculates the bias-corrected technical efficiency (BTE) scores of Sub-Saharan African countries using the Bootstrap Data Envelopment Analysis (DEA-Bootstrap) method. Then, using beta regression, it assesses the impact of cash crop production levels on these efficiency scores. The results show that a higher proportion of cash crops in total agricultural production improves the efficiency of public agricultural expenditures (EDPA) and, by extension, food security in the region. In 79% of the studied countries, cash crops occupy less than 15% of cultivated land, but an increase in this proportion is associated with a significant improvement in food security.

In conclusion, this chapter underscores the importance of considering the structure of agricultural production when formulating public policies. It highlights the crucial role of cash crops in improving the efficiency of public agricultural expenditures, suggesting that future policies should integrate this dimension to maximize their impact on food security in the region.

The issue of trade openness and income inequality is illustrated in the third chapter of the thesis, which examines the relationship between trade openness and income inequality within countries, with a particular focus on resource-rich economies. For a long time, traditional trade theories posited that trade

liberalization would be beneficial for all parties (Ricardo, 1817*a,b*). However, recent evidence, such as the emergence of trade tensions between major economic powers and increasing protests in resource-exporting countries, challenges this optimistic view (OECD, 2018). Indeed, many countries, especially those rich in natural resources, have seen trade openness accompanied by worsening inequality, leading to social unrest and even military coups, as observed in Mali in 2020, Burkina Faso in 2022, and Niger in 2023 (Deutsche Welle, 2023). This raises the question of whether trade openness benefits countries equally. Empirical studies and stylized facts indicate that this is not always the case (Lee et al., 2020; Le et al., 2020; Antràs et al., 2017).

This chapter specifically explores the interaction between global factors, such as trade openness, and internal factors, such as natural resource wealth, which play a crucial role in income distribution. Natural resource endowment is particularly relevant in the context of the ongoing energy transition, as many resource-rich countries are deeply integrated into global trade through fossil fuels and resources critical for clean energy technologies. However, these countries are often poorly equipped to manage the risks and leverage the opportunities of this transition, which may worsen income inequality (OECD, 2022).

It is therefore essential to understand the drivers of these inequalities in resource-rich countries within a globalized world. Our analysis, based on a sample of 71 low- and middle-income countries and a panel model with quantile regression, aims to distinguish between two types of natural resources: *point-source* resources, such as oil and precious metals, and *diffuse-source* resources, such as agricultural and forestry products. These categories can explain the divergent effects of trade openness on income inequality found in the literature. First, across the sample, trade openness has a significant positive effect on income inequality. Conversely, wealth from *diffuse-source* natural resources has a significant negative effect on income inequality, while wealth from *point-source* resources does not have a significant effect. Additionally, our descriptive statistics show that countries relatively richer in *diffuse-source* natural resources tend to perform better in terms of self-employment, indicating greater potential for income generation independent of centralized systems.

Furthermore, our results indicate that in countries relatively richer in *diffuse-source* resources (i.e., with a level above the sample median), trade openness does not have a significant impact on income inequality, and wealth from *point-source* resources in these countries may actually reduce inequality. Moreover, in these economies, governance quality does not play a significant role in reducing inequality. Conversely, in countries relatively poorer in *diffuse-source* resources, both trade openness and wealth from *point-source* resources have significant positive effects on income inequality. In these countries, good governance is crucial for reducing inequality.

Indeed, in countries relatively rich in *point-source* resources, which are geographically concentrated and exploited by actors such as the state or multinational corporations, the benefits of trade are often captured by elites or the state, thereby exacerbating inequality if governance is ineffective. In contrast, in countries relatively rich in *diffuse-source* resources, which are more widely distributed among the population, trade

openness is based on more inclusive economic participation and thus does not affect income inequality. Consequently, in these countries, governance effectiveness does not have a significant impact on reducing inequality. This chapter suggests that the nature of a country's resource wealth—whether concentrated or diffuse—might determine how trade openness affects income distribution.

Thus, this chapter highlights the importance of distinguishing between different types of natural resources when analyzing the effects of trade openness on income inequality. These results suggest that investing in the development of *diffuse-source* resources could be a way to limit inequalities, especially in countries with weaker institutional frameworks.

Chapter 1

Chapter 1

Natural Resource Discoveries and Fiscal Discipline

Co-written with Camélia Turcu

1.1 Introduction

The presence of natural resources in a country can be a priori considered as a benefit for the domestic economy as natural resources remain a highly prized commodity in the global economy. In this context, the random character of their location has been seen as a *blessing* for the countries where they were discovered and produced. Nevertheless, many resource-rich countries tend to have a lower economic performance compared to less resource-rich economies: hence, a new hypothesis emerged, related to a possible resource *curse*. This has generated a large literature on the link between the abundance of natural resources and economic performance. This literature includes studies showing both a positive and a negative correlation between natural resource abundance and the economic growth and development of countries. For example, natural resources are found to slow economic growth in resource-rich developing countries (Ploeg, 2011), limit export diversification (Ross, 2017), promote exchange rate appreciation (Stokke, 2007), or decrease foreign direct investment in non-resource sectors (Poelhekke and van der Ploeg, 2013). They may also be associated with positive effects on the economy, such as lower public debt and low inflation (Fasano, 2002), high public spending on education (Sarraf and Jiwaji, 2001) or high economic growth (Larsen, 2006).

Beyond economic impacts, natural resources often play a key role in the socio-political landscape of many countries. Within this framework, the geographical location and the distribution of income from natural resources are crucial factors. For example, the discovery of oil in the North Sea off the coast of Scotland has fueled the debate on Scotland's independence from the United Kingdom since the 1970s, being at the heart of the 2014 referendum. Similar territorial or sovereignty claims in the rest of the world are undoubtedly motivated by the perceived potential gain or budgetary independence linked to the discovery or exploitation of natural resources. In this context, the literature on natural resources also

highlights their role in armed conflicts and other independence claims (Berdal and Keen, 1997; Le Billon, 2001; Humphreys, 2005) particularly in the Southern countries. This supports a potential negative link between natural resources and a country's economic growth and development.

Most studies on natural resources focus on the direct impact of resource exploitation on countries' economic growth, development, and policy decisions. In this chapter, we take a different view and analyze the impact of resource discoveries themselves on the economy. Natural resource discoveries can indeed be considered as news shocks, i.e., the announcement of news about a resource discovery can generate expectations at the level of the economy that can have rapid consequences on the economic cycle through the anticipations of economic agents, and this is happening even before the start of exploitation. Thus, by studying the resource discoveries, the mechanism at play that we consider is based on the effect of expectations of future revenues related to the discoveries rather than on the revenues themselves: there is a delay of several years between the announcement of the discovery and the start of exploitation.

A historical example (Arezki et al., 2017) of the impact of natural resource discoveries on a country's economic activities is Norway, where, following the first oil discoveries in the North Sea in the 1960s and 1970s, the anticipation of greater future production led to an increase in investment and a fall in the savings rate, generating a current account deficit, approaching 15% of GDP at its lowest point in 1977. Following the discoveries, the country also saw its debt increase significantly to finance its oil installations (Arezki et al., n.d.). Very few studies exploit the effect of the resource discoveries themselves on the economy (Arezki et al., 2017; Bhattacharyya et al., 2017). If they do so, they focus on the response of macroeconomic aggregates (such as savings rate, investment, GDP, etc.) to natural resource discoveries. Our contribution is different as we aim to study the impact of resource discoveries on a specific economic policy, the fiscal policy. This is done as the announcement of the future arrival of large amounts of financial resources in the economy directly concerns the government's budget and may have implications for current government expenditure and revenue policy. Fiscal policy is crucial as poor fiscal management leads to persistent budget deficits typically financed by public debt. This raises concerns about the sustainability of sovereign debt—a challenge faced by many economies, including advanced economies. Therefore, understanding how the anticipation of future resource abundance influences fiscal policy is essential for policymakers. This remains largely unexplored in the literature.

We therefore analyze the impact of natural resource discoveries on the design and evolution of fiscal policies, exploiting the effect of expectations due to the discovery of large oil and gas deposits. The response of fiscal policy to natural resource discoveries is analyzed through changes in the cyclicity of fiscal policy. The effect of natural resource discoveries is also assessed in interaction with institutional quality and the presence of fiscal rules. To do this, we use a Local Projection approach (LP) on a sample of high-income and upper-middle-income countries (HMIs) as well as a sample of low and lower-middle-income countries (LMICs) over the period 1984-2012. Our results show that natural resource discoveries do drive fiscal policy response in HMIs and LMICs. Indeed, following the announcement of a natural resource discovery, we observe, around the first year after the discovery, an increasing tendency towards

contracyclicality in total public spending in the HMIs. This contracyclicality is stronger in the presence of fiscal rules, and the fiscal policy response is faster in the presence of good institutions. Thus, the HMIs have a disciplined response to a natural resource discovery shock. However, for LMICs, discovery shocks have different effects depending on the type of public spending. For these countries, there is an increasing tendency towards procyclicality in public consumption expenditure from the first year after discovery, whereas, for public investment expenditure, this tendency begins in the second year after discovery, following a slight trend towards contracyclicality between the date of discovery and the second year. These results are robust to different sample sizes, different specifications, and different measures of cyclicity coefficient.

The rest of the chapter is structured as follows: section 2 presents the literature review motivating our intuitions, section 3 describes and justifies the methodology used along with the data, section 4 presents the results, section 5 details the robustness tests and section 6 concludes.

1.2 Literature Review

Expectations generated by natural resource discoveries significantly influence the behavior of economic agents, drive economic cycles, and impact policy responses, often shaped by the access of economic agents to different types of news. The interplay between news and policy responses has become a key area of research, and it will be central to our study as well, with a focus on fiscal outcomes at a more general level. For instance, Blanchard and Leigh (2013) highlight that governments might engage in procyclical behavior—spending more in good times and less in downturns—often in response to economic news. This tendency can exacerbate economic fluctuations, highlighting the need for countercyclical fiscal strategies. Other recent studies emerge on the expectations generated by natural resource discoveries. They are related in particular to the impact of news about natural resource discoveries on macroeconomic fluctuations, via macroeconomic aggregates. This is the case, for example, of Arezki et al. (2017), who analyze the dynamic impact of the discovery of large oil deposits on the current account and macroeconomic aggregates such as employment, GDP, investment, and savings. Using a sample covering the period 1970–2012 for about 130 countries and using a dynamic panel model with distributed lag, the authors conclude that once production begins, these indicators generally improve alongside GDP. However, employment declines from the announcement onward. This decline continues but at a slower rate in the years that follow. Similar results are found by Toscani (2017) who focuses on a smaller sample, namely part of Latin America.

Few studies examine how news of natural resource discoveries impact macroeconomic fluctuations. This research aims to contribute by exploring the role of expectations related to these discoveries on the economy, with a focus on fiscal policy design and evolution.

We assess the impact of natural resource discoveries on fiscal policy through changes in the cyclicity of fiscal policy in response to a discovery shock. The fiscal policy literature generally advocates for counter-cyclical policies, where governments reduce spending and debt during economic booms and

increase spending during downturns to stabilize the economy (Larsen, 2006; Sarraf and Jiwanji, 2001). However, many countries fail to adopt counter-cyclical fiscal policies. Research often attributes fiscal policy's procyclicality to socio-political motivations. According to the political-fiscal cycle models, three key behaviors explain this tendency. First, a government may initiate an expansionary fiscal policy in anticipation of re-election, particularly in the lead-up to elections, without taking into account the economic cycle (Persson and Svensson, 1989). Second, a government may consciously pursue a policy of massive indebtedness to undermine the governance of its opponent successor (Alesina and Tabellini, 1990; Persson and Svensson, 1989). Finally, Tornell and Lane (1999) highlights the "voracity effects" to explain the procyclicality of fiscal policy, where interest groups close to the government influence public spending, amplifying fiscal policy's procyclicality (this becomes even more accentuated in periods of export booms).

Thus, positive shocks to the budget seem to lead to greater procyclicality in fiscal policy in some countries. Hence, we argue that the discovery of natural resources, such as a positive exogenous shock, could potentially lead to procyclicality in fiscal policy and induce similar behavior among policymakers even before exploitation begins. However, this outcome will largely depend on the presence of fiscal rules and the quality of institutions.

One solution proposed by the literature to combat the procyclicality of fiscal policy is the introduction of fiscal rules. Schaechter et al. (2012) describe fiscal rules as "agreements to mitigate deficit bias and promote fiscal discipline by limiting fiscal aggregates through numerical limits". In the context of the 2008 financial crisis and the debt crisis, there has been growing interest in fiscal rules, with more than 90 countries adopting fiscal rules by 2014 (IMF, 2015) compared with 10 in the 1990s. Fiscal rules aim to enforce fiscal discipline by curbing misuse of fiscal policy. In the context of resource discovery shocks, they are expected to help maintain fiscal stability.

Within this framework, a strand of the literature focuses on the application of fiscal rules to understand how they can become more effective. Some studies link the effectiveness of fiscal rules to structural factors such as institutions and exchange rate regimes. For example, Keita and Turcu (2023) show that fiscal rules alone are not sufficient to promote fiscal discipline. They explore how fiscal rules and institutions can mitigate the pro-cyclical nature of fiscal policy—specifically, how government spending reacts to fluctuations in GDP—across different exchange rate regimes. Their findings indicate that, under fixed exchange rate regimes, stronger institutions can lessen procyclicality, while fiscal rules either increase it or have no effect. In contrast, under flexible exchange rate regimes, their results suggest that institutions and fiscal rules work together to reduce procyclicality. Rules help reduce procyclicality and are more effective, in particular, when institutions are stronger.

As already mentioned, the literature illustrates the importance of expectations and institutional quality in shaping effective fiscal responses. Regarding institutional quality, a substantial body of literature highlights its key role in the effective implementation and functioning of economic, social, and environmental policies (MacLeod, 2013; Gholipour and Farzanegan, 2018; Roy and Tisdell, 1998). Thus, one might expect a country's fiscal policy response to a natural resource discovery shock to be more disciplined

in the presence of fiscal rules and/or good institutions.

Accordingly, we aim to answer the following questions: What is the effect of expectations due to the discovery of natural resources on the cyclicity of fiscal policy? Can the perception of future abundance due to the discovery of natural resources lead countries to deviate from fiscal discipline? Does the presence of fiscal rules and/or good institutions promote good fiscal governance in the context of a natural resource discovery shock? The methodology and the data used to answer these questions are described in the section below.

1.3 Methodology and data

The use of resource discoveries as news shocks is recent (Arezki et al., 2017; Bhattacharyya et al., 2017). A natural resource discovery represents a significant anticipated increase in future production. Identifying agents' expectations requires indeed shocks of considerable magnitude, and large resource discoveries, being rare and country-specific, carry an element of surprise that qualifies them as key country-specific shocks. Additionally, the time lag between discovery and exploitation—due to the construction of extraction infrastructure, environmental assessments, and necessary authorizations—helps isolate the effects of the discovery itself. For instance, it typically takes around four years from drilling to production for large oil deposits. This delay provides a window to study the effects of the discovery as a news shock independently of production impacts (Arezki et al., 2017). Finally, while technological advances can identify with varying degrees of accuracy the regions likely to hold resources, the exact timing of discoveries remains unpredictable. This unpredictability underpins our identification strategy, which relies on the exogenous nature of discovery dates.

To assess the impact of natural resource discoveries on fiscal policy through changes in the cyclicity of fiscal policy, we proceed in two steps. First, we calculate the cyclicity coefficient and, second, we analyze the relationship between resource discoveries and the cyclicity coefficient by adopting a local projection approach. We will explain in detail in the Subsection 3.2. why this approach is suitable for our analysis. Some elements that we can already mention are related to the fact that this approach allows us to capture the heterogeneity of countries and to identify possible non-linearities in the response of fiscal policy (through the cyclicity coefficient) to these natural resource discovery shocks.

1.3.1 Computing the cyclicity coefficient

Following Guerguil et al. (2017) and Keita and Turcu (2019) we calculate the cyclicity coefficient with a non-parametric regression method, Local Gaussian-Weighted Ordinary Least Squares (LGWOLS), illustrated by the following equation :

$$\Delta \text{Log}(EXP_{i,t}) = \alpha_{i,t} + \beta_{i,t} \Delta \text{Log}(GDP_{i,t}) + \varepsilon_{i,t} \quad (1.1)$$

$$\text{With } \varepsilon_{i,t} \rightarrow N(0, \frac{\sigma^2}{\omega_t(\tau)}) \quad \text{and} \quad \omega_t(\tau) = \frac{1}{\sigma\sqrt{2\pi}} \exp\left(-\frac{(\tau-t)^2}{2\sigma^2}\right)$$

We follow Aghion et al. (2007) and Guerguil et al. (2017) for the choice of σ so $\sigma = 5$. $\Delta \text{Log}(EXP_{i,t})$ is, for country i at time t , the growth rate of real public expenditure and $\Delta \text{Log}(GDP_{i,t})$ is the growth rate of real GDP. $\hat{\beta}_{i,t}$ is the cyclical coefficient, which takes into account temporal variations and individual country specificities. It captures the behavior of fiscal policy according to the different phases of the economic cycle over time. Implicitly, this method consists in calculating the cyclical coefficient by giving a weight to all observations by a Gaussian centered at t , for country i , and then performing a regression for each date t , giving more weight to the observation close to the year in question.

Thus, the cyclical coefficient $\hat{\beta}_{i,t}$ measures the cyclical of public spending in country i in period t . Fiscal policy is considered pro-cyclical when $\hat{\beta}_{i,t}$ is positive and significant and counter-cyclical when $\hat{\beta}_{i,t}$ is negative and significant. When $\hat{\beta}_{i,t}$ is close to zero then fiscal policy is acyclical.

1.3.2 Addressing the link between natural resource discoveries and the cyclical of fiscal policy: a Local Projections approach

To estimate the dynamic responses of fiscal policy cyclical to natural resource discovery shocks, we use the local projections (LPs) approach developed by Jordà (2005). This method is widely used in the literature to assess the dynamic effect of shocks (Auerbach and Gorodnichenko, 2012; Jordà et al., 2013; Jordà and Taylor, 2016; Asonuma et al., 2016). Local projections (LPs) are particularly well-suited for our investigation, especially when compared to VAR models typically used for computing impulse responses. We can argue, in line with the literature (Avril et al., 2022; Jordà, 2005), that LPs are simple and can be estimated using standard regression techniques. Further, they are flexible: they allow for a separate model to be estimated for each projection year, unlike VAR models, which rely on a fixed state-space representation. This flexibility is important for addressing potential nonlinearities, such as a possible adjustment period before a shock affects economic outcomes, depending on the transmission channels. Additionally, LPs are a more efficient method for estimating and interpreting the dynamics of treatment/event effects, in contrast to panel VAR models, which can become complex and difficult to estimate due to their high dimensionality. The simplicity of LPs also allows for conditioning on a broader set of control variables, improving model identification. Finally, because LPs generate projections that are local to each forecast year, they may be more robust than VAR models, where specification errors can accumulate over longer projection horizons.

Our model is presented below. Let $t = 1, 2, 3, \dots, T$ be the time dimension of the data and $h = 0, 1, 2, 3, 4$ the projection horizon. Let $CC_{i,t}$ be the cyclical coefficient which is our dependent variable, and $DSC_{i,t}$ the resource discovery dummy variable, our main explanatory variable. The $X_{i,t}$ vector gathers our control variables, among which $IQ_{i,t}$ and $FR_{i,t}$ that represent institutional quality and fiscal rules, respectively. Based on the set of available data in t , the LPs method generates estimates for each forecast

horizon h by regressing the dependent variable at $t+h$. Hence, the model to be estimated is the following:

$$\Delta CC_{i,t+h} = \alpha_{i,h} + \beta_h DSC_{i,t} + \sum_{k=1}^q \mu_h CC_{i,t-k} + \sum_{j=0}^1 \lambda_h X_{i,t-j} + \gamma_h U_{t+h} \quad (1.2)$$

such that

$$U_{t+h} \sim N(0, 1), \gamma_h > 0, \Delta CC_{i,t+h} = CC_{t+h} - CC_{t-1} \text{ for } h$$

Thus an estimate of the local projection of the impulse response $RI_{h,t}$ of the cyclical coefficient at horizon h , faced with a natural resource discovery shock at period t is a graphical representation of the evolution of β_h with $h=0,1,2,3,4$. An impulse response can be defined as the difference between two forecasts :

$$RI_{h,t} = E \left[\frac{CC_{t+h} - CC_{t-1}}{DSC_{t=1}} \right] - E \left[\frac{CC_{t+h} - CC_{t-1}}{DSC_{t=0}} \right] = \beta_h$$

We limit the h horizon to 4 because on average, production starts 4 years after discovery. Thus, after this date, fiscal policy will depend more on the level of production than on expectations. The X vector of the control variables also contains our variables of interest IQ_t and FR_t and we introduce q lags of the cyclical coefficient to account for possible serial dependence, with $q = 1,2$. We use the control variables at t and $t-1$ because the effect of a discovery shock at date t will most likely depend on the economic situation at period $t-1$ and t . $IQ_{i,t}$ and $FR_{i,t}$ represent institutional quality and fiscal rules, respectively. Based on the literature, we introduce as control variables, the presence or absence of a target inflation rate (Combes et al., 2018), the electoral calendar, the level of development of countries and the degree of trade openness, because in general developed countries tend to have better fiscal discipline (Jalles, 2020) according to their degree of trade openness. We also introduce the level of public debt (debt ratio), which is a determining factor in decisions regarding the government budget. Finally, the Dutch disease has taught us that the abundance of natural resources associated with bad public management can have negative consequences on the economy: thus, we introduce the natural resource rents ratio. We also control for exploration effort (more details on this variable are available in the next section).

Equation (2) translates our basic scenario. It gives the dynamic reaction of the cyclical coefficient to a natural resource discovery shock (β_h). Equation (3) reflects the effect of the interaction between discovery shocks and institutional quality δ_h . Equation (4) captures the effect of the interaction between discovery shocks and the fiscal rules ϕ_h on the cyclical coefficient :

$$\Delta CC_{i,t+h} = \alpha_{i,h} + \delta_h DSC_{i,t} \times IQ_{i,t} + \sum_{k=1}^q \mu_h CC_{i,t-k} + \sum_{j=0}^1 \lambda_h X_{i,t-j} + \gamma_h U_{t+h} \quad (1.3)$$

$$\Delta CC_{i,t+h} = \alpha_{i,h} + \phi_h DSC_{i,t} \times FR_{i,t} + \sum_{k=1}^q \mu_h CC_{i,t-k} + \sum_{j=0}^1 \lambda_h X_{i,t-j} + \gamma_h U_{t+h} \quad (1.4)$$

1.3.3 Data and descriptive statistics

We use data on three categories of variables: resource discovery data; macroeconomic data; and control variables. Data is available for 31 HMIs and 41 LMIs. First, the data on large oil and gas

discoveries are from Arezki et al. (2017). According to these authors, a large deposit is considered to be a deposit capable of producing at least 500 million barrels of oil or gas equivalent recoverable over time¹. In fact, in order to get the shock effect and capture the effect of expectations, deposits must be large. As Bhattacharyya et al. (2017), we also control for the exploration effort by introducing a variable that captures whether countries have discovered resources during the three years preceding the discovery of the large deposit. Due to the availability of macroeconomic data, we restrict this database to the period starting in 1984, resulting in a sample that spans from 1984 to 2012 for all variables. Table 1 shows the spatial and temporal distribution of large resource discoveries in the world over the period.

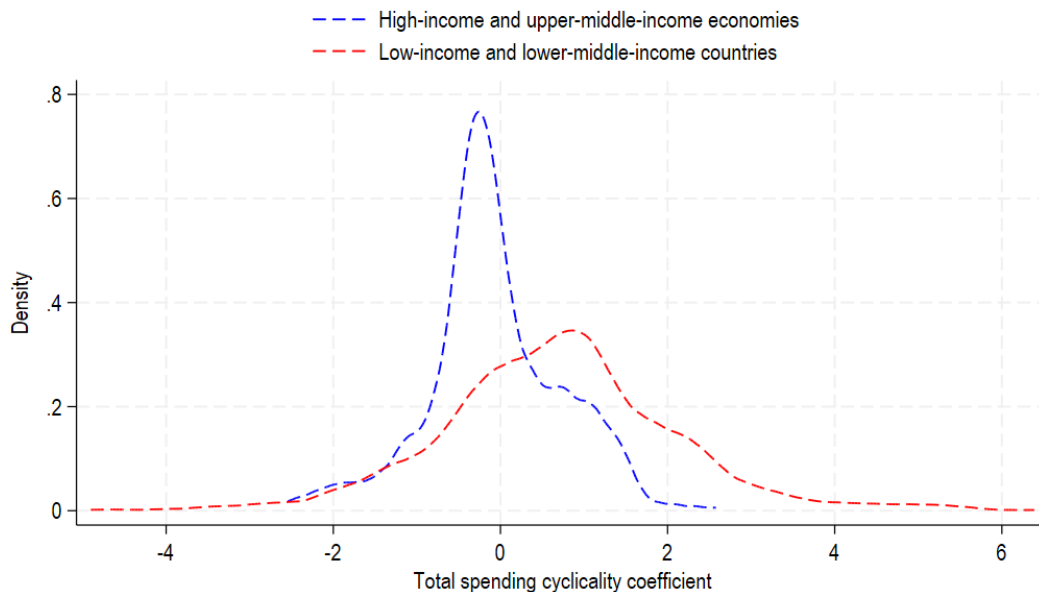
Table 1.1: Spatial and Temporal Distribution of Large Oil and Gas Deposits: DISC indicates the number of discoveries per 10-year interval (e.g. Disc1980s indicates the number of discoveries that took place in the 1980s).

Region: weo	Disc1980s	Disc1990s	Disc2000s	Disc2010s	Total
Africa	2	9	9	9	29
Asia	6	20	23	0	49
Central and Eastern Europe	0	1	0	0	1
Commonwealth of Independent States and Mongolia	1	2	5	3	11
Europe	2	6	3	5	16
Middle East and North Africa	2	15	11	2	30
Western Hemisphere	9	11	12	2	34

Then, to compute the cyclical coefficient, we use the World Bank macroeconomic data (public real expenditures and real GDP). We choose to assess the cyclical coefficient of fiscal policy by estimating the impact of real GDP growth on real public spending. We focus on this indicator as, in order to influence the economic cycle, the government usually stimulates or slows down demand by increasing or decreasing public spending. Moreover, according to Bergman and Hutchison (2015), the joint evolution of GDP and public spending allows us to clearly observe the nature of a fiscal policy (pro-cyclical or counter-cyclical). Hence, we focus on public spending as a measure of the cyclical coefficient of fiscal policy. This is also in line with Kaminsky et al. (2004). We also compute the cyclical coefficient in a disaggregated manner by calculating the cyclical coefficient of investment spending and consumption spending (see their distributions in the Appendix). Figure 1.1 shows the distribution of the computed cyclical coefficient for HMIs and LMIs.

¹This value is based on the estimate at the time of discovery, which is important because expectations are based on the estimate at the time of discovery.

Figure 1.1: Distribution of computed Total Spending Cyclical Coefficient by Country Income Level

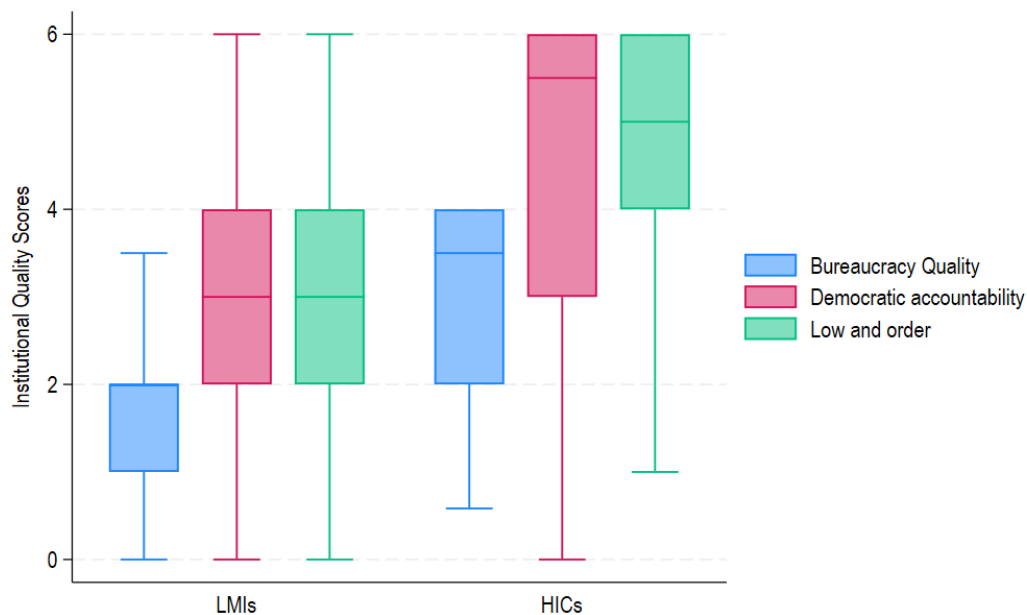


Source: Authors' construction.

The distribution shows that HMIs and LMIs have different regression curves, with HMIs tending toward contracyclicality while LMIs appear to be characterized by procyclical fiscal policy. This implies a separate analysis of the two groups of countries in the panel.

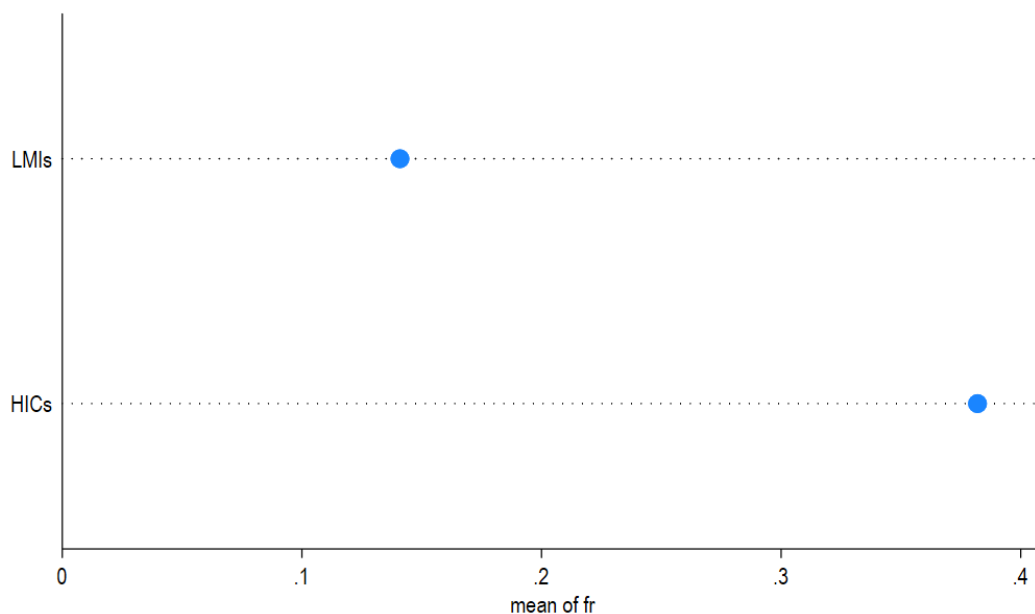
The data on fiscal rules used as key control variables are from the IMF (IMF Fiscal Rules Dataset 2016). We exploit in this database, details on the presence or absence of fiscal rules of any type (expenditure rules, debt rules, budget balance rules, revenue rules) since 1985. Data on institutional quality are provided by the "International Country Risk Guide" (ICRG 2016). For observations beginning in 1984, we alternately use different indicators of institutional quality from the ICRG 2016: Bureaucracy Quality (BQ); Democratic Accountability (DAC); and Law and Order (LO), depending on their availability. We mainly use Bureaucracy Quality (BQ) as a measure of institutional quality. Bureaucracy Quality represents "the institutional strength and quality of bureaucracy; a buffer that tends to minimize policy revisions when governments change" (ICRG 2015). It ranges from 0 to 4, "with high points indicating countries where the bureaucracy has the strength and expertise to govern without drastic policy changes or disruptions to government services. In these low-risk countries, the bureaucracy tends to be somewhat independent of political pressures and has an established mechanism for recruitment and training" (ICRG). Figures 1.2 and 1.3 present descriptive statistics on these variables for our sample and by country group:

Figure 1.2: Institutional Quality by group of countries



Source: Authors' construction, Data from ICRG

Figure 1.3: Fiscal rules adoption by group of countries



Source: Authors' construction, Data from IMF

On average, the 31 HICs have much higher institutional quality scores and adopt fiscal rules more often than the 41 LMIs, which supports our choice to study these two types of countries separately. Indeed, in terms of institutional quality, the HICs in our sample have an average score of 3.15 out of 4 compared to 1.60 out of 4 for LMIs, and 38.20% of the HICs have adopted fiscal rules while only 14.09%

of the LMIs have adopted them.

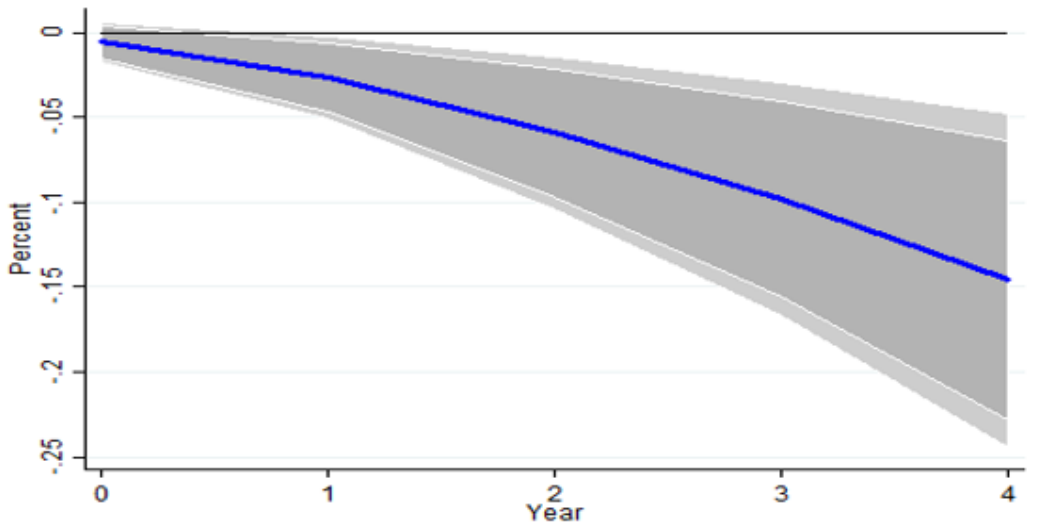
1.4 Results and interpretations

As shown by the distribution of cyclical coefficients and descriptive statistics, unlike developing countries, developed countries generally have counter-cyclical fiscal policies because of their better institutional quality and greater frequency of application of fiscal rules. Thus, to account for this structural difference in the panel, we analyze the dynamic response of fiscal policy to natural resource discoveries by country group. The list of countries can be found in the appendix: the first group is composed of high-income and upper-middle-income countries (HMIs) and the second of low-income and lower-middle-income countries (LMIs) according to the World Bank classification.

1.4.1 High-income countries and upper-middle income countries (HMIs)

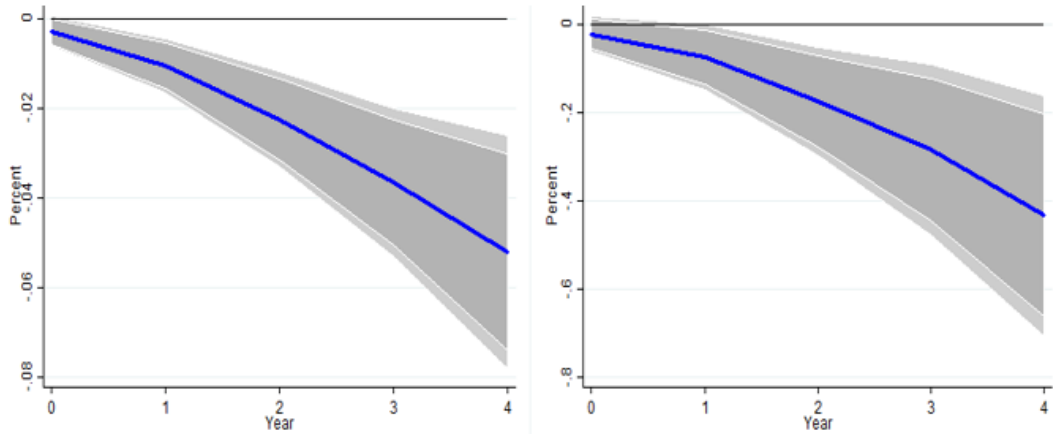
We begin the presentation of results by first focusing on the case of high-income and upper-middle-income countries. These results are represented in the figures below. In order to facilitate the reading of these results we underline that the x-axis represents the years after the discovery at period zero, and the y-axis represents the percentage changes in the cyclical coefficient. Thus the blue line indicates the evolution of the coefficients β_h ; δ_h ; ϕ_h over time, alternatively. The bands "dark grey" and "light grey" represent respectively the confidence intervals at the upper and lower threshold (for example at the threshold of 10% (dark grey) and 5% (light grey)). The effect is significant when zero is outside the band, otherwise, the effect is not significant.

Figure 1.4: Direct effect of natural resource discoveries (equation (1.2)), at the 5% and 10% threshold.



Source: Authors' construction

Figure 1.5: Effect of natural resource discoveries in interaction with institutional quality (equation (1.3)) and fiscal rules (equation (1.4)), at the 5% and 10% threshold.



Source: Authors' construction

The evidence shows that for the HMIs, the fiscal policy response to natural resource discoveries is counter-cyclical. Indeed, the reaction of these countries is immediate. As soon as the discovery of resources is announced, around the first year after the discovery, the effect begins to be significant, leading to an increasing tendency towards contracyclicality of about 0.15% in the fourth year (Figure 1.4).

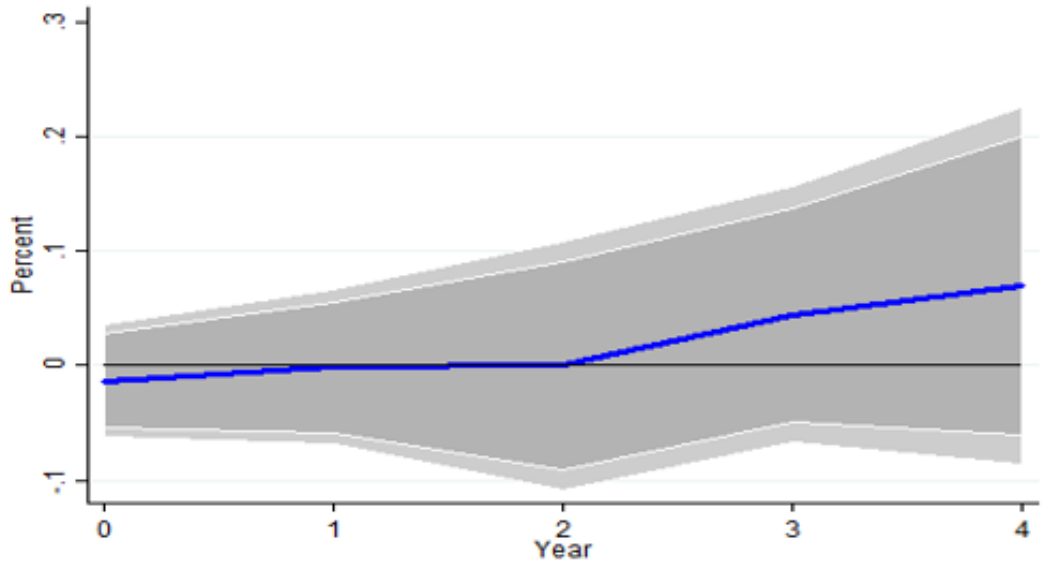
Then when institutional quality is taken into account (Figure 1.5 on the left), the fiscal policy response is faster and also leads to a tendency towards contracyclicality. Even before the first year after the discovery, a tendency towards contracyclicality of fiscal policy is observed, but to a lesser extent (about 0.048% at the end of the fourth year). The small effect may be due to the fact that these countries are already characterized by good institutional quality, which could therefore attenuate this variable's effect. Institutional quality therefore seems to favor a more rapid fiscal policy response to natural resource discoveries. Figure 1.5 (on the right) shows that the presence of fiscal rules does not change the response time of fiscal policy; it remains essentially the same, i.e., contracyclicality begins after one year after the discovery. However, fiscal rules lead to much higher contracyclicality, from about 0.1% after the first year to 0.45% in the fourth year after the discovery. In short, the more developed a country is, the better the reaction of its fiscal policy (contracyclicality) to a natural resource discovery shock. Thus, the perception of future abundance due to the discovery of natural resources does not seem to affect the fiscal discipline of developed countries, and the disciplinary response is faster and/or stronger in the presence of institutional quality and/ or fiscal policy.

1.4.2 Low-income and lower-middle income countries (LMIs)

The results show that natural resource discoveries do not have a significant effect on the fiscal policy of LMIs before the start of resource exploitation. We advance three potential reasons. First, these countries don't have the technology to exploit their natural resources, so they sign exploitation contracts with multinationals in which they have a small share of the revenues. Hence, knowing this, they do not react to discoveries as there are no high expectations. Second, the lack of confidence of the population due

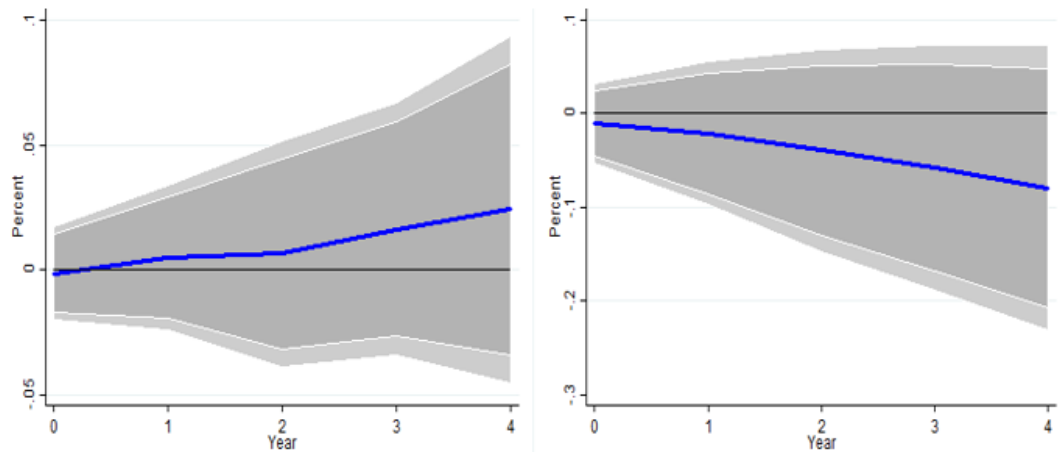
to corruption in these countries leads to a less optimistic view regarding the discovery, and further to less economic activity. Third, this may be due to the bad quality of institutions to deal with shocks in the economy, characterized by a slow response of economic policies. However, it is clear that there is a trend toward procyclicality in fiscal policy for these countries and that institutional quality may favor less procyclicality while fiscal rules may lead to counter-cyclicality. To go further in studying the reactions of these countries, we disaggregate public spending into public investment spending and public consumption spending, in order to examine more precisely which type of spending responds most to natural resource discoveries.

Figure 1.6: Direct effect of natural resource discoveries (equation (1.2)), at the 5% and 10% threshold.



Source: Authors' construction

Figure 1.7: Effect of natural resource discoveries in interaction with institutional quality (equation (1.3)) and fiscal rules (equation (1.4)), at the 5% and 10% threshold.

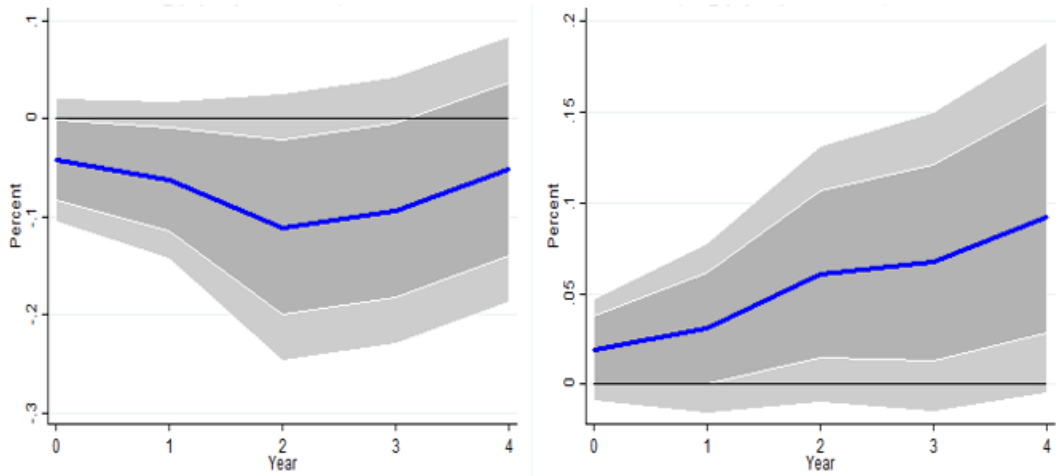


Source: Authors' construction

Figure 1.8 shows that, for public investment spending (in the left), a relative tendency towards counter-cyclicality is observed from the time of the announcement of the discovery of natural resources until

the second year when the tendency towards procyclicality begins. The procyclicality is likely due to investment spending on petroleum facilities after discovery. However, this result is significant at the 15% threshold. Nevertheless, given the reaction of consumer spending, it seems that this tendency towards procyclicality in the presence of a discovery shock does exist in LMIs. Consumer spending tends to be pro-cyclical, implying that consumption (and therefore economic activity) increases in these countries following the announcement of natural resource discoveries. The disaggregated results for HMIs can be found in the appendix.

Figure 1.8: Public investment and consumption expenditure, direct effect of natural resource discoveries (equation (1.2)), at the 5% and 15% threshold.



Source: Authors' construction

1.5 Robustness Tests

1.5.1 Different sample sizes

To test the robustness of our results we remove from our two samples, groups of countries likely to drive the results and potential outliers. Thus we rerun the analysis by removing the major traditional oil and gas producers and countries where there has not been a major oil and gas discovery since 1960. These countries may indeed bias the results. Hence, the samples go from 26 to 21 HMIs and from 46 to 33 LMIs. The list of countries can be found in the appendix. The robustness of our results obtained in Figures 1.4 and 1.5 and 1.8 respectively are presented below in Figures 1.12, 1.13 and 1.14 respectively. These figures show that our results are robust to a relevant restriction of our samples. In fact, the general trend of the results does not change following a change in the samples.

Our results are also robust to various measures of institutional quality. Figure 1.15 shows the effect of natural resource discovery interacting with institutional quality (equation (3)) for HMIs with Democratic Accountability (in the Left) and Law and Order (in the right) as alternative measures of institutional quality, respectively, at the 5% and 10% threshold.

1.5.2 Different specifications

Several specifications are further considered. First, we exclude from our sample large oil and gas producers. Second, we evaluate the sensitivity of our results to additional control variables and to the variation in the number of lags in our model (i.e., $q = 1, 2, 3, 4$). We add to the control variables, the sizes of the deposits in million barrels of oil or gas equivalent recoverable in the future, based on the estimate at the time of discovery, as well as a variable that captures whether or not the discoveries are made sequentially. Discoveries may have less effect on expectations when they occur sequentially. The respective robustness results of Figures 1.4 and 1.5 and 1.8 obtained after a change in specification are presented below in Figures 1.16, 1.17 and 1.18 respectively, these figures show that our results remain valid with changes in specification, which is further evidence that our results are robust.

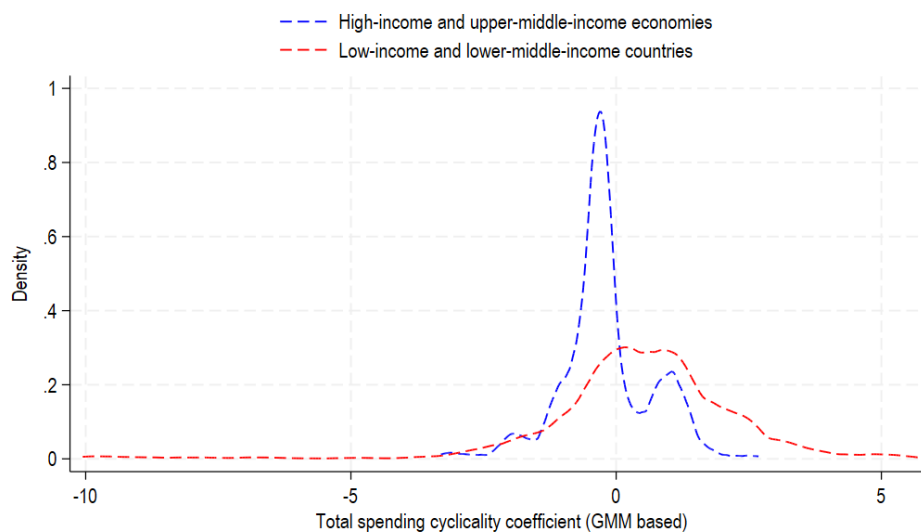
1.5.3 Another measure of the cyclical coefficient

We further assess the robustness of our results while considering an alternative measure of our dependent variable, the cyclical coefficient. To do so, we proceed in two steps. First, we calculate an augmented version of the cyclical coefficient and then we use this new measure of the cyclical coefficient to rerun the analysis with the corrected samples. Indeed, under an expansionary fiscal policy, government spending causes GDP growth, and in this framework, we propose a method that takes this into account. In order to capture the inertia of public spending and to take into account possible inverse causalities between changes in public spending and changes in real GDP, we introduce lagged values of the two variables and estimate the following specification :

$$\Delta \log(\text{EXP}_{i,t}) = \alpha_{i,t} + \rho_{i,t} \Delta \log(\text{GDP}_{i,t}) + \theta_{i,t} \Delta \log(\text{GDP}_{i,t-1}) + \pi_{i,t} \Delta \log(\text{EXP}_{i,t-1}) + \varepsilon_{i,t} \quad (1.5)$$

Where $\rho_{i,t}$ is the resulting cyclical coefficient, corrected for potential bias and varying over time and across individuals with $\varepsilon_{i,t}$ the error term with the initial properties. The figure 1.9 shows respectively the distributions of the cyclical coefficients of HMIs and LMIs.

Figure 1.9: Distribution of revised computed Total Spending Cyclical Coefficient by Country Income Level



Source: Authors' construction

As can be seen in Figure 1.9, the trend for each group of countries remains essentially the same, with HMIs tending towards contracyclicality while procyclicality dominates among LMIs. The respective robustness results of Figures 1.4 and 1.5 and 1.8 obtained with these coefficients are presented below in Figures 1.19, 1.20 and 1.21 respectively.

All these investigations show that our results are significant overall. The different robustness tests underline that our results are not subject to potential biases due to a certain group of countries, nor to the variation of the specification. The results are also not very sensitive to different measures of cyclicity or institutional quality. In sum, we can state that our results are robust overall.

1.6 Conclusion

To our knowledge, we are providing the first study assessing the effect of the perception of future abundance due to the discovery of natural resources on countries' fiscal discipline. Our study shows that there is an effect of expectations due to the discovery of natural resources on the definition and evolution of fiscal policy. Natural resource discoveries, such as positive shocks to the government budget, lead to a disciplined response (contracyclicality) of fiscal policy in countries characterized by good institutions and a high frequency of application of fiscal rules. However, deviations in fiscal discipline in the face of such shocks are observed in countries with weak institutions and less frequent application of fiscal rules. Thus, we can conclude that the presence of fiscal rules and/or good institutions promotes good fiscal governance in the context of resource discovery shocks.

Thus, the contribution of this study to the existing literature is at two levels. Firstly, our study makes a contribution to the literature on the role of expectations in fluctuations in the economic cycle,

and secondly, we add to the literature on the role of institutions in the application of economic policies, and more particularly to the literature on the role of fiscal rules in fiscal discipline design (in the context of a natural resource discovery shock).

Moreover, since the plausible effect of expectations due to natural resource discoveries has been highlighted, a relevant question that might arise is the effect that natural resource discoveries might have on countries' access to international capital markets. Good fiscal governance is one of the main factors taken into account in the assessment strategies of rating agencies and multilateral lenders such as the IMF and the World Bank (Bodea and Hicks, 2018). For that reason, could the discovery of large oil or gas deposits in a country, potentially seen as near financial solvency, provide better access to the international capital market, regardless of the quality of fiscal governance in that country? If so, then what impact could this have on the financial market? Future research on the role of expectations in general and on the role of expectations due to the discovery of natural resources, in particular, could be addressed in order to bring new elements to this less explored part of the literature.

1.7 Appendix

Table 1.2: List of low income and lower-middle income countries

Countries				
LMICs				
Albania	Algeria	Ghana	Pakistan	Ukraine
Bangladesh	Angola	India	Peru	Uzbekistan
Libya	Azerbaijan	Indonesia	Philippines	
Iraq	Bolivia	Iran	Romania	
Morocco	Brazil	Kazakhstan	Sierra Leone	
Namibia	China	Liberia	Sudan	
Côte d'Ivoire	Colombia	Malaysia	Tanzania	
Ecuador	Congo	Mozambique	Thailand	
Mexico	Egypt	Myanmar	Turkmenistan	
Tajikistan	Ethiopia	Nigeria	Vietnam	
Tunisia	Gabon	Papua New Guinea	Yemen	

Table 1.3: List of high income and upper middle income countries

Countries		
HMICs		
Argentina	Kuwait	Venezuela
Australia	Netherlands	United Kingdom
Brunei	New Zealand	United States
Canada	Norway	Italy
Cyprus	Oman	
Denmark	Qatar	
Equatorial Guinea	Russian Federation	
France	Saudi Arabia	
Germany	Spain	
Hungary	Trinidad and Tobago	
Israel	United Arab Emirates	

Table 1.4: List of Countries removed from the sample

Countries removed from the sample			
HMICs		LMICs	
Russian Federation	Albania	Namibia	Tunisia
United States	Bangladesh	Côte d'Ivoire	Ukraine
Canada	Libya	Ecuador	Uzbekistan
Saudi Arabia	Iraq	Mexico	
Qatar	Morocco	Tajikistan	

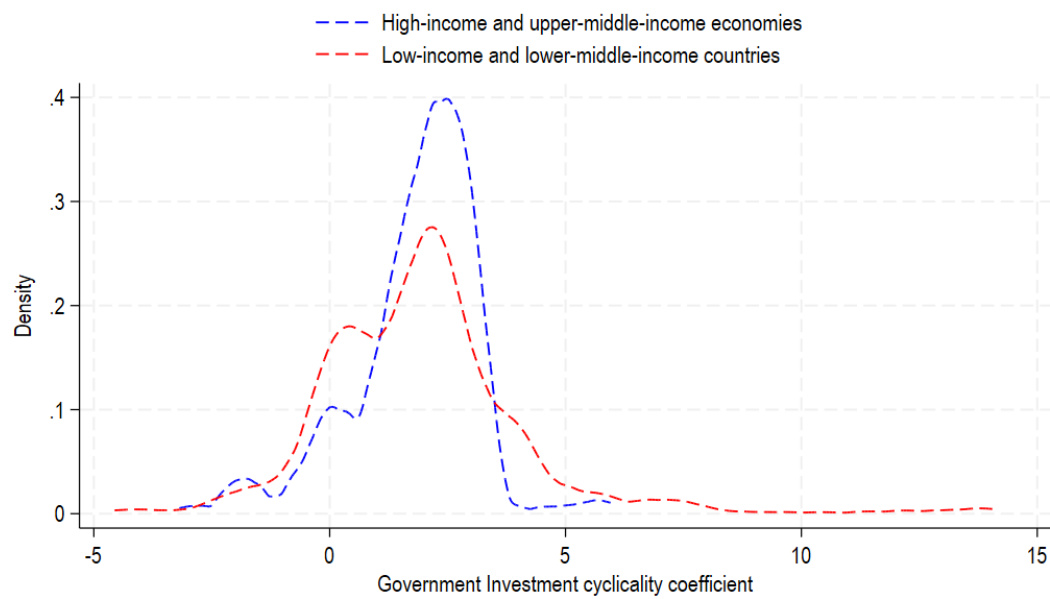
Variables	Definitions	Sources
DISC	Variable muette égale à 1 au moment t si au moins une découverte a eu lieu en t, 0 sinon	Arezki et al. (2017)
URR_E	Estimation des tailles des découvertes : en millions de barils d'équivalent pétrole (et/ou gaz) finalement récupérables	Arezki et al. (2017)
DSCSQ	Variable muette pour les découvertes séquentielles (égale à 1 si les découvertes sont faites de manière séquentielle, 0 sinon)	Arezki et al. (2017)
DISCP3	Variable muette pour les découvertes précédées de découvertes au cours des 3 dernières années (égale à 1 s'il y a eu des découvertes au cours des 3 années précédentes la découverte, 0 sinon)	Arezki et al. (2017)
RGDP	PIB réel, déflaté	FMI WEO avril 2017
REXP	Dépenses totales réelles du gouvernement	FMI WEO avril 2017
GINEXP	Dépenses réelles d'investissement du gouvernement : Formation brute de capital fixe, Les données sont en dollars américains constants de 2010.	Données des comptes nationaux de la Banque mondiale, et données des comptes nationaux de l'OCDE.
GCEXP	Dépenses de consommation finale des administrations publiques (en dollars constants de 2010)	Données des comptes nationaux de la Banque mondiale, et

Variables	Définitions et transformations	Sources
BQ	Bureaucracy Quality	ICRG 2016
DAC	Democratic Accountability	ICRG 2016
LO	Law and Order	ICRG 2016
FR	Variable muette pour la présence de règles budgétaires : tout type de règles (=1 s'il y a au moins une règle budgétaire en place et =0 sinon)	FMI 2016 et calculs de l'auteur
DR	Le ratio de la dette publique : Dette brute des administrations publiques en pourcentage du PIB	FMI WEO avril 2017
GDPC	PIB par habitant (dollars US constants de 2010)	Données des comptes nationaux de la Banque mondiale, et données des comptes nationaux de l'OCDE.
TNRSR	Rentes totales des ressources naturelles (% du PIB)	Banque mondiale, 2011
IT	Variable muette de l'existence d'un seuil d'inflation ou non (=1 s'il en a et =0 sinon)	Keita et Turcu (2019)
ELCT	Variable muette du calendrier électoral (=1 à l'année précédente l'année électorale et =0 sinon)	Calculs de l'auteur

Table 1.5: List and definitions of variables

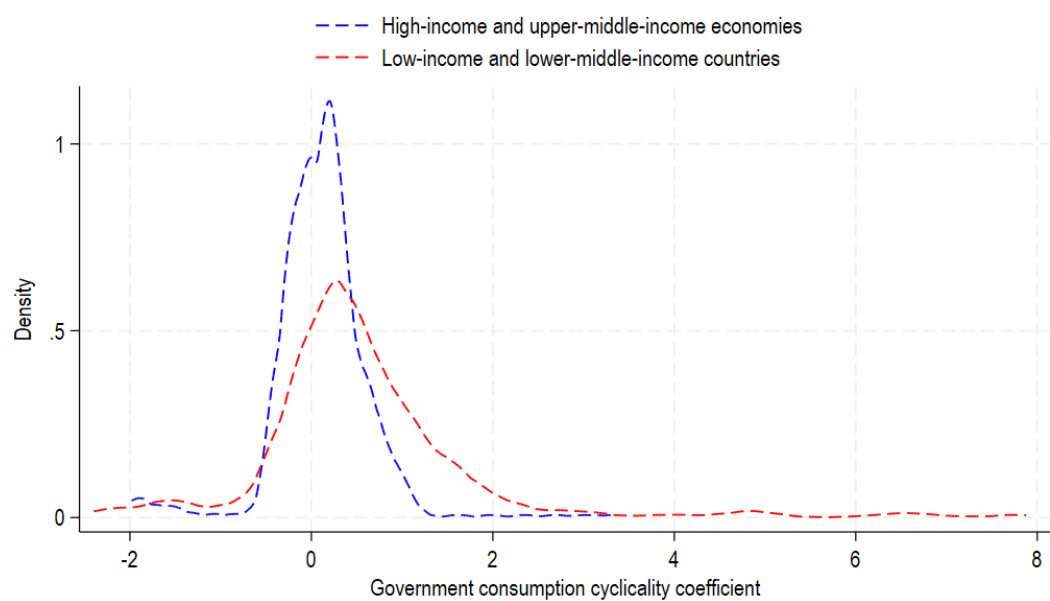
Variables	Définitions et transformations	Sources
IMPORT	Montant des importations de biens et de services	Données des comptes nationaux de la Banque mondiale, et données des comptes nationaux de l'OCDE.
EXPORT	Montant des exportations de biens et de services	Données des comptes nationaux de la Banque mondiale, et données des comptes nationaux de l'OCDE.
OPENESS	$OPENESS = (((IMPORT + EXPORT) / 2) / RGDP) * 100$	Calculs de l'auteur

Figure 1.10: Distribution of computed Government Investment cyclical coefficient by Country Income Level



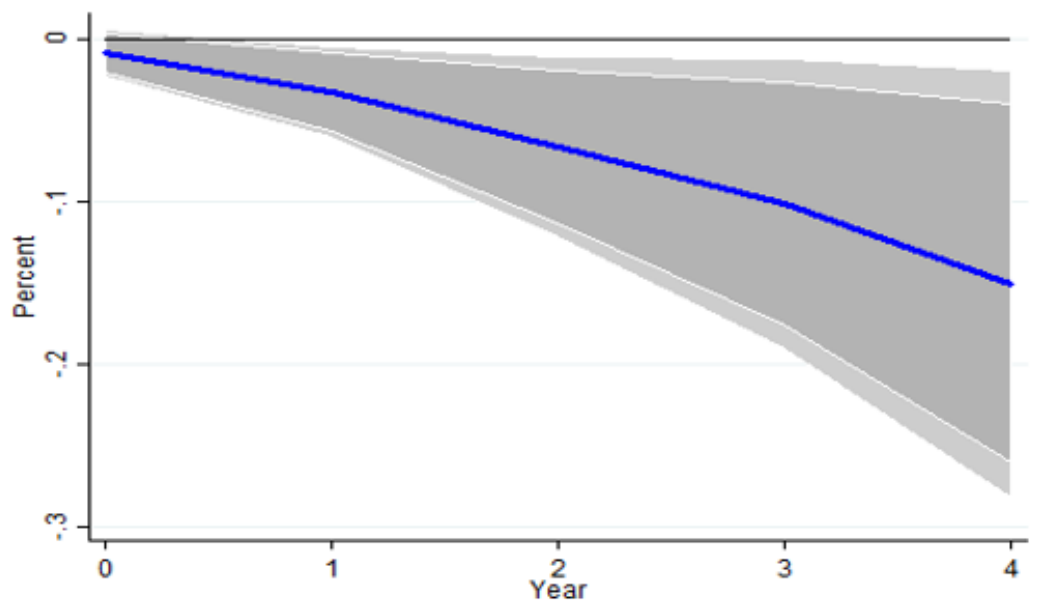
Source: Authors' construction

Figure 1.11: Distribution of computed Government consumption cyclical coefficient by Country Income Level



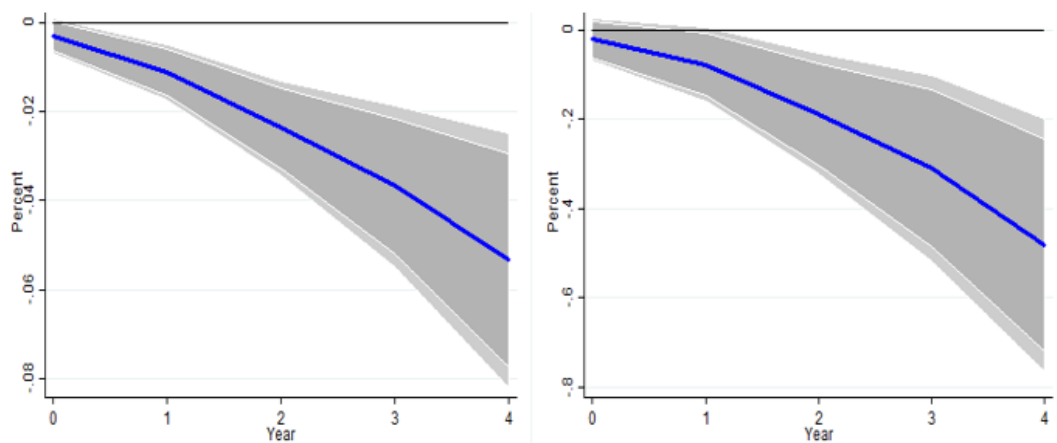
Source: Authors' construction

Figure 1.12: Direct effect of natural resource discoveries (equation (1.2)), at the 5% and 10% threshold.



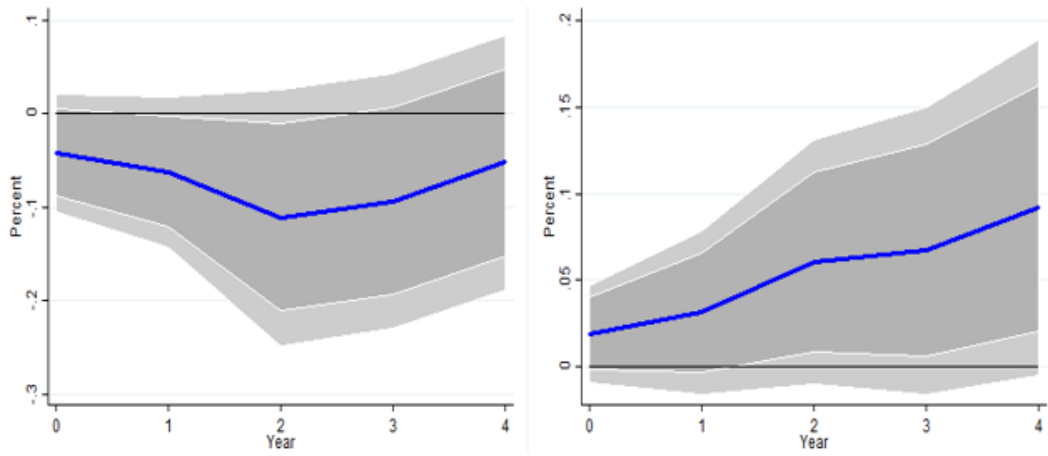
Source: Authors' construction

Figure 1.13: Effect of natural resource discoveries in interaction with institutional quality (equation (1.3)) and fiscal rules (equation (1.4)), at the 5% and 10% threshold.



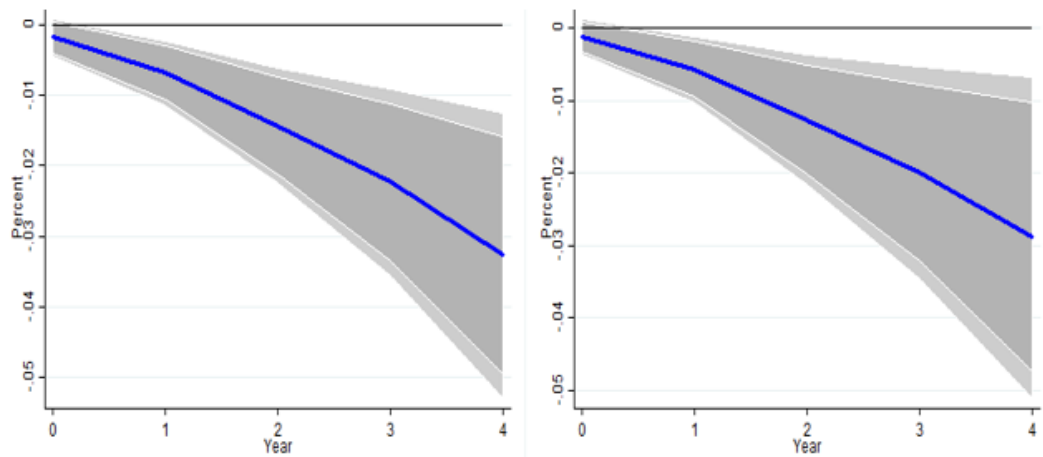
Source: Authors' construction

Figure 1.14: Public investment and consumption expenditure, direct effect of natural resource discoveries (equation (1.2)), at the 5% and 15% threshold.



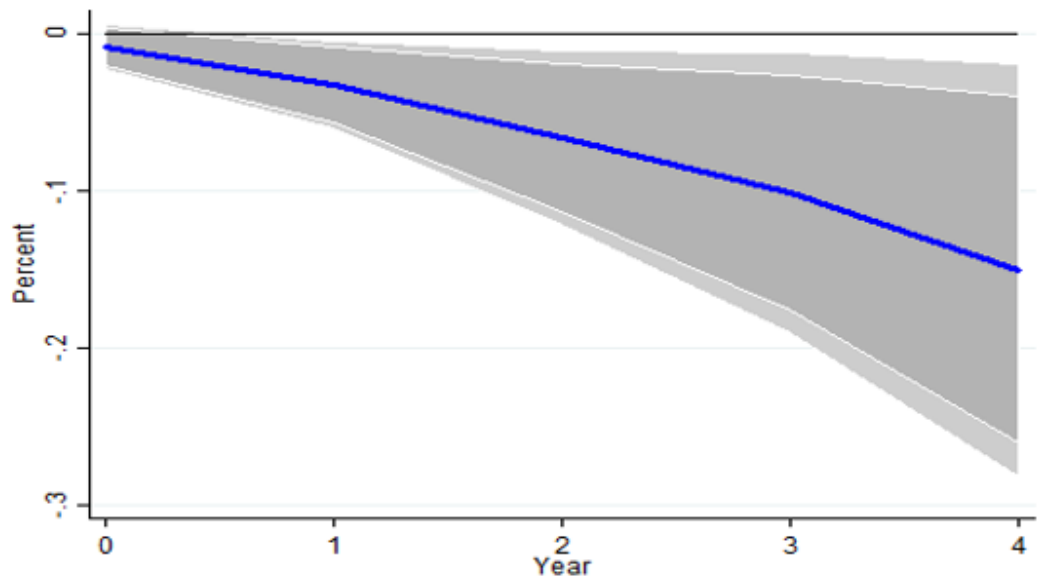
Source: Authors' construction

Figure 1.15: Effect of natural resource discoveries interacting with alternative measures of institutional quality (equation (1.3)), at the 5% and 10% threshold.



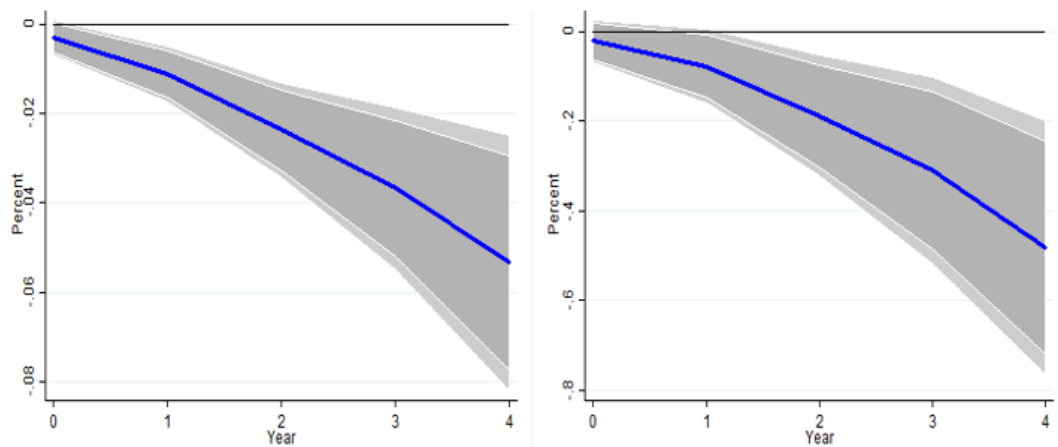
Source: Authors' construction

Figure 1.16: Direct effect of natural resource discoveries (equation (1.2)), at the 5% and 10% threshold.



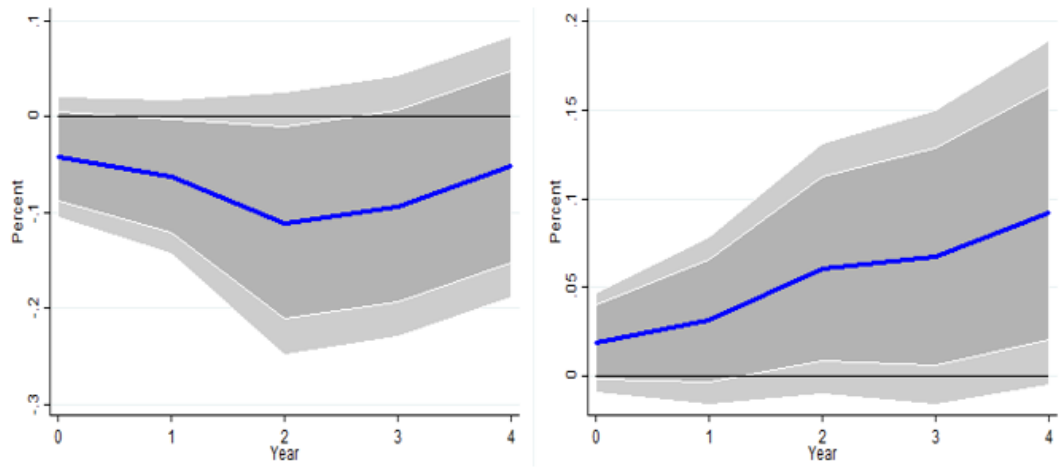
Source: Authors' construction

Figure 1.17: Effect of natural resource discoveries in interaction with institutional quality (equation (1.3)) and fiscal rules (equation (1.4)), at the 5% and 10% threshold.



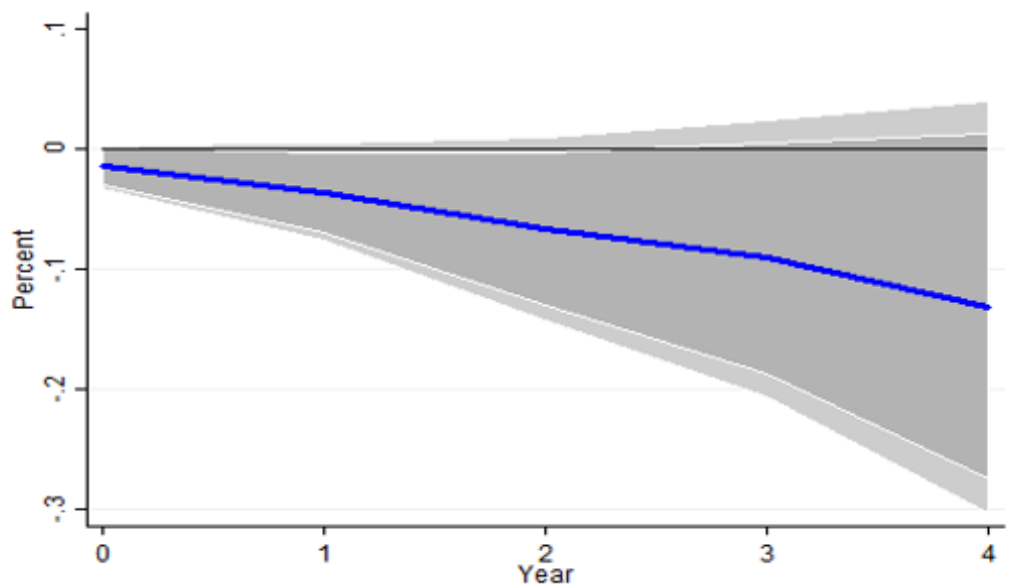
Source: Authors' construction

Figure 1.18: Public investment and consumption expenditure, direct effect of natural resource discoveries (equation (1.2)), at the 5% and 15% threshold.



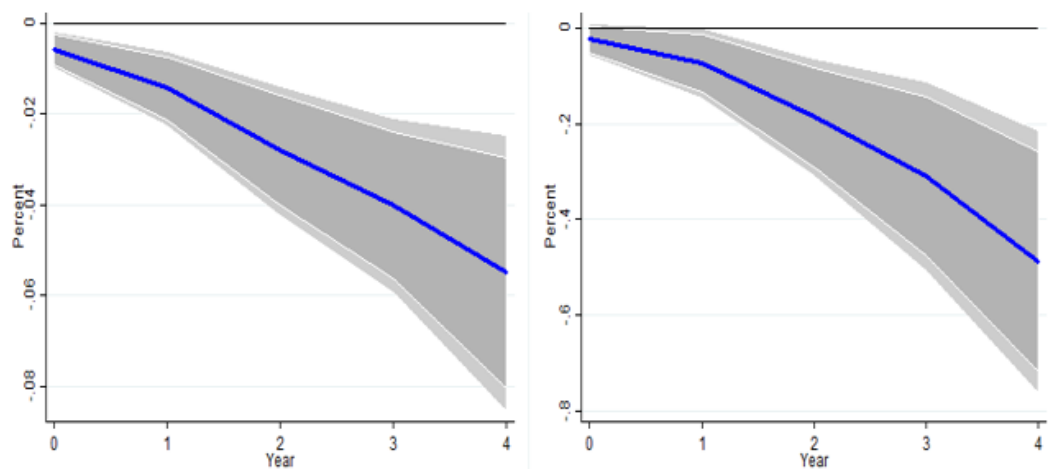
Source: Authors' construction

Figure 1.19: Direct effect of natural resource discoveries (equation (1.2)), at the 5% and 10% threshold.



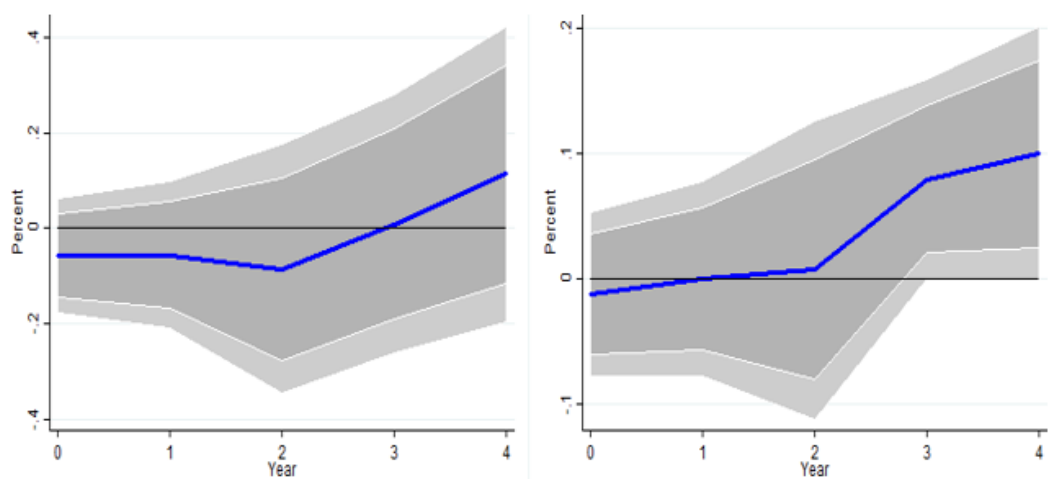
Source: Authors' construction

Figure 1.20: Effect of natural resource discoveries in interaction with institutional quality (equation (1.3)) and fiscal rules (equation (1.4)), at the 5% and 10% threshold.



Source: Authors' construction

Figure 1.21: Public investment and consumption expenditure, direct effect of natural resource discoveries (equation (1.2)), at the 5% and 15% threshold.



Source: Authors' construction

Chapter 2

Chapter 2

Public Agricultural Expenditure Efficiency and Food Security in Sub-Saharan African Countries: Cash Crops or Food Crops ?

Job Market paper: Revise & Resubmit at Applied Economics

2.1 Introduction

Food security is achieved when all individuals have access at all times to sufficient, safe, and nutritious food to maintain a healthy and active life (Food and Agriculture Organization of the United Nations (FAO), 1996). The concept encompasses four dimensions: stability, access to food, availability of nutritionally adequate food, and biological utilization (FAO, 1996). Today, food insecurity is a major global issue that continues to worsen due to environmental, socio-economic, and security factors such as climate change, the COVID-19 pandemic, and recent conflicts (Fontan Sers and Mughal, 2019; FAO, 2020; Campi et al., 2021; Nchanji and Lutomia, 2021). In 2023, global food insecurity remained alarming, with nearly 282 million people in acute food insecurity needing urgent assistance, an increase of nearly 24 million people compared to the previous peak in 2022 due to the war in Ukraine (Food Security Information Network (FSIN), 2024). Moreover, Africa is the largest battleground against hunger in the world; in 2021, about 278 million people in Africa (20.2% of the population) were food insecure (FAO and al., 2022). Indeed, in 2023, of the 45 countries worldwide needing food aid, 33 were African, with the vast majority in sub-Saharan Africa (SSA) (FAO, 2024). Thus, SSA is by far the most affected region by food insecurity.

Given its importance, the global food system appears as a key element of several Sustainable Development Goals (SDGs) (United Nations (UN), 2015), particularly the second SDG (Zero Hunger by 2030).

Consequently, African leaders and international institutions have increasingly focused on ways to eradicate hunger and ensure the right and access to food for the continent's growing population. One of the solutions advocated by the FAO, the International Fund for Agricultural Development (IFAD), and the World Food Programme (WFP) for African countries is to increase the share of public spending allocated to agriculture, thereby boosting agricultural productivity, encouraging diversification, and ensuring the production of nutritious food (FAO, IFAD, WFP, 2015). Indeed, 63% of the population in SSA lives in rural areas and relies heavily on agriculture (?). Since hunger is more prevalent in countries where public agricultural expenditure (PAE) per worker is lower (FAO, 2012), the FAO suggests that PAE is a key factor in successfully reducing undernutrition and poverty, especially in rural areas (FAO, 2012; FAO, IFAD, WFP, 2015).

In this context, African countries committed to allocating at least 10% of public expenditure to agriculture through the Maputo and Malabo Declarations, under the Comprehensive Africa Agriculture Development Programme (CAADP). This investment aimed to achieve a 6% annual agricultural production growth rate, crucial for ending hunger and halving poverty by 2025 (African Union, 2003, 2014). Despite progress in PAE, the literature reveals that this spending frequently misses the 10% goal and shows inconsistent effects on food security and nutrition across SSA countries (Ruel and Alderman, 2013; Beyene and Engida, 2016; Fontan Sers and Mughal, 2019; Bizikova et al., 2020; Kamenya et al., 2022; Ngoben and Muchopa, 2022).

Thus, our study aims to contribute to recent studies analyzing the effect of PAE on food security in SSA region, focusing on the factors influencing this relationship that may cause inefficiency in PAE in terms of food security. In this study, we are interested in PAE efficiency (PAEE) in SSA, especially considering the challenges of mobilizing resources to finance African agriculture, which has recently faced additional difficulties due to global shocks such as the 2008 crisis, the COVID-19 pandemic, and the war in Ukraine. These crises have deteriorated the fiscal balances of the region's countries, increasing the risk of over-indebtedness. Since many countries in the region rely on food, fertilizers, and fuel imports (Food Security Information Network, 2020), the disruption of supply chains and significant price increases due to these crises have raised import bills, subsidy expenditures, and social protection measures for vulnerable populations. Thus, these crises have not only exacerbated food insecurity but also degraded the already insufficient financial capacity of African countries to combat food insecurity. Finally, in an increasingly tense global context with the protracted war in Ukraine and the outbreak of the Israeli-Hamas conflict, the situation could become increasingly difficult for the region's countries; high public debt levels could prevent governments from making necessary investments in their food systems and reduce their ability to respond to future shocks.

Ultimately, in a context where African governments face growing macroeconomic challenges, limited fiscal space, and shrinking resources for international humanitarian aid due to recent global crises, coupled with the rising trend of food insecurity figures, PAEE on food security becomes crucial. Therefore, we aim to answer the following questions: Why public agricultural expenditure is not efficient in achieving food

security in SSA region? What are the factors playing a role in these countries? How public agricultural expenditure can become efficient in achieving food security?

To address these questions, we analyze the region’s agricultural production structure, which includes *food crops* production mainly for local consumption and *cash crops* production mainly for export. The impact of *cash crops* production (e.g., coffee, cocoa, tobacco, cotton, cashew nuts etc...) on food security is debated in the literature. While some studies highlight positive effects on food security (Kuma et al., 2019; Bitama et al., 2020; Rubhara et al., 2020), others report negative outcomes (Masanjala, 2006; Adjimoti and Kwadzo, 2018; Ayeni and Adewumi, 2023). This debate underscores uncertainty about whether income from *cash crops* compensates for reduced *food crops* production and enhances food security. However, most existing studies in this literature rely on household surveys from specific regions in specific countries, providing limited insights for broader policymaking.

We hypothesize that a production structure dominated (or not) by *cash crops* influences PAEE. To explore this, we analyze the effect of *cash crops* production on PAEE in SSA region. In line with Jarzebski et al. (2020) and FAO data, we identify 10 key *cash crops* in SSA (among 144 primary agricultural products) with the remainder being *food crops* (see Table 2.10).

To achieve our research objective, we employ a two-step approach. First, we calculate the Bias-corrected Technical Efficiency (BTE) scores for SSA countries using the Bootstrap Data Envelopment Analysis (DEA-Bootstrap) method, where PAE per capita serves as input, and food security indicators serve as output. Second, we analyze the impact of *cash crops* production¹ on these efficiency scores using beta regression, controlling for economic, demographic, institutional, and natural hazard factors affecting food security. Our dataset spans 2003-2017 and includes 39 SSA countries.

Our findings reveal that in 79% of SSA countries, cash crops occupy less than 15% of harvested land. However, a significant positive effect of *cash crops* share in harvested land (CSHL) on PAEE suggests that a higher proportion of *cash crops* enhances food security in SSA. While the Maputo (2003) and Malabo (2014) declarations to allocate at least 10% of public expenditure to agriculture have yielded mixed outcomes, our analysis indicates that these policies are more effective in countries with higher CSHL.

This study underscores the importance of considering agricultural production structures in policies aimed at eradicating hunger in SSA, supporting the Sustainable Development Goal of Zero Hunger by 2030. Our contributions are twofold: providing a cross-countries perspective on the impact of *cash crops* on food security and offering insights into the mediating role of *cash crops* in the relation between PAE and food security in SSA.

Our results remain robust across different BTE measures, samples, econometric methods, and model specifications. The paper is structured as follows: Section 2 reviews the relevant literature; Section 3 presents stylized facts; Section 4 outlines the empirical methodology; Section 5 describes the data; Section 6 presents the econometric results; Section 7 conducts robustness tests; and Section 8 concludes.

¹Where *cash crops* production is measured by the share of harvested land allocated to cash crops production in the total amount of harvested land, the remaining share corresponding to that of food crops.

2.2 Literature review

Our literature review is structured in two parts: the first part concerns the relationship between PAE and food security, and the second one is related to the effect of *cash crops* production on food security.

2.2.1 *Public agricultural expenditure and food security*

Research on the relationship between PAE and food security in Africa can be categorized into two perspectives: individual countries studies and cross-countries analysis.

Individual countries perspective: Studies in this category use household-level data to explore the impact of PAE on food security, nutrition, and well-being within specific countries or communities. The findings reveal both direct and indirect effects of PAE on food security, depending on how funds are allocated for irrigation, training, research, and infrastructure (Fan et al., 2000; Fan and Zhang, 2008; Beyene and Engida, 2016). However, these positive effects are not guaranteed; they depend on contextual factors like rainfall and population growth (Ngoben and Muchopa, 2022). Bizikova et al. (2020) reviewed 66 studies and found that 67% of agricultural interventions positively impacted food security, while 23% showed no effect and 10% had negative outcomes. Effective interventions often require multifaceted strategies, targeted support, and community involvement.

Cross-countries perspective: While there is substantial evidence linking PAE to household food security (Ruel and Alderman, 2013), fewer studies examine its regional impacts. The literature suggests that increased PAE, while indicative of commitment to the agricultural sector, does not directly translate to improved food security (Fontan Sers and Mughal, 2019; Kamenya et al., 2022). Factors such as institutional quality, climate change, and research and development spending also play significant roles (Benin, 2015; Goyal and Nash, 2017; Mason-D'Croz et al., 2019; Soko et al., 2023). Despite the CAADP leading to higher agricultural spending, its effect on regional food security remains unsatisfactory (Fontan Sers and Mughal, 2019; Kamenya et al., 2022).

Our study investigates the mixed effect of PAE on food security across SSA countries. We suggest that, beyond cyclical factors, the structure of agricultural production also significantly influences this relationship, contributing to the ongoing debate about *cash crops* production's effects on food security.

2.2.2 *Cash crops production and food security*

The literature on *cash crops* production's impact on food security is mixed. Some studies suggest positive effects, indicating that income from *cash crops* such as coffee and tea can enhance food security by increasing household income and dietary diversity (Kuma et al., 2019; Bitama et al., 2020; Rubhara et al., 2020). Conversely, other studies report negative effects, arguing that *cash crops* production can increase food insecurity due to rising food prices, land competition, and inadequate calorie intake despite higher incomes (Anderman et al., 2014; Adjimoti and Kwadzo, 2018; Ayeni and Adewumi, 2023).

Overall, the evidence remains fragmented, often focusing on specific crops or mechanisms that affect food

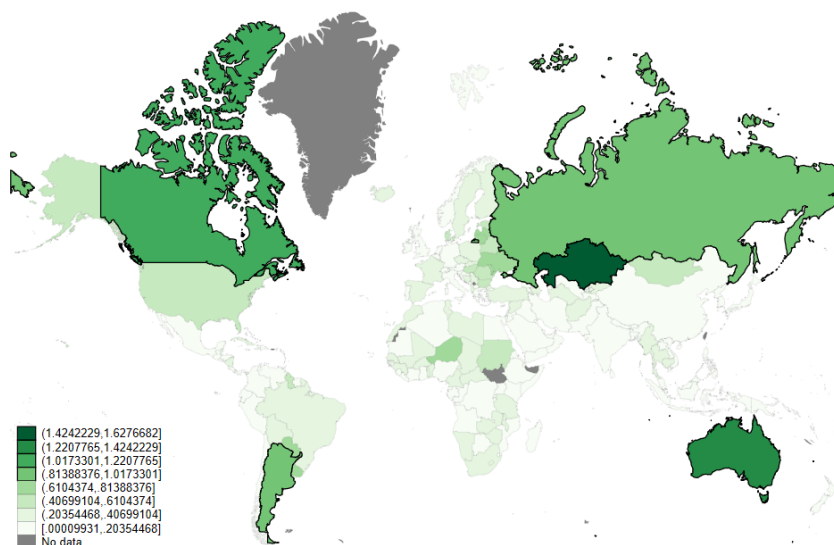
access and availability, with limited attention to utilization and stability. Our study aims to provide a more comprehensive analysis by considering all *cash crops* produced in the SSA region and all dimensions of food security.

In summary, our study contributes to two strands of the literature: the one investigating the effect of PAE on food security in SSA, where no significance has been established in cross-countries analysis, and the one related to the conflicting evidence on the impact of *cash crops* production on food security.

2.3 Stylised facts

In this section, we begin by providing an overview of the quantity of arable land per capita available in each country of the world, as well as the percentage of undernourished people, in order to situate SSA and highlight the problem of food security in this region. We limit our analysis to 2018 to avoid including the periods of exceptional spending and food insecurity caused by the COVID-19 crisis and the war in Ukraine.

Figure 2.1: Arable land (hectares) per capita in 2018

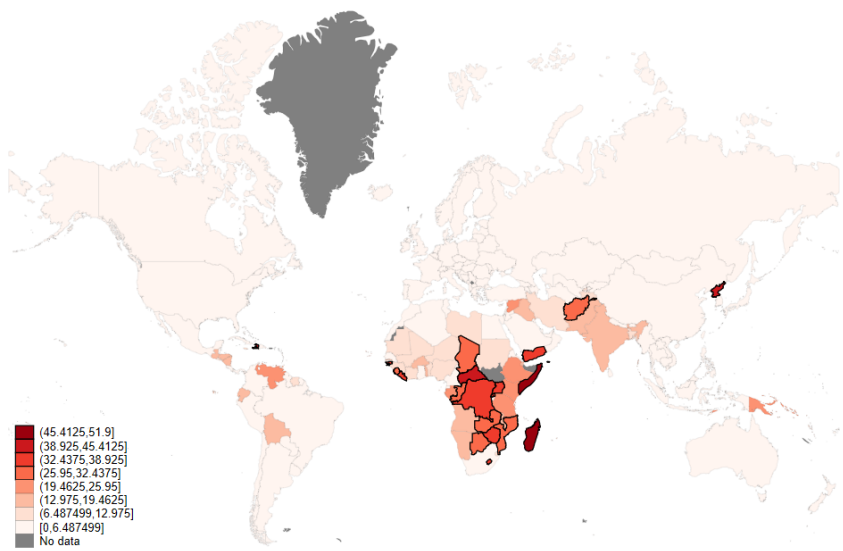


Source: Author's construction, Data from World Bank.

Figures 2.1 and 2.2 suggest that although SSA has similar amounts of arable land per capita as Western Europe, Asia and Latin America, it has a relatively higher percentage of undernourished people than in any other region of the world. This suggests that it is not only the amount of arable land available that explains food security but also other cyclical factors such as PAE and adequate agricultural policies as described in the literature. In this study we focus on structural factors such as the structure of agricultural production.

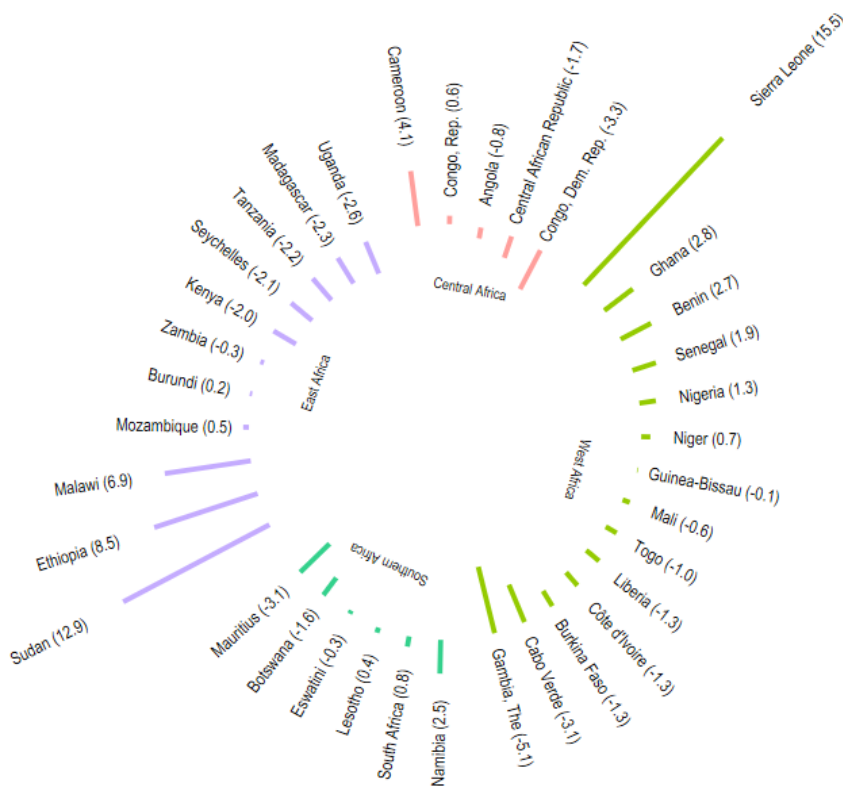
Figure 2.3 shows the progress in increasing PAE between 2000 and 2018. The top performer since the Maputo Declaration, having increased their PAE the most is Sierra Leone (15.5 % points) and the least is Gambia (-5.1 % points).

Figure 2.2: Prevalence of undernourishment (% of total population) in 2018



Source: Author's construction, Data from FAO.

Figure 2.3: Change in the share of public agricultural expenditure from 2000 to 2018



Source: Author's construction, Data from FAO.

After highlighting SSA situation in terms of PAE, arable land per capita and food security, the next section presents our empirical methodology.

2.4 Empirical methodology

Our empirical methodology will be carried out in two steps. The first step consists of a theoretical presentation of the concept of efficiency and the second presents our econometric strategy.

2.4.1 Theoretical conception of efficiency

The efficiency of a Decision-Making Unit (DMU) can be described in two ways: output-oriented, which aims to maximize outputs with a given amount of inputs, and input-oriented, which focuses on minimizing inputs for a given amount of outputs. In our study, we adopt the output-oriented approach to achieve the best possible food security outcomes, considering the limited resources available to SSA countries. Each country, for a given year, represents a DMU. To understand how each DMU compares to the efficiency frontier and determine its efficiency, we refer to Figure 2.4

Figure 2.4: Efficiency representation

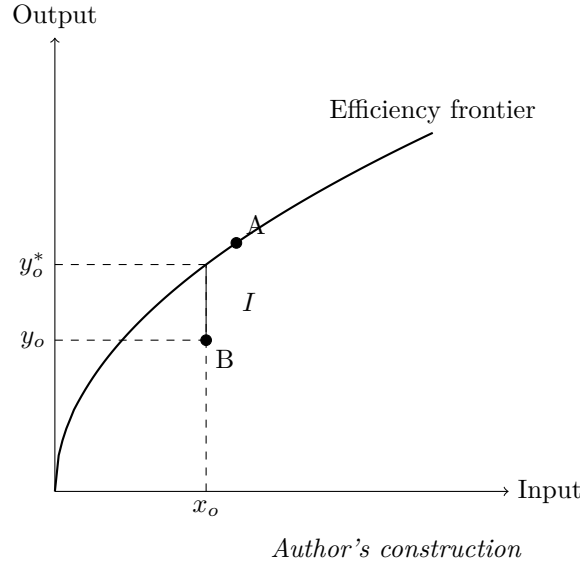


Figure 2.4 illustrates the output orientation we have chosen. The efficiency frontier represents the locus of DMUs with best practices. Therefore, DMU A, which is located on the efficiency frontier, is considered efficient and will have an efficiency score of 1. On the other hand, DMU B, which is not on the efficiency frontier, is considered inefficient, and its efficiency score will be less than 1.

To calculate efficiency scores, we must first establish the type of efficiency frontier. Indeed, there are two main categories of efficiency evaluation methods: parametric² and non-parametric³ methods. In our study, we chose one of the non-parametric methods, the Data Envelopment Analysis (DEA) method⁴

²These methods construct the efficiency frontier by assuming a functional form of the production function. Stochastic Frontier Analysis (SFA) is commonly used and incorporates a random error term to distinguish between inefficiency and statistical noise. However, these methods require defining a functional form and making assumptions about the distribution of errors (De Borger and Kerstens, 1996; Borodak, 2007).

³These methods determine the efficiency frontier using mathematical programming techniques without assuming a functional form. Although deterministic and including statistical noise in the results, recent techniques like bootstrap have mitigated these limitations. Their flexibility and available corrective tools make them preferable (Borodak, 2007).

⁴Key non-parametric methods include Free Disposal Hull (FDH) (no convexity assumption) and DEA (with convexity

with the bias correction bootstrap and the variable returns to scale (VRS) approach. The DEA method is one of the most widely used for analysing the efficiency of public spending (Gupta and Verhoeven, 2001; Afonso et al., 2010a; Adam et al., 2011; Cetin and Bahce, 2016; Afonso and Kazemi, 2017; Afonso and Fraga, 2024).

2.4.2 *Econometric strategy*

Our econometric strategy consists of a two-stage approach. First, we compute and analyse the relative technical efficiency (TE) scores and the relative bias-corrected technical efficiency (BTE) scores using DEA-Bootstrap with VRS method and output orientation. In the second stage, we analyse the effect of *cash crops* production on BTE using the beta regression method, controlling for a range of cyclical factors affecting food security.

Stage 1: Estimation of TE and BTE scores: DEA-Bootstrap with VRS method and output orientation

For the first stage of our analysis, focusing on the calculation and analysis of TE and BTE scores, we chose the DEA method to closely approximate the real efficiency frontier. DEA, developed by Charnes et al. (1978), is a non-parametric method that uses linear programming to measure efficiency. It constructs an efficiency frontier by connecting the most efficient units in a dataset, based on 'best-observed practice,' enveloping inefficient units. DEA assigns a set of weights to each DMU to optimize their efficiency score (Jacobs et al., 2006). This flexible method does not require specifying production functions and can handle multiple inputs and outputs (Jacobs et al., 2006). However, as a data-driven approach, DEA interprets any deviation from the frontier as inefficiency. In an output-oriented model, DEA calculates TE by maximizing output while keeping inputs constant.

In a DEA model with n DMUs, each using i inputs to produce j outputs, the output-oriented TE of a DMU_{r_0} can be assessed by solving the following linear programming problem:

$$\hat{\theta}_{r_0} = \max \lambda$$

subject to:

$$\begin{aligned} \sum_r X_{ir} \gamma_r - X_{ir_0} &\leq 0, \quad i = 1, \dots, I \\ \sum_r Y_{jr} \gamma_r - \lambda Y_{jr_0} &\geq 0, \quad j = 1, \dots, J \\ \gamma_r &\geq 0, \quad r = 1, \dots, R \end{aligned} \tag{1}$$

where Y_{jr} represents the amount of the j th output observed for the r th DMU, and X_{ir} denotes the amount of the i th input consumed by the r th DMU. The scalar λ aims to proportionally expand all outputs given the input quantities. The efficiency of a DMU_{r_0} is then the reciprocal of its inefficiency

assumption). DEA can use models such as CRS (constant returns to scale) (Charnes et al., 1978) and VRS (variable returns to scale) (Banker et al., 1984), with linear and convex frontiers, respectively.

$\hat{\theta}_{r_0}$, determined by solving the linear programming problem in Equation (1). Here, γ_r represents non-negative input/output weights that delineate the best practice frontier for the DMU_{r_0} . Similarly, DEA computes these weights for all DMUs in the sample.

The measure of TE derived from Equation (1) assumes constant returns to scale (CRS), implying that all DMUs operate at an optimal level. However, in reality, this assumption may not always hold, as DMUs can vary significantly in size and operation. To address this, Banker et al. (1984) introduce a convexity constraint to the initial model by Charnes et al. (1978), formulated as:

$$\sum_r \gamma_r = 1 \quad (2)$$

To compute the BTE scores, we employ the bootstrap method proposed by Simar and Wilson (1998) to account for the data-generating process and mitigate bias in the DEA TE scores. Specifically, in line with the literature, we conducted 2000⁵ bootstrap replications and 95% confidence interval.⁶

Stage 2: Estimation of the effect of cash crop production on BTE scores: A Beta Regression Model

In the second stage of our analysis, we examine the effect of *cash crops* production on BTE scores, using the following regression model:

$$B\hat{T}E_r = z_r\alpha + \epsilon_r, \quad r = 1, \dots, R \quad (2.1)$$

where $B\hat{T}E_r$ is the vector of estimated BTE scores, z_r is a vector of explanatory variables that may influence the efficiency of DMU_{r_0} , α represents the parameter vector to be estimated, and ϵ_r is a normally distributed error term with zero mean and variance σ_ϵ^2 .

As noted by Fonchamnyo and Sama (2016), traditional methods such as Ordinary Least Squares (OLS), tobit estimation (Afonso et al., 2010b), fractional logit estimation (Papke and Wooldridge, 1996), and beta regression (Ferrari and Cribari-Neto, 2004) are commonly employed. However, fractional and beta regression models are particularly suited to our dependent variables ($0 < B\hat{T}E < 1$).

We employ a beta regression model⁷, as introduced by Ferrari and Cribari-Neto (2004), designed to handle a dependent variable (y) that is continuously measured within the unit interval, $0 < y < 1$. This model is ideal when the normality assumption is not met, offering a flexible alternative for asymmetric data. In beta regression, the dependent variable follows a beta distribution, denoted by $\mathcal{B}(\mu, \phi)$, where the density function is defined as:

$$f(y; \mu, \phi) = \frac{\Gamma(\phi)}{\Gamma(\mu\phi)\Gamma((1-\mu)\phi)} y^{\mu\phi-1} (1-y)^{(1-\mu)\phi-1}, \quad (2.2)$$

for $0 < y < 1$,

⁵ According to Simar and Wilson (1998), adequate estimates of confidence intervals using bias-corrected methods typically require 1,000 or more replications.

⁶ We use the `teradialbc` command in Stata18, with the option `invert`, this option makes `teradialbc` calculate and use the Shephard instead of the Farrell (default) efficiency measure, i.e. efficiency scores are inverted. With option `invert` scores smaller than one indicate inefficiency for the output-oriented efficiency measures (i.e. the factor by which output generation proportionally fall short of what is technically feasible)

⁷ The fractional regression will be used in robustness and the results are available under request

where $\Gamma(\cdot)$ is the gamma function, $0 < \mu < 1$, and $\phi > 0$. Here, μ is the expected value of y ($E(y) = \mu$), and ϕ is the precision parameter. The model typically expresses only the mean parameter μ in terms of independent variables, while the precision parameter ϕ is assumed constant across all observations.

Various link functions, such as logit, probit, cloglog, and log-log, can map the linear predictor to the observed values of y on the unit interval. In this study, we employ these four link functions and select the best fit according to the Bayesian Information Criterion (BIC).

2.5 Data and statistics

The study covers the period from 2003 to 2017 with 39 SSA countries, we use this period based on the availability of data for computing the DEA efficiency scores and to avoid period of exceptional expenditure and food security shocks as covid 19 crisis and Ukraine war. Table 2.9 provides the list and sources of the selected variables.

We compute two efficiency scores whose difference lies in the measurement of output. We use PAE per head as the input for the two efficiency scores and we use a composite food security index developed by Caccavale and Giuffrida (2020) for the output of our main efficiency score. For the second efficiency score, which is used in the robustness check, we use variables that capture three of the four dimensions of food security (availability; access; stability). We did not introduce the fourth (biological utilization) due to the lack of complete data.

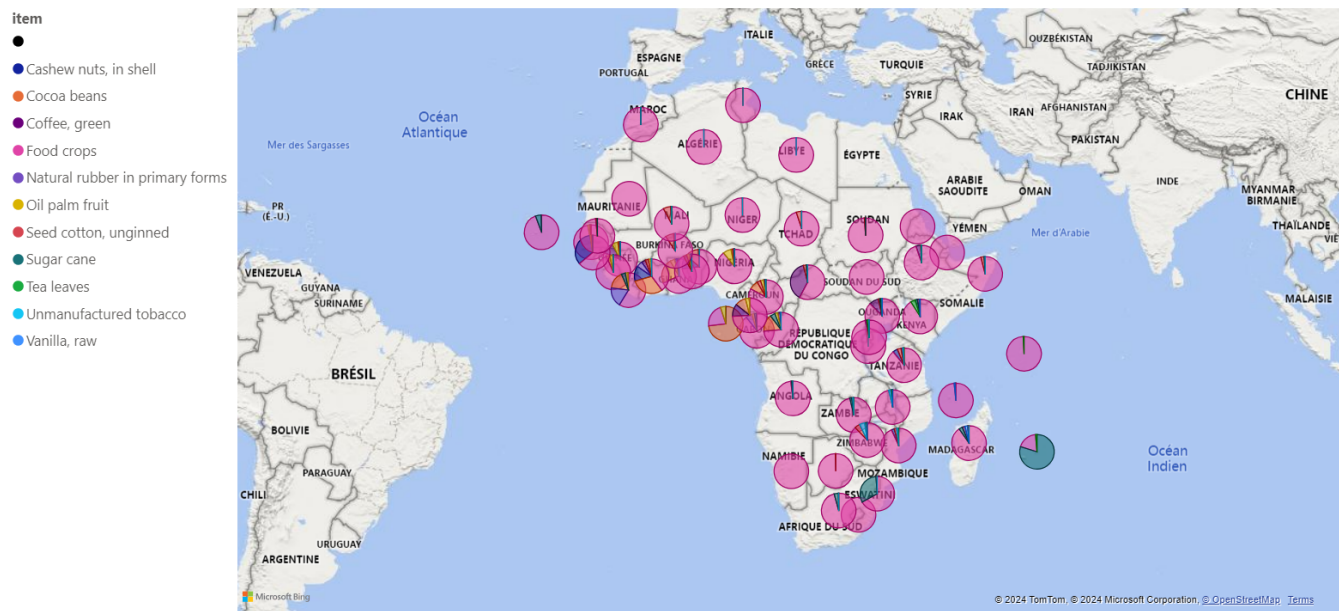
Cash crops Production: Given that the agricultural production structure of SSA countries is characterized by the production of two types of crops (*food crops* and *cash crops*), our identification strategy relies on analyzing the effect of an increase in the share of *cash crops* production in total agricultural production on PAEE.

In our study we use harvested land to compute the share of *cash crops* production in total agricultural production⁸.

Using FAO data on primary crops production in SSA and in line with Jarzebski et al. (2020), we identified 10 *cash crops* out of 144 primary crops (Table 2.10, Figure 2.5). These *cash crops*, often inherited from colonization, are predominantly produced in coastal countries, facilitating transport to northern countries and leading to infrastructure development. Therefore, most SSA countries (79%) dedicate less than 15% of their harvested land to *cash crops* (Figure 2.6).

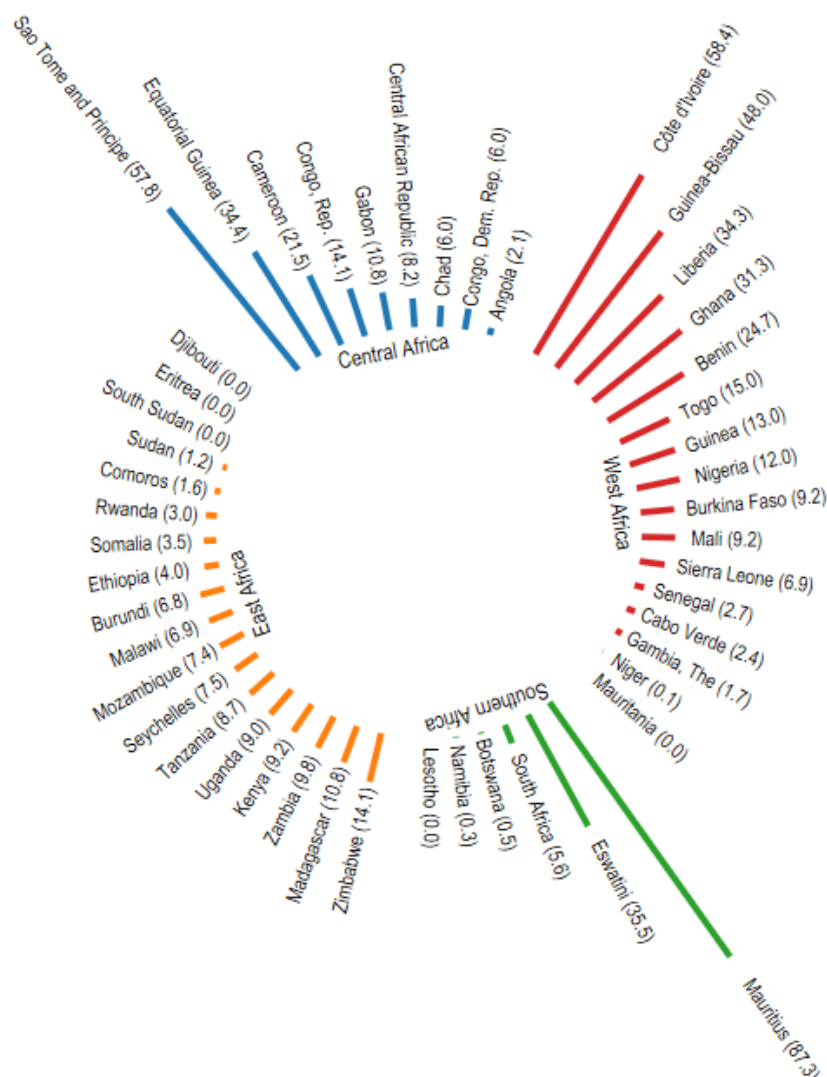
⁸Indeed, using agricultural production in value does not necessarily provide relevant information about our explanatory variable of interest effect on *food crops* production and food security, as some crops may have low/high market values while they are or are not land-intensive and thus may or may not have a major effect on *food crops* production and food security. The same is true for *cash crops* production by quantity; calculating the shares of *cash crops* by quantity does not capture the real effect of these crops on *food crops* and food security. For example, a country producing cocoa would mistakenly have a higher share of *cash crops* than a country cultivating tea as a *cash crops*, creating a bias in country comparisons. A similar analysis can be observed with production in kcal.

Figure 2.5: Cash crops % share of harvested area in 2022



Source: Author's construction, Data from FAO.

Figure 2.6: Cash crops % share of harvested area (Average 2000-2018)



Source: Author's construction, Data from FAO.

2.6 Results and interpretations

This section involves two steps: first, we present and analyze our computed TE and BTE scores, followed by the interpretation of our econometric results from the beta regression, using BTE scores as the dependent variable. In the first step, we analyze TE and BTE scores based on average input and output for a simplified overview. For the econometric analysis, BTE scores are computed using input and output data over the full study period (2003-2017). Both steps utilize the DEA-Bootstrap method (2000 replications) with an output-oriented approach and VRS for TE and BTE score computation.

2.6.1 *Public agricultural expenditure efficiency scores*

For the first step of the efficiency analysis of SSA countries, specifically the calculation and analysis of relative TE and BTE scores, we use the average per capita PAE as input and the average of our food security composite index as output.

We classified countries into two groups based on the median (8.39%) of CSHL. Group 1 consists of countries with an average share above the median, while Group 2 includes countries with an average share below the median.

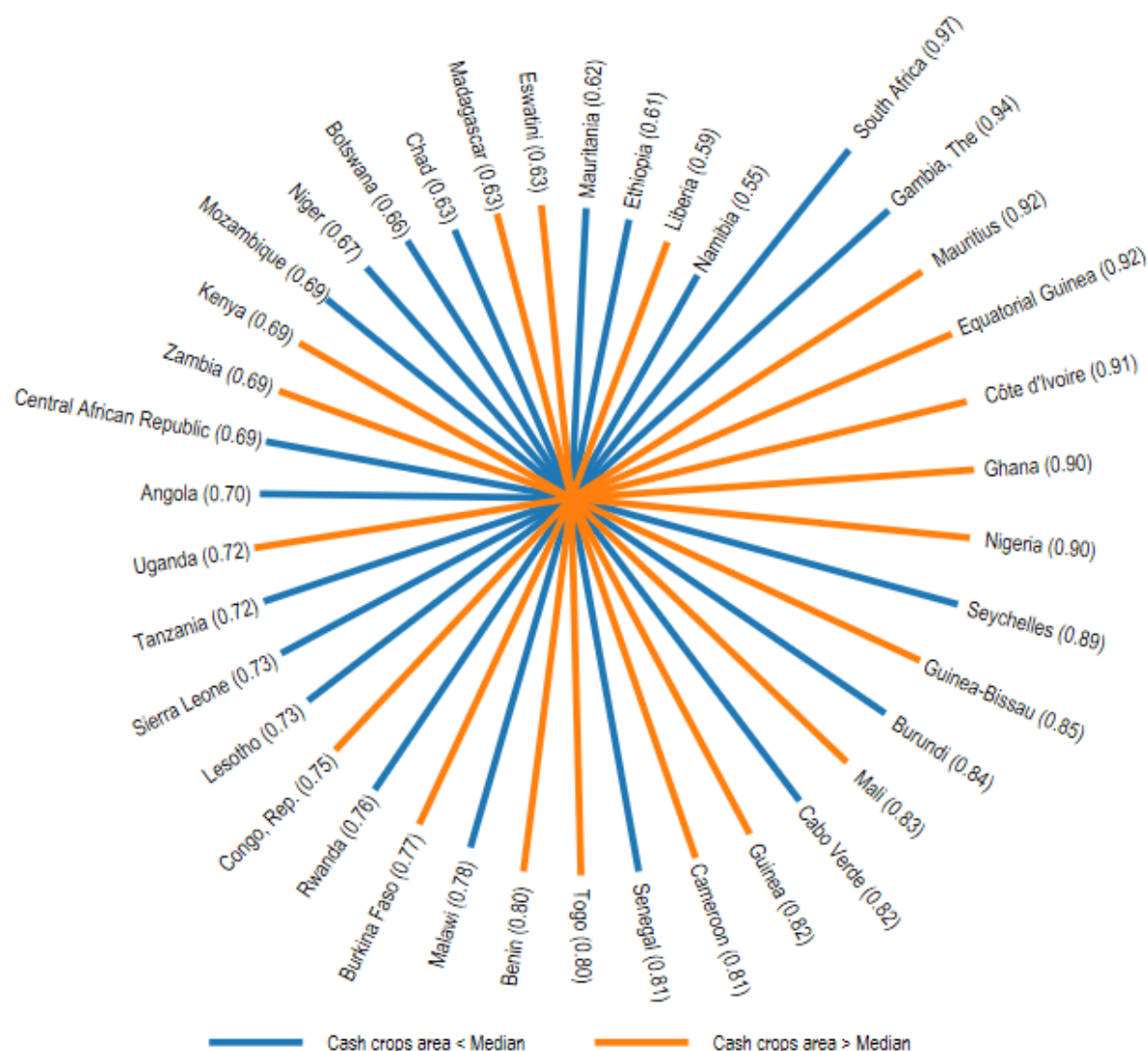
Figures 2.9 and 2.7 show respectively the computed TE and BTE scores. They outline a trend where Group 1 countries tend to be more efficient in using PAE to achieve food security. However, we will refer to the BTE scores for the rest of our analysis.

Figure 2.7 shows BTE scores with the efficiency scores in parentheses, where $0 < BTE < 1$. Results indicate that the majority of the most efficient countries come from group 1, as well as some countries from groups 2. Indeed, the top 7 efficient countries in decreasing order of CSHL are : Mauritius (86.96%), Côte d'Ivoire (58.92%), Equatorial Guinea (32.13%), Ghana (31.78%), Nigeria (11.9%) South Africa (5.5%) and Gambia (1.7%). While the 7 least efficient countries are mainly in group 2: Eswatini (35.75%), Liberia (33.35%), Madagascar (10.64%), Chad (5.4%), Ethiopia (4%), Namibia(.18%) and Mauritania (0%).

Our results suggest that *cash crops* production seems to outweighs *food crops* production in the trade-off between *cash crops* and *food crops* in achieving food security. However, we also observe that some countries with CSHL below the sample median, or nearly nonexistent, are among the most efficient (South Africa (5.5%), Gambia (1.7%)). Indeed, these countries have particular characteristics. The case of South Africa is not surprising because, although it primarily produces *food crops*, it exports *food crops* products instead of *cash crops* products (Jarzebski et al., 2020), which means that it has better infrastructures (Figure 2.10) to produce, store, process, and export these crops⁹.

⁹Exporting *food crops* such as fruits, one of the main food products exported by South Africa (Jarzebski et al., 2020) is more logistically challenging than exporting *cash crops*. In fact, because of their fragility and faster perishability, exporting *food crops* products demands advanced infrastructure for swift transport, proper storage, and specialized packaging.

Figure 2.7: Computed BTE scores: Average 2003-2017



Source: Author's construction.

This gives South Africa the dual advantage of having agricultural production suited to local consumption (*food crops*), resulting in better food access, as well as the benefit of being able to store the value of agricultural production through sales as *cash crops* allow it.

Gambia also have a particular characteristic : it is a relatively very small size country with access to fishing, which could favors food security due to a relatively high "Fish production-to-population" ratio (Figure 2.11).

These results support our intuition, however, an econometric analysis is necessary to establish the relationship between *cash crops* production and PAEE, which is the aim of the following section.

2.6.2 *The effect of cash crops production on public agricultural expenditure efficiency*

In our econometric analysis, we will use BTE scores as the dependent variable and *cash crops* production captured by CSHL as the main explanatory variable. To ensure robustness, we will calculate alternative BTE scores. Our main BTE scores will be referred to as BTE1, while the alternative BTE scores for robustness will be referred to as BTE2.

Table 2.1 presents the results of our econometric model. As we can see, the results show a positive and significant effect of *cash crops* production on PAEE. In SSA countries, an increase in the share of *cash crops* in agricultural production has a positive and significant effect on PAEE. Consequently, our results indicate that a production structure favoring *cash crops* plays an important role in the link between PAE and food security. These findings contribute to the literature on the effect of PAE on food security (Beyene and Engida, 2016; Fontan Sers and Mughal, 2019; Bizikova et al., 2020; Kamenya et al., 2022; Ngoben and Muchopa, 2022). Additionally, the trade-off between more *cash crops* or *food crops* favors increased *cash crops* production. Our study aligns with other research that establishes a positive effect between *cash crops* production and food security (Kuma et al., 2019; Bitama et al., 2020; Rubhara et al., 2020). This can be explained by the fact that *cash crops* allow to store and transfer agricultural value over time, through sales, protecting from seasonal fluctuations (stability and availability). This characteristic of *cash crops* is vital given the lack of infrastructure to store, preserve, or process *food crops*, which are easily perishable. The income from selling *cash crops* also enables populations to access a variety of food products from import more easily, improving nutritional diversity and quality (access and biological utilization).

As we have seen in the stylized facts, most SSA countries allocate a small share (less than 15%) of harvested land to *cash crops* production. Thus, these countries have room to increase CSHL. However, an increase in *cash crops* products on the international market could reduce their value and cancel out their positive effect on food security. A better strategy would therefore be to use a part of income from *cash crops* export to develop infrastructure to increase the production and value of *food crops* products in the international value chain.

Furthermore, Number of disasters; Rural population share; Government effectiveness and Climate ODA through agriculture appear to be the most determining factors of PAEE.

VARIABLES	BTE 1	BTE 1	BTE 1	BTE 1
Cash crops share in harvested area	0.01710*** (0.00124)	0.00971*** (0.00065)	0.00833*** (0.00052)	0.01516*** (0.00115)
Number of disasters	-0.04145** (0.01705)	-0.02485** (0.01042)	-0.02347** (0.01036)	-0.03556*** (0.01380)
Rural population (% of total population)	-0.01135*** (0.00152)	-0.00694*** (0.00091)	-0.00684*** (0.00086)	-0.00933*** (0.00127)
Government effectiveness	0.26919*** (0.04170)	0.15827*** (0.02405)	0.14271*** (0.02140)	0.22899*** (0.03601)
Climate ODA through agriculture/head	0.01476*** (0.00321)	0.00794*** (0.00161)	0.00632*** (0.00120)	0.01340*** (0.00292)
Development flows to agriculture/head	-0.00031 (0.00024)	-0.00018 (0.00015)	-0.00015 (0.00014)	-0.00028 (0.00020)
Arable land/head	-0.07383 (0.09429)	-0.04917 (0.05792)	-0.05701 (0.05982)	-0.05798 (0.07441)
Inflation	0.00468 (0.00392)	0.00287 (0.00235)	0.00281 (0.00220)	0.00376 (0.00329)
Constant	1.66473*** (0.12275)	1.02438*** (0.07289)	0.67671*** (0.06796)	1.70649*** (0.10392)
Observations	570	570	570	570
Link Function	Logit	Probit	Cloglog	Loglog
Information criteria (BIC)	-1119.4439	-1125.9293	-1134.8149	-1112.6395

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 2.1: Main results, *cash crops* production and PAEE

2.7 Robustness tests

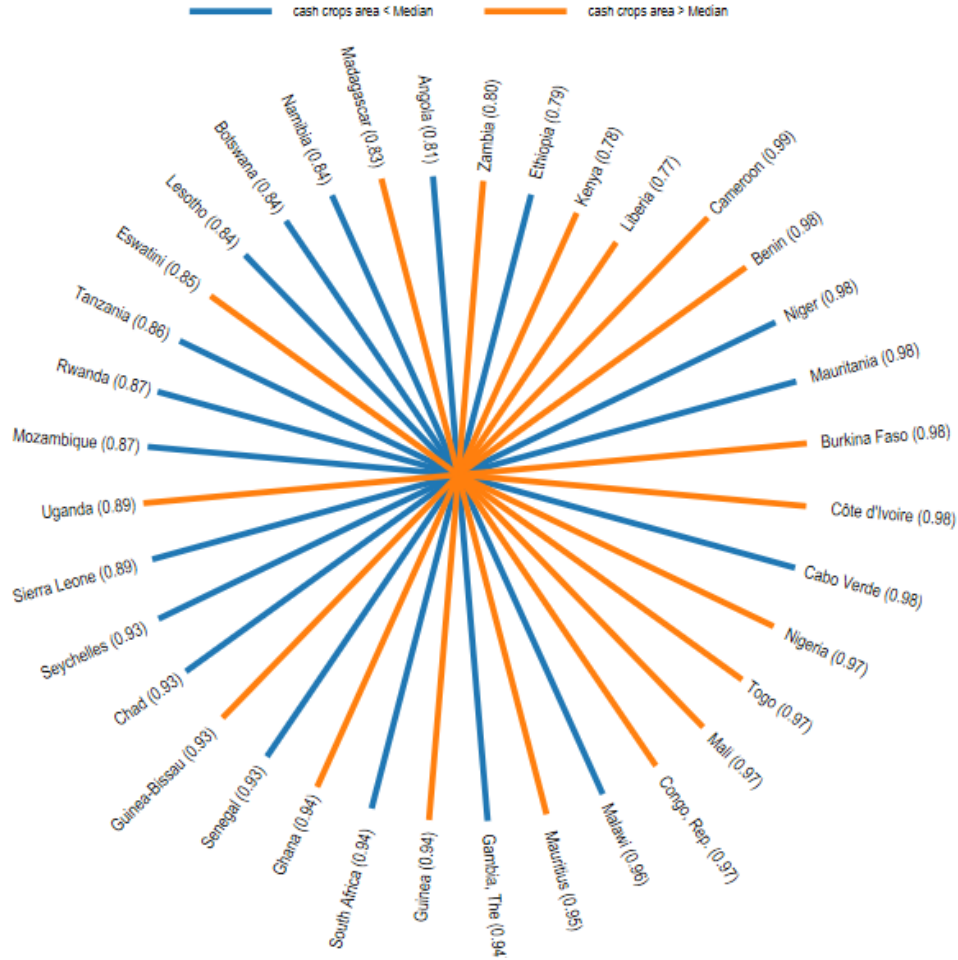
We test the sensitivity of our results to different measures of efficiency scores, different samples, different econometric methods and to additional control variables. We also endorse the robustness of our results by revisiting the effect of the policy of increasing PAE on food security in the light of our finding.

2.7.1 Robustness 1 : Alternative measure of efficiency scores

In this section we use our second measure of efficiency scores (BTE 2). As outlined in the data section, the second measure of efficiency scores is different from the first with regard to the variables used to capture the output. To compute our BTE 2 scores, we have complete data for 36 of the 39 countries used to calculate BTE 1 scores. The median CSHL is 8.34%.

Figure 2.8 shows the computed BTE 2 scores, with the efficiency scores in parentheses. BTE 2 scores also indicate the same trend with the majority of the most efficient countries coming from the group 1, as well as some countries from groups 2. Table 2.2 presents the econometric results of the effect of *cash crops* production on the BTE 2 score, that confirms our finding.

Figure 2.8: Computed BTE 2 scores: Average 2003-2017



Source: Author's construction.

2.7.2 Robustness 2 : Alternative samples

As a second robustness test, we remove from our two samples (samples of BTE 1 and BTE 2), specific groups of countries. Thus we run the analysis by removing the top five countries with highest CSHL from our samples, because they could drive the results. Table 2.3 shows respectively results with BTE 1 and BTE 2 samples. As we can see, our results remain valid after this change in our samples.

2.7.3 Robustness 3 : Alternative econometric method

Still with the aim of testing the robustness of our results, we use another alternative method proposed by Simar and Wilson (2007) to estimate the effect of cash crop production on PAEE. In fact, the authors highlighted that because it is necessary to include data from all other DMUs when estimating the TE score for each DMU, the DEA efficiency scores tend to be upwardly biased and serially correlated. Additionally, a correlation might exist between inputs, outputs, and non-discretionary variables that explain efficiency,

potentially violating the independence assumption between the noise term ϵ_r and z_r .

To address these issues, Simar and Wilson (2007) suggested a two-stage procedure to explain inefficiency. This method involves a double-bootstrap process to ensure consistent inference on efficiency scores, including standard errors, confidence intervals, and accurate parameter estimation. A descriptive of Simar and Wilson (2007) methodology is available in the appendix.

Table 2.4 shows the results with BTE 1 and BTE 2 scores computed à la Simar and Wilson (2007), both with and without the top five countries with the highest CSHL, respectively. As we can see, our results remain robust to an alternative econometric approach. *Cash crops* production has a positive and significant effect on PAEE in achieving food security, all of other variables keep the sign they had in the initial setting.

2.7.4 Robustness 4 : Additional control variables

As observed during the analysis of efficiency scores, certain countries like South Africa and Gambia, with very low CSHL? were among the most efficient nations. Indeed, these countries exhibit specific characteristics related to the level of infrastructure development and access to the sea, respectively. In our fourth robustness test, we evaluate the sensitivity of our results to the inclusion of two new variables that capture these two aspects, namely the level of infrastructure development and access to the sea. Accordingly, we introduce the following control variables:

Infrastructure Development: To capture the level of infrastructure development, we use the Africa Infrastructure Development Index (AIDI). The AIDI is an index that serves to monitor and evaluate the status and progress of infrastructure development across the continent. It encompasses 4 dimensions: Transport composite index; Electricity composite index; Information, communication and technologies composite index and Water and sanitation composite index (AfDB, 2023).

Fish Production-to-Population” Ratio: To consider access to the sea we calculate the fish production/head using the total annual fisheries production. Total fisheries production measures the volume of aquatic species caught by a country for all commercial, industrial, recreational and subsistence purposes. The harvest from mariculture, aquaculture and other kinds of fish farming is also included (?).

We have therefore carried out all the econometric estimations, from the basic regression to the previous robustness tests, by including these two new variables. And as we can see from the results, our finding remain valid after adding relevant additional control variables.

Tables 2.5 and 2.6 present the results for efficiency scores 1 and 2, respectively. Columns BTE 1 and BTE 1', as well as BTE 2 and BTE 2', display the results with and without the top 5 countries with the highest CSHL, respectively.

Table 2.7 shows the robustness results with BTE 1 and BTE 2 scores computed in line with Simar and Wilson (2007) methodology, with our additional control variables and with and without the top five countries with highest the CSHL, respectively.

2.7.5 *Robustness 5 : Revisiting the effect of the policy of increasing public agricultural expenditure on food security in light of our findings*

To ensure the robustness of our findings, we also examine their implications within the existing literature concerning the effect of PAE on food security. Specifically, we assess whether incorporating the share of *cash crops* influences the significance of PAE impact on food security. Following the approach of Fontan Sers and Mughal (2019), we use the prevalence of undernourishment as a percentage of the total population as our dependent variable. Our analysis spans the period from 2000 to 2018, covering 42 SSA countries (Table 2.12), and employs a robust fixed-effect panel model estimation.

In Table 2.8 : column (1) gives the result of the basic regression, without including the production share of *cash crops*. Columns (2) and (3) give the results of the sub-samples for which *cash crops* shares are higher than the median and the mean of the sample, respectively. Thus, the effect of PAE on food security becomes significant when we use observations for which CSHL is higher than the mean of the sample.

Column (6) gives the result of the interaction effect between PAE and CSHL on food security. Again, we note that the effect of PAE crossed with CSHL becomes significant.

We also created binary variables for our analysis: *up median* takes the value 1 when CSHL is greater than the sample median and 0 otherwise; *up mean* takes the value 1 when CSHL is greater than the sample mean and 0 otherwise. These variables were then interacted with PAE (column (4) and (5)). Our results consistently point in the same direction. While this analysis warrants further detailed exploration, it sufficiently confirms the robustness of our findings and offers perspectives for future research.

2.8 Conclusion and discussion

This study provides a cross-countries perspective to two areas of food security literature: First, it provides a contribution on the debate over the effect of cash versus *food crops* production on food security in SSA. Second, it underscores the mediating role of *cash crops* in the relationship between PAE and food security. Our findings reveal that most SSA countries allocate less than 15% of their harvested land to *cash crops*, yet increasing this share positively affect PAEE. Moreover, public spending policies targeting agriculture are more effective in countries with high CSHL. The revenue from *cash crops* helps stabilize agricultural production value, diversify consumption, and buffer against seasonal uncertainties, addressing issues like inadequate storage and infrastructure.

However, focusing heavily on *cash crops* for export can compromise food sovereignty by increasing dependency on food imports. For countries already heavily reliant on *cash crops* exports, we recommend imposing quotas on the land allocated to *food crops* and using tax revenue from *cash crops* to subsidize *food crops* production and development, thereby extending their value and lifespan within the global food chain. This strategy could gradually reduce their dependence on *cash crops* exports while enhancing competitiveness and resilience to global market shocks. For countries with a low share of *cash crops*, it

might be beneficial to encourage the development of *cash crops*, but with carefully managed quotas to prevent market oversupply.

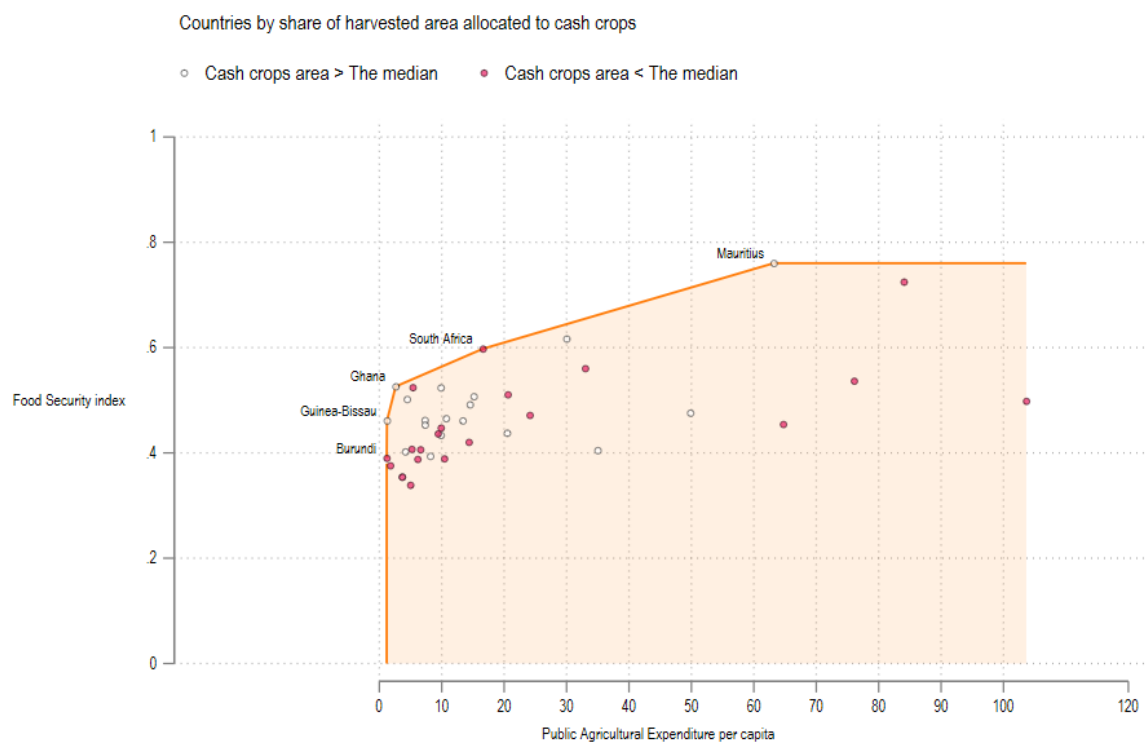
Regional coordination is essential for managing the supply of *cash crops* across SSA, similar to how OPEC controls oil production. By regulating the amount of land dedicated to each type of crop, SSA countries could stabilize *cash crops* prices and mitigate the risks of market volatility. This strategy would also allow for a more balanced approach to addressing both food security and economic goals.

Furthermore, reinvesting a portion of *cash crops* export revenues into developing *food crops* could help reduce vulnerability to international food trade shocks. This would support a gradual shift toward greater food sovereignty, minimizing reliance on global imports.

These findings offer valuable insights for policymakers seeking to enhance resource allocation and progress toward the Sustainable Development Goal of zero hunger in SSA. Future research should delve into the mechanisms by which *cash crops* impact food security and examine the trade-offs involved in different agricultural strategies. Additionally, further exploration is needed into how production structures affect the relationship between PAE and food security, particularly in determining the optimal balance between cash and *food crops*.

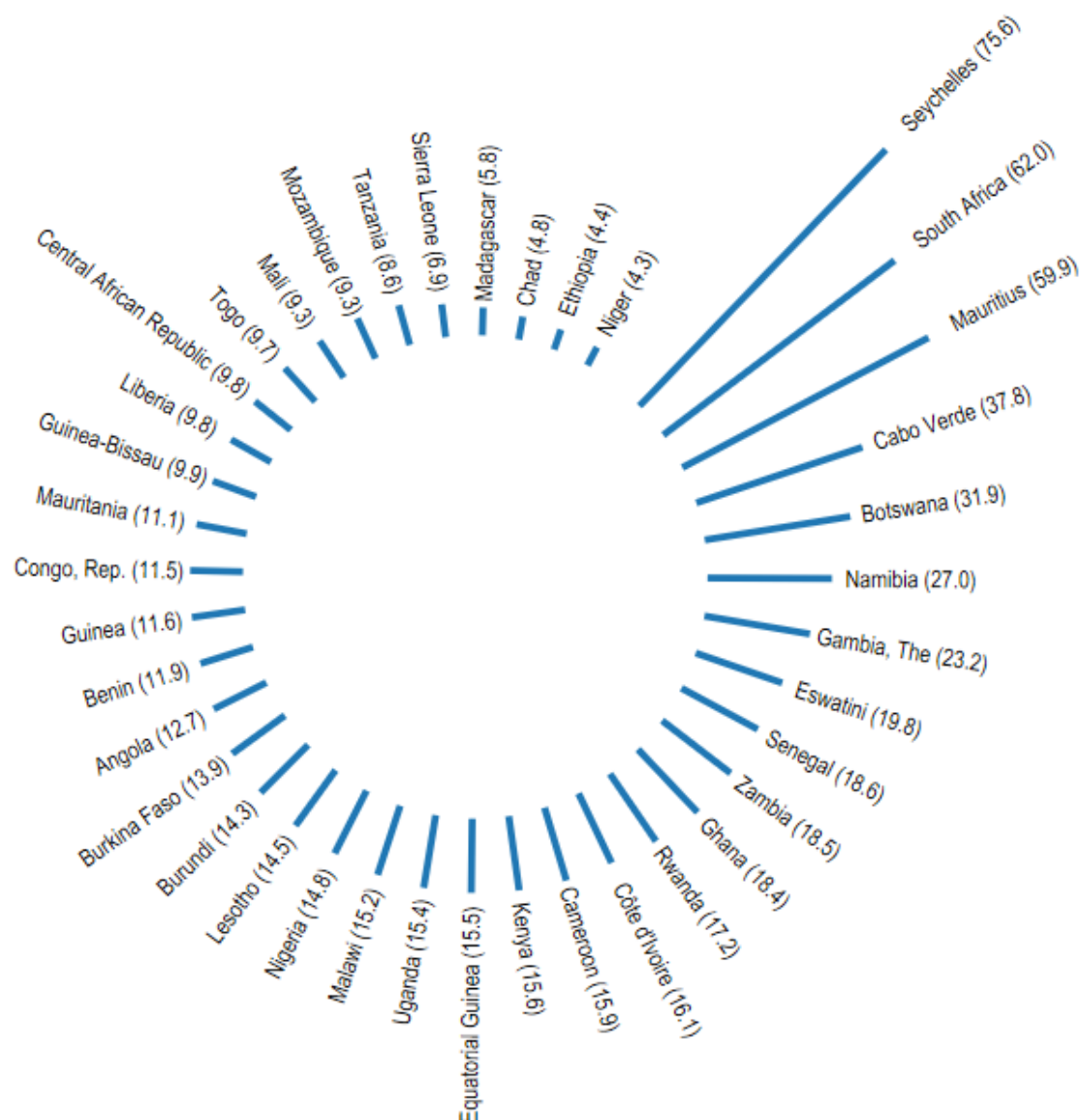
2.9 Appendix

Figure 2.9: Computed TE scores : Average 2003-2017



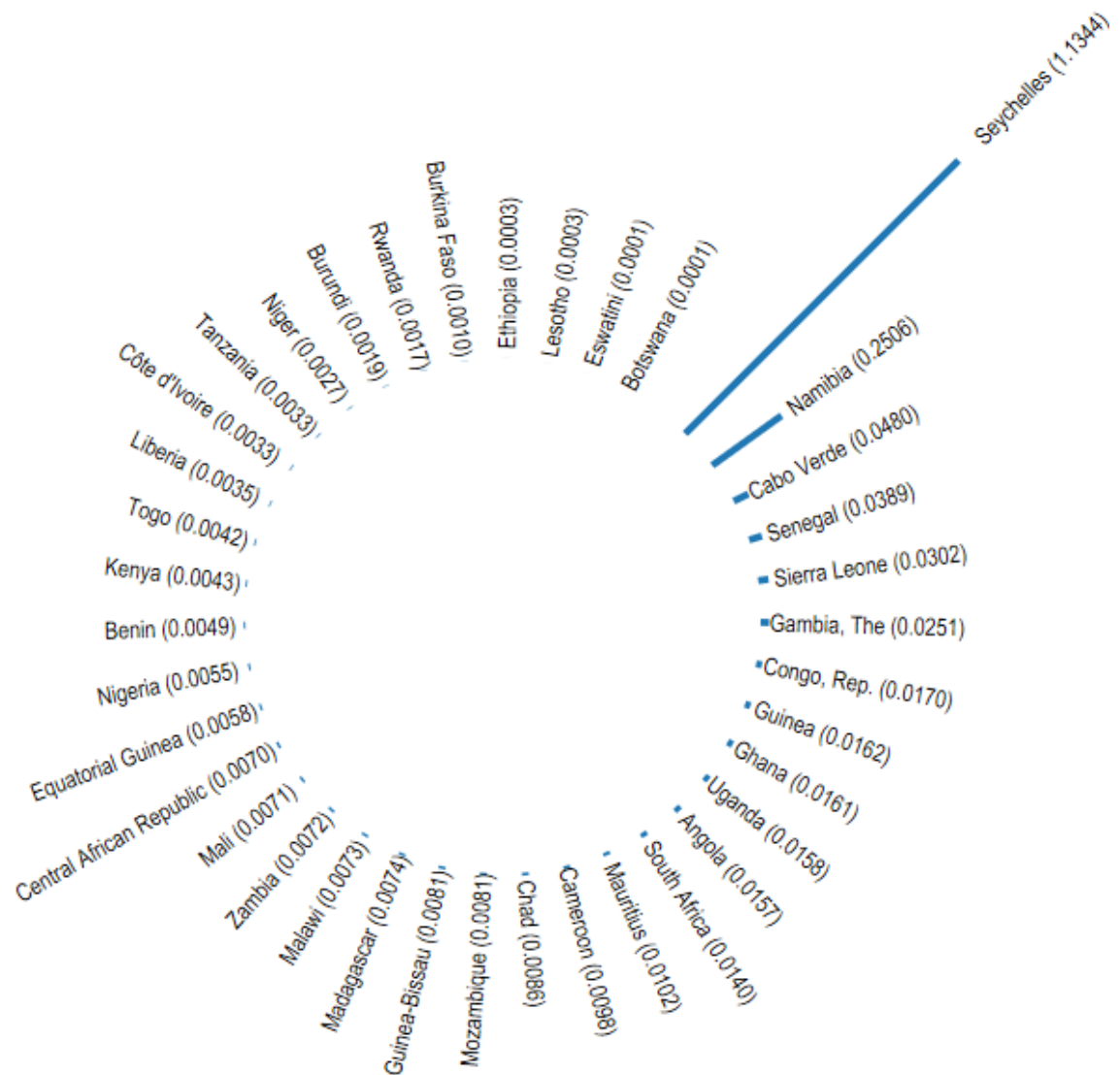
Author's construction

Figure 2.10: Africa Infrastructure Development Index : Average 2003-2017



Author's construction, Data from African Development Bank

Figure 2.11: Fish production-to-population ratio : Average 2003-2017



Author's construction, Data from World Bank

VARIABLES	BTE 2	BTE 2	BTE 2	BTE 2
Cash crops share in harvested area	0.00777*** (0.00144)	0.00430*** (0.00076)	0.00358*** (0.00060)	0.00710*** (0.00134)
Number of disasters	0.00683 (0.02580)	0.00466 (0.01438)	0.00484 (0.01205)	0.00536 (0.02354)
Rural population (% of total population)	-0.00839*** (0.00175)	-0.00469*** (0.00095)	-0.00396*** (0.00078)	-0.00764*** (0.00162)
Government effectiveness	0.13051** (0.05710)	0.07121** (0.03023)	0.05811** (0.02380)	0.12003** (0.05339)
Climate ODA through agriculture/head	0.00307* (0.00164)	0.00173** (0.00087)	0.00147** (0.00069)	0.00278* (0.00153)
Development flows to agriculture/head	-0.00055** (0.00025)	-0.00032** (0.00014)	-0.00028** (0.00012)	-0.00049** (0.00022)
Arable land/head	0.84667*** (0.21201)	0.46572*** (0.11181)	0.38490*** (0.08790)	0.77730*** (0.19824)
Inflation	0.00235 (0.00425)	0.00131 (0.00232)	0.00109 (0.00191)	0.00215 (0.00390)
Constant	1.95459*** (0.15055)	1.16018*** (0.08097)	0.74557*** (0.06493)	2.01677*** (0.13936)
Observations	540	540	540	540
Link Function	Logit	probit	cloglog	loglog
Information criteria (BIC)	-1139.2804	-1139.7931	-1140.4384	-1138.9528

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 2.2: Sensitivity to alternative BTE scores

VARIABLES	BTE 1	BTE 1	BTE 1	BTE 1	BTE 2	BTE 2	BTE 2	BTE 2
Cash crops share in harvested area	0.01250*** (0.00296)	0.00751*** (0.00171)	0.00720*** (0.00151)	0.01059*** (0.00262)	0.01105*** (0.00329)	0.00630*** (0.00182)	0.00545*** (0.00152)	0.00993*** (0.00301)
Number of disasters	-0.03953** (0.01728)	-0.02376** (0.01059)	-0.02229** (0.01060)	-0.03352** (0.01399)	0.00220 (0.02590)	0.00225 (0.01452)	0.00304 (0.01226)	0.00100 (0.02355)
Rural population (% of total population)	-0.01212*** (0.00156)	-0.00732*** (0.00093)	-0.00707*** (0.00088)	-0.01008*** (0.00132)	-0.00800*** (0.00182)	-0.00447*** (0.00099)	-0.00378*** (0.00081)	-0.00729*** (0.00168)
Government effectiveness	0.22980*** (0.05036)	0.14068*** (0.03007)	0.13821*** (0.02813)	0.19006*** (0.04260)	0.09425 (0.07209)	0.05426 (0.03948)	0.04753 (0.03245)	0.08429 (0.06635)
Climate ODA through agriculture/head	0.01461*** (0.00309)	0.00787*** (0.00155)	0.00622*** (0.00117)	0.01327*** (0.00282)	0.00381** (0.00170)	0.00210** (0.00090)	0.00174** (0.00071)	0.00349** (0.00160)
Development flows to agriculture/head	-0.00034 (0.00026)	-0.00019 (0.00016)	-0.00017 (0.00015)	-0.00030 (0.00022)	-0.00052** (0.00025)	-0.00030** (0.00014)	-0.00026** (0.00012)	-0.00046** (0.00022)
Arable land/head	-0.09648 (0.09695)	-0.05984 (0.05952)	-0.06079 (0.06128)	-0.07945 (0.07660)	0.80358*** (0.20490)	0.44653*** (0.10957)	0.37408*** (0.08767)	0.73382*** (0.19036)
Inflation	0.00508 (0.00432)	0.00307 (0.00255)	0.00296 (0.00235)	0.00417 (0.00364)	0.00096 (0.00393)	0.00054 (0.00217)	0.00047 (0.00179)	0.00088 (0.00361)
Constant	1.72508*** (0.12821)	1.05522*** (0.07602)	0.69651*** (0.07064)	1.76391*** (0.10910)	1.90015*** (0.15341)	1.12908*** (0.08320)	0.71843*** (0.06739)	1.96772*** (0.14129)
Observations	525	525	525	525	495	495	495	495
Link Function	Logit	probit	cloglog	loglog	Logit	probit	cloglog	loglog
Information criteria (BIC)	-964.91829	-967.52303	-972.84483	-961.27975	-1012.6813	-1013.3392	-1014.2564	-1012.2967

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 2.3: Sensitivity to alternative BTE scores and to alternative sample

VARIABLES	BTE 1	BTE 1	BTE 2	BTE 2
Cash crops share in harvested area	0.00319*** (0.00027)	0.00209*** (0.00039)	0.00172*** (0.00026)	0.00234*** (0.00046)
Number of disasters	-0.00669** (0.00327)	-0.00705** (0.00323)	0.00086 (0.00354)	0.00013 (0.00353)
Rural population (% of total population)	-0.00237*** (0.00026)	-0.00259*** (0.00026)	-0.00110*** (0.00030)	-0.00105*** (0.00029)
Government effectiveness	0.04873*** (0.00700)	0.04897*** (0.00739)	0.03772*** (0.00757)	0.03380*** (0.00869)
Climate ODA through agriculture/head	0.00238*** (0.00062)	0.00256*** (0.00064)	0.00066 (0.00048)	0.00073 (0.00050)
Development flows to agriculture/head	-0.00008** (0.00004)	-0.00008** (0.00004)	-0.00011*** (0.00004)	-0.00010*** (0.00004)
Arable land/head	-0.00215 (0.02601)	-0.00264 (0.02593)	0.17505*** (0.03206)	0.17356*** (0.03131)
Inflation	0.00027 (0.00050)	0.00019 (0.00049)	0.00025 (0.00056)	0.00015 (0.00055)
Constant	0.87255*** (0.01840)	0.88978*** (0.01802)	0.86974*** (0.02090)	0.86053*** (0.02074)
Observations	570	525	540	495
Bootstrap confidence intervals	2000	2000	2000	2000
Bootstrap bias correction	1500	1500	1500	1500

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

Table 2.4: Sensitivity to alternative methodology, alternative BTE scores and to alternative sample

VARIABLES	BTE 1	BTE 1	BTE 1	BTE 1	BTE 1'	BTE 1'	BTE 1'	BTE 1'
Cash crops share in harvested area	0.01714*** (0.00143)	0.00966*** (0.00074)	0.00827*** (0.00057)	0.01523*** (0.00132)	0.01532*** (0.00359)	0.00911*** (0.00207)	0.00853*** (0.00184)	0.01315*** (0.00316)
Fish production/head	0.36386** (0.14315)	0.21209*** (0.07443)	0.19140*** (0.05781)	0.32270** (0.13453)	0.42020*** (0.15494)	0.22769*** (0.08224)	0.18384*** (0.06567)	0.38568*** (0.14401)
Infrastructure Index	0.02171*** (0.00295)	0.01187*** (0.00168)	0.00958*** (0.00147)	0.01960*** (0.00253)	0.02023*** (0.00332)	0.01152*** (0.00190)	0.00988*** (0.00167)	0.01786*** (0.00285)
Number of disasters	-0.02529 (0.01592)	-0.01626* (0.00983)	-0.01689* (0.00995)	-0.02051 (0.01267)	-0.02297 (0.01608)	-0.01439 (0.00993)	-0.01436 (0.01011)	-0.01900 (0.01283)
Rural population (% of total population)	-0.00580*** (0.00164)	-0.00384*** (0.00098)	-0.00423*** (0.00093)	-0.00447*** (0.00138)	-0.00664*** (0.00185)	-0.00415*** (0.00109)	-0.00427*** (0.00102)	-0.00534*** (0.00157)
Government effectiveness	-0.09438 (0.05823)	-0.05258 (0.03451)	-0.04456 (0.03194)	-0.08286* (0.04890)	-0.09941 (0.06129)	-0.05463 (0.03668)	-0.04328 (0.03469)	-0.08738* (0.05135)
Climate ODA through agriculture/head	0.00143 (0.00292)	0.00072 (0.00146)	0.00054 (0.00109)	0.00124 (0.00267)	0.00167 (0.00287)	0.00070 (0.00143)	0.00035 (0.00107)	0.00162 (0.00262)
Development flows to agriculture/head	-0.00044** (0.00018)	-0.00025** (0.00011)	-0.00021** (0.00010)	-0.00039** (0.00016)	-0.00047** (0.00018)	-0.00026** (0.00011)	-0.00022** (0.00010)	-0.00041*** (0.00016)
Arable land/head	0.12581 (0.09149)	0.05996 (0.05602)	0.03090 (0.05760)	0.12890* (0.07217)	0.09710 (0.09653)	0.05088 (0.05900)	0.03331 (0.06023)	0.09823 (0.07666)
Inflation	0.00899** (0.00398)	0.00558** (0.00239)	0.00558** (0.00224)	0.00716** (0.00332)	0.00893** (0.00408)	0.00548** (0.00243)	0.00542** (0.00225)	0.00721** (0.00342)
Constant	0.64548*** (0.16294)	0.45249*** (0.09583)	0.19159** (0.08901)	0.80882*** (0.13832)	0.73669*** (0.19190)	0.48155*** (0.11193)	0.18568* (0.10153)	0.90799*** (0.16462)
Observations	481	481	481	481	442	442	442	442
Link Function	Logit	Probit	cloglog	loglog	Logit	Probit	cloglog	Loglog

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 2.5: Sensitivity to additional variables and to alternative sample

Chapter 2 - Public Agricultural Expenditure Efficiency and Food Security in Sub-Saharan African Countries: Cash Crops or Food Crops ?

VARIABLES	BTE 2	BTE 2	BTE 2	BTE 2	BTE 2'	BTE 2'	BTE 2'	BTE 2'
Cash crops share in harvested area	0.01390*** (0.00131)	0.00750*** (0.00067)	0.00608*** (0.00052)	0.01281*** (0.00123)	0.02340*** (0.00328)	0.01302*** (0.00174)	0.01088*** (0.00137)	0.02128*** (0.00305)
Fish production/head	0.68972*** (0.14459)	0.37762*** (0.07503)	0.31074*** (0.05781)	0.63257*** (0.13509)	0.54704*** (0.15230)	0.30191*** (0.07833)	0.25188*** (0.05941)	0.49911*** (0.14328)
Infrastructure Index	0.00110 (0.00267)	0.00042 (0.00147)	0.00015 (0.00122)	0.00114 (0.00246)	0.00615** (0.00274)	0.00329** (0.00146)	0.00259** (0.00117)	0.00569** (0.00254)
Number of disasters	0.01601 (0.02393)	0.01022 (0.01365)	0.00988 (0.01170)	0.01302 (0.02149)	0.01301 (0.02377)	0.00902 (0.01361)	0.00951 (0.01175)	0.00983 (0.02125)
Rural population (% of total population)	-0.00653*** (0.00192)	-0.00390*** (0.00108)	-0.00356*** (0.00093)	-0.00570*** (0.00173)	-0.00387* (0.00204)	-0.00239** (0.00115)	-0.00228** (0.00098)	-0.00331* (0.00184)
Government effectiveness	0.17616** (0.08134)	0.08974** (0.04351)	0.06879* (0.03515)	0.16764** (0.07539)	0.11499 (0.07601)	0.05871 (0.04088)	0.04489 (0.03322)	0.11039 (0.07041)
Climate ODA through agriculture/head	-0.00074 (0.00197)	-0.00027 (0.00107)	-0.00008 (0.00086)	-0.00081 (0.00181)	-0.00157 (0.00198)	-0.00079 (0.00106)	-0.00056 (0.00085)	-0.00152 (0.00183)
Development flows to agriculture/head	-0.00070*** (0.00019)	-0.00042*** (0.00011)	-0.00038*** (0.00010)	-0.00062*** (0.00017)	-0.00068*** (0.00018)	-0.00040*** (0.00010)	-0.00036*** (0.00009)	-0.00060*** (0.00015)
Arable land/head	2.10460*** (0.40283)	1.07606*** (0.18744)	0.82538*** (0.12855)	1.98212*** (0.38153)	2.02764*** (0.36298)	1.05989*** (0.17046)	0.83301*** (0.11900)	1.89486*** (0.34670)
Inflation	0.01356*** (0.00464)	0.00735*** (0.00257)	0.00599*** (0.00213)	0.01246*** (0.00425)	0.01023** (0.00439)	0.00558** (0.00243)	0.00459** (0.00203)	0.00938** (0.00401)
Constant	1.38019*** (0.20142)	0.87736*** (0.11152)	0.54361*** (0.09295)	1.46630*** (0.18375)	1.06438*** (0.20202)	0.69071*** (0.11170)	0.37854*** (0.09268)	1.18700*** (0.18422)
Observations	455	455	455	455	416	416	416	416
Link Function	Logit	Probit	Cloglog	Loglog	Logit	Probit	Cloglog	Loglog

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 2.6: Sensitivity to alternative BTE scores, to additional variables and to alternative sample

VARIABLES	BTE 1	BTE 1	BTE 2	BTE 2
Cash crops share in harvested area	0.00301*** (0.00028)	0.00236*** (0.00039)	0.00213*** (0.00026)	0.00321*** (0.00043)
Fish production/head	0.06642* (0.03646)	0.10497*** (0.03981)	0.09961*** (0.03283)	0.09144*** (0.03358)
Infrastructure Index	0.00399*** (0.00055)	0.00341*** (0.00053)	0.00102** (0.00051)	0.00141*** (0.00054)
Number of disasters	-0.00401 (0.00333)	-0.00469 (0.00315)	0.00271 (0.00337)	0.00195 (0.00323)
Rural population (% of total population)	-0.00130*** (0.00029)	-0.00163*** (0.00028)	-0.00072** (0.00031)	-0.00054* (0.00031)
Government effectiveness	-0.01097 (0.00983)	-0.00155 (0.00958)	0.02927*** (0.01082)	0.02025* (0.01084)
Climate ODA through agriculture/head	0.00007 (0.00067)	0.00043 (0.00070)	-0.00030 (0.00054)	-0.00037 (0.00055)
Development flows to agriculture/head	-0.00010*** (0.00004)	-0.00010*** (0.00004)	-0.00012*** (0.00004)	-0.00011*** (0.00003)
Arable land/head	0.02811 (0.02809)	0.02434 (0.02756)	0.27338*** (0.03437)	0.26770*** (0.03272)
Inflation	0.00056 (0.00062)	0.00036 (0.00061)	0.00136** (0.00065)	0.00105 (0.00064)
Constant	0.69130*** (0.02959)	0.72665*** (0.02903)	0.78333*** (0.03036)	0.75476*** (0.03034)
Observations	481	442	455	416
Bootstrap confidence intervals	2000	2000	2000	2000
Bootstrap bias correction	1500	1500	1500	1500

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

Table 2.7: Sensitivity to alternative methodology, alternative BTE scores, to additional variables, and to alternative sample

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
Agricultural expenditure share (%total expenditure)	-0.093 (0.162)	-0.400 (0.246)	-0.908* (0.475)	0.097 (0.192)	-0.016 (0.170)	0.168 (0.206)
Arable land per capita	-1.257 (18.218)	-12.707 (34.500)	20.023 (50.996)	-0.571 (16.668)	-2.754 (17.825)	-3.457 (16.818)
GDP growth rate	0.016 (0.128)	-0.071 (0.075)	-0.031 (0.072)	0.032 (0.130)	0.019 (0.130)	0.029 (0.126)
Population growth rate	0.588 (1.232)	0.399 (0.955)	-0.279 (0.872)	0.528 (1.183)	0.745 (1.308)	0.667 (1.212)
Inflation	0.029 (0.044)	0.001 (0.063)	-0.007 (0.071)	0.029 (0.046)	0.029 (0.045)	0.028 (0.044)
Number of disaster	-0.095 (0.326)	-0.489* (0.270)	-0.992 (0.702)	-0.078 (0.296)	-0.078 (0.320)	-0.071 (0.299)
Participation to CAADP	-4.015*** (1.377)	-2.644** (1.261)	-1.191 (1.034)	-3.827*** (1.401)	-3.998*** (1.372)	-3.999*** (1.347)
Up median				5.481*** (2.104)		
Up median×Agricultural expenditure share				-0.510** (0.209)		
Up mean					5.876** (2.604)	
Up mean×Agricultural expenditure share					-0.763** (0.366)	
Cash crops share in harvested area						0.284** (0.119)
Cash crops share×Agricultural expenditure share						-0.029** (0.012)
Constant	23.364*** (5.260)	27.162*** (7.092)	19.571* (10.006)	32.547*** (4.921)	32.542*** (5.600)	20.002*** (5.480)
Observations	744	382	203	744	744	744
R-squared	0.082	0.107	0.239		0.107	
Number of countries	42	28	19	42	42	42
Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 2.8: Revisiting the impact of public agricultural expenditure on food security

Methodology based on Simar and Wilson (2007):

1. Calculate $\hat{\beta}_r$ (DEA output-oriented technical efficiency) using the original data.
2. Estimate $\hat{\alpha}$ of α and $\hat{\sigma}^2$ of σ^2 using the maximum likelihood method, where $\hat{\beta} > 1$.
3. For each DMU $r = 1, \dots, R$, repeat steps (a)-(d) B times to obtain B bootstrapped technical efficiencies $\hat{\beta}_{r,B}^*$ for $b = 1, \dots, B$.
 - (a) For each $r = 1, \dots, R$, draw ϵ_r from $N(0, \hat{\sigma}_\epsilon^2)$ truncated at $1 - z_r \hat{\alpha}$.
 - (b) For each $r = 1, \dots, R$, compute $\hat{\beta}_r^* = \hat{\alpha} z_r + \epsilon_r$.
 - (c) Use bootstrap estimates to construct pseudo-data (x_r, y_r^*) , where $y_r^* = y_r \hat{\beta}_r / \hat{\beta}_r^*$.
 - (d) Re-estimate new DEA technical efficiency scores β_r^* using the pseudo-data.
4. For each DMU, calculate the corrected technical efficiency $\hat{\hat{\beta}}_r = \hat{\beta}_r - \text{bias}_r$, where $\text{bias}_r = \frac{1}{B} \sum_{b=1}^B (\beta_{r,B}^* - \hat{\beta}_r)$.
5. Estimate the truncated regression $\hat{\hat{\beta}}_r = \alpha z_r + \epsilon_r$ to obtain estimates of (α, σ) by $(\hat{\hat{\alpha}}, \hat{\hat{\sigma}})$ using the maximum likelihood technique.
6. Repeat steps (a), (b), and (c) B_1 times to determine the main bootstrap estimates of interest $(\hat{\hat{\alpha}}_b^*, \hat{\hat{\sigma}}_b^*)$ for $b = 1, \dots, B_1$.
 - (a) For each $r = 1, \dots, R$, draw ϵ_r from $N(0, \hat{\sigma}_\epsilon^2)$ truncated at $1 - \hat{\hat{\alpha}} z_r$.
 - (b) For each $r = 1, \dots, R$, compute $\hat{\hat{\beta}}_r^{**} = \hat{\hat{\alpha}} z_r + \epsilon_r$.
 - (c) Use the maximum likelihood technique to estimate $\hat{\hat{\beta}}_r^{**} = \alpha z_r + \epsilon_r$, obtaining estimates $(\hat{\hat{\alpha}}^*, \hat{\hat{\sigma}}^*)$ of (α, σ) .
7. Construct a confidence interval for the estimates of interest using the obtained bootstrap results.

Table 2.9: List of Variables and their Sources

Variables	Sources
First stage regression	
Inputs	
Public agricultural expenditure per capita (PAE)	IFPRI SPEED database & ReSAKSS
Outputs	
Composite index of Food security (we use 1-The index, because the higher the index, the lower the level of food security)	Caccavale and Giuffrida (2020)
Average Dietary Energy Supply Adequacy (ADESA) (%)	FAOSTAT
Domestic food price index (we use the inverse)	FAOSTAT
Per capita food production variability, (constant) 2014–2016 thousand international \$ (we use the inverse).	FAOSTAT
Second stage regression	
Dependant variables	
efficiency scores 1 = with Food security composite index	computed
efficiency scores 2 = traditional food security dimension	computed
Explanatory variables	
Cash crops share in total harvested area(%)	FAOSTAT
Number of disasters associated with food shortage, crop failure or famine (Table 2.13)	Emdat
Proportion of total population living in rural areas (% of total population)	World Bank (WDI)
Government effectiveness	World Bank (WDI)
Overseas Development Assistance (ODA) for climate adaptation and mitigation through agriculture and forestry (per capita)	OECD (2016)
Development aid flows to agriculture (per capita)	FAO (2016)
Quantity of arable land per capita (ha)	World Bank (WDI)
Inflation, consumer prices (annual%)	International Monetary Fund, International Financial Statistics
Africa Infrastructure Development Index	African Development Bank
Fish production-to-population ratio	Author computation
Fish production (in tonnes)	World Bank (WDI)
Total population to put variables by head	World Bank (WDI)
Additional variables for robustness	
Dependant variable	
Prevalence of undernourishment (%) (3-year average)	FAOSTAT
Explanatory variables	
Public Agricultural expenditure share (% total expenditure)	IFPRI SPEED database & ReSAKSS
up median : Binary =1 if cash crops share > median, 0 otherwise	Authors construction
up mean : Binary =1 if cash crops share > mean, 0 otherwise	Author construction
Population growth rate (%)	UNICEF, WHO, World Bank, UN
Participation in CAADP (Comprehensive Africa Agriculture Development Programme) : Binary=1 from Maputo declaration, 0 otherwise	African Union (AU)
GDP growth rate (constant 2015 US\$)	World Bank (WDI)

Table 2.10: List of Agricultural Products

Crops
Abaca, manila hemp, raw; Almonds, in shell; Anise, badian, coriander, cumin, caraway, fennel and juniper berries, raw; Apples; Apricots; Artichokes; Asparagus; Avocados; Bambara beans, dry; Bananas; Barley; Beans, dry; Beans, green; Berries nes; Brazil nuts, in shell; Broad beans and horse beans, dry; Broad beans and horse beans, green; Buckwheat; Cabbages; Cantaloupes and other melons; Carrots and turnips; Cashew nuts, in shell; Cashewapple; Cassava leaves; Cassava, fresh; Castor oil seeds; Cauliflowers and broccoli; Cereals n.e.c.; Cherries; Chestnuts, in shell; Chick peas, dry; Chicory roots; Chillies and peppers, dry (Capsicum spp., Pimenta spp.), raw; Chillies and peppers, green (Capsicum spp. and Pimenta spp.); Cinnamon and cinnamon-tree flowers, raw; Cloves (whole stems), raw; Cocoa beans; Coconuts, in shell; Coffee, green; Cow peas, dry; Cucumbers and gherkins; Currants; Dates.
Edible roots and tubers with high starch or inulin content, n.e.c., fresh; Eggplants (aubergines); Figs; Fonio; Fruit, citrus nes; Fruit, stone nes; Fruit, tropical fresh nes; Ginger, raw; Grapes; Green corn (maize); Green garlic; Groundnuts, excluding shelled; Hazelnuts, in shell; Hop cones; Jute, raw or retted; Karite nuts (sheanuts); Kenaf, and other textile bast fibres, raw or retted; Kola nuts; Leeks and other alliaceous vegetables; Lemons and limes; Lentils, dry; Lettuce and chicory; Linseed; Lupins; Maize (corn); Mangoes, guavas and mangosteens; Maté leaves; Melonseed; Millet; Mushrooms and truffles; Mustard seed; Natural rubber in primary forms; Nutmeg, mace, cardamoms, raw; Nuts, nes; Oats; Oil palm fruit; Oil seeds nes; Okra; Onions and shallots, dry (excluding dehydrated); Onions and shallots, green; Oranges; Papayas; Peaches and nectarines.
Pears; Peas, dry; Peas, green; Pepper (Piper spp.), raw; Pigeon peas, dry; Pineapples; Pistachios, in shell; Plantains and cooking bananas; Plums and sloes; Pomelos and grapefruits; Potatoes; Pulses, nes; Pumpkins, squash and gourds; Pyrethrum, dried flowers; Quinces; Rape or colza seed; Raspberries; Rice; Rye; Safflower seed; Seed cotton, unginced; Sesame seed; Sisal, raw; Sorghum; Soya beans; Spices, nes; Spinach; Strawberries; String beans; Sugar beet; Sugar cane; Sunflower seed; Sweet potatoes; Tangerines, mandarins, clementines; Taro; Tea leaves; Tomatoes; Tung nuts; Unmanufactured tobacco; Vanilla, raw; Vegetables, fresh nes; Vetches; Walnuts, in shell; Watermelons; Wheat; Yams; Yautia; Citrus nes; Crops, nes.

Table 2.11: List of countries

Country	Country
Angola	Mali
Burundi	Mozambique
Benin	Mauritania
Burkina Faso	Mauritius
Botswana	Malawi
Central African Republic	Namibia
Côte d'Ivoire	Niger
Cameroon	Nigeria
Congo, Rep.	Rwanda
Cabo Verde	Senegal
Ethiopia	Sierra Leone
Ghana	Eswatini
Guinea	Seychelles
Gambia, The	Chad
Guinea-Bissau	Togo
Equatorial Guinea	Tanzania
Kenya	Uganda
Liberia	South Africa
Lesotho	Zambia
Madagascar	

Table 2.12: List of Countries in Robustness 5

Country	Country
Angola	Mozambique
Benin	Mauritania
Burkina Faso	Mauritius
Botswana	Malawi
Central African Republic	Namibia
Côte d'Ivoire	Niger
Cameroon	Nigeria
Congo, Dem. Rep.	Rwanda
Congo, Rep.	Senegal
Comoros	Sierra Leone
Cabo Verde	Somalia
Djibouti	Sao Tome and Principe
Ethiopia	Eswatini
Gabon	Seychelles
Ghana	Chad
Guinea	Togo
Gambia, The	Tanzania
Guinea-Bissau	Uganda
Kenya	South Africa
Liberia	Zambia
Lesotho	Zimbabwe
Madagascar	Mali

Table 2.13: Disasters associated with food shortage, crop failure or famine

Disaster subgroup	Disaster type	Disaster subtype
Hydrological	Flood	Riverine flood
Hydrological	Flood	Flood (General)
Meteorological	Storm	Tornado
Climatological	Drought	Drought
Hydrological	Flood	Flash flood
Meteorological	Storm	Tropical cyclone
Biological	Infestation	Locust infestation
Biological	Epidemic	Parasitic disease
Meteorological	Extreme temperature	Heat wave
Climatological	Wildfire	Land fire (Brush, Bush, Pasture)
Hydrological	Mass movement (wet)	Mudslide

Chapter 3

Chapter 3

Trade Openness, Natural Resources Abundance and Income Inequality

3.1 Introduction

Globalization in all its dimensions is often perceived as one of the causes of crises, economic difficulties, and social inequalities (Stiglitz, 2002; Milanovic, 2017; Castañeda and Shemesh, 2020). In this chapter, we focus on the relationship between the trade dimension of globalization and income inequalities within countries. For a long time, trade liberalization was considered to be beneficial for all parties (Ricardo, 1817*a,b*). This is what traditional and new trade theory predicted (Ricardo, 1817*a,b*). However, it appears that the reality has not unfolded as initially anticipated. This is evident in the emergence of terms like “trade war” and “trade tensions” between major economic powers, as well as the increasing protests of populations in many low- and middle-income resource-exporting countries. They felt disadvantaged in the trade of their natural resources, for example, leading to social unrest, including military coups, as seen in Mali in 2020, Burkina Faso in 2022 and Niger in 2023 (Ross, 2001*a*; Collier and Hoeffler, 2004; Jensen and Wantchekon, 2004; Ross, 2012; Deutsche Welle, 2023). Indeed, according to the Organization for Economic Cooperation and Development (OECD, 2018), over the past decades, the bottom 40% of the population in many countries have benefited very little from their countries’ economic development and export diversification. Therefore, are all parties winners from trade liberalization? Literature and stylized facts (Lee et al., 2020; Le et al., 2020; Antràs et al., 2017) provide nuanced answers, as shown by the dynamics of trade openness and income inequality over the past few decades (Figure 3.4). Their dynamics support this reality, as rising inequality in developing countries and lower or stable inequality trends in advanced countries have been observed (Bogliaccini, 2013; Artuc et al., 2020; Hellier, 2023).

Indeed, greater global integration, export diversification, and the apparent deterioration of income distribution within many countries have become crucial issues (Antràs et al., 2017; Lee et al., 2020; Le et al., 2020). The literature on the effect of globalization on income inequality still lacks clear conclusions. It is crucial to acknowledge that the relationship between globalization and income inequality within countries is complex and unresolved. This complexity arises not only from varying definitions of globalization and

different methods of measuring inequality but also from the difficulty of disentangling the effects of global forces from domestic developments (Amin, 2004). The overlapping nature of these influences makes it challenging to establish a clear, direct link between globalization and income inequality within countries.

This study focuses on the interaction between global factors, such as trade openness, and domestic factors, specifically natural resource abundance. Our motivation to focus on natural resource abundance as an important domestic factor is due to the fact that natural resource-rich countries play a key role in the current energy transition. Most of their economic activities are based on the trade of both fossil fuels and energy transition resources. And many of them are among the least well-equipped to overcome the risks and seize the opportunities of the low-carbon transition, which could significantly increase inequalities in these countries during the energy transition process. Thus, having a deep understanding of the determinants of income inequality in these countries in a globalized world context is fundamental to be able to support them in the energy transition, in order to ensure a socially just energy transition in these countries. In addition, resource-rich countries have very specific characteristics which requires particular consideration of this factor when analysing the relationship between trade openness and income inequality. Indeed, in the literature on the economic performance of resource-rich countries, being resource-rich has often been associated with either economic success or economic failure. The literature provides evidence in both directions. For example, natural resources are found to slow economic growth in resource-rich developing countries (Ploeg, 2011), limit export diversification (Ross, 2017), promote exchange rate appreciation (Stokke, 2007), decrease foreign direct investment in non-resource sectors (Poelhekke and van der Ploeg, 2013), or increase income inequality (Bourguignon and Morrisson, 1990; Ross, 2001*b*; Gylfason and Zoega, 2003). They can also be associated with positive effects on the economy, reflected in declining public debt and low inflation (Fasano, 2002), high public spending on education (Sarraf and Jiwanji, 2001), or strong economic growth (Larsen, 2006). However, these studies predominantly focus on point-source natural resources such as hydrocarbons and minerals, overlooking diffuse-source natural resources such as agri-commodities that may also play a role in shaping income inequality.

In this work, alongside hydrocarbons and minerals, we also include agri-commodities as part of the natural resources considered. By broadening our scope to encompass agricultural commodities, we aim to capture a more diverse range of natural resources and their impact on income inequality in a globalized world context. We classify these natural resources into two categories: point and diffuse source natural resources (Isham et al., 2005). Point-resource natural resources refer to those that are geographically concentrated, such as minerals, gaze coal and oil, while diffuse-source natural resources are more widespread, like agricultural commodities, which are spread over larger areas and often require different management and policy considerations.

We argue that the nature of the natural resource source plays a crucial role in shaping the economic and social outcomes associated with resource abundance. The type and characteristics of the resources, whether they are point or diffuse, influence how wealth is generated, distributed, and managed within an economy, thus affecting broader development and income inequality. Point-source natural resources

are generally characterized by a centralization of the exploitation of these resources by the government and/or multinationals (Ross, 1999*b*). Hence, without an effective social planner to redistribute the income from the exploitation of natural resources, trade openness based on this kind of natural resource could increase income inequality. Indeed, point-source natural resources have a higher tendency to be captured by the state or elite classes, which in turn leads to more concentrated production and revenue patterns (Murshed, 2002), and benefits being distributed to fewer economic agents. Elites typically might not have much interest in long-term developmental projects (Easterly, 2007), and might oppose plans that invest in human capital, which in turn meant increasing gaps between the rich and poor in terms of educational levels and subsequently income inequality levels. In contrast, in countries rich in diffuse-source natural resources, where access to the value chain of these resources is more widespread—even through informal channels—trade openness could significantly reduce inequality. This is because diffuse resources, such as agri-commodities, tend to be more widely distributed among the population, allowing broader participation in their production, processing, and distribution (Cervantes-Godoy et al., 2010; FAO, 2023*b,a*, 2019). As a result, trade in these resources could contribute to more inclusive economic growth and greater income distribution across different social groups, thereby reducing income disparities. Therefore, in the case of diffuse-source natural resources, the negative effects of poor institutional quality and corruption should be mitigated. Since these resources are more broadly accessible and often involve large segments of the population in their value chains, the opportunities for economic participation are more evenly distributed. This widespread access could dilute the ability of corrupt elites or weak institutions to control and concentrate resource wealth, thereby reducing the impact of institutional failures on economic and social outcomes.

We argue that the conflicting findings in the literature regarding the relationship between trade openness and income inequality might stem from the oversight of the nature of natural resources. Our study shows the importance of distinguishing between different types of natural resources—point and diffuse sources—when examining the effects of trade openness on income inequality. The primary contribution of our research is to clarify how trade openness and natural resource wealth interact to influence income inequality, depending on the nature of natural resources involved.

To do so, we use a panel approach with quantile regressions developed by (Machado and Silva, 2019), on a sample of 71 low- and middle-income countries to assess the role of natural resources, based on their type, in the relationship between trade openness and income inequality. We use the sum of oil, gas, coal, and mineral rents as a percentage of GDP as the measure of point-source natural resource wealth, and the value added from agriculture, forestry, and fisheries as a percentage of GDP to represent diffuse-source natural resource wealth. Our findings reveal that, in the whole sample, trade openness has a significant positive effect on income inequality. In contrast, wealth from diffuse-source natural resources has a significant negative effect on income inequality, while wealth from point-source natural resources shows no significant effect. Furthermore, our descriptive statistics highlight that countries relatively richer in diffuse-source natural resources tend to perform better in terms of self-employment, indicating a greater

potential for generating income independently.

Additionally, by dividing our sample into two groups based on the median level of diffuse-source natural resource wealth, the results show that in countries relatively richer in diffuse-source natural resources (i.e., those with diffuse resource rents as a percentage of GDP above the median), trade openness does not significantly impact income inequality, and wealth from point-source natural resources actually reduces inequality. Moreover, in these countries, governance quality does not play a significant role in reducing inequalities suggesting that independently from an efficient social planner inequalities could be reduced in these countries. Conversely, in countries relatively poor in diffuse-source natural resources (i.e., those with diffuse resource rents as a percentage of GDP below the median), both trade openness and point-source natural resource wealth have significant positive effects on income inequality. In these countries, good governance is crucial in reducing inequality.

These findings suggest that diffuse-source natural resources act as a driving factor, influencing both the effect of trade openness and the effect of point-source natural resources on income inequality.

Our study thus contributes to the conflicting literature on the impact of trade openness on income inequality by providing additional insights for a better understanding of this relationship, particularly in resource-rich countries. These findings could help policymakers better support resource-rich countries in the context of the energy transition.

The rest of the work will proceed as follows. Section 2 presents the literature review. Section 3 describes the data and statistics. Section 4 presents the methodology. Section 5 summarizes the econometric results. Section 6 presents robustness checks and section 7 concludes.

3.2 Literature Review

The debate over globalization's impact on inequality has remained highly contentious (Ravallion, 2018). While neoliberalism is frequently blamed for exacerbating global inequalities, evidence on this relationship remains mixed. A central challenge in this debate is the complex and multifaceted nature of globalization itself. As Amin (2004) notes, understanding the link between globalization and inequality is difficult due to diverse definitions of globalization, varied measures of inequality, and the intertwined nature of global and domestic factors, making it hard to isolate their individual effects.

Over time, scholars have sought to identify factors that drive inequality. Earlier work, such as Kuznets' theory, emphasized internal factors, like industrialization and economic development (Amin, 2004). However, more recent literature focuses on the role of external factors—primarily trade and foreign direct investment (FDI)—as contributors to income disparities (Alderson and Nielsen, 1999; Dollar and Kraay, 2002; Meschi and Vivarelli, 2009). Researchers have also explored how political and institutional elements affect inequality (Piketty, 2014), while others, such as Milanovic (2003), have highlighted cultural dimensions like ethnic diversity. Additionally, the role of financialization has come to the forefront, particularly in advanced economies, where its effects on inequality are being scrutinized (Assa, 2012; Kus, 2012).

In our context, the interaction between trade openness as an external factor and resource abundance

as an internal factor becomes crucial. Traditionally, the Heckscher-Ohlin-Samuelson approach supports the idea that trade openness benefits countries by allowing them to specialize according to their factor endowments (Reuveny and Li, 2003). In theory, developing countries, rich in labor, would see wages rise and inequality fall, while developed countries might experience the opposite effect. However, this classical argument has faced criticism for oversimplifying real-world dynamics, particularly in assuming identical technologies and immobile labor and capital across countries (IMF, 2008). Additionally, trade openness may trigger a "race to the bottom," where governments cut social spending to attract foreign investment (Piketty, 2014), and reduced tariffs can lead to revenue loss, limiting funds available for social programs and potentially affecting inequality. The concept of Skill-Biased Technological Change (SBTC) suggests that trade openness can indeed increase income inequality by favoring skilled over unskilled labor. As countries integrate more deeply into global markets, the demand for skilled workers—particularly in sectors that experience growth from globalization—tends to rise. This dynamic can lead to a wider income gap between skilled and unskilled workers. Those with advanced education and specific skills often capture greater economic advantages, while unskilled workers may see their relative income and job opportunities diminish (Autor, 2006).

Empirical studies on trade openness and inequality yield conflicting results. Some studies, such as IMF (2008), argue that trade has an “equalizing impact” on income distribution, challenging the notion that trade inherently increases inequality. On the other hand, Ravallion (2001) finds that openness correlates with rising inequality in developing countries and reduced inequality in wealthier nations. Similarly, Savvides (1998) observes that less-developed countries with open economies experienced greater income disparities in the 1980s. Meschi and Vivarelli (2009), in a study of 65 developing countries, conclude that trade with high-income nations worsens internal income distribution. In contrast, Reuveny and Li (2003) assert that trade reduces inequality, while Babones and Vonada (2009) and Dollar and Kraay (2002) find no significant link between trade openness and income inequality. These mixed results highlight the complexity of the relationship and suggest that outcomes may vary based on the countries studied, time periods considered, and model specifications used (Babones and Vonada, 2009). More recently, The concept of Global Value Chains (GVCs) highlights how the fragmentation of production across borders allows countries to specialize in specific stages of the production process. This specialization can result in unequal economic benefits, depending on the position a country occupies within the value chain. Countries that focus on high-value-added activities, such as design, research and development, and branding, tend to experience more significant income growth and economic gains. In contrast, those engaged in low-value-added stages, such as basic assembly or raw material extraction, often face stagnant wages and limited economic progress (Gereffi and Fernandez-Stark, 2011; Fernandez-Stark and Gereffi, 2019). This dynamic can exacerbate income inequalities both within countries—by creating wage disparities between different sectors—and between countries, as those participating in high-value activities accumulate more wealth compared to those engaged in lower-value segments.

Yet, a critical factor that has received less attention in these discussions is the role of natural re-

source abundance in shaping inequality. Despite the importance of natural resources in many developing countries, the literature has only recently begun to address how resource wealth interacts with trade to influence income distribution. Scholars have argued that the type and magnitude of resource wealth can significantly shape inequality, often leading to elite capture, where resource wealth remains concentrated within a small segment of society (Isham et al., 2005; Milanovic, 2003; Murshed, 2002).

Some of the earliest work in this area, such as Bourguignon and Morrisson (1990), demonstrated that countries with greater resource endowments—be it minerals or land—tend to have higher levels of inequality. Gylfason and Zoega (2003) find that dependency on natural resources is associated with lower growth rates and higher income inequality. This dynamic occurs as labor is drawn away from the manufacturing sector, known for more equitable wages, into resource extraction, which often benefits a narrower segment of society. Similarly, Ross (2001*b*) provides evidence that mineral-rich countries are particularly prone to higher levels of income inequality.

Therefore, the literature on trade and inequality has generally overlooked the crucial distinction between point-source natural resources (such as oil and minerals) and diffuse-source natural resources (such as agricultural products) and their distinct distributional effects (Isham et al., 2005). The wealth generated from natural resources, particularly hydrocarbons and minerals, has been associated with both economic success and failure, reflecting a broader debate on the *resource curse*. However, the focus has predominantly been on these point-resources, often neglecting other types of wealth, such as agricultural commodities, which may play a unique role in shaping inequality.

Our research aims to address this gap by considering not only the wealth generated from point-source resources (like oil and minerals) but also diffuse-resources (like agri-commodities). By distinguishing between these types, we aim to provide a clearer understanding of how the nature of natural resources, in the context of trade openness, influences income inequality.

3.3 Data and statistics

3.3.1 Data

In this section, we proceed in two steps: first, we present the data used, and then we discuss the stylized facts through descriptive statistics.

First, for our sample, we start with the complete sample of low- and middle-income countries as classified by the World Bank, encompassing 131 countries from 1980 to 2023. To identify the optimal study period, we focus on the years with the most extensive data coverage across the largest number of countries. The Gini index from the SWIID database, our measure of income inequality and the dependent variable, serves as the reference for data availability since it is derived from other socio-economic variables. Countries with more comprehensive tracking of these variables are more likely to have data available for the Gini index, making its availability a strong indicator for data availability in our dataset. Consequently, we identified 1995-2018 as the optimal period for analysis. To enhance the panel's completeness, we applied

an algorithm to exclude countries with more than five missing observations during this period. This process resulted in a working sample of 71 low- and middle-income countries over the period 1995-2018. Table 3.9 in the appendix presents the variables used and their sources.

As control variables, we incorporate several key factors based on existing literature. First, **point-source natural resource wealth** represents resources extracted from a concentrated geographic or economic base, such as oil, gas, coal, and mineral rents, which we measure as a percentage of GDP (Isham et al., 2005). Complementing this, **diffuse-source natural resource wealth** is gauged through the value added from agriculture, forestry, and fisheries as a percentage of GDP, offering a broader view of resource contributions across the economy (Isham et al., 2005).

Trade openness is an essential measure, captured by the sum of exports and imports of goods and services relative to GDP, to evaluate the economy's exposure to international markets. In line with prior research, **foreign direct investment (FDI)** is included as it can influence income inequality in varied ways: FDI in labor-intensive manufacturing and services (such as textiles, agribusiness, and hospitality) tends to alleviate inequality in low-wage countries by enhancing capital accumulation and increasing demand for low-skilled labor (Avarmaa et al., 2013; Cornia, 2011). Conversely, FDI directed toward skilled labor sectors, like finance or telecommunications, and capital-intensive industries (e.g., chemicals and machinery), tends to exacerbate income inequality by raising wages primarily for skilled workers. Here, FDI is represented as net inflows as a percentage of GDP.

To account for human capital, often linked to income inequality, we use an index reflecting years of education and returns on education (Marimon and Quadrini, 2011; Paweenawat and McNown, 2014; Lessmann and Seidel, 2017). Another factor, **industrialization**, contributes to income distribution through structural changes, as indicated by the industry value added as a share of GDP (Avarmaa et al., 2013; Cornia, 2011). We also consider the **population growth rate** (annual %), given that demographic changes can alter labor market dynamics, impacting income inequality directly through shifts in labor supply and demand (Asteriou et al., 2014).

Institutional quality plays a vital role, especially in resource-rich countries, by shaping economic and social outcomes (Stokke, 2007; Ross, 2017; Poelhekke and van der Ploeg, 2013). Government effectiveness, used as a proxy, reflects perceptions of public service quality, civil service independence, policy formulation quality, and government commitment to policies (Swanson, 2007). Additionally, **ethno-linguistic fragmentation** is addressed through a measure of ethnic tensions, as high fragmentation may hinder social policy effectiveness. Countries with high racial and nationality tensions receive lower ratings, indicating greater division and intolerance, while minimal tensions yield higher ratings (ElGindi, 2017; The PRS Group et al., 2023).

Lastly, **unemployment**, expressed as the percentage of the total labor force without work but seeking employment, is a well-recognized variable in inequality studies (ElGindi, 2017). This multifaceted approach to control variables allows us to account for diverse socio-economic dynamics that may influence income inequality.

3.3.2 Statistics

In this section, we conduct a two-step analysis. First, we examine the relationship between natural resource wealth and income inequality, focusing on the total sample of low- and middle-income countries, and considering the type of natural resources. Next, we analyze the export structure of the countries in our study sample.

Natural resources and income inequalities

In this section, we start by using the full sample of low- and middle-income countries as classified by the World Bank, totaling 131 countries over the period 1980-2023. We then calculate the average of our variables of interest over this period¹ to get Figures 3.1 and 3.2.

Figure 3.1, with income inequality level in parentheses, displays the average level of inequality over the period, categorizing countries into two groups: those relatively rich in diffuse-source natural resources (agricultural value added above the sample median of 16.13%) and those relatively poor (values below this median). The results show that among the top 40 countries with the highest inequality, only 30% are relatively rich in diffuse-source natural resources. Conversely, among the 40 countries with the lowest inequality, 57.5% are relatively rich in diffuse-source natural resources. These findings suggest a potential negative relationship between wealth in diffuse-source natural resources and inequality levels.

¹Countries without data are excluded before generating the figures. Thus, two countries without data on agricultural value added are removed from the total sample before generating Figure 1, and five countries without data on point-source natural resources are excluded from the total sample before generating Figure 2.

(24) are relatively rich in point-source natural resources, while among the 40 countries with the lowest self-employment rates, more than half (28) are relatively rich in these resources.

These stylized facts confirm our initial hypothesis regarding the effect of diffuse-source natural resource wealth on income inequality. Due to their diffuse nature, these resources seem to offer easier access to their value chains, allowing populations to benefit even if social planning is inefficient because of poor institutional quality. As labor-intensive resources, they seem to contribute to reducing inequality. In contrast, the point-source natural resources often discussed in the literature do not appear to have a clear relationship with income inequality.

Export structure

Figure 3.8 shows the average share of natural resource exports in the total exports of the countries in our sample, regardless of the type of natural resources ³. It reveals that over 39% of the countries in our sample have at least 50% of their total exports comprised of natural resources. This highlights the significant proportion of resource-rich countries, underscoring the importance of considering these countries and the specific types of natural resources in which they are abundant when analyzing the relationship between trade openness and inequality.

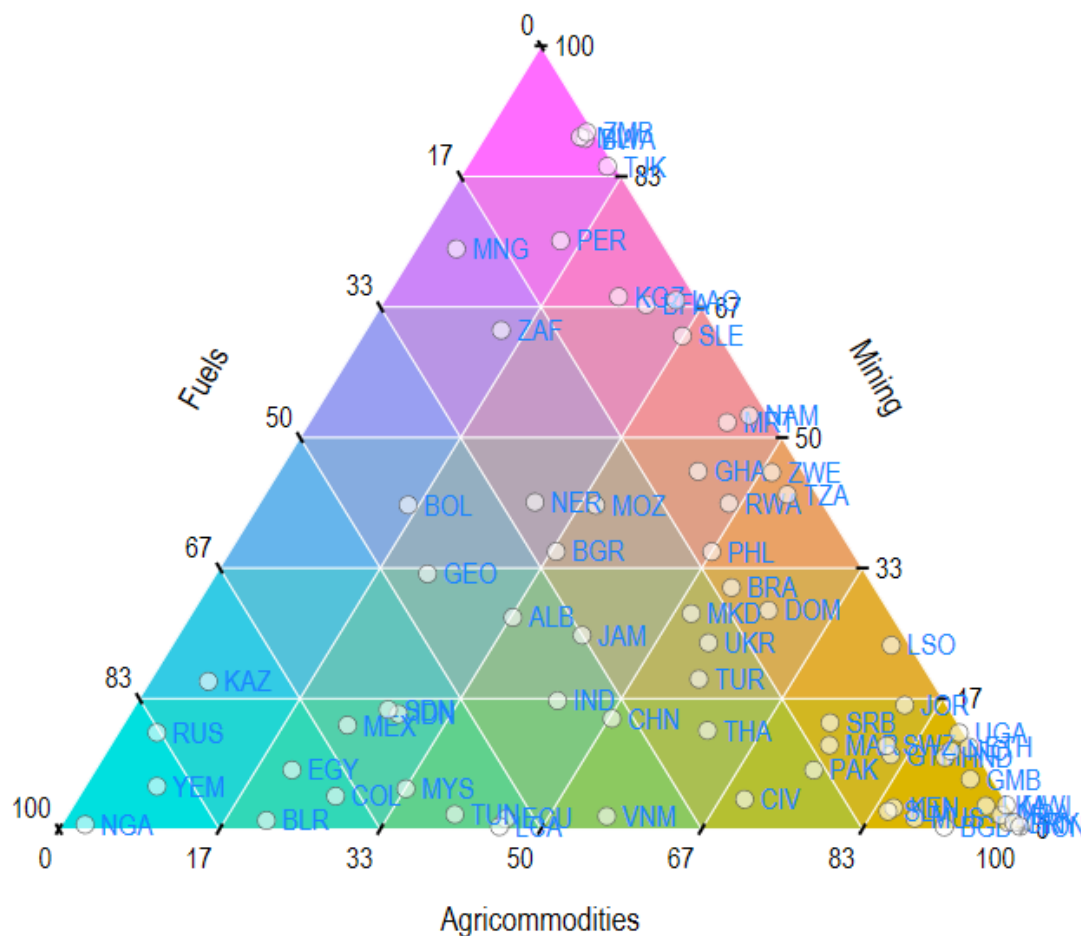
Figure 3.3 shows a ternary plot that represents the export shares of different natural resources—fuels, agricommodities, and mining—in the total natural resource exports of the countries of our sample of study (71 countries). Countries positioned near the fuels vertex, such as Yemen (YEM), Nigeria (NGA), Russian Federation (RUS) and Kazakhstan (KAZ) rely heavily on fuel exports, primarily oil and gas. In contrast, countries like Tonga (TON), Paraguay (PRY), Costa Rica (CRI), Moldova (MDA) and Malawi (MWI), located near the agricommodities vertex, focus predominantly on agricultural exports. Those closer to the mining vertex, such as Zambia (ZMB), Mali (MLI), Botswana (BWA), Tajikistan (TJK), base most of their natural resource exports on mining activities. Countries situated toward the middle of the triangle exhibit a more balanced distribution of their exports across all three resource categories. The color-coded sections of the plot help highlight countries with similar natural resources export profiles, providing a clear visual representation of the diversification of natural resource exports among our countries.

In our sample, it appears that on average, most countries' natural resource exports are dominated by agricommodities, followed by mining products, with fuels making up the smallest share.

However, Figure 3.11 and 3.12 show that from 1995 to 2018 exports of natural resources have diversified significantly between the three types of natural resource.

³We computed the total exports of countries to the rest of the world in each of the three types of natural resources using the 6-digit of the Harmonised System (HS6) classification of the CEPII's BACI database. Our HS6 code classification of the three types of natural resources is shown in Table 3.10 in the appendix.

Figure 3.3: Share by commodity in total commodities export (average 1995-2018)



Source: Author's construction, Data from BACI.

3.4 Methodology

In this study, our primary objective is to analyze the effect of trade openness and natural resource wealth—differentiated by point and diffuse-source natural resources—on income inequality. We also aim to understand how the type of natural resource wealth influences the relationship between trade openness and income inequality, hence, subsequently, we examine the interaction effect between trade openness and wealth in each type of natural resource. Given the differences in inequality levels across countries, the effect of trade openness could vary depending on these levels. To capture this, we use quantile regression, which allows us to analyze these effects across the entire distribution of inequality.

Thus, we can start by formulating the following relationships:

$$GINI_{it} = \phi_i + \gamma_1 TO_{i,t} + \gamma_2 Diffuse_{i,t} + \gamma_3 Point_{i,t} + \gamma_4 CV_{i,t} + \epsilon_{i,t} \quad (3.1)$$

$$GINI_{it} = \phi_i + \gamma_1 (TO_{i,t} \times Diffuse_{i,t}) + \gamma_2 TO_{i,t} + \gamma_3 Diffuse_{i,t} + \gamma_4 Point_{i,t} + \gamma_5 CV_{i,t} + \epsilon_{i,t} \quad (3.2)$$

$$GINI_{it} = \phi_i + \gamma_1 (TO_{i,t} \times Point_{i,t}) + \gamma_2 TO_{i,t} + \gamma_3 Diffuse_{i,t} + \gamma_4 Point_{i,t} + \gamma_5 CV_{i,t} + \epsilon_{i,t} \quad (3.3)$$

Where ϕ_i is the fixed effect of country i and t is the time dimension ($t = 1, \dots, T$), $GINI_{it}$, $TO_{i,t}$, $Diffuse_{i,t}$, $Point_{i,t}$ and $CV_{i,t}$ are respectively the GINI index, the trade openness variable, wealth in diffuse and point-source natural natural resources variable and the set of control variables of country i in period t .

While equations (1), (2), and (3) can address whether our three effects—direct and interaction effects—influence income inequality, they do not answer the question of whether these effects vary across countries with different levels of income inequality. From the perspective of policymaking and a thorough study of trade openness, we are also interested in what happens in extreme situations. To address these issues, a useful method is quantile regression. This is an extension of the conventional regression method that can provide a complete picture with a variable conditional distribution. The approach allows us to determine the overall impact of our 3 effects on the total distribution of income inequality. In addition, the model is robust to heteroscedasticity, skewness, and outliers (Koenker and Hallock, 2011).

The equation can be written as follows:

$$R_{yt}(\omega | x_t) = \phi_\omega + x_t^T \gamma_\omega \quad (3.4)$$

With $0 < \omega < 1$, where $R_{yt}(\omega | x_t)$ denotes the ω -th conditional quantile of y_t , x_t groups the control variables, and γ_ω and ϕ_ω are the unobserved effect and the parameters at the ω -th quantile, respectively. The effect of the determinants on the conditional mean of the response variables is measured in classical least squares (OLS) regression, but with quantile regression, γ_ω showing the function of the ω -th quantile of the conditional distribution. When the marginal effect of the determinants is a simple "location shift," the effect of the mean value is consistent with that of the state of the distribution as a whole (Heckman et al., 1997).

Advantages of panel data over time series data include increasing the number of observations and appropriate variation, as well as eliminating noise from individual time series regression effects (Hsiao, 2007). Thus, we can transform equation (4) into a panel quantile regression:

$$R_{yit}(\omega | \phi_i, x_{it}) = x_{it}' \gamma_\omega + \phi_i \quad (3.5)$$

Although panel data have been widely used in quantile regression models in the literature, these studies still assume that individual effects are only a "location shift" and have no impact on the overall distribution. More importantly, these methods cannot handle models with endogenous variables. To overcome these problems, Machado and Silva (2019) advanced the moment quantile regression (MM-QR) model. Knowing the importance of endogeneity and heterogeneity problems for the performance of panel data regression models, by using a more flexible moment estimation, the MM-QR method can estimate the panel data regression model with individual effects and simultaneously deal with endogeneity problems, thus providing more robust estimation results. Following Machado and Silva (2019), the model proceeds as follows:

$$y_{it} = \phi_i + x'_{it}\gamma + \theta(\sigma_i + w'_{it}\tau)B_{it} \quad (3.6)$$

Where w'_{it}/w_{it} is the known differentiable transformation of x_{it} , $\theta(\cdot)$ is a known C^2 function, for example, $P(\theta(\sigma_i + w'_{it}\tau) > 0) = 1$, moreover $B_{it} \perp x_{it}$, $E(B) = 0$, and $E(|B|) = 1$. From equation (6) we get:

$$R_{yit}(\omega|x_{it}) = \phi_i + x'_{it}\gamma + \theta(\sigma_i + w'_{it}\tau)r(\omega) \quad (3.7)$$

Where $r(\omega) = F_W^{-1}(\omega)$ and thus $P(W < q(\omega)) = \omega$. When $\theta(\cdot)$ is an identity function and $w_{it} = x_{it}$, equation (7) can be written as follows:

$$R_{yit}(\omega|x_{it}) = (\phi_i + \sigma_i r(\omega)) + x'_{it}\gamma + x'_{it}\tau r(\omega) \quad (3.8)$$

Here, $\phi_i(\omega) = \phi_i + \sigma_i r(\omega)$ expresses the ω^{th} quantile of the fixed effect of country i . It is different from general quantile fixed effects and a "location shift". In other words, the method allows time-invariant individual characteristics to significantly affect the distribution of y_{it} (here the GINI index) across countries. The marginal effect of the variable $x_{it,k}$ in the ω^{th} quantile of y_{it} is $\gamma_k + r(\omega) \times \rho\theta(\sigma_i + w'_{it}\tau)/\rho_{x_{it,k}}$.

3.5 Econometric Results

Table 3.1, 3.2 and 3.3 present the results from equation (1) (2) and (3) respectively, using panel quantile regression à la Machado and Silva (2019). Thus, Table 3.1 shows the direct effects of trade openness and natural resource wealth, differentiated by the type of resource on income inequality. We observe that trade openness has a positive and significant effect on income inequality, particularly in countries with lower inequality levels (except for very low income inequality level). In contrast, wealth in diffuse-source natural resources has a negative and significant effect on income inequality, also predominantly in countries with lower inequality. However, wealth in point-source natural resources does not have a significant effect on inequality, regardless of the level of inequality in the countries.

Additionally, good governance and human capital are significant determinants in reducing inequality across all levels of inequality. The absence of ethnic tensions is also associated with lower inequality, specifically in countries with initially lower levels of inequality. Unemployment, on the other hand, increases inequality, especially in countries with higher inequality levels.

Table 3.1: Direct effects on income inequalities

VARIABLES	10th	20th	30th	40th	50th	60th	70th	80th	90th
Trade Openness	2.500 (1.732)	2.426* (1.418)	2.362** (1.197)	2.292** (1.042)	2.219** (1.024)	2.146* (1.157)	2.078 (1.384)	2.021 (1.616)	1.940 (1.989)
Agriculture value added (% of GDP)	-0.179** (0.085)	-0.163** (0.070)	-0.150** (0.059)	-0.136*** (0.051)	-0.120** (0.051)	-0.105* (0.057)	-0.091 (0.068)	-0.079 (0.080)	-0.063 (0.098)
Oil, gas, coal and mining rent (% of GDP)	0.047 (0.064)	0.031 (0.052)	0.017 (0.044)	0.002 (0.039)	-0.014 (0.038)	-0.030 (0.043)	-0.045 (0.051)	-0.057 (0.060)	-0.075 (0.073)
Government effectiveness	-2.704*** (1.035)	-2.587*** (0.847)	-2.487*** (0.716)	-2.376*** (0.623)	-2.261*** (0.613)	-2.147*** (0.692)	-2.039** (0.827)	-1.950** (0.966)	-1.822 (1.189)
Human capital	-7.850*** (1.253)	-7.763*** (1.026)	-7.688*** (0.866)	-7.605*** (0.754)	-7.520*** (0.741)	-7.434*** (0.837)	-7.353*** (1.001)	-7.287*** (1.169)	-7.191*** (1.439)
Unemployment (% of total labor force)	0.087 (0.076)	0.101 (0.062)	0.113** (0.052)	0.126*** (0.046)	0.139*** (0.045)	0.153*** (0.051)	0.166*** (0.061)	0.177** (0.071)	0.192** (0.087)
FDI net inflows (% of GDP)	-0.005 (0.043)	-0.003 (0.035)	-0.001 (0.030)	0.001 (0.026)	0.004 (0.026)	0.006 (0.029)	0.008 (0.035)	0.010 (0.040)	0.012 (0.050)
Population growth rate	-0.153 (0.523)	-0.112 (0.428)	-0.077 (0.361)	-0.038 (0.314)	0.002 (0.309)	0.042 (0.349)	0.080 (0.418)	0.111 (0.488)	0.156 (0.600)
Absence of ethnic tensions	-0.455* (0.252)	-0.394* (0.206)	-0.342** (0.174)	-0.284* (0.152)	-0.224 (0.149)	-0.165 (0.168)	-0.108 (0.201)	-0.062 (0.235)	0.005 (0.289)
Industry	0.035 (0.067)	0.018 (0.055)	0.004 (0.047)	-0.011 (0.041)	-0.027 (0.040)	-0.044 (0.045)	-0.059 (0.054)	-0.071 (0.063)	-0.089 (0.077)
Observations	640	640	640	640	640	640	640	640	640
Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

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

Tables 3.2 and 3.3 present the interaction effects between trade openness and wealth in diffuse-source natural resources (Table 3.2) and point-source natural resources (Table 3.3) on income inequality respectively. It is evident that trade openness, when combined with wealth in diffuse-source natural resources, leads to a reduction in income inequality, regardless of a country's initial inequality level (except for very low income inequality level). In contrast, the effect of trade openness in conjunction with point-source natural resource wealth is neutral. These results confirm the findings observed in our stylized facts, indicating that in a context of trade openness, wealth in diffuse-source natural resources plays a much more significant role in reducing income inequality than wealth in point-source natural resources.

Table 3.2: Interaction effects on income inequalities : trade openness and diffuse source natural resource

VARIABLES	10th	20th	30th	40th	50th	60th	70th	80th	90th
Trade Openness × Agriculture value added (% of GDP)	-0.102 (0.063)	-0.115** (0.052)	-0.127*** (0.044)	-0.140*** (0.039)	-0.155*** (0.039)	-0.169*** (0.045)	-0.181*** (0.054)	-0.190*** (0.062)	-0.206*** (0.076)
Trade Openness	4.793*** (1.809)	5.092*** (1.514)	5.384*** (1.280)	5.725*** (1.119)	6.073*** (1.128)	6.425*** (1.312)	6.719*** (1.558)	6.948*** (1.786)	7.333*** (2.210)
Agriculture value added (% of GDP)	-0.094 (0.092)	-0.073 (0.077)	-0.051 (0.065)	-0.026 (0.057)	-0.001 (0.058)	0.025 (0.067)	0.046 (0.080)	0.063 (0.091)	0.091 (0.113)
Oil, gas, coal and mining rent (% of GDP)	0.040 (0.053)	0.024 (0.045)	0.009 (0.038)	-0.009 (0.033)	-0.027 (0.033)	-0.045 (0.039)	-0.060 (0.046)	-0.072 (0.053)	-0.092 (0.065)
Government effectiveness	-2.426*** (0.891)	-2.372*** (0.746)	-2.320*** (0.630)	-2.259*** (0.550)	-2.196*** (0.554)	-2.133*** (0.645)	-2.081*** (0.767)	-2.040** (0.880)	-1.971* (1.088)
Human capital	-7.939*** (1.055)	-7.911*** (0.883)	-7.884*** (0.745)	-7.852*** (0.650)	-7.819*** (0.656)	-7.787*** (0.764)	-7.759*** (0.908)	-7.738*** (1.042)	-7.702*** (1.289)
Unemployment (% of total labor force)	0.105* (0.064)	0.115** (0.053)	0.125*** (0.045)	0.137*** (0.039)	0.149*** (0.040)	0.162*** (0.046)	0.172*** (0.055)	0.180*** (0.063)	0.193** (0.078)
FDI net inflows (% of GDP)	-0.010 (0.034)	-0.006 (0.028)	-0.002 (0.024)	0.003 (0.021)	0.008 (0.021)	0.013 (0.024)	0.017 (0.029)	0.020 (0.033)	0.026 (0.041)
Population growth rate	-0.188 (0.441)	-0.130 (0.369)	-0.073 (0.311)	-0.006 (0.272)	0.062 (0.274)	0.131 (0.319)	0.188 (0.379)	0.233 (0.435)	0.309 (0.538)
Absence of ethnic tensions	-0.497** (0.232)	-0.432** (0.194)	-0.368** (0.164)	-0.293** (0.144)	-0.216 (0.145)	-0.139 (0.169)	-0.075 (0.200)	-0.024 (0.229)	0.060 (0.284)
Industry	0.037 (0.056)	0.022 (0.047)	0.007 (0.040)	-0.010 (0.035)	-0.028 (0.035)	-0.046 (0.041)	-0.062 (0.048)	-0.073 (0.056)	-0.093 (0.069)
Observations	640	640	640	640	640	640	640	640	640
Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

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

Table 3.3: Interaction effects on income inequalities : trade openness and point source natural resource

VARIABLES	10th	20th	30th	40th	50th	60th	70th	80th	90th
Trade Openness × Oil, gas, coal and mining rent (% of GDP)	-0.152 (0.454)	-0.156 (0.391)	-0.159 (0.329)	-0.162 (0.258)	-0.167 (0.182)	-0.170 (0.126)	-0.174* (0.104)	-0.177 (0.125)	-0.182 (0.192)
Trade Openness	3.888 (5.946)	3.898 (5.120)	3.908 (4.303)	3.919 (3.381)	3.932* (2.383)	3.944** (1.648)	3.955*** (1.358)	3.965** (1.638)	3.978 (2.507)
Oil, gas, coal and mining rent (% of GDP)	0.157 (0.408)	0.145 (0.352)	0.134 (0.296)	0.121 (0.232)	0.105 (0.164)	0.092 (0.113)	0.078 (0.093)	0.067 (0.113)	0.051 (0.172)
Agriculture value added (% of GDP)	-0.148 (0.272)	-0.138 (0.234)	-0.127 (0.197)	-0.115 (0.155)	-0.101 (0.109)	-0.088 (0.075)	-0.076 (0.062)	-0.066 (0.075)	-0.051 (0.115)
Government effectiveness	-2.621 (3.413)	-2.547 (2.939)	-2.473 (2.470)	-2.387 (1.941)	-2.288* (1.368)	-2.199** (0.947)	-2.110*** (0.780)	-2.038** (0.940)	-1.935 (1.440)
Human capital	-7.940* (4.179)	-7.904** (3.599)	-7.868*** (3.025)	-7.826*** (2.376)	-7.778*** (1.675)	-7.735*** (1.158)	-7.692*** (0.955)	-7.657*** (1.151)	-7.607*** (1.762)
Unemployment (% of total labor force)	0.104 (0.246)	0.114 (0.212)	0.123 (0.178)	0.135 (0.140)	0.147 (0.099)	0.159** (0.068)	0.171*** (0.056)	0.180*** (0.068)	0.193* (0.104)
FDI net inflows (% of GDP)	-0.003 (0.139)	-0.000 (0.120)	0.002 (0.101)	0.005 (0.079)	0.009 (0.056)	0.012 (0.039)	0.014 (0.032)	0.017 (0.038)	0.020 (0.059)
Population growth rate	-0.188 (1.714)	-0.138 (1.476)	-0.089 (1.241)	-0.032 (0.975)	0.034 (0.687)	0.094 (0.475)	0.153 (0.392)	0.201 (0.472)	0.270 (0.723)
Absence of ethnic tensions	-0.431 (0.856)	-0.380 (0.737)	-0.329 (0.620)	-0.270 (0.487)	-0.203 (0.343)	-0.142 (0.238)	-0.080 (0.196)	-0.031 (0.236)	0.040 (0.361)
Industry	0.019 (0.221)	0.006 (0.190)	-0.006 (0.160)	-0.021 (0.125)	-0.038 (0.089)	-0.053 (0.061)	-0.068 (0.051)	-0.081 (0.061)	-0.098 (0.093)
Observations	640	640	640	640	640	640	640	640	640
Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

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

3.6 Robustness Tests

To test the robustness of our descriptive statistics and econometric findings, we employ 3 robustness checks. The first test involves analyzing the direct effects of trade openness and natural resource wealth, differentiated by resource type, by dividing our sample into two groups based on the median (13.30%) of diffuse-source natural resource wealth ⁴. This allows us to observe the effects of our variables of interest within countries that are relatively rich in diffuse-source natural resources and those that are relatively poorer. The second robustness test involves repeating this analysis using an alternative proxy for wealth in diffuse-source and point-source natural resources. In this test, diffuse-source wealth is measured by the share of these resources in total exports, while point-source wealth is assessed by the percentage of total exports attributed to these resources. The third robustness test consists of repeating all previous analyses using an alternative econometric method.

3.6.1 Robustness 1: sub-samples, relative rich VS poor in diffuse-source natural resources

In this first robustness test, we analyse the direct effects of trade openness and natural resource wealth, differentiated by resource type, by dividing our sample into two groups based on the median (13.30%) of diffuse-source natural resource wealth.

Table 3.4 presents the results for the sample of countries relatively poor in diffuse-source natural resources. In these countries, trade openness has a positive and significant effect on income inequality, regardless of the initial inequality level. Additionally, the effect of wealth in point-source natural resources becomes significant: in countries relatively poor in diffuse-source natural resources, wealth in point-source natural resources exacerbates income inequality, particularly in those with initially lower levels of inequality. Good governance for resource redistribution is a crucial factor in reducing inequality in these countries whatever the initial inequality level. Human capital, the unemployment rate, and the level of industrialization are also important factors influencing income inequality in this context.

In contrast, in countries relatively rich in diffuse-source natural resources (Table 3.5), trade openness does not have a significant effect on income inequality. In these countries, wealth in point-source natural resources leads to a reduction in inequality, regardless of the initial level of inequality. Governance quality, whether good or poor, does not significantly impact income inequality in this context. However, human capital, unemployment rates, foreign direct investment, and ethnic tensions are key determinants that affect income inequality in these countries.

This analysis reveals that in low- and middle-income countries, the effect of trade openness on income inequality is positive and significant, but primarily in countries that are relatively poor in diffuse-source natural resources, while the effect is neutral in countries relatively rich in these types of resources. Furthermore, the results indicate that the impact of natural resource wealth on income inequality—primarily

⁴We classify countries according to they average value of diffuse-source natural resource variable on the period of study (1995-2018)

examined in the literature through point-source natural resources—is driven by the level of diffuse-source natural resource wealth. Specifically, the effect of wealth in point-source natural resources on income inequality is positive and significant in countries relatively poor in diffuse-source natural resources, whereas it is negative and significant in countries relatively rich in diffuse-source natural resources. These findings provide a response to the conflicting literature on the effect of trade openness on income inequality in general and contribute to the specific branch of literature analyzing the impact of trade openness in resource-rich countries. In Addition, The results also show that good governance is crucial for reducing inequality in countries relatively poor in diffuse-source natural resources, while it has no significant effect in countries that are relatively rich in these types of resources, suggesting that the presence of an efficient social planner is far more imperative in countries that are relatively poor in diffuse-source natural resources. Moreover, the findings indicate that in low- and middle-income countries, the determinants of inequality levels are not always the same. These results confirm our hypothesis that the nature of natural resources influences the effect of trade openness on income inequality.

Table 3.4: **Direct effects on income inequalities: countries relatively poor in diffuse-source natural resources**

VARIABLES	10th	20th	30th	40th	50th	60th	70th	80th	90th
Trade Openness	4.046** (1.904)	4.453*** (1.581)	4.833*** (1.340)	5.126*** (1.216)	5.588*** (1.172)	6.059*** (1.321)	6.461*** (1.569)	6.786*** (1.824)	7.728*** (2.676)
Agriculture value added (% of GDP)	-0.133 (0.127)	-0.109 (0.105)	-0.086 (0.089)	-0.069 (0.081)	-0.042 (0.078)	-0.014 (0.088)	0.010 (0.104)	0.029 (0.121)	0.085 (0.178)
Oil, gas, coal and mining rent (% of GDP)	0.190** (0.078)	0.167** (0.065)	0.145*** (0.055)	0.128** (0.050)	0.101** (0.048)	0.074 (0.054)	0.051 (0.064)	0.032 (0.075)	-0.022 (0.110)
Government effectiveness	-3.280*** (1.027)	-3.212*** (0.853)	-3.149*** (0.722)	-3.100*** (0.653)	-3.023*** (0.627)	-2.944*** (0.710)	-2.877*** (0.845)	-2.823*** (0.981)	-2.666* (1.440)
Human capital	-10.507*** (1.320)	-10.309*** (1.096)	-10.124*** (0.928)	-9.981*** (0.841)	-9.757*** (0.809)	-9.528*** (0.914)	-9.332*** (1.087)	-9.174*** (1.263)	-8.716*** (1.853)
Unemployment (% of total labor force)	0.077 (0.084)	0.090 (0.069)	0.101* (0.059)	0.110** (0.053)	0.124** (0.051)	0.139** (0.058)	0.151** (0.069)	0.161** (0.080)	0.190 (0.117)
FDI net inflows (% of GDP)	0.019 (0.077)	0.017 (0.064)	0.015 (0.054)	0.014 (0.049)	0.012 (0.047)	0.010 (0.054)	0.008 (0.064)	0.006 (0.074)	0.002 (0.109)
Population growth rate	-0.011 (0.580)	0.073 (0.482)	0.152 (0.408)	0.214 (0.370)	0.310 (0.356)	0.408 (0.402)	0.492 (0.478)	0.559 (0.555)	0.755 (0.815)
Absence of ethnic tensions	-0.146 (0.297)	-0.088 (0.247)	-0.034 (0.209)	0.007 (0.190)	0.072 (0.182)	0.139 (0.206)	0.196 (0.245)	0.242 (0.285)	0.375 (0.418)
Industry	-0.115 (0.078)	-0.122* (0.065)	-0.129** (0.055)	-0.134*** (0.050)	-0.142*** (0.048)	-0.150*** (0.054)	-0.157** (0.064)	-0.163** (0.074)	-0.180 (0.109)
Observations	392	392	392	392	392	392	392	392	392
Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

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

Table 3.5: Direct effects on income inequalities: countries relatively rich in diffuse-source natural resources

VARIABLES	10th	20th	30th	40th	50th	60th	70th	80th	90th
Trade Openness	0.460 (0.657)	0.417 (0.526)	0.383 (0.440)	0.348 (0.381)	0.309 (0.366)	0.265 (0.422)	0.232 (0.499)	0.198 (0.597)	0.159 (0.724)
Agriculture value added (% of GDP)	-0.105 (0.081)	-0.096 (0.065)	-0.088 (0.054)	-0.081* (0.047)	-0.072 (0.045)	-0.063 (0.052)	-0.055 (0.061)	-0.048 (0.073)	-0.039 (0.089)
Oil, gas, coal and mining rent (% of GDP)	-0.118** (0.059)	-0.120** (0.047)	-0.121*** (0.039)	-0.122*** (0.034)	-0.124*** (0.033)	-0.126*** (0.038)	-0.127*** (0.044)	-0.129** (0.053)	-0.130** (0.064)
Government effectiveness	0.408 (1.524)	0.417 (1.221)	0.425 (1.022)	0.432 (0.884)	0.440 (0.850)	0.450 (0.978)	0.457 (1.159)	0.464 (1.385)	0.473 (1.679)
Human capital	-4.714*** (1.648)	-4.613*** (1.320)	-4.534*** (1.105)	-4.452*** (0.956)	-4.361*** (0.919)	-4.257*** (1.058)	-4.178*** (1.253)	-4.099*** (1.497)	-4.007** (1.816)
Unemployment (% of total labor force)	0.106 (0.085)	0.108 (0.068)	0.110* (0.057)	0.112** (0.050)	0.114** (0.048)	0.116** (0.055)	0.118* (0.065)	0.119 (0.078)	0.121 (0.094)
FDI net inflows (% of GDP)	0.046 (0.036)	0.046 (0.029)	0.046* (0.024)	0.046** (0.021)	0.047** (0.020)	0.047** (0.023)	0.047* (0.027)	0.048 (0.032)	0.048 (0.039)
Population growth rate	-0.084 (0.837)	-0.143 (0.670)	-0.190 (0.561)	-0.237 (0.486)	-0.290 (0.467)	-0.351 (0.537)	-0.397 (0.636)	-0.443 (0.760)	-0.497 (0.922)
Absence of ethnic tensions	-0.446* (0.263)	-0.390* (0.211)	-0.347** (0.177)	-0.301** (0.153)	-0.252* (0.148)	-0.194 (0.170)	-0.151 (0.200)	-0.108 (0.239)	-0.057 (0.290)
Industry	0.090 (0.075)	0.079 (0.060)	0.071 (0.050)	0.062 (0.044)	0.052 (0.042)	0.041 (0.048)	0.032 (0.057)	0.024 (0.068)	0.014 (0.083)
Observations	248	248	248	248	248	248	248	248	248
Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

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

3.6.2 Robustness 2: sub-samples, relative rich VS poor in diffuse-source natural resources, alternative measure of diffuse-source and point-source natural resources wealth

With these alternative measures for diffuse-source and point-source natural resource wealth, our results remain robust, as shown in Tables 3.6 and 3.7. However, it appears that an export share dominated by point-source natural resources may help reduce inequality, particularly when inequality levels are very high.

Table 3.6: Direct effects on income inequalities: countries relatively poor in diffuse-source natural resources

VARIABLES	10th	20th	30th	40th	50th	60th	70th	80th	90th
Trade Openness	5.127*** (1.986)	5.333*** (1.612)	5.527*** (1.334)	5.679*** (1.202)	5.854*** (1.181)	6.058*** (1.334)	6.262*** (1.628)	6.460*** (1.987)	6.695*** (2.468)
Agricultural products export (% of total export)	-0.018 (0.045)	-0.012 (0.036)	-0.006 (0.030)	-0.002 (0.027)	0.003 (0.026)	0.009 (0.030)	0.015 (0.036)	0.021 (0.045)	0.027 (0.055)
Oil, gas, coal and mining export (% of total export)	0.007 (0.035)	-0.006 (0.028)	-0.018 (0.024)	-0.028 (0.021)	-0.039* (0.021)	-0.052** (0.024)	-0.065** (0.029)	-0.077** (0.035)	-0.092** (0.043)
Government effectiveness	-3.170*** (1.017)	-3.173*** (0.825)	-3.175*** (0.683)	-3.177*** (0.615)	-3.179*** (0.603)	-3.182*** (0.682)	-3.184*** (0.833)	-3.187*** (1.018)	-3.190** (1.264)
Human capital	-9.614*** (1.329)	-9.336*** (1.078)	-9.074*** (0.892)	-8.868*** (0.804)	-8.631*** (0.790)	-8.355*** (0.893)	-8.079*** (1.089)	-7.812*** (1.329)	-7.494*** (1.651)
Unemployment (% of total labor force)	0.078 (0.087)	0.083 (0.070)	0.088 (0.058)	0.091* (0.052)	0.096* (0.051)	0.101* (0.058)	0.106 (0.071)	0.111 (0.087)	0.117 (0.108)
FDI net inflows (% of GDP)	0.050 (0.069)	0.037 (0.056)	0.024 (0.046)	0.014 (0.042)	0.003 (0.041)	-0.010 (0.046)	-0.024 (0.057)	-0.036 (0.069)	-0.052 (0.086)
Population growth rate	0.263 (0.583)	0.273 (0.473)	0.282 (0.391)	0.289 (0.353)	0.297 (0.346)	0.307 (0.391)	0.316 (0.478)	0.325 (0.583)	0.336 (0.725)
Absence of ethnic tensions	-0.023 (0.301)	0.032 (0.245)	0.084 (0.203)	0.125 (0.182)	0.172 (0.179)	0.227 (0.203)	0.281 (0.247)	0.334 (0.301)	0.397 (0.374)
Industry	-0.007 (0.080)	-0.012 (0.065)	-0.016 (0.053)	-0.019 (0.048)	-0.023 (0.047)	-0.027 (0.053)	-0.032 (0.065)	-0.036 (0.080)	-0.041 (0.099)
Observations	389	389	389	389	389	389	389	389	389
Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

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

Table 3.7: **Direct effects on income inequalities: countries relatively rich in diffuse-source natural resources**

VARIABLES	10th	20th	30th	40th	50th	60th	70th	80th	90th
Trade Openness	-0.171 (0.512)	-0.113 (0.406)	-0.079 (0.353)	-0.036 (0.300)	0.011 (0.271)	0.071 (0.292)	0.119 (0.347)	0.156 (0.405)	0.199 (0.481)
Agricultural products export (% of total export)	-0.081 (0.058)	-0.079* (0.046)	-0.078* (0.040)	-0.076** (0.034)	-0.074** (0.031)	-0.072** (0.033)	-0.070* (0.039)	-0.069 (0.046)	-0.067 (0.055)
Oil, gas, coal and mining export (% of total export)	-0.014 (0.022)	-0.018 (0.018)	-0.020 (0.015)	-0.022* (0.013)	-0.025** (0.012)	-0.029** (0.013)	-0.032** (0.015)	-0.034* (0.018)	-0.036* (0.021)
Government effectiveness	1.045 (1.548)	0.916 (1.226)	0.842 (1.066)	0.747 (0.905)	0.644 (0.819)	0.512 (0.882)	0.407 (1.049)	0.325 (1.225)	0.232 (1.455)
Human capital	-4.248*** (1.524)	-3.964*** (1.207)	-3.801*** (1.050)	-3.592*** (0.893)	-3.365*** (0.810)	-3.075*** (0.872)	-2.845*** (1.034)	-2.665** (1.206)	-2.459* (1.432)
Unemployment (% of total labor force)	0.099 (0.094)	0.101 (0.074)	0.101 (0.065)	0.103* (0.055)	0.104** (0.050)	0.106** (0.053)	0.107* (0.064)	0.108 (0.074)	0.109 (0.088)
FDI net inflows (% of GDP)	0.015 (0.023)	0.014 (0.018)	0.013 (0.016)	0.012 (0.013)	0.011 (0.012)	0.009 (0.013)	0.008 (0.015)	0.007 (0.018)	0.006 (0.021)
Population growth rate	0.061 (0.805)	0.042 (0.637)	0.031 (0.554)	0.017 (0.470)	0.001 (0.425)	-0.019 (0.458)	-0.034 (0.545)	-0.047 (0.637)	-0.061 (0.756)
Absence of ethnic tensions	-0.665** (0.309)	-0.590** (0.244)	-0.547** (0.213)	-0.492*** (0.181)	-0.432*** (0.165)	-0.356** (0.177)	-0.295 (0.209)	-0.247 (0.244)	-0.193 (0.290)
Industry	0.069 (0.080)	0.047 (0.063)	0.034 (0.055)	0.018 (0.047)	0.001 (0.043)	-0.022 (0.046)	-0.039 (0.054)	-0.053 (0.063)	-0.069 (0.075)
Observations	250	250	250	250	250	250	250	250	250
Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

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

3.6.3 Robustness 3: Alternative methodology

In this second robustness test, we repeat all previous analyses using an alternative econometric method, a panel fixed effect with robust standard errors. This methodology is illustrated by the equations (1), (2) and (3) in the methodology section. Tableau 3.8 shows the results with this alternative econometrics method: column (1), (2) and (3) show robustness results from our main results of Table 3.1, 3.2 and 3.3 respectively. As we can see, our results remain consistent to this alternative results, as in low- and middle-income countries, trade openness has positive and significant effect on income inequality, while diffuse-source natural resources wealth has negative and significant effect on income inequality. Results also confirm that point-source natural resources do not have significant effect on income inequality. column (4) and (5) show robustness results from our first robustness test, with column (4) being the results of sample of relatively diffuse-source natural resources rich countries and column (5) being the results for the relatively poor countries in diffuse-source natural resources. Again our results remain valid to this alternative econometrics methode. Columns (6) and (7) show the results of the robustest 2 test with column (6) being the results of sample of relatively diffuse-source natural resources rich countries and column (7) being the results for the relatively poor countries in diffuse-source natural resources. here again our results remain valid.

Table 3.8: Direct and interaction effects on income inequality

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Trade Openness	2.231*	6.012**	3.930**	0.309	5.623**	0.018	5.882**
	(1.319)	(2.506)	(1.820)	(0.454)	(2.590)	(0.242)	(2.610)
Agriculture value added (% of GDP) $\times$ Trade Openness		-0.152*					
		(0.079)					
Oil, gas, coal and mining rent (% of GDP) $\times$ Trade Openness			-0.166				
			(0.103)				
Agricultural products export (% of total export)					-0.074	0.004	
					(0.059)	(0.048)	
Oil, gas, coal and mining export (% of total export)					-0.025	-0.040	
					(0.018)	(0.035)	
Agriculture value added (% of GDP)	-0.123*	-0.005	-0.103	-0.072	-0.040		
	(0.066)	(0.080)	(0.063)	(0.057)	(0.123)		
Oil, gas, coal and mining rent (% of GDP)	-0.011	-0.024	0.107	-0.124*	0.099*		
	(0.043)	(0.042)	(0.101)	(0.061)	(0.051)		
Government effectiveness	-2.280**	-2.207**	-2.300**	0.440	-3.017***	0.629	-3.180***
	(0.919)	(0.932)	(0.923)	(1.543)	(0.948)	(1.565)	(1.020)
Human capital	-7.534***	-7.825***	-7.784***	-4.361*	-9.740***	-3.333	-8.594***
	(1.490)	(1.517)	(1.558)	(2.323)	(1.823)	(2.173)	(1.715)
Unemployment (% of total labor force)	0.137**	0.147**	0.146**	0.114	0.125**	0.104	0.097
	(0.067)	(0.063)	(0.067)	(0.094)	(0.057)	(0.096)	(0.064)
FDI net inflows (% of GDP)	0.003	0.007	0.008	0.047	0.012	0.010	0.001
	(0.027)	(0.025)	(0.025)	(0.036)	(0.061)	(0.020)	(0.061)
Population growth rate	-0.005	0.050	0.027	-0.290	0.317	-0.001	0.298
	(0.402)	(0.414)	(0.411)	(0.755)	(0.470)	(0.676)	(0.541)
Absence of ethnic tensions	-0.234	-0.230	-0.211	-0.252	0.078	-0.424*	0.179
	(0.213)	(0.225)	(0.220)	(0.155)	(0.256)	(0.235)	(0.218)
Industry	-0.025	-0.025	-0.036	0.052	-0.143*	-0.002	-0.024
	(0.053)	(0.052)	(0.055)	(0.042)	(0.071)	(0.050)	(0.070)
Constant	60.633***	58.467***	59.913***	51.274***	66.594***	51.270***	60.890***
	(4.709)	(4.663)	(4.647)	(6.178)	(6.086)	(6.116)	(5.441)
Observations	640	640	640	248	392	250	389
R-squared	0.328	0.349	0.339	0.149	0.509	0.140	0.530
Number of countries	54	54	54	28	26	29	26
Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

3.7 Conclusion

The findings of this study provide key insights into the relationship between trade openness, natural resource wealth, and income inequality in low- and middle-income countries. Our results reveal that, across the entire sample, trade openness has a significant positive effect on income inequality. In contrast, wealth from diffuse-source natural resources, such as agriculture, has a significant negative effect on inequality, while wealth from point-source natural resources, like oil and minerals, shows no significant impact on inequality.

Furthermore, our descriptive analysis highlights that countries richer in diffuse-source natural resources tend to perform better in terms of self-employment, indicating a greater potential for income generation independent of centralized systems. This suggests that diffuse-source resources contribute to reducing inequality by enabling broader economic participation.

Additionally, in countries relatively rich in diffuse-source natural resources, trade openness does not significantly impact income inequality, and point-source resource wealth actually reduces inequality. Governance quality plays a less critical role in these countries, suggesting that inequality can be reduced even in the absence of strong institutional frameworks. Conversely, in countries with lower levels of diffuse-source natural resource wealth, both trade openness and point-source resource wealth exacerbate inequality. In these cases, good governance becomes crucial for mitigating income disparities.

These results suggest that diffuse-source natural resources act as a pivotal factor in shaping the effects of both trade openness and point-source natural resources on inequality. Countries rich in diffuse resources appear better equipped to leverage trade openness for more equitable outcomes, while those with lower levels of such resources face greater inequality unless supported by robust governance.

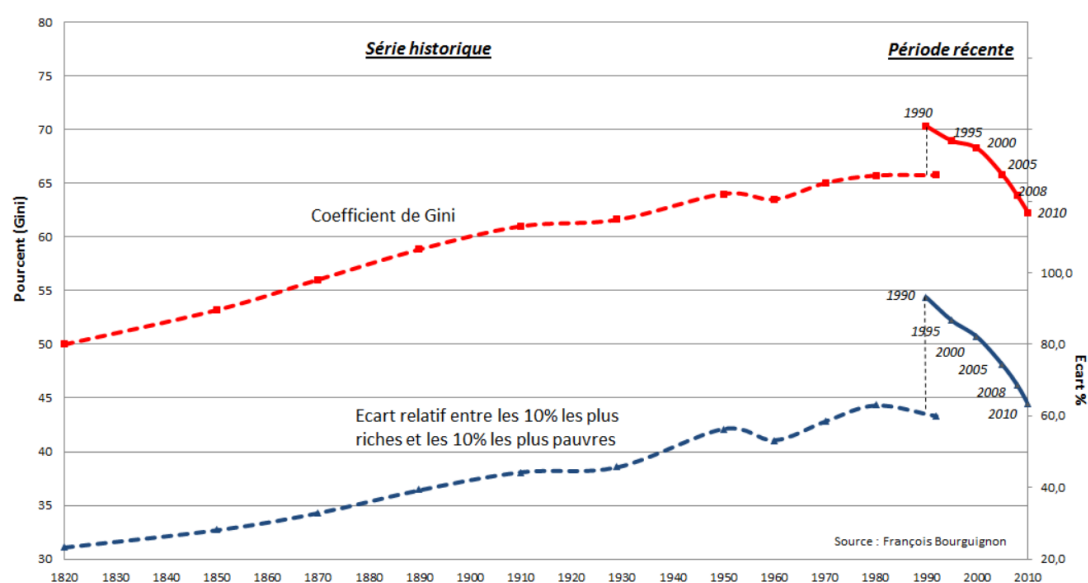
Our findings also point to broader policy implications, particularly in the context of the ongoing global energy transition. Investment in the development of diffuse resources, such as agriculture, could be an important strategy for achieving a just energy transition. In countries that are rich in point-source resources but suffer from poor institutional quality, investing in agriculture and other diffuse resources could help redistribute revenues from point-source resources and ensure a fair and inclusive transition. This strategy would enhance economic resilience and reduce dependence on centralized systems, leading to more equitable income distribution.

3.8 Appendix

Table 3.9: List of Variables and their Sources

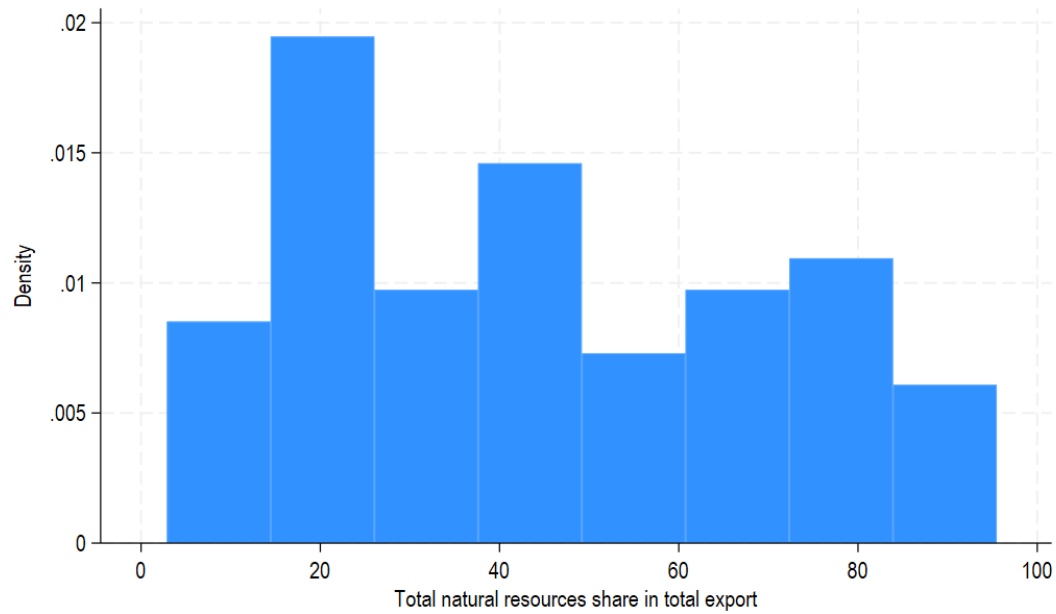
Variables	Sources
Dependant variable	
Income inequality = GINI index	SWIID Database
Explanatory variables	
Diffuse-source natural resource wealth = Agriculture, forestry, and fisheries value added (% of GDP)	World Bank (WDI)
Point-source natural resource wealth = Oil, gas, coal, and mineral rents (% of GDP)	World Bank (WDI)
Trade openness = (Export + Import of goods & services)/GDP	World Bank (WDI)
Foreign direct investment net inflows	World Bank (WDI)
Human capital	PWT 9.0
industry = industry (including construction), value added (% of GDP)	World Bank (WDI)
Unemployment (% of total labor force)	World Bank (WDI)
Institutional quality = Government effectiveness	World Bank (WDI)
Ethno-linguistic fragmentation = Ethnic tensions	ICRG (2018)
Population growth rate (annual %)	World Bank (WDI)
Export share	BACI

Figure 3.4: Inequality trend



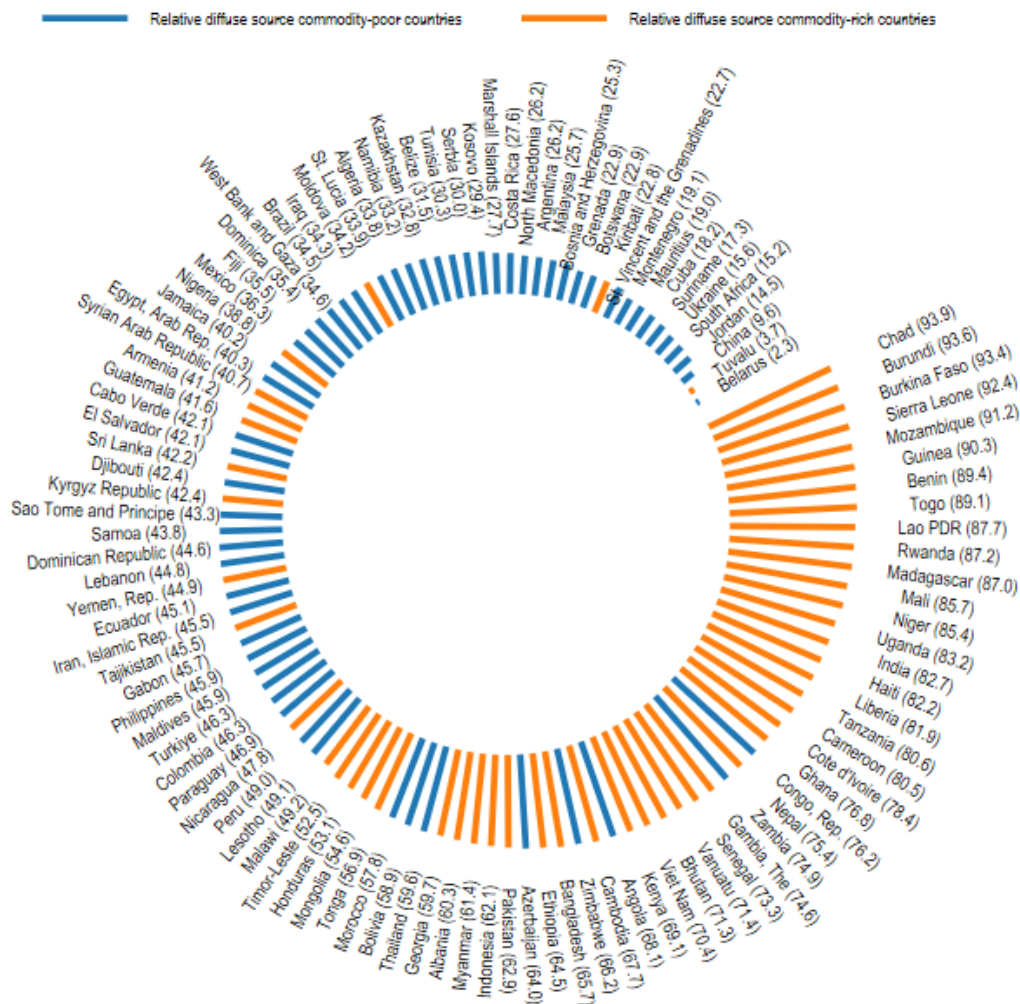
Source: Bourguignon (2012).

Figure 3.5: Distribution of total natural resources share in total export (average 1988-2022)



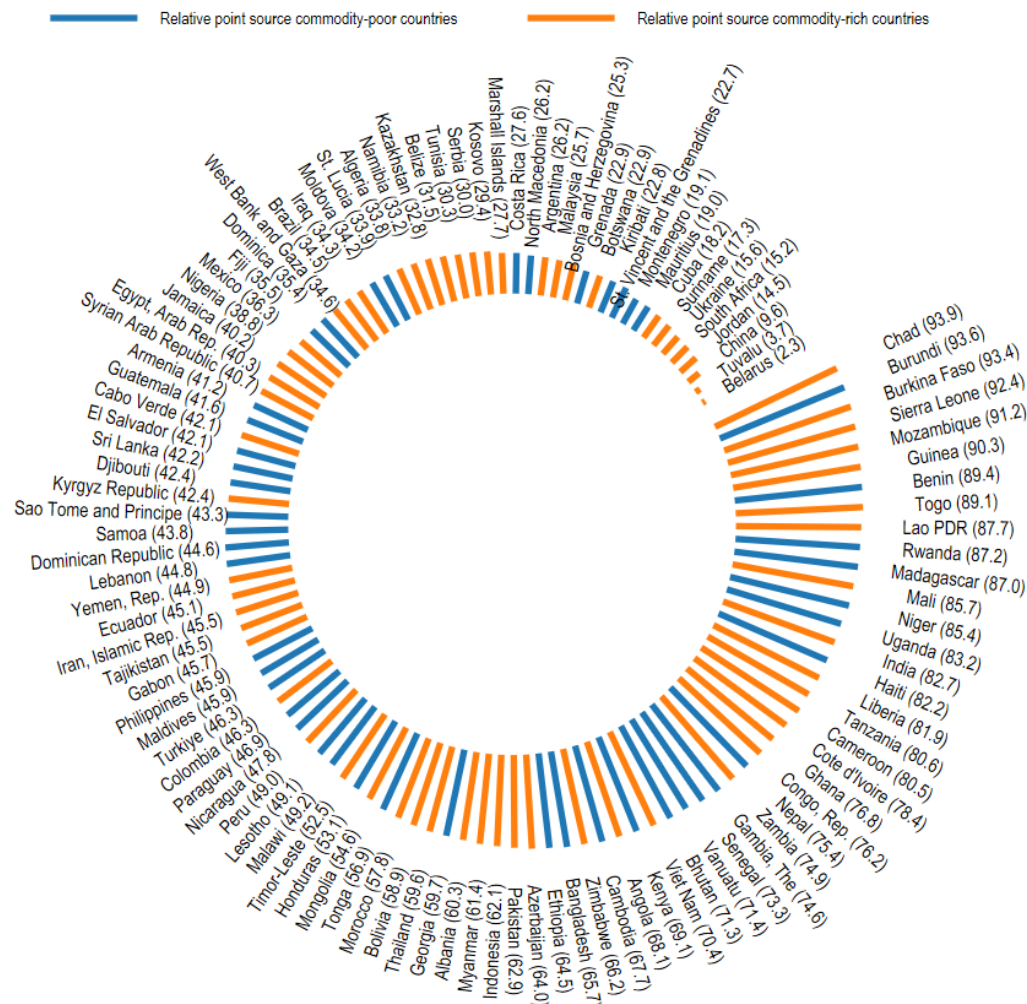
Source: Author's construction, Data from World Bank WITS.

Figure 3.6: Self-employment (% of total employment) and diffuse-source natural resources (Average 1990-2018)



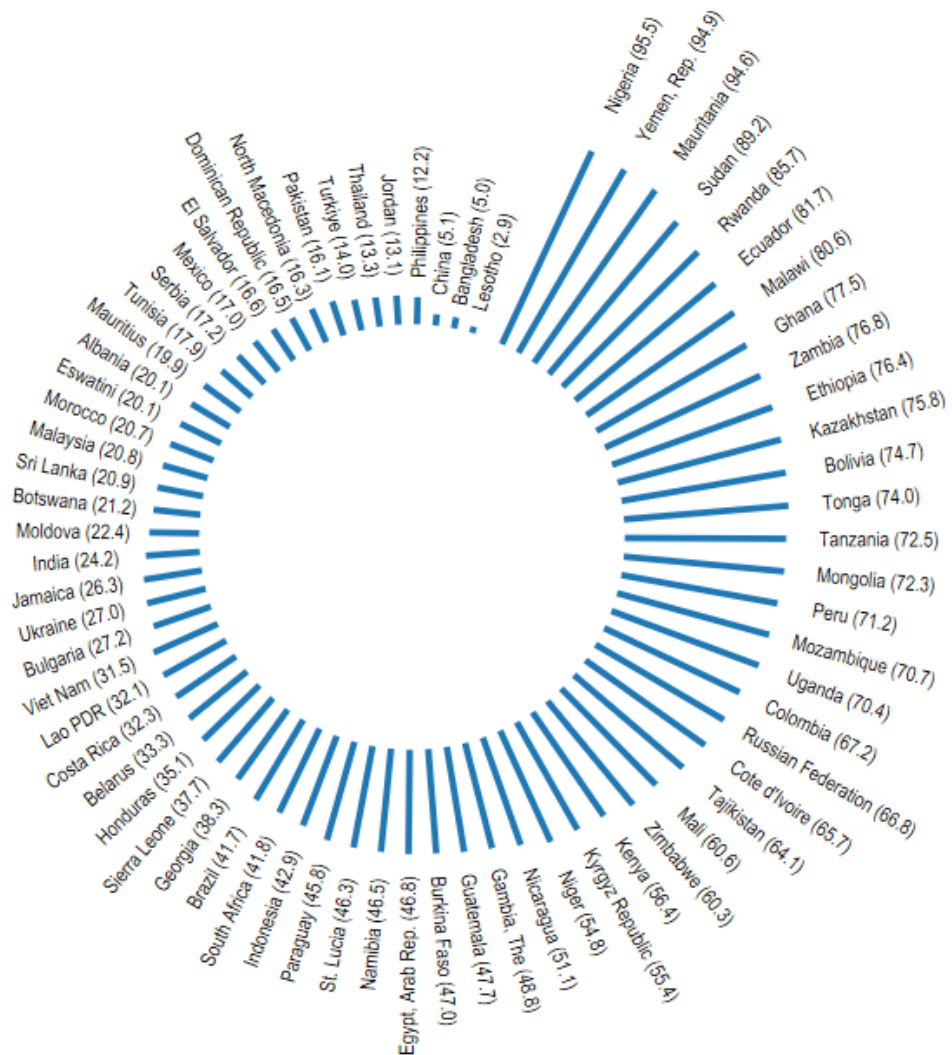
Source: Author's construction, Data from World Bank.

Figure 3.7: Self-employment (% of total employment) and point-source natural resources (Average 1990-2018)



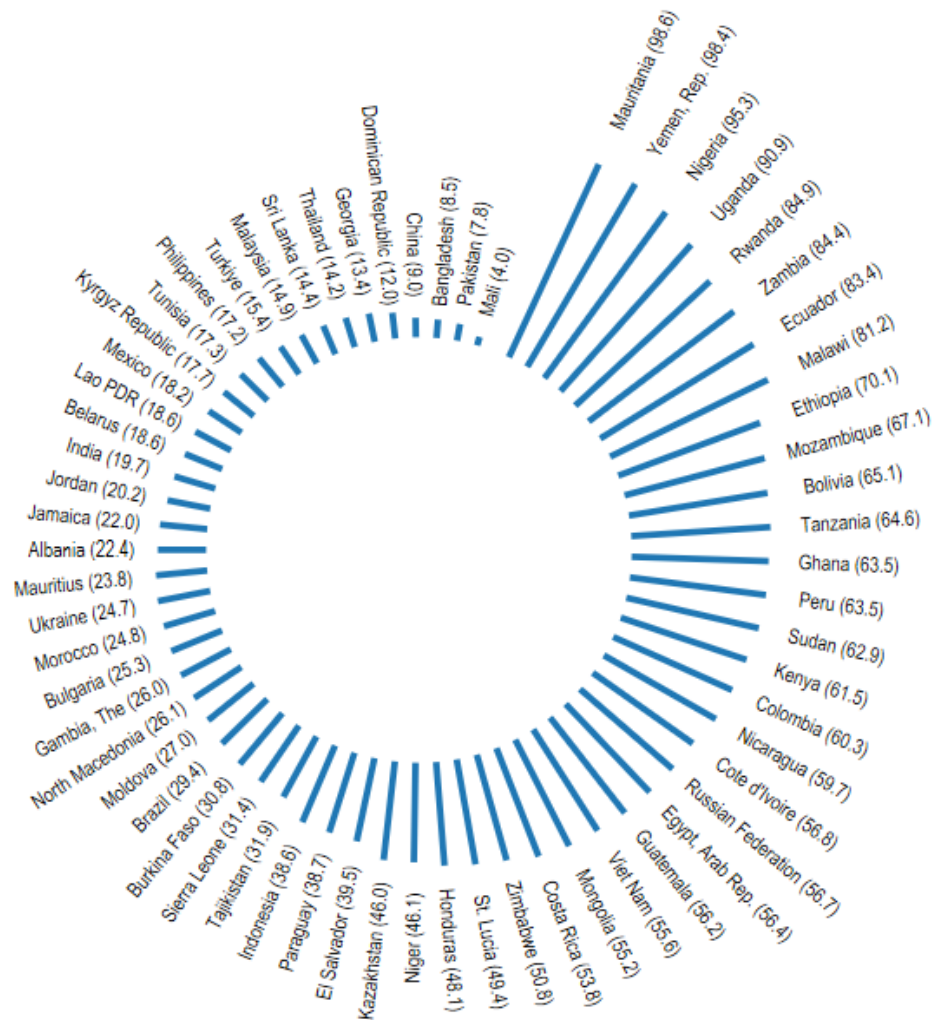
Source: Author's construction, Data from World Bank.

Figure 3.8: Share of total natural resources in total export (average 1995-2018)



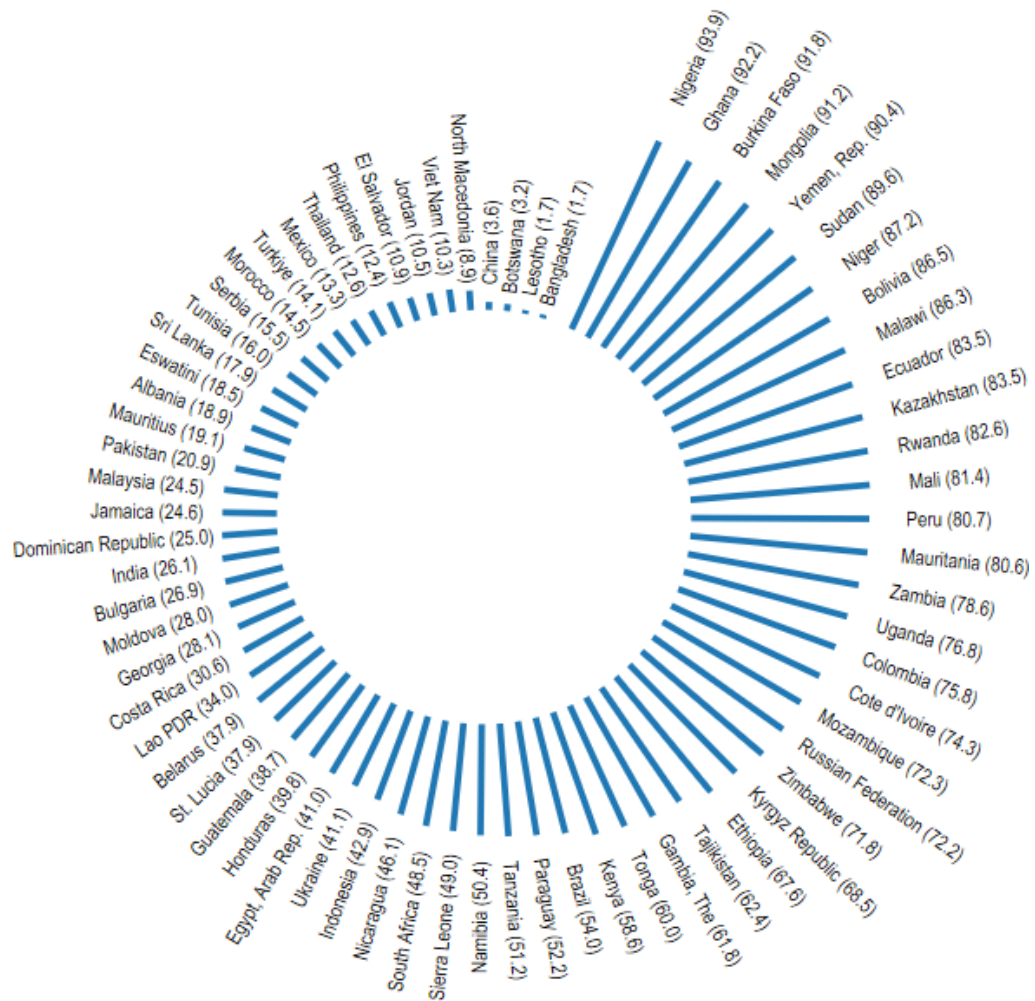
Source: Author's construction, Data from BACI.

Figure 3.9: Share of total natural resources in total export (1995)



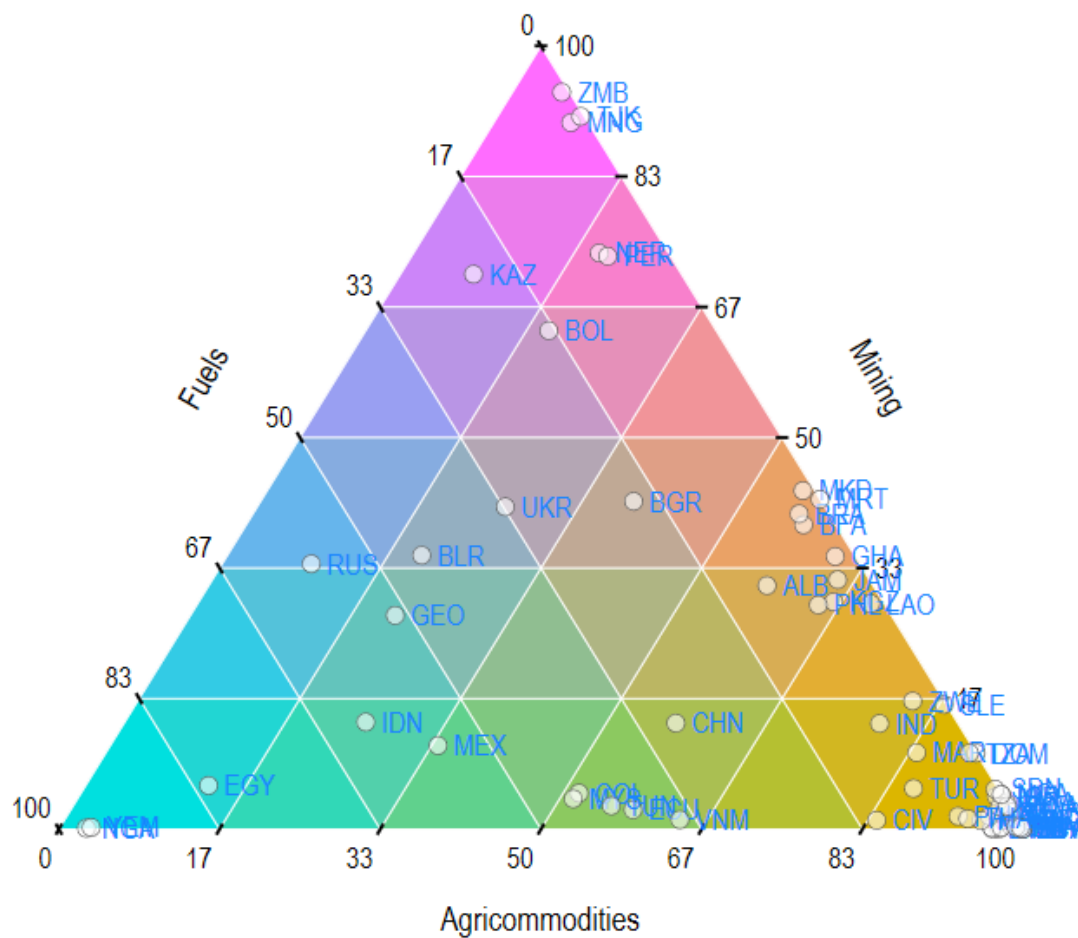
Source: Author's construction, Data from BACI.

Figure 3.10: Share of total natural resources in total export (2018)



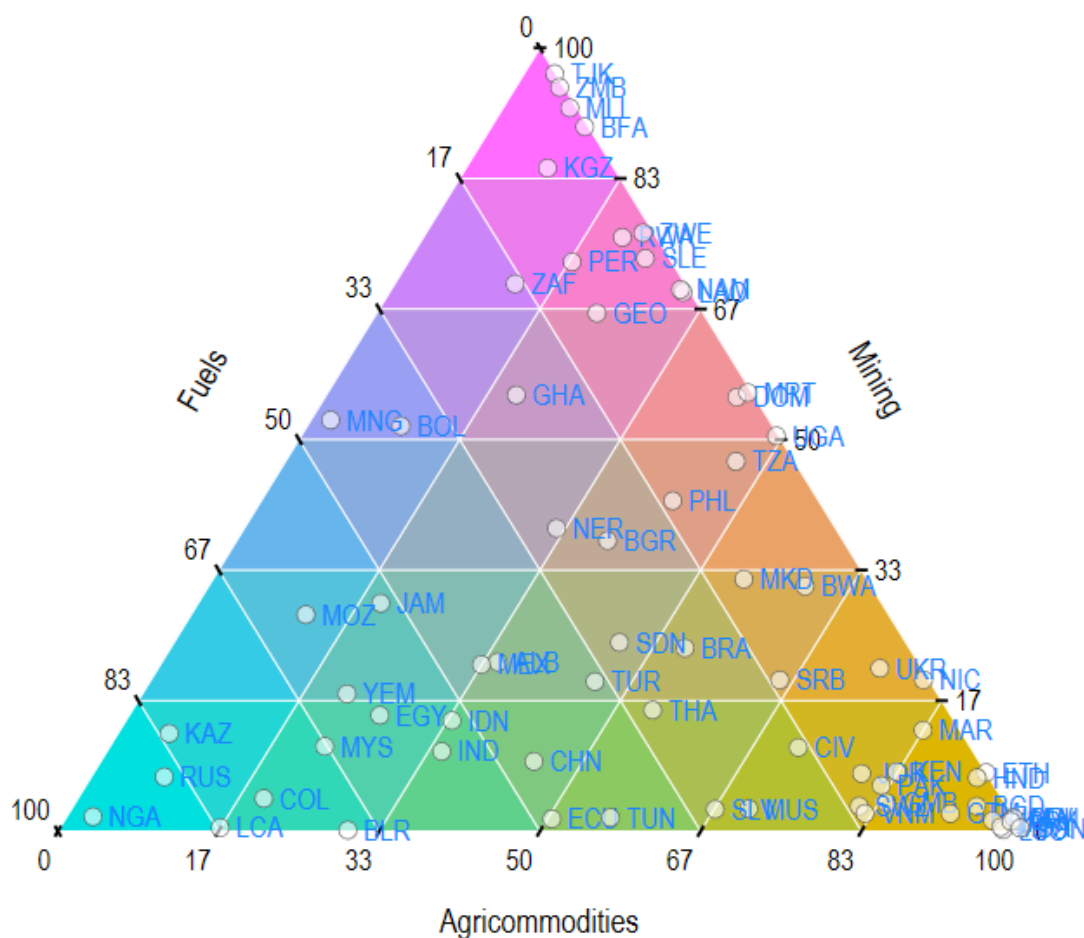
Source: Author's construction, Data from BACI.

Figure 3.11: Share by commodity in total commodities export (1995)



Source: Author's construction, Data from BACI.

Figure 3.12: Share by commodity in total commodities export (2018)



Source: Author's construction, Data from BACI.

Table 3.10: Classification of HS6 Codes by Natural Resource Type

Fuels	Mining	Agricommodities
270111 to 271500	260111 to 261790	010111 to 140490
	710210	150710 to 151560
	710610 to 710692	151620
	710811 to 710813	170111, 170112
	711011 to 711019	180100 to 180500
	720110 to 720140	240110 to 240130
	740200 to 740319	
	750110 to 750300	
	760110 to 760200	
	790111 to 790390	
	800110 to 800200	
	810510 to 810590	

Table 3.11: Countries used in the sample

Country	Country	Country	Country
Albania	Indonesia	Malaysia	Namibia
Burkina Faso	India	Niger	Nigeria
Bangladesh	Jamaica	Nicaragua	Pakistan
Bulgaria	Jordan	Peru	Philippines
Belarus	Kazakhstan	Paraguay	Russian Federation
Bolivia	Kenya	Rwanda	Sudan
Brazil	Kyrgyz Republic	Sierra Leone	El Salvador
Botswana	Lao PDR	Serbia	Eswatini
China	St. Lucia	Thailand	Tajikistan
Cote d'Ivoire	Sri Lanka	Tonga	Tunisia
Colombia	Lesotho	Turkiye	Tanzania
Costa Rica	Morocco	Uganda	Ukraine
Dominican Republic	Moldova	Viet Nam	Yemen, Rep.
Ecuador	Mexico	South Africa	Zambia
Egypt, Arab Rep.	North Macedonia	Zimbabwe	Mongolia
Ethiopia	Mali	Mozambique	Mauritania
Georgia	Mauritius	Malawi	Gambia, The
Ghana	Guatemala	Honduras	

General Conclusion

General conclusion

This thesis has explored the complex interactions between natural resources, fiscal policies, and trade openness, highlighting their effects on socio-economic outcomes such as income inequality and food security. The policy implications, limitations to consider, and conclusions drawn from each chapter contribute to a better understanding of the challenges and opportunities faced by resource-rich countries, to better guide them in their sustainable development strategies.

The first chapter showed that discoveries of natural resources, such as large oil or gas deposits, influence the expectations and fiscal discipline of countries. The findings indicate that in countries with strong institutions and frequently applied fiscal rules, positive shocks related to resource discoveries promote countercyclical fiscal policy. Conversely, in countries with weak institutions, significant deviations from fiscal discipline are observed. These findings underscore the importance of institutions and the use of fiscal rules, particularly in resource-rich countries where revenue volatility from natural resources can lead to significant economic shocks. Thus, the results confirm that the economic and social success of resource-rich countries in the face of positive or negative exogenous shocks will depend on fiscal policies and transparent practices in natural resource management (Bodea and Hicks, 2018), to avoid repeating the errors associated with the *resource curse* and ensure that the energy transition benefits everyone, including the most vulnerable populations (Dalabajan et al., 2022).

Moreover, since the plausible effect of expectations due to natural resource discoveries has been highlighted, a relevant question that might arise is the effect that natural resource discoveries might have on countries' access to international capital markets. In fact, good fiscal governance is one of the main factors taken into account in the assessment strategies of rating agencies and multilateral lenders such as the IMF and the World Bank (Bodea and Hicks, 2018). For that reason, could the discovery of large oil or gas deposits in a country, potentially seen as near financial solvency, provide better access to the international capital market, regardless of the quality of fiscal governance in that country? If so, then what impact could this have on the financial market? Future research on the role of expectations in general and on the role of expectations due to the discovery of natural resources, in particular, could be addressed in order to bring new elements to this almost unexploited part of the literature.

The second chapter analyzed budget management related to agricultural production and food security. This chapter revealed that, while most Sub-Saharan African (SSA) countries (79%) allocate only 15% of their harvested land to cash crops, cash crops mediate the relationship between public agricultural

expenditure and food security in Sub-Saharan Africa. A high proportion of cash crops contributes to improving the efficiency of public agricultural expenditures but, in the long term, may compromise food sovereignty by increasing dependency on food imports. Policies must therefore be developed to balance cash crop and food crop production to prevent excessive dependency (Kuma et al., 2019; Masanjala, 2006).

For countries already heavily reliant on cash crop exports, we recommend imposing quotas on the land allocated to food crops and using tax revenue from cash crops to subsidize food crop production and development, thereby extending their value and lifespan within the global food chain. This strategy could gradually reduce their dependence on cash crop exports while enhancing competitiveness and resilience to global market shocks. For countries with a low share of cash crops, it might be beneficial to encourage the development of cash crops, but with carefully managed quotas to prevent market oversupply. Regional coordination is essential for managing the supply of cash crops across SSA, similar to how OPEC controls oil production. By regulating the amount of land dedicated to each type of crop, SSA countries could stabilize cash crop prices and mitigate the risks of market volatility. This strategy would also allow for a more balanced approach to addressing both food security and economic goals.

Furthermore, reinvesting a portion of cash crop export revenues into developing food crops could help reduce vulnerability to international food trade shocks. This would support a gradual shift toward greater food sovereignty, minimizing reliance on global imports. Future research should delve into the mechanisms by which cash crops impact food security and examine the trade-offs involved in different agricultural strategies. Additionally, further exploration is needed into how production structures affect the relationship between public agricultural expenditure (PAE) and food security, particularly in determining the optimal balance between cash and food crops.

The third chapter shows that in low- and middle-income countries, trade openness has a positive and significant effect on income inequality, while wealth from *diffuse-source* renewable resources such as agricultural and fishery resources has a mitigating effect on this inequality. The results also show that wealth from *point-source* resources, such as gas, oil, and precious metals, does not have a significant effect on income inequality. Furthermore, our results indicate that in countries that are relatively richer in *diffuse-source* resources (i.e., with a level above the sample median), trade openness has no significant impact on income inequality, and wealth from *point-source* resources in these countries may actually reduce inequality. Moreover, in these countries, the quality of governance does not play a significant role in reducing inequality, suggesting that, irrespective of an effective social planner, inequalities can be reduced. Conversely, in countries that are relatively less rich in *diffuse-source* resources, both trade openness and wealth from *point-source* resources have significantly positive effects on income inequality. In these countries, good governance is crucial for reducing inequality.

Furthermore, our descriptive analysis highlights that countries richer in *diffuse-source* natural resources tend to perform better in terms of self-employment, indicating a greater potential for income generation independent of centralized systems. This suggests that *diffuse-source* resources contribute to

reducing inequality by enabling broader economic participation.

These results suggest that *diffuse-source* natural resources act as a pivotal factor in shaping the effects of both trade openness and *point-source* natural resources on inequality. Countries rich in diffuse resources appear better equipped to leverage trade openness for more equitable outcomes, while those with lower levels of such resources face greater inequality unless supported by robust governance. Our findings also point to broader policy implications, particularly in the context of the ongoing global energy transition. In countries that are rich in *point-source* resources but suffer from poor institutional quality, investing in agriculture and other *diffuse-source* resources could help redistribute revenues from *point-source* resources and ensure a fair and inclusive transition. This strategy would enhance economic resilience and reduce dependence on centralized systems, leading to more equitable income distribution.

Future research should explore how governance quality and investment in *diffuse-source* resources influence the long-term effectiveness of trade policies and income distribution in resource-rich countries. Additionally, further investigation could examine the role of international collaborations and policy frameworks in supporting these strategies.

Bibliography

- Acemoglu, D. and Robinson, J. (2012), *Why Nations Fail: the Origins of Power, Prosperity, and Poverty*, Crown Publishers, New York.
- Adam, A., Delis, M. and Kammas, P. (2011), ‘Public sector efficiency: leveling the playing field between oecd countries’, *Public Choice* **146**, 163–183.
- Adjimoti, G. O. and Kwadzo, G. T.-M. (2018), ‘Crop diversification and household food security status: evidence from rural benin’, *Agriculture & Food Security* **7**(1), 1–12.
- AfDB (2023), ‘Africa infrastructure development index (aidi), 2022’.
- Afonso, A. and Fraga, G. B. (2024), ‘Government spending efficiency in latin america’, *Empirica* **51**(1), 127–160.
- Afonso, A. and Kazemi, M. (2017), *Assessing public spending efficiency in 20 OECD countries*, Springer.
- Afonso, A., Schuknecht, L. and Tanzi, V. (2010*a*), ‘Income distribution determinants and public spending efficiency’, *The Journal of Economic Inequality* **8**(3), 367–389.
- Afonso, A., Schuknecht, L. and Tanzi, V. (2010*b*), ‘Public sector efficiency: evidence for new eu member states and emerging markets’, *Applied economics* **42**(17), 2147–2164.
- African Union (2003), African Union Declaration on Agriculture and Food Security in Africa, Technical report, African Union, Assembly/AU/Decl.4-11 (II).
- African Union (2014), African Union Summit 2014, Decisions, Declarations and Resolution in Malabo, Technical report, African Union, Malabo.
- Aghion, P., Marinescu, I., Caballero, R. J. and Kashyap, A. K. (2007), ‘Cyclical budgetary policy and economic growth: What do we learn from oecd panel data?[with comments and discussion]’, *NBER Macroeconomics annual* **22**, 251–297.
- Alderson, A. S. and Nielsen, F. (1999), ‘Income inequality, development, and dependence: A reconsideration’, *American Sociological Review* **64**(4), 606–631.

- Alesina, A. and Tabellini, G. (1990), ‘A positive theory of fiscal deficits and government debt’, *The Review of Economic Studies* **57**(3), 403–414.
- Amin, A. (2004), ‘Regulating economic globalization’, *Transactions of the Institute of British Geographers* **29**(2), 217–233.
- Anderman, T. L., Remans, R., Wood, S. A., DeRosa, K. and DeFries, R. S. (2014), ‘Synergies and tradeoffs between cash crop production and food security: a case study in rural ghana’, *Food security* **6**, 541–554.
- Antràs, P., De Gortari, A. and Itskhoki, O. (2017), ‘Globalization, inequality and welfare’, *Journal of International Economics* **108**, 387–412.
- Arezki, R. and Gylfason, T. (2011), Chapter 2 commodity price volatility, democracy, and economic growth, in ‘Economic growth and development’, Emerald Group Publishing Limited, pp. 9–24.
- Arezki, R., Ramey, V. A. and Sheng, L. (2017), ‘News shocks in open economies: Evidence from giant oil discoveries’, *The quarterly journal of economics* **132**(1), 103–155.
- Arezki, R., Ramey, V. A. and Sheng, L. (n.d.), ‘News shocks in open economies: Evidence from giant oil discoveries’.
- Artuc, E., Porto, G. and Rijkers, B. (2020), ‘Inequality and trade: Simulation evidence for 54 developing nations’, *Vox EU blog* **6**.
- Asonuma, M. T., Chamon, M. and Sasahara, A. (2016), *Trade costs of sovereign debt restructurings: Does a market-friendly approach improve the outcome?*, International Monetary Fund.
- Assa, J. (2012), ‘Financialization and its consequences: The oecd experience’, *Finance Research* **1**(1), 35–39.
- Asteriou, D., Dimelis, S. and Moudatsou, A. (2014), ‘Globalization and income inequality: A panel data econometric approach for the eu27 countries’, *Economic modelling* **36**, 592–599.
- Auerbach, A. J. and Gorodnichenko, Y. (2012), Fiscal multipliers in recession and expansion, in ‘Fiscal policy after the financial crisis’, University of Chicago Press, pp. 63–98.
- Autor, D. (2006), ‘The polarization of the us labor market’.
- Avarmaa, M., Hazak, A. and Männasoo, K. (2013), ‘Does leverage affect labour productivity? a comparative study of local and multinational companies of the baltic countries’, *Journal of Business Economics and Management* **14**(2), 252–275.
- Avril, P., Levieuge, G., Turcu, C. et al. (2022), *Natural Disasters and Financial Stress: Can Macroprudential Regulation Tame Green Swans?*, Banque de France.

- Ayeni, M. D. and Adewumi, M. O. (2023), ‘Food security among cashew farming households in kogi state, nigeria’, *GeoJournal* **88**(4), 3953–3968.
- Babones, S. J. and Vonada, D. C. (2009), ‘Trade globalization and national income inequality—are they related?’, *Journal of Sociology* **45**(1), 5–30.
- Baldwin, R. E. (1992), ‘Are economists’ traditional trade policy views still valid?’, *Journal of Economic Literature* **30**(2), 804–829.
- Banker, R. D., Charnes, A. and Cooper, W. W. (1984), ‘Some models for estimating technical and scale inefficiencies in data envelopment analysis’, *Management science* **30**(9), 1078–1092.
- Benin, S. (2015), *Returns to agricultural public spending in Africa south of the Sahara*, Vol. 1491, Intl Food Policy Res Inst.
- Berdal, M. and Keen, D. (1997), ‘Violence and economic agendas in civil wars: some policy implications’, *Millennium* **26**(3), 795–818.
- Bergman, U. M. and Hutchison, M. (2015), ‘Economic stabilization in the post-crisis world: are fiscal rules the answer?’, *Journal of International Money and Finance* **52**, 82–101.
- Beyene, L. M. and Engida, E. (2016), ‘Public investment in irrigation and training, growth and poverty reduction in ethiopia’, *International Journal of Microsimulation* **9**(1), 86–108.
- Bhattacharyya, S., Conradie, L. and Arezki, R. (2017), ‘Resource discovery and the politics of fiscal decentralization’, *Journal of Comparative Economics* **45**(2), 366–382.
- Bitama, P., Lebailly, P., Ndimanya, P. and Burny, P. (2020), ‘Cash crops and food security: a case of tea farmers in burundi’, *Asian Social Science* **16**(7).
- Bizikova, L., Jungcurt, S., McDougal, K. and Tyler, S. (2020), ‘How can agricultural interventions enhance contribution to food security and sdg 2.1?’, *Global Food Security* **26**, 100450.
- Blanchard, O. J. and Leigh, D. (2013), ‘Growth forecast errors and fiscal multipliers’, *American Economic Review* **103**(3), 117–120.
- Bleaney, M. and Halland, H. (2009), The resource curse and fiscal policy volatility, Technical report, CREDIT research paper.
- Bodea, C. and Hicks, R. (2018), ‘Sovereign credit ratings and central banks: Why do analysts pay attention to institutions?’, *Economics & Politics* **30**(3), 340–365.
- Bogliaccini, J. A. (2013), ‘Trade liberalization, deindustrialization, and inequality: Evidence from middle-income latin american countries’, *Latin American Research Review* **48**(2), 79–105.
- Borodak, D. (2007), ‘Les outils d’analyse des performances productives utilisés en économie et gestion: la mesure de l’efficience technique et ses déterminants’, *Cahier de recherche* **5**, 1–16.

- Bourguignon, F. (2011), A turning point in global inequality... and beyond, in 'Annual Bank Conference of Development Economics, Papers and Proceedings'.
- Bourguignon, F. (2012), 'La mondialisation de l'inégalité, co-édition seuil', *République des Idées, Paris*.
- Bourguignon, F. and Morrisson, C. (1990), 'Income distribution, development and foreign trade: A cross-sectional analysis', *European economic review* **34**(6), 1113–1132.
- Bova, E., Medas, P. and Poghosyan, T. (2018), 'Macroeconomic stability in resource-rich countries: the role of fiscal policy', *Journal of Banking and Financial Economics* (1 (9), 103–122.
- Caccavale, O. M. and Giuffrida, V. (2020), 'The proteus composite index: Towards a better metric for global food security', *World Development* **126**, 104709.
- Campi, M., Dueñas, M. and Fagiolo, G. (2021), 'Specialization in food production affects global food security and food systems sustainability', *World Development* **141**, 105411.
- Castañeda, E. and Shemesh, A. (2020), 'Overselling globalization: The misleading conflation of economic globalization and immigration, and the subsequent backlash', *Social Sciences* **9**(5).
URL: <https://www.mdpi.com/2076-0760/9/5/61>
- Cervantes-Godoy, D., Dewbre, J. et al. (2010), *Importance économique de l'agriculture dans la lutte contre la pauvreté*, OECD Publishing.
- Cetin, V. R. and Bahce, S. (2016), 'Measuring the efficiency of health systems of oecd countries by data envelopment analysis', *Applied Economics* **48**(37), 3497–3507.
- Charnes, A., Cooper, W. W. and Rhodes, E. (1978), 'Measuring the efficiency of decision making units', *European journal of operational research* **2**(6), 429–444.
- Collier, P. and Goderis, B. (2012), 'Commodity prices and growth: An empirical investigation', *European Economic Review* **56**(6), 1241–1260.
- Collier, P. and Hoeffler, A. (2004), 'Greed and grievance in civil war', *Oxford economic papers* **56**(4), 563–595.
- Combes, J.-L., Debrun, X., Minea, A. and Tapsoba, R. (2018), 'Inflation targeting, fiscal rules and the policy mix: Cross-effects and interactions', *The Economic Journal* **128**(615), 2755–2784.
- Cornia, G. A. (2011), 'Economic integration, inequality and growth: Latin america versus the european economies in transition', *Review of Economics and Institutions* **2**(2).
- Dalabajan, D., Mayne, R., Bobson, B., Qazzaz, H., Ushie, H., Ocharan, J., Farr, J., Romero, J., Priego, K., Gomez Correa, L. V. et al. (2022), 'Towards a just energy transition: Implications for communities in lower-and middle-income countries'.

- De Borger, B. and Kerstens, K. (1996), ‘Cost efficiency of belgian local governments: A comparative analysis of fdh, dea, and econometric approaches’, *Regional science and urban economics* **26**(2), 145–170.
- Deutsche Welle (2023), ‘Military alliances formed in sahel: Analyzing mali, niger, and burkina faso’s security pact’. Consulté en octobre 2024.
URL: <https://www.dw.com/en/juntas-of-mali-niger-and-burkina-faso-sign-security-pact/a-66834143>
- Dollar, D. and Kraay, A. (2002), ‘Growth is good for the poor’, *Journal of economic growth* **7**, 195–225.
- Earthjustice (2023), ‘Protecting lands and wildlife from fossil fuels’. Accessed: 2023-10-10.
URL: https://earthjustice.org/our_work/campaigns/protecting-public-lands-and-wildlife-from-fossil-fuels
- Easterly, W. (2007), ‘Inequality does cause underdevelopment: Insights from a new instrument’, *Journal of development economics* **84**(2), 755–776.
- ElGindi, T. (2017), ‘Natural resource dependency, neoliberal globalization, and income inequality: Are they related? a longitudinal study of developing countries (1980–2010)’, *Current Sociology* **65**(1), 21–53.
- Fan, S., Hazell, P. and Thorat, S. (2000), ‘Government spending, growth and poverty in rural india’, *American journal of agricultural economics* **82**(4), 1038–1051.
- Fan, S. and Zhang, X. (2008), ‘Public expenditure, growth and poverty reduction in rural uganda’, *African Development Review* **20**(3), 466–496.
- FAO (1996), Rome Declaration on World Food Security and World Food Summit Plan of Action, Technical report, World Food Summit, Rome. World Food Summit 13–17 November 1996.
- FAO (2012), The State of Food and Agriculture: Investing in Agriculture for a Better Future, Technical report, FAO, Rome.
- FAO (2019), ‘Afrique – vue d’ensemble régionale de la sécurité alimentaire et la nutrition’. Consulté le 7 novembre 2024.
URL: <https://openknowledge.fao.org/items/e2ea01ba-a43d-46a9-83c0-a94d8b481772>
- FAO (2020), Tracking progress on food and agriculture-related sdg indicators, Technical report, FAO, Rome.
URL: <https://www.fao.org/family-farming/detail/en/c/1439675/>
- FAO (2023a), ‘La situation des femmes dans les systèmes agroalimentaires’. Consulté le 7 novembre 2024.
URL: <https://www.fao.org/newsroom/detail/women-s-equality-in-agrifood-systems-could-boost-the-global-economy-by-1-trillion-reduce-food-insecurity-by-45-million-new-fao-report/fr>

FAO (2023b), ‘Réduction des inégalités au service de la sécurité alimentaire et de la nutrition’. Consulté le 7 novembre 2024.

URL: <https://openknowledge.fao.org/items/8bf9ff9b-4065-49ef-a10a-d11c5d33eae4>

FAO (2024), Crop Prospects and Food Situation Triannual Global Report No. 1, March 2024, Technical report, FAO, Rome.

FAO and al. (2022), FAOSTAT Statistical Database, Technical report, FAO, Rome.

URL: <https://www.fao.org/faostat/en/home>

FAO, IFAD, WFP (2015), The State of Food Insecurity in the World 2015. Meeting the 2015 International Hunger Targets: Taking Stock of Uneven Progress, Technical report, FAO, Rome.

URL: <https://www.fao.org/publications/sofi/2015/en/>

Fasano, U. (2002), ‘With open economy and sound policies, uae has turned oil “curse” into a blessing, imfsurvey’, *October* **21**, 330–332.

Fernandez-Stark, K. and Gereffi, G. (2019), Global value chain analysis: A primer, in ‘Handbook on global value chains’, Edward Elgar Publishing, pp. 54–76.

Ferrari, S. and Cribari-Neto, F. (2004), ‘Beta regression for modelling rates and proportions’, *Journal of applied statistics* **31**(7), 799–815.

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

Fontan Sers, C. and Mughal, M. (2019), ‘From maputo to malabo: public agricultural spending and food security in africa’, *Applied economics* **51**(46), 5045–5062.

Food and Agriculture Organization of the United Nations (FAO) (1996), Rome Declaration on World Food Security and World Food Summit Plan of Action, Technical report, World Food Summit, Rome. World Food Summit 13–17 November 1996.

Food Security Information Network (2020), 2020 – Global Report on Food Crises, Technical report, Food Security Information Network.

Food Security Information Network (FSIN) (2024), Global Report on Food Crises 2024, Technical report, FSIN, Rome.

URL: <https://www.fsinplatform.org/report/global-report-food-crises-2024/>

Fund, I. M. (2010), *Chad: 2010 Article IV Consultation-Staff Report; Staff Supplements; Public Information Notice on the Executive Board Discussion; and Statement by the Executive Director for Chad*, International Monetary Fund.

- Gelb, A. and Grasmann, S. (2010), ‘How should oil exporters spend their rents?’, *Center for Global Development Working Paper* (221).
- Gereffi, G. and Fernandez-Stark, K. (2011), ‘Global value chain analysis: a primer’, *Center on Globalization, Governance & Competitiveness (CGGC), Duke University, North Carolina, USA* p. 33.
- Gholipour, H. F. and Farzanegan, M. R. (2018), ‘Institutions and the effectiveness of expenditures on environmental protection: evidence from middle eastern countries’, *Constitutional Political Economy* **29**(1), 20–39.
- Goyal, A. and Nash, J. (2017), Agricultural public spending in africa is low and inefficient.
- Guerguil, M., Mandon, P. and Tapsoba, R. (2017), ‘Flexible fiscal rules and countercyclical fiscal policy’, *Journal of Macroeconomics* **52**, 189–220.
- Gupta, S. and Verhoeven, M. (2001), ‘The efficiency of government expenditure: experiences from africa’, *Journal of policy modeling* **23**(4), 433–467.
- Gylfason, T. and Zoega, G. (2003), ‘Inequality and economic growth: Do natural resources matter?’.
- Heckman, J. J., Smith, J. and Clements, N. (1997), ‘Making the most out of programme evaluations and social experiments: Accounting for heterogeneity in programme impacts’, *The Review of Economic Studies* **64**(4), 487–535.
- Hellier, J. (2023), ‘Globalization and inequality in advanced economies’, *Economic Studies* .
- Hsiao, C. (2007), ‘Panel data analysis—advantages and challenges’, *Test* **16**(1), 1–22.
- Humphreys, M. (2005), ‘Natural resources, conflict, and conflict resolution: Uncovering the mechanisms’, *Journal of conflict resolution* **49**(4), 508–537.
- Humphreys, M. (2007), *Escaping the resource curse*, Columbia University Press.
- IMF, I. M. F. (2008), *World Economic Outlook, October 2007: Globalization and Inequality*, International Monetary Fund.
- Isham, J., Woolcock, M., Pritchett, L. and Busby, G. (2005), ‘The varieties of resource experience: natural resource export structures and the political economy of economic growth’, *The World Bank Economic Review* **19**(2), 141–174.
- Jacobs, R., Smith, P. C. and Street, A. (2006), *Measuring efficiency in health care: analytic techniques and health policy*, Cambridge University Press.
- Jalles, J. T. (2020), ‘Dynamics of government spending cyclicity’, *Economic Modelling* .

- Jarzebski, M. P., Ahmed, A., Karanja, A., Boafo, Y. A., Balde, B. S., Chinangwa, L., Degefa, S., Dompreeh, E. B., Saito, O. and Gasparatos, A. (2020), 'Linking industrial crop production and food security in sub-saharan africa: local, national and continental perspectives', *Sustainability Challenges in Sub-Saharan Africa I: Continental Perspectives and Insights from Western and Central Africa* pp. 81–136.
- Jensen, N. and Wantchekon, L. (2004), 'Resource wealth and political regimes in africa', *Comparative political studies* **37**(7), 816–841.
- Jordà, Ò. (2005), 'Estimation and inference of impulse responses by local projections', *American economic review* **95**(1), 161–182.
- Jordà, Ò., Schularick, M. and Taylor, A. M. (2013), 'When credit bites back', *Journal of Money, Credit and Banking* **45**(s2), 3–28.
- Jordà, Ò. and Taylor, A. M. (2016), 'The time for austerity: estimating the average treatment effect of fiscal policy', *The Economic Journal* **126**(590), 219–255.
- Kamenya, M. A., Hendriks, S. L., Gandidzanwa, C., Ulimwengu, J. and Odjo, S. (2022), 'Public agriculture investment and food security in ecowas', *Food Policy* **113**, 102349.
- Kaminsky, G. L., Reinhart, C. M. and Végh, C. A. (2004), 'When it rains, it pours: procyclical capital flows and macroeconomic policies', *NBER macroeconomics annual* **19**, 11–53.
- Keita, K. and Turcu, C. (2019), *On Promoting Fiscal Discipline: The Role of Exchange Rate Regimes, Fiscal Rules and Institutions*, The World Bank.
- Keita, K. and Turcu, C. (2023), 'Promoting counter-cyclical fiscal policy: fiscal rules versus institutions', *Comparative Economic Studies* **65**(4), 736–781.
- Koenker, R. and Hallock, K. (2011), 'Quantile regression lse short course', *CEMMAP and University of Illinois, Urbana-Champaign* pp. 16–17.
- Kuma, T., Dereje, M., Hirvonen, K. and Minten, B. (2019), 'Cash crops and food security: Evidence from ethiopian smallholder coffee producers', *The Journal of Development Studies* **55**(6), 1267–1284.
- Kus, B. (2012), 'Financialisation and income inequality in oecd nations: 1995-2007', *The Economic and Social Review* **43**(4, Winter), 477–495.
- Larsen, E. R. (2006), 'Escaping the resource curse and the dutch disease? when and why norway caught up with and forged ahead of its neighbors', *American Journal of Economics and Sociology* **65**(3), 605–640.
- Le Billon, P. (2001), 'The political ecology of war: natural resources and armed conflicts', *Political geography* **20**(5), 561–584.

- Le, T.-H., Nguyen, C. P., Su, T. D. and Tran-Nam, B. (2020), 'The kuznets curve for export diversification and income inequality: Evidence from a global sample', *Economic Analysis and Policy* **65**, 21–39.
- Lee, C.-C., Lee, C.-C. and Lien, D. (2020), 'Income inequality, globalization, and country risk: A cross-country analysis', *Technological and Economic Development of Economy* **26**(2), 379–404.
- Lessmann, C. and Seidel, A. (2017), 'Regional inequality, convergence, and its determinants—a view from outer space', *European Economic Review* **92**, 110–132.
- Machado, J. A. and Silva, J. S. (2019), 'Quantiles via moments', *Journal of econometrics* **213**(1), 145–173.
- MacLeod, W. B. (2013), 'On economics: a review of why nations fail by d. acemoglu and j. robinson and pillars of prosperity by t. besley and t. persson', *Journal of Economic Literature* **51**(1), 116–43.
- Marimon, R. and Quadrini, V. (2011), 'Competition, human capital and income inequality with limited commitment', *Journal of Economic Theory* **146**(3), 976–1008.
- Masanjala, W. H. (2006), 'Cash crop liberalization and poverty alleviation in africa: evidence from malawi', *Agricultural economics* **35**(2), 231–240.
- Mason-D'Croz, D., Sulser, T. B., Wiebe, K., Rosegrant, M. W., Lowder, S. K., Nin-Pratt, A., Willenbockel, D., Robinson, S., Zhu, T., Cenacchi, N. et al. (2019), 'Agricultural investments and hunger in africa modeling potential contributions to sdg2–zero hunger', *World development* **116**, 38–53.
- Meschi, E. and Vivarelli, M. (2009), 'Trade and income inequality in developing countries', *World development* **37**(2), 287–302.
- Milanovic, B. (2003), 'Is inequality in africa really different?', *Available at SSRN 636588*.
- Milanovic, B. (2017), 'Economists explain the link between inequality and globalization', *World Economic Forum*. Accessed: 2024-10-10.
URL: <https://www.weforum.org/agenda/2017/01/economists-explain-link-between-inequality-and-globalization/>
- Murshed, S. M. (2002), *On natural resource abundance and underdevelopment*, World Bank.
- Nchanji, E. B. and Lutomia, C. K. (2021), 'Regional impact of covid-19 on the production and food security of common bean smallholder farmers in sub-saharan africa: Implication for sdg's', *Global Food Security* **29**, 100524.
- Ngobeni, E. and Muchopa, C. L. (2022), 'The impact of government expenditure in agriculture and other selected variables on the value of agricultural production in south africa (1983–2019): vector autoregressive approach', *Economies* **10**(9), 205.
- OECD (2018), OCDE (2018), Development Co-operation Report 2018 : Joining Forces to Leave No One Behind, Éditions OCDE, Paris, Technical report, OCDE, Paris.

- OECD (2022), *Equitable Framework and Finance for Extractive-based Countries in Transition (EFECT)*, OECD Development Policy Tools, Technical report, OECD, Paris.
- Organisation for Economic Co-operation and Development (OECD) (2022), *Equitable Framework and Finance for Extractive-based Countries in Transition (EFECT)*, OECD Development Policy Tools, Technical report, OECD, Paris.
- Papke, L. E. and Wooldridge, J. M. (1996), 'Econometric methods for fractional response variables with an application to 401 (k) plan participation rates', *Journal of applied econometrics* **11**(6), 619–632.
- Paweenawat, S. W. and McNown, R. (2014), 'The determinants of income inequality in thailand: A synthetic cohort analysis', *Journal of Asian Economics* **31**, 10–21.
- Persson, T. and Svensson, L. E. (1989), 'Why a stubborn conservative would run a deficit: Policy with time-inconsistent preferences', *The Quarterly Journal of Economics* **104**(2), 325–345.
- Piketty, T. (2014), 'Capital in the twenty-first century'.
- Ploeg, F. v. d. (2011), 'Natural resources: curse or blessing?', *Journal of Economic literature* **49**(2), 366–420.
- Poelhekke, S. and van der Ploeg, F. (2013), 'Do natural resources attract nonresource fdi?', *Review of Economics and Statistics* **95**(3), 1047–1065.
- Ravallion, M. (2001), 'Growth, inequality and poverty: looking beyond averages', *World development* **29**(11), 1803–1815.
- Ravallion, M. (2018), 'Inequality and globalization: A review essay', *Journal of Economic Literature* **56**(2), 620–642.
- Reuveny, R. and Li, Q. (2003), 'Economic openness, democracy, and income inequality: An empirical analysis', *Comparative Political Studies* **36**(5), 575–601.
- Ricardo, D. (1817a), *On the Principles of Political Economy and Taxation*, Liberty Fund, Inc. Accessed: 2024-10-10.
URL: <https://www.econlib.org/library/Ricardo/ricP.html>
- Ricardo, D. (1817b), *On the Principles of Political Economy and Taxation*, Project Gutenberg. Accessed: 2024-10-10.
URL: <https://www.gutenberg.org/ebooks/33310>
- Ross, M. L. (1999a), 'The political economy of the resource curse', *World politics* **51**(2), 297–322.
- Ross, M. L. (1999b), 'The political economy of the resource curse', *World Politics* **51**(2), 297–322.
- Ross, M. L. (2001a), 'Does oil hinder democracy?', *World politics* **53**(3), 325–361.

- Ross, M. L. (2001*b*), *Extractive sectors and the poor*, Oxfam America.
- Ross, M. L. (2012), *The oil curse: How petroleum wealth shapes the development of nations*, Princeton University Press.
- Ross, M. L. (2017), ‘What do we know about economic diversification in oil-producing countries?’, *Available at SSRN 3048585*.
- Rother, M. B., Sosa, M. S., Debbich, M., Castrovillari, C. and Prifti, E. (2023), ‘Global food crisis update: Recent developments, outlook, and imf engagement’.
- Roy, K. C. and Tisdell, C. A. (1998), ‘Good governance in sustainable development: the impact of institutions’, *International Journal of Social Economics*.
- Rubhara, T. T., Mudhara, M., Oduniyi, O. S. and Antwi, M. A. (2020), ‘Impacts of cash crop production on household food security for smallholder farmers: A case of shamva district, zimbabwe’, *Agriculture* **10**(5), 188.
- Ruel, M. T. and Alderman, H. (2013), ‘Nutrition-sensitive interventions and programmes: how can they help to accelerate progress in improving maternal and child nutrition?’, *The lancet* **382**(9891), 536–551.
- Sarraf, M. and Jiwanji, M. (2001), ‘Beating the resource curse: the case of botswana’.
- Savvides, A. (1998), ‘Trade policy and income inequality: new evidence’, *Economics Letters* **61**(3), 365–372.
- Schaechter, A., Kinda, T., Budina, N. T. and Weber, A. (2012), ‘Fiscal rules in response to the crisis-toward the’next-generation’rules: A new dataset’.
- Shaffer, B. and Ziyadov, T. (2011), *Beyond the resource curse*, University of Pennsylvania Press.
- Simar, L. and Wilson, P. W. (1998), ‘Sensitivity analysis of efficiency scores: How to bootstrap in nonparametric frontier models’, *Management science* **44**(1), 49–61.
- Simar, L. and Wilson, P. W. (2007), ‘Estimation and inference in two-stage, semi-parametric models of production processes’, *Journal of econometrics* **136**(1), 31–64.
- Soko, N. N., Kaitibie, S. and Ratna, N. N. (2023), ‘Does institutional quality affect the impact of public agricultural spending on food security in sub-saharan africa and asia?’, *Global Food Security* **36**, 100668.
- Stiglitz, J. E. (2002), *Globalization and Its Discontents*, W.W. Norton & Company, New York.
- Stokke, H. E. (2007), ‘Resource boom, productivity growth and real exchange rate dynamics’.
- Swanson, E. (2007), ‘World development indicators 2007’.

- The PRS Group et al. (2023), ‘International country risk guide’. Political Risk Services.
- Tornell, A. and Lane, P. R. (1999), ‘The voracity effect’, *American economic review* **89**(1), 22–46.
- Toscani, M. F. G. (2017), *The impact of natural resource discoveries in Latin America and the Caribbean: a closer look at the case of Bolivia*, International Monetary Fund.
- UNCTAD (2023), Global public debt hits record \$97 trillion in 2023, unctad urges action, Technical report, United Nations Conference on Trade and Development (UNCTAD). Accessed: 2024-10-10.
URL: <https://unctad.org/press-material/global-public-debt-hits-record-97-trillion-2023-unctad-urges-action>
- UNEP (2024), Resourcing the energy transition: principles to guide critical energy transition minerals towards equity and justice, Technical report, United Nations, Rome.
- UNEP, U. N. E. P. (2022), ‘The role of critical minerals in clean energy transitions’. Accessed: 2023-10-10.
URL: <https://www.unep.org/resources/report/role-critical-minerals-clean-energy-transitions>
- United Nations Environment Programme (UNEP) (2024), Resourcing the energy transition: principles to guide critical energy transition minerals towards equity and justice, Technical report, United Nations, Rome.
- United Nations (UN) (2015), The Millennium Development Goals Report, Technical report, United Nations, New York. The Millennium Development Goals.

Résumé français

Résumé français

L'un des grands défis de notre décennie est la gestion durable des ressources naturelles mondiales afin de freiner le dérèglement climatique tout en assurant une transition énergétique juste. Cette transition nécessite une compréhension approfondie des économies des pays riches en ressources naturelles, en particulier en ce qui concerne leurs politiques budgétaires et les impacts socio-économiques liés à la découverte, à l'exploitation et à la commercialisation de ces ressources. En effet, ces pays sont dotés à la fois de ressources polluantes, comme le pétrole et le gaz, encore indispensables à l'économie mondiale, ainsi que de ressources essentielles pour la transition énergétique, comme certains métaux critiques. De plus, les ressources forestières, halieutiques et agricoles, souvent affectées par l'exploitation des premières, jouent un rôle crucial dans la sécurité alimentaire mondiale. Ainsi, la gestion de ces ressources repose sur une interaction complexe entre celles-ci.

La transition énergétique mondiale représente une opportunité cruciale pour réduire les émissions de carbone et faire face aux enjeux du dérèglement climatique. Toutefois, cette transition doit être équitable, notamment pour les pays riches en ressources naturelles, qui sont à la fois indispensables à cette transformation et vulnérables à ses impacts (United Nations Environment Programme (UNEP), 2024; Organisation for Economic Co-operation and Development (OECD), 2022). En effet, ces économies sont souvent caractérisées par des situations paradoxales : la richesse en ressources naturelles peut conduire à la prospérité, mais aussi à des échecs économiques. Dans la littérature sur la performance économique des pays riches en ressources naturelles, essentiellement basée sur l'analyse de l'effet de la dotation en ressources fossiles et métaux précieux sur les performances socio-économiques, la richesse en ressources naturelles a souvent été associée soit à des succès économiques, soit à des échecs économiques, et la littérature fournit des preuves dans les deux directions. Par exemple, il a été montré que les ressources naturelles ralentissent la croissance économique dans les pays en développement riches en ressources naturelles (??), limitent la diversification des exportations (Ross, 2017), favorisent l'appréciation du taux de change (Stokke, 2007), réduisent les investissements directs étrangers dans les secteurs non liés aux ressources naturelles (Poelhekke et van der Ploeg, 2013), ou accroissent les inégalités de revenu (Bourguignon et Morrisson, 1990; Ross, 2001*b*; Gylfason et Zoega, 2003). Elles peuvent aussi être associées à des effets positifs sur l'économie, comme la baisse de la dette publique et une faible inflation (Fasano, 2002), des dépenses publiques élevées dans l'édu-

cation (Sarraf et Jiwanji, 2001), ou une forte croissance économique (Larsen, 2006).

Cependant, les échecs économiques des pays riches en ressources naturelles sont particulièrement observés dans les pays en développement caractérisés par de mauvaises qualités institutionnelles, où la mauvaise gouvernance et la corruption prédominent (Acemoglu et Robinson, 2012). Cet échec économique, connu sous le nom de la *malédiction des ressources* (Ross, 1999a; Humphreys, 2007; Shaffer et Ziyadov, 2011), a alimenté un sentiment d'injustice dans ces pays, où les populations se sentent lésées par les effets de la mondialisation et du commerce de leurs ressources naturelles. Ces frustrations ont souvent conduit à des troubles sociaux, voire à des coups d'État militaires, comme observé au Mali en 2020, au Burkina Faso en 2022 et au Niger en 2023 (Ross, 2001a; Collier et Hoeffler, 2004; Jensen et Wantchekon, 2004; Ross, 2012; ?; Deutsche Welle, 2023).

Il est important de noter que la mondialisation, dans toutes ses dimensions (flux migratoires, flux de capitaux et commerce), est souvent perçue comme l'une des causes sous-jacentes des crises, des difficultés économiques et des inégalités sociales (Stiglitz, 2002; Milanovic, 2017; Castañeda et Shemesh, 2020). Plus particulièrement, pendant longtemps, l'on a cru que la libéralisation des échanges ne pouvait être que bénéfique pour toutes les parties, comme le prédisait la théorie traditionnelle du commerce international (Ricardo, 1817a,b). Cependant, selon la littérature et les faits stylisés, la réalité a dévié de ces prévisions (Lee et al., 2020; Le et al., 2020; Antràs et al., 2017). En ce sens, selon l'OECD (2018), au cours des dernières décennies, les 40 % les plus pauvres de la population dans de nombreux pays ont très peu bénéficié du développement économique de leurs pays et de la diversification des exportations. Ainsi, plusieurs pays riches en ressources naturelles ont été victimes de la *malédiction des ressources* dans le commerce de leurs ressources naturelles.

Au-delà de cette *malédiction des ressources*, l'exploitation des ressources fossiles et des métaux précieux a des effets dévastateurs sur les ressources naturelles renouvelables, notamment les forêts, les terres agricoles et les écosystèmes halieutiques, aggravant la perte de biodiversité et l'insécurité alimentaire (UNEP, 2022; Earthjustice, 2023). Les populations des pays en développement, particulièrement vulnérables, sont les premières à souffrir de ces conséquences (Earthjustice, 2023). En parallèle, la demande mondiale pour des métaux critiques tels que le lithium, le cobalt et le nickel devrait tripler d'ici 2030 pour répondre aux besoins de la transition énergétique (UNEP, 2024). Cette augmentation de la demande pourrait aggraver la dépendance des pays producteurs de ces ressources, exacerbant ainsi les tensions géopolitiques et les défis environnementaux et sociaux, comme la dégradation des écosystèmes et de la sécurité alimentaire, les violations des droits humains et les conflits sociaux.

Ainsi, pour ces pays, dont beaucoup sont parmi les moins bien équipés pour surmonter les risques et saisir les opportunités de la transition vers une économie à faible émission de carbone, le processus de transition énergétique pourrait, sans politiques adaptées, considérablement augmenter les inégalités de revenu et les crises sociales. Cela met en évidence l'importance de politiques budgétaires et de pratiques transparentes pour éviter une répétition des erreurs liées à la *malédiction des ressources* et

garantir que la transition énergétique bénéficie à tous, y compris aux populations les plus vulnérables (Dalabajan et al., 2022).

Il ressort de ce qui précède que les résultats socio-économiques de la découverte, de l'exploitation et de la commercialisation des ressources naturelles ainsi que de la transition énergétique dépendront fortement de la qualité des politiques économiques et sociales, en particulier des politiques budgétaires adoptées par les pays concernés. En effet, la question de la politique budgétaire est cruciale, car une mauvaise gestion budgétaire conduit à des déficits budgétaires permanents, généralement financés par la dette publique. Dans ce contexte se pose la question de la soutenabilité de la dette souveraine, un défi auquel de nombreuses économies sont confrontées. Ce problème est devenu d'autant plus critique à la suite des crises récentes, telles que la pandémie de Covid-19 et la guerre qui a débuté en Ukraine depuis 2022, qui ont affaibli les capacités budgétaires de nombreux pays, générant des déficits accrus et des niveaux d'endettement record (UNCTAD, 2023). Les niveaux élevés de dette publique pourraient empêcher les gouvernements de mobiliser les fonds nécessaires sur les marchés internationaux de capitaux et de réaliser les investissements essentiels à leur développement économique, réduisant ainsi leur capacité à répondre aux chocs futurs. En effet, un poids excessif de la dette restreint souvent les ressources budgétaires disponibles, ce qui force les gouvernements à prioriser le service de la dette au détriment d'investissements clés, comme les dépenses sociales et celles destinées à renforcer la résilience face aux conséquences du changement climatique. Cette incapacité à investir pourrait aggraver des défis, notamment pour les pays vulnérables aux chocs climatiques, accentuer les inégalités et augmenter les risques d'instabilité sociale à long terme.

La nécessité d'une bonne politique budgétaire dans les pays riches en ressources naturelles est largement reconnue comme essentielle pour la stabilité économique et la durabilité à long terme (Bleaney et Halland, 2009; Gelb et Grasmann, 2010; Collier et Goderis, 2012; ?). Ces pays sont souvent confrontés à des défis majeurs en raison de la volatilité des prix des matières premières, de la finitude des ressources naturelles et des risques de dépendance excessive aux revenus de ces ressources (Bleaney et Halland, 2009). La volatilité des revenus issus des ressources naturelles peut entraîner des chocs économiques importants comme le montrent les exemples du Congo et de l'Angola, qui ont vu leurs revenus pétroliers chuter de plus de moitié en 2009, affectant sévèrement leurs budgets publics (Bova et al., 2018; Fund, 2010; Arezki et Gylfason, 2011). Une politique budgétaire bien conçue permet d'atténuer ces fluctuations par des mesures contracycliques, en épargnant pendant les périodes de prix élevés pour stabiliser les dépenses publiques lors des baisses des prix des matières premières (Larsen, 2006; Sarraf et Jiwanji, 2001). Une gestion prudente permet de réduire les déséquilibres macroéconomiques, cette approche est préconisée par des institutions comme le Fond Monétaire International (FMI) (Bova et al., 2018).

Cette thèse propose une approche intégrée sur la manière dont la découverte, l'exploitation, la typologie des ressources, l'ouverture commerciale et les politiques budgétaires interagissent et influencent des résultats socio-économiques tels que les inégalités de revenus et la sécurité alimentaire.

Le premier chapitre aborde la question de l'impact des découvertes de ressources naturelles sur la politique budgétaire des pays riches en ressources naturelles. La découverte de nouvelles ressources, comme les vastes gisements de pétrole ou de gaz, est souvent perçue comme une bénédiction économique pour les pays concernés. Toutefois, cette bénédiction peut également se transformer en malédiction. Cette malédiction se manifeste lorsque la découverte de ressources est suivie par une mauvaise gestion budgétaire. Dans ce cas-là, l'abondance de ressources naturelles, plutôt que de stimuler la croissance économique, finit par freiner le développement des pays concernés, entraînant des déséquilibres macroéconomiques, une faible diversification des exportations, et une dépendance accrue à un seul secteur économique.

Ce chapitre se concentre sur les effets anticipés de la découverte de ressources naturelles, en particulier les chocs économiques induits par l'annonce de ces découvertes avant même que l'exploitation ne commence. En effet, l'annonce de la découverte de nouvelles ressources peut générer des attentes de revenus futurs importants, ce qui influence les comportements des acteurs économiques et les politiques budgétaires des gouvernements concernés. Ces attentes de revenus futurs peuvent entraîner une indiscipline budgétaire, notamment dans les pays où les institutions sont souvent fragiles et la gestion budgétaire procyclique. En d'autres termes, plutôt que de maintenir une discipline budgétaire stricte, ces pays tendent à augmenter les dépenses publiques en anticipation des revenus futurs, aggravant ainsi leur déficit budgétaire. L'exemple de la Norvège, suite aux découvertes de pétrole dans la mer du Nord dans les années 1960 et 1970, est emblématique des conséquences économiques que ces découvertes peuvent engendrer. L'anticipation de revenus futurs a entraîné une baisse du taux d'épargne et une augmentation des investissements, provoquant un déficit du compte courant atteignant 15 % du PIB à son plus bas en 1977. Le pays a également vu sa dette publique augmenter considérablement pour financer les installations pétrolières. Cette dynamique illustre comment les attentes économiques liées à la découverte de ressources et leurs conséquences peuvent précéder de plusieurs années les véritables flux de revenus.

Dans ce contexte, ce chapitre utilise le modèle des projections locales (LPM) pour analyser l'impact des découvertes de ressources naturelles sur les politiques budgétaires dans les pays à revenu faible et élevé. L'étude révèle que, dans les pays à revenu élevé, les gouvernements parviennent à maintenir une discipline budgétaire, même après l'annonce de découvertes importantes. En revanche, les pays à faible revenu adoptent des politiques budgétaires procycliques, augmentant les dépenses publiques dès la première année suivant la découverte, avec des effets différenciés entre les dépenses de consommation publique et les dépenses d'investissement public. Les résultats montrent également que la qualité des institutions et la présence de règles budgétaires jouent un rôle crucial dans la modération des effets de ces découvertes sur les politiques budgétaires. Ainsi, ce chapitre met en lumière la nécessité pour les pays riches en ressources naturelles de développer des cadres institutionnels solides et des règles budgétaires afin de gérer efficacement les ressources naturelles et éviter les pièges de la "malédiction des ressources".

Dans les pays riches en ressources naturelles, les institutions faibles peuvent conduire à une mauvaise gestion des revenus, à la corruption et à des dépenses inefficaces, réduisant ainsi les bénéfices potentiels des ressources naturelles. Le respect de règles budgétaires, telles que celles qui régissent l'utilisation des revenus des ressources, permet d'améliorer la transparence et de réduire les risques de mauvaise gestion. Par exemple, dans les pays à revenus faibles et intermédiaires, la mise en place de règles budgétaires peut contribuer à modérer la tendance à la procyclicité des politiques budgétaires. En somme, une politique budgétaire solide est indispensable dans les pays riches en ressources naturelles pour assurer une croissance économique durable, protéger contre les chocs extérieurs et garantir une utilisation équitable des revenus issus des ressources au profit des générations actuelles et futures.

Après avoir exploré l'impact des découvertes de ressources naturelles sur les politiques budgétaires et la gestion économique, le deuxième chapitre se concentre sur une autre conséquence essentielle de la gestion des ressources naturelles, à savoir la sécurité alimentaire. En effet, dans de nombreuses économies riches en ressources naturelles, l'exploitation de ces ressources ainsi que le dérèglement climatique affectent également les ressources naturelles renouvelables, notamment les forêts, les terres agricoles et les écosystèmes halieutiques, aggravant la perte de biodiversité et l'insécurité alimentaire des populations locales.

Ce chapitre examine la relation entre les dépenses publiques agricoles et la sécurité alimentaire dans les pays d'Afrique subsaharienne, où l'insécurité alimentaire est devenue une problématique persistante et alarmante. La sécurité alimentaire, définie comme l'accès permanent à une alimentation suffisante, sûre et nutritive pour mener une vie saine et active (Food and Agriculture Organization of the United Nations (FAO), 1996), repose sur quatre dimensions : la stabilité, l'accès, la disponibilité des aliments et l'utilisation biologique (FAO, 1996). Aujourd'hui, cette sécurité alimentaire est menacée par de nombreux facteurs environnementaux, socio-économiques et sécuritaires, tels que le changement climatique, la pandémie de COVID-19 et les récents conflits géopolitiques, notamment la guerre en Ukraine (FAO, 2020; Campi et al., 2021; Nchanji et Lutomia, 2021). En 2023, on estime que près de 282 millions de personnes se trouvaient en situation d'insécurité alimentaire aiguë, nécessitant une assistance urgente (Food Security Information Network (FSIN), 2024), et une grande majorité de ces personnes se trouvent en Afrique, particulièrement en Afrique subsaharienne.

L'importance de ce sujet est renforcée par les objectifs de développement durable (ODD), notamment l'ODD 2, qui vise à éradiquer la faim d'ici 2030 (United Nations (UN), 2015). Face à cette réalité, les dirigeants africains et les institutions internationales, comme la FAO et le Fonds international de développement agricole (FIDA), ont plaidé pour un accroissement des dépenses publiques dans le secteur agricole afin d'améliorer la productivité, encourager la diversification et garantir une alimentation nutritive (FAO, IFAD, WFP, 2015). Cependant, malgré les efforts des gouvernements africains, notamment à travers les déclarations de Maputo et de Malabo, qui engageaient les pays à consacrer au moins 10 % de leurs dépenses publiques à l'agriculture, les résultats en termes de

sécurité alimentaire restent mitigés dans de nombreux pays de la région (Fontan Sers et Mughal, 2019; FAO and al., 2022).

Dans ce chapitre, l'accent est mis sur l'efficience des dépenses publiques agricoles (EDPA) en Afrique subsaharienne. En effet, la mobilisation de ressources pour financer l'agriculture reste un défi majeur pour les gouvernements africains, particulièrement face aux crises récentes telles que la pandémie de COVID-19 et la guerre en Ukraine, qui ont perturbé les chaînes d'approvisionnement et aggravé les déséquilibres budgétaires dans de nombreux pays. Ces crises ont entraîné une augmentation des factures d'importation, des subventions alimentaires et des mesures de protection sociale pour les populations vulnérables. Elles ont également exacerbé les difficultés budgétaires, limitant la capacité des pays à investir dans leur système alimentaire et à répondre aux chocs futurs.

Ce chapitre tente de répondre à une question clé : pourquoi les dépenses publiques agricoles ne parviennent-elles pas à garantir la sécurité alimentaire en Afrique subsaharienne ? Pour y répondre, l'étude examine la structure de production agricole de la région, qui se divise entre les cultures vivrières destinées à la consommation locale et les cultures de rente, principalement destinées à l'exportation. L'impact des cultures de rente, telles que le café, le cacao et le coton, sur la sécurité alimentaire est l'objet d'un débat dans la littérature. Alors que certaines études mettent en avant des effets positifs sur la sécurité alimentaire (Kuma et al., 2019; Bitama et al., 2020), d'autres signalent des effets négatifs (Masanjala, 2006; Adjimoti et Kwadzo, 2018).

Cette étude cherche à comprendre comment la structure de la production agricole, en particulier la proportion des cultures de rente, influence l'efficience des dépenses publiques agricoles dans la région. À travers une analyse en deux étapes, ce chapitre calcule d'abord les scores d'efficience technique corrigée du biais (BTE) des pays d'Afrique subsaharienne en utilisant la méthode Bootstrap Data Envelopment Analysis (DEA-Bootstrap). Ensuite, l'étude examine l'impact de la production des cultures de rente sur ces scores d'efficience à travers une régression bêta. Les résultats montrent qu'une proportion plus élevée de cultures de rente dans la production agricole totale améliore l'efficience des dépenses publiques agricoles (EDPA) et, par extension, la sécurité alimentaire dans la région. Dans 79 % des pays étudiés, les cultures de rente occupent moins de 15 % des terres cultivées, mais une augmentation de cette proportion est associée à une amélioration significative de la sécurité alimentaire.

En conclusion, ce chapitre souligne l'importance de prendre en compte la structure de la production agricole dans la formulation des politiques publiques visant à éradiquer la faim en Afrique subsaharienne. Il met en lumière le rôle crucial des cultures de rente dans l'amélioration de l'efficience des dépenses publiques agricoles, suggérant que les politiques futures devraient intégrer cette dimension pour maximiser leur impact sur la sécurité alimentaire dans la région.

La problématique de l'ouverture commerciale et des inégalités de revenu est illustrée dans le troisième chapitre de la thèse, qui examine la relation entre l'ouverture commerciale et les inégalités de revenu au sein des pays, avec un accent particulier sur les économies riches en ressources naturelles.

Alors que pendant longtemps les théories traditionnelles du commerce ont postulé que la libéralisation des échanges serait bénéfique pour toutes les parties (Ricardo, 1817*a,b*), des preuves récentes, telles que l'émergence de tensions commerciales entre grandes puissances économiques et les protestations croissantes dans les pays exportateurs de ressources, remettent en question cette vision optimiste (OECD, 2018). En effet, de nombreux pays, notamment ceux riches en ressources naturelles, ont vu l'ouverture commerciale s'accompagner d'une aggravation des inégalités conduisant à des troubles sociaux et même parfois à des coups d'État militaires, comme cela a été observé au Mali en 2020, au Burkina Faso en 2022 et au Niger en 2023 (Deutsche Welle, 2023). Cela soulève la question fondamentale de savoir si l'ouverture commerciale profite à tous de manière égale. Les études empiriques et les faits stylisés indiquent que ce n'est pas toujours le cas (Lee et al., 2020; Le et al., 2020; Antràs et al., 2017).

Ce chapitre explore spécifiquement l'interaction entre les facteurs globaux, telles que l'ouverture commerciale, et des facteurs internes, comme la richesse en ressources naturelles, qui jouent un rôle crucial dans la répartition des revenus. La richesse en ressources naturelles est particulièrement pertinente dans le contexte de la transition énergétique en cours, car de nombreux pays riches en ressources naturelles sont profondément intégrés au commerce mondial à travers les combustibles fossiles et les ressources critiques pour les technologies d'énergie propre. Cependant, ces pays sont souvent mal équipés pour faire face aux risques et saisir les opportunités de cette transition, ce qui pourrait aggraver les inégalités de revenus dans ces pays (OECD, 2022).

Il est donc essentiel de comprendre les moteurs de ces inégalités dans les pays riches en ressources naturelles dans le contexte d'un monde globalisé, afin de pouvoir les soutenir dans une transition énergétique juste.

L'analyse fondée sur un échantillon de 71 pays à faible et moyen revenu et un modèle de panel avec régression quantile, se concentre sur la distinction entre deux types de ressources naturelles : les ressources naturelles issues de sources ponctuelles (point-source) comme le pétrole et les métaux précieux et les ressources diffuses (diffuse-source) comme les produits agricoles et forestiers. Ces catégories permettent d'expliquer les effets divergents de l'ouverture commerciale sur les inégalités de revenu trouvés dans la littérature. D'abord, dans l'ensemble de l'échantillon, l'ouverture commerciale a un effet positif significatif sur les inégalités de revenus. En revanche, la richesse provenant des ressources naturelles de type diffus a un effet négatif significatif sur les inégalités de revenus, tandis que la richesse issue des ressources naturelles de type "point source" n'a pas d'effet significatif. De plus, nos statistiques descriptives montrent que les pays relativement plus riches en ressources naturelles de type diffus tendent à mieux performer en termes d'auto-emploi, indiquant un plus grand potentiel de génération de revenus indépendamment des systèmes centralisés.

Ensuite, nos résultats indiquent que dans les pays relativement riches en ressources naturelles de type diffus (c'est-à-dire avec un niveau supérieur à la médiane de l'échantillon), l'ouverture commerciale n'a pas d'impact significatif sur les inégalités de revenus, et la richesse provenant des ressources na-

turelles de type "point source" dans ces pays, peut effectivement réduire les inégalités. De plus, dans ces pays, la qualité de la gouvernance ne joue pas un rôle significatif dans la réduction des inégalités, suggérant que, indépendamment d'une bonne gestion du planificateur sociale, les inégalités peuvent être réduites dans ces pays. À l'inverse, dans les pays relativement moins riches en ressources naturelles de type diffus, à la fois l'ouverture commerciale et la richesse en ressources naturelles de type "point source" ont des effets positifs significatifs sur les inégalités de revenus. Dans ces pays, une bonne gouvernance est cruciale pour réduire les inégalités.

En effet, dans les pays relativement riches en ressources "point-source", géographiquement concentrées et exploitées par des acteurs comme l'État ou des multinationales, les bénéfices du commerce sont souvent capturés par les élites ou l'État, exacerbant ainsi les inégalités si le planificateur social n'est pas efficace. En revanche, dans les pays relativement riches en ressources "diffuse-source", qui sont plus largement réparties parmi la population, l'ouverture commerciale est basée sur une participation économique plus inclusive, elle n'a donc pas d'effet sur les inégalités de revenu. Ainsi, dans ces pays l'efficacité du planificateur sociale n'est pas significatif dans la réduction des inégalités. Ce chapitre démontre que la nature de la richesse en ressources d'un pays—qu'elle soit concentrée ou diffuse—détermine la manière dont l'ouverture commerciale affecte la distribution des revenus.

Ainsi, ce chapitre met en lumière l'importance de distinguer les différents types de ressources naturelles lorsqu'on analyse les effets de l'ouverture commerciale sur les inégalités de revenu. Ces résultats suggèrent que l'investissement dans le développement des ressources diffuse-source, telles que l'agriculture, pourrait être une voie vers une transition énergétique juste, notamment dans les pays dotés de cadres institutionnels plus faibles.

