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PERTINENCE ET LIMITES DU SYNDROME HOLLANDAIS DANS LES PAYS EN DÉVELOPPEMENT : LE CAS DES RESSOURCES NATURELLES EN AFRIQUE

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Résumé

Cette thèse a pour objectif de contribuer à la compréhension de la théorie du “syndrome hollandais” et de ses implications pour les pays en développement. Pour cela, elle questionne certaines des hypothèses fondamentales des modèles théoriques du syndrome hollandais et teste la pertinence de ces hypothèses à partir d’analyses portant sur des pays africains riches en ressources naturelles.

Le chapitre 1 propose une revue de la littérature sur le syndrome hollandais dans les pays en développement riches en ressources naturelles. Il décrit les modèles originaux du syndrome hollandais, ainsi que certaines extensions abordées dans la littérature théorique. Il présente ensuite la littérature empirique ayant émergé depuis les années 1980, afin d’en présenter les limites aussi bien théoriques que méthodologiques. Cette littérature démontre que le syndrome hollandais demeure un sujet d’actualité dans nombre de pays en développement, et particulièrement en Afrique. Finalement, le chapitre discute les différents outils et politiques publiques ayant été mises en place pour faire face au syndrome hollandais dans les pays en développement.

Le chapitre 2 questionne les définitions du taux de change réel utilisées dans la littérature sur le syndrome hollandais. A cette fin, il propose une distinction entre mesures internes et mesures externes du taux de change, et en propose des estimations pour les produits agricoles et pour les produits manufacturiers séparément. En reprenant l’approche dite du Taux de Change d’Equilibre Comportemental, il estime l’impact des revenus et des prix du pétrole sur ces divers indicateurs du taux de change réel dans un panel de neuf pays Africains exportateurs de pétrole. Les méthodes dites de Mean-Group,

Pooled-Mean-Group et cross-sectionally augmented Pooled-Mean-Group y sont utilisées. Les résultats indiquent une nette appréciation du taux de change réel causée par les revenus et prix du pétrole, sauf pour le taux de change interne des produits manufacturiers. Cela semble révéler que le syndrome hollandais affecte plus la compétitivité du secteur agricole que celle du secteur manufacturier dans le cas des pays considérés.

Le chapitre 3 cherche à identifier deux des mécanismes par lesquels une hausse des cours internationaux du pétrole se traduit par un phénomène d'inflation dans les pays exportateurs de pétrole : l'effet de "pass-through" et le syndrome hollandais. Il cherche notamment à distinguer ces deux effets pour les cinq pays producteurs de pétrole de la Communauté Economique et Monétaire de l'Afrique centrale : le Cameroun, la République du Congo, le Gabon, la Guinée Equatoriale et le Tchad. Basé sur des analyses en séries temporelles multiples entre 1995 et 2019, ce chapitre discute également l'hétérogénéité entre pays en ce qui concerne l'impact des chocs de prix et de production de pétrole. A partir de la méthode des Moindres Carrés Ordinaires Dynamiques et de modèles autorégressifs, il conclut à l'existence d'un phénomène de pass-through au Cameroun, Congo et Tchad et à celle d'un syndrome hollandais en Guinée Equatoriale. Ces résultats contribuent notamment à la compréhension des relations entre dynamiques internationales des cours des matières premières et hausse des indices de prix à la consommation domestique. De tels résultats peuvent contribuer à une amélioration de l'efficacité des politiques de lutte contre l'inflation dans les pays de la CEMAC en estimant la vulnérabilité de ces pays face aux chocs internationaux.

Le chapitre 4 discute les approches empiriques utilisées dans la littérature sur le syndrome hollandais pour estimer l'impact des ressources naturelles sur les transformations structurelles. Pour cela, ce chapitre s'intéresse notamment au choix du modèle explicatif, à la manière dont les variables explicatives et dépendantes sont mesurées (en dollars internationaux ou en part du PIB), et à la sélection des variables de contrôle. Pour illustrer cette discussion, un panel de 50 pays africains entre 1995 et 2019 est utilisé. A partir des méthodes de moindres carrés ordinaires en panel et en données transversales, de moindres écarts absolus et d'effets fixes filtrés, ce chapitre estime l'impact des ressources extractives sur le développement de l'agriculture, des industries manufacturières, de la construction et des services. Les résultats ne permettent pas de conclure à un impact négatif des ressources extractives sur le secteur manufacturier. Toutefois, l'étude semble indiquer un impact globalement négatif de ces ressources sur le développement du secteur agricole, en dépit de la sensibilité des résultats économétriques au modèle économique choisi.

Abstract

This thesis is dedicated to the understanding of the "Dutch disease" theory and its implications for developing countries. To that aim, it questions some of the main underlying assumptions of theoretical Dutch disease models, and tests their relevance based on empirical evidence for resource-rich African countries.

Chapter 1 surveys the literature on the Dutch disease caused by natural resources revenues in developing countries. It describes the original models of Dutch disease and some important extensions proposed in the theoretical literature, focusing on the ones that meet the developing countries' conditions. It then reviews the main empirical studies that have been conducted since the 1980s, aiming to understand the methodological issues and to highlight the current gaps in the literature. This reviews suggests that the Dutch disease is still a topical issue for many developing countries, particularly in Africa. Finally, it also provides a discussion on the different policy instruments used to cope with Dutch disease, specifically in developing countries.

Chapter 2 questions the definition of real exchange rates used in the Dutch disease literature. For this, it differentiates internal and external measures of real exchange rates, estimated for both agricultural and manufacturing sectors separately. Following the Behavioural Equilibrium Exchange Rate approach, it then estimates the impact of oil revenues and oil prices on these different real exchange rates in a panel of nine African oil-exporting countries, using Mean-Group, Pooled-Mean-Group and a cross-sectionally augmented version of the Pooled-Mean-Group estimators. Results show a clear appreciation of the RER generated by an increase in oil revenues or interna-

tional oil prices, except for the internal real exchange rate for manufacturing goods. This could imply that oil revenues and oil prices hit more the competitiveness of agricultural sectors than of manufacturing sectors in these countries.

Chapter 3 identifies two of the causal mechanisms through which variations in international crude oil prices translate into changes in net-oil exporting countries' domestic prices, namely the pass-through effect and the Dutch disease effect. It then intends to disentangle these two effects for the five oil producing countries of the Central African Economic and Monetary Community : Cameroon, the Republic of Congo, Chad, Equatorial Guinea, and Gabon. It also investigates the heterogeneity across countries in the face of international oil price and domestic oil production shocks based on a multiple time-series strategy covering the period 1995-2019. Applying Dynamic Ordinary Least Squares and AutoRegressive Distributed Lag methods, it concludes to the presence of a pass-through effect in Cameroon, Chad, and Congo and of a Dutch disease effect in Equatorial Guinea. This contributes to the understanding of the relationships between international commodity prices and domestic consumer price variations but can also help policymakers in the CEMAC by assessing the vulnerability of its members toward external shocks.

Chapter 4 discusses the way the impact of natural resource exploitation on structural transformations is tested empirically in Dutch disease studies. It notably focuses on the choice of the underlying empirical model, on how dependent and explanatory variables are measured (in international USD per capita or as a share of GDP), and on the selection of control variables. This discussion is illustrated with a panel of 50 African covering the period 1995-2019. Applying Ordinary Least Squares in panel and cross-sections, Least Absolute Deviations, and Fixed-Effects Filtered methods, the chapter assesses the impact of extractive resources on agriculture, manufacture, construction, and service sectors. Results do not allow to conclude to any negative impact of these resources on manufacturing value-added. However, they are consistent with a "de-agriculturalization" effect of extractive resources, even if the results remain highly sensitive to the choice of the underlying empirical model.

Table des matières

Table des figures

Liste des tableaux

Introduction Générale

Depuis le début de la décennie 2010, diverses découvertes de gisements d'hydrocarbures ont contribué à faire entrer nombre de pays africains dans le cercle des pays riches en ressources naturelles, ou à renforcer leur place dans ce domaine : début de l'exploitation de pétrole au Niger en 2011, découverte de réserves offshore de pétrole dans le canal du Mozambique en 2010 et au large des côtes sénégalaises en 2014, découverte de gisements gaziers en Egypte en 2015 et pétroliers en 2020... Dans le même temps, la demande mondiale croissante pour les minerais nécessaires à la production d'appareils numériques et à la transition énergétique (terres rares, cuivre…) alimente les efforts d'exploration et de mise en exploitation des réserves minières déjà connues (comme en République Démocratique du Congo). Pour ces pays, se pose alors la question de l'impact -social, économique ou environnemental- de l'exploitation des ressources naturelles. Si les revenus tirés de ces ressources peuvent constituer une manne permettant le financement du développement économique, une mauvaise gestion de cette rente peut toutefois avoir des conséquences délétères. L'une des conséquences la plus connue est le phénomène dit de syndrome hollandais, qui apparait quand l'exportation des ressources naturelles entraine une perte de compétitivité des autres secteurs d'exportation et, *in fine*, le déclin de leur production. Cette hypothèse a fréquemment été avancée pour expliquer la désindustrialisation de certains pays développés, ou même les difficultés à s'industrialiser de pays en développement riches en ressources naturelles. Dans cette thèse, nous questionnons la pertinence du modèle de syndrome hollandais et de son application au cas des pays africains riches en ressources naturelles [1].

Qu'est-ce que le syndrome hollandais ?

L'expression « syndrome hollandais » [2] a été utilisée pour la première fois dans un article du journal *The Economist* (1977) dans le but d'expliquer le déclin industriel observé aux Pays-Bas après le début de l'exploitation de réserves gazières découvertes en Mer du Nord dans les années 1960. Ce terme a par la suite été repris

1. Les sections "Qu'est-ce que le syndrome hollandais ?", "Le syndrome hollandais : un canal de malédiction des ressources comme un autre ?" et "Faut-il craindre le syndrome hollandais" de cette introduction sont partiellement inspirées du début de l'article "40 Years of Dutch Disease Literature : Lessons for Developing Countries" publié en 2021 dans la revue *Comparative Economic Studies* et dont l'essentiel est repris et approfondi dans le chapitre 1 de cette thèse.

2. Pour des raisons d'homogénéité, nous utiliserons tout au long de cette étude le terme « syndrome hollandais » pour traduire l'expression « Dutch disease » même si d'autres traductions existent (« mal hollandais », « maladie hollandaise »…)

pour caractériser les situations du Royaume-Uni et de l'Australie, avant d'être étendu à tous les pays producteurs de ressources naturelles. Ce paradoxe apparent d'un impact négatif de l'exploitation des ressources naturelles sur l'industrialisation a dès lors rapidement attiré l'attention des journalistes, personnels politiques et économistes, conduisant à l'apparition des premiers modèles économiques de syndrome hollandais dès 1980. Si l'on considère aujourd'hui le modèle de Corden et Neary (1982) comme l'article fondateur sur le sujet, ce modèle doit en réalité être replacé dans un contexte général de multiplication de modèles théoriques caractérisant la première moitié des années 1980 (comme nous le verrons dans le chapitre 1). En dépit de l'hétérogénéité des hypothèses et définitions adoptées, les modèles de syndrome hollandais concluent en général qu'un boom de ressources naturelles (découverte de nouveaux gisements, hausse des prix ou progrès technologique permettant un accroissement de la production) conduit (i) à une hausse des dépenses (publiques et privées), une appréciation du taux de change réel, et donc un déclin de la compétitivité des secteurs d'exportation (« *spending effect* »), et (ii) à des mouvements de facteurs de production entre secteurs conduisant à des variations de prix intersectorielles et à des déséquilibres entre offre et demande (« *resource-movement effect* »). Ces deux effets se conjuguent pour aboutir à un déclin du secteur des biens échangeables, c'est-à-dire soumis à la concurrence internationale. **Le syndrome hollandais peut ainsi simplement se définir comme le mécanisme par lequel un boom exogène de revenus tirés des ressources naturelles aboutit à un déclin absolu des autres secteurs échangeables, avec un impact indéterminé sur les secteurs protégés de la concurrence internationale**. Les biens échangeables étant souvent associés aux industries manufacturières, le syndrome hollandais est généralement considéré comme une cause de désindustrialisation. Toutefois, Corden (1984) soulignait déjà que les secteurs échangeables peuvent également inclure des biens agricoles, et que le syndrome hollandais peut alors conduire à un déclin du secteur agricole (« *de-agriculturalization* »). Ce point est véritablement important pour nombre de pays en développement et tout particulièrement en Afrique, souvent faiblement industrialisés et spécialisés dans la production de biens agricoles destinés à l'exportation. Au contraire, certains produits agricoles (par exemple l'agriculture de subsistance) et certaines activités industrielles (construction et BTP) peuvent être considérés comme non-échangeables. Il est à noter qu'Aoki et Edwards (1983) privilégiaient ainsi le terme de « *tradable squeeze effect* » plutôt que celui de désindustrialisation.

Le syndrome hollandais : un canal de malédiction des ressources comme un autre ?

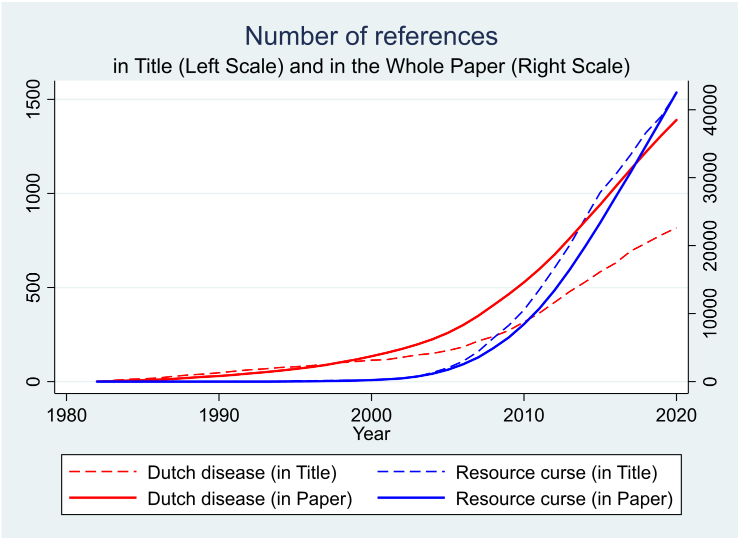
Les concepts de syndrome hollandais et de « malédiction des ressources » (« *Resource curse* ») sont parfois employés comme synonymes mais leur définition aussi bien que leur origine diffèrent pourtant. L'expression de malédiction des ressources désigne plus généralement l'idée d'une corrélation négative entre dotation en ressources naturelles et croissance économique. Cette idée peut à première vue apparaitre contre-intuitive et s'oppose en effet à nombre de théories économiques dominantes jusqu'à la fin du 20ème siècle. Elle entre ainsi en contradiction avec les analyses classiques de Smith et Ricardo sur les gains à la spécialisation internationale (la présence de ressources fournissant en effet un avantage tant comparatif qu'absolu dans ce secteur), mais également avec les théories de Rostow sur le développement économique dominantes dans les années 1950 et 1960, selon lesquelles les ressources naturelles peuvent servir de base à un processus d'industrialisation (Badeeb et al., 2017). Toutefois, quelques auteurs avaient déjà mis en évidence un potentiel effet négatif des ressources sur l'économie. Davis (1995) souligne par exemple que la présence de ressources naturelles a pu être utilisée pour expliquer la faible croissance de l'Argentine dès les années 1930. Cette idée peut aussi être rapprochée de l'hypothèse de Prebisch-Singer selon laquelle les biens primaires seraient soumis, à long terme, à une tendance à la baisse de leurs prix relativement à celui des biens manufacturés (Prebisch, 1950 ; Singer, 1950). Cependant, l'expression de malédiction des ressources n'apparait dans la littérature économique qu'avec Auty (1993) pour expliquer la faible croissance économique de nombreux pays riches en ressources naturelles dans les années 1980 et 1990. Elle fut ensuite reprise dans l'étude empirique de Sachs et Warner (1995) qui, bien que fortement critiquée par la suite, a donné naissance à une très vaste littérature sur le sujet, et est encore aujourd'hui considérée comme fondatrice de la littérature sur la malédiction des ressources.

Il est ici utile de noter que le terme de malédiction des ressources naturelles est plus récent que celui de syndrome hollandais (même si l'idée est plus ancienne). De plus, contrairement au syndrome hollandais, appliqué initialement à des pays industrialisés, la malédiction des ressources appartient bien originellement à la littérature de l'économie du développement. Pourtant, ce dernier concept a eu tendance à supplanter le premier, le syndrome hollandais étant désormais fréquemment défini comme un canal de la malédiction parmi d'autres. Ainsi, l'intérêt récent pour la question de la malédiction a partiellement éclipsé l'analyse du syndrome hollandais. De fait, la figure 1 présente le nombre d'articles mentionnant les termes « *Dutch disease* » et « *Resource curse* » dans leur titre ou le texte à partir du moteur de recherche *Google Scholar*. La malédiction des ressources a ainsi attiré bien plus d'attention à partir du milieu des années 2000. Une divergence est également apparue à cette période entre le nombre d'articles citant le syndrome hollandais dans le titre et dans le corps du texte, supportant l'idée que le syndrome hollandais est désormais davantage perçu comme un simple canal de la malédiction des ressources (et donc essentiellement mentionné comme un canal possible dans des études plus larges portant sur la malédiction des ressources en général).

Toutefois, nous considérons ici que ces deux termes recouvrent des réalités différentes. Ainsi, la malédiction des ressources est un concept multidimensionnel incluant des dimensions politiques (corruption, conflits...) tout autant qu'économiques (volatilité des cours, inégalités, fuites des capitaux...). De fait, Hausmann et Rigobon (2003) arguent que si la correlation négative entre ressources naturelles et croissance économique est globalement admise, les canaux de transmission sont eux beaucoup plus sujets à débats. Au contraire, le syndrome hollandais sert d'explication à un phénomène de transformations structurelles, mais n'implique pas nécessairement une croissance économique faible ou même négative. Plusieurs économistes ont d'ailleurs soutenu l'idée que le syndrome hollandais ne doit pas être appréhendé comme un mal ou une malédiction mais plus simplement comme le passage d'un équilibre économique à un autre (voir par exemple Davis, 1995 ; Gylfason, 2008 ; ou Nülle et Davis, 2018), sans aucun effet négatif sur l'économie dans son ensemble [3].

3. "*There is nothing inherently growth-inhibiting in mineral booms and any resulting Dutch disease phenomena. The Dutch disease is simply a description of the causes and structural effects of boom-induced growth. [...] If the mineral boom is indefinite, the Dutch disease merely describes the transformation of the economy from one long-run equilibrium to another*" (Davis, 1995, p. 1768)

Figure 1 – Nombre cumulé de références aux termes "Dutch disease" et "Resource curse"



Source : Goujon et Mien (2021) à partir de Google Scholar

Nous adoptons ici une position intermédiaire consistant à considérer le syndrome hollandais comme un concept spécifique, pouvant éventuellement (mais pas nécessairement) conduire à une malédiction des ressources et/ou interagir avec d'autres canaux de cette malédiction des ressources.

Faut-il craindre le syndrome hollandais ?

En effet, les remarques précédentes ne doivent pas inciter à penser que le syndrome hollandais puisse être négligé par les autorités publiques. Le syndrome hollandais reste un enjeu majeur pour les pays riches en ressources naturelles et ce pour plusieurs raisons.

Tout d'abord, il est fréquent dans la littérature économique de considérer que les secteurs d'exportation ont une place particulière dans l'économie car les firmes y bénéficieraient d'économies d'échelle, d'effets d'apprentissage par la pratique (« *learning-by-doing* »), ou généreraient des externalités positives pour les autres secteurs. Ainsi, un déclin dans le secteur des biens échangeables pourrait être nuisible au développement économique de long-terme, même si de tels effets ne seraient pas perceptibles immédiatement.

Ensuite, le syndrome hollandais peut interagir avec différents canaux économiques ou politiques de la malédiction des ressources, renforçant ceux-ci ou étant renforcé par eux. Par exemple, les prix des biens primaires sont souvent soumis à une forte volatilité, impliquant une forte volatilité des revenus publics ainsi que de la valeur des exportations. Si le syndrome hollandais implique une dégradation de la balance commerciale hors ressources naturelles (même si la balance commerciale totale s'améliore), l'équilibre commercial devient de plus en plus dépendant des revenus tirés des ressources. Cela implique qu'une chute brutale des cours peut conduire à la formation d'un déficit commercial majeur. De même, la dépendance de l'Etat aux revenus des ressources naturelles peut s'avérer problématique en cas de chute des prix internationaux, comme observé en 2020 lorsque la chute des cours du pétrole a conduit en pleine crise du Covid-19 à un effondrement des revenus de nombreux états exportateurs de pétrole au moment même où les dépenses publiques s'avéraient les plus nécessaires pour soutenir leur économie. La conjonction du syndrome hollandais et de l'instabilité des cours peut également générer une forte variabilité du taux de change, décourageant les investissements directs étrangers (Gylfason, 2008).

Le syndrome hollandais peut aussi être relié à des phénomènes politiques de corruption ou d'affaiblissement des institutions démocratiques. Les élites des Etats autoritaires peuvent de fait avoir intérêt à promouvoir une surévaluation du taux de change afin de favoriser les populations urbaines (via leur consommation de biens importés) au détriment des populations rurales par souci d'éviter des révoltes urbaines (Bates, 1981). Dès lors, une appréciation du taux de change causée par un syndrome hollandais peut aider des gouvernements corrompus à se maintenir au pouvoir, les décourageant de fait de chercher à enrayer ce phénomène d'appréciation. Or, la corruption est souvent considérée comme l'un des problèmes majeurs les plus répandus dans les pays riches en ressources naturelles. Ainsi, parmi les 10 pays les plus corrompus au monde en 2020 selon l'Indice de Perception de la Corruption de l'ONG *Transparency International*, 8 étaient de larges producteurs de pétrole (République Démocratique du Congo, Libye, Guinée Equatoriale, Soudan, Venezuela, Yemen, Syrie et Soudan du Sud) [4].

Enfin, il est possible de souligner que, même si le revenu général de l'économie tend à s'accroitre, le syndrome hollandais implique que certains secteurs bénéficient des revenus alors que d'autres en pâtissent. Or, si la mobilité intersectorielle est faible, il peut en résulter une hausse du chômage ou une baisse des revenus pour les travailleurs des secteurs négativement affectés. Cela peut être une

4. https://www.transparency.org/en/cpi/2020/index/aze

source de préoccupation pour les décideurs publics requérant la mise en place de politiques redistributives ou de soutien aux secteurs en déclin (au moins à court-terme). De par son mécanisme de redistribution des revenus des secteurs hors-ressources vers le secteur des ressources, le syndrome hollandais peut donc accroitre des inégalités préexistantes si la rente tirée des ressources est captée par une élite restreinte. Le syndrome hollandais demeure alors bien un enjeu, non en terme de revenu moyen, mais du point de vue de la distribution de ce revenu.

Le syndrome hollandais peut-il avoir d'autres causes que les ressources naturelles ?

Bien que les premiers modèles économiques du syndrome hollandais aient défini ce phénomène comme une conséquence d'un boom de ressources naturelles, plusieurs économistes ont par la suite identifié d'autres causes possibles. Un syndrome hollandais peut ainsi être généré par les transferts de fonds de migrants (Acosta et al., 2009), par l'aide internationale (Rajan et Subramanian, 2011) ou par tout type de revenus considérés comme exogènes, comme ceux tirés du canal de Suez dans le cas de l'Egypte (Cottenet, 2000). Il est à ce titre notable que Corden et Neary (1982) mentionnent dès l'introduction de leur article que le syndrome hollandais peut être provoqué par n'importe quel secteur en expansion rapide par rapport aux autres secteurs de l'économie (par exemple un secteur industriel bénéficiant de technologies particulièrement avancées). L'idée est donc ici qu'un secteur d'exportation caractérisé par une très forte rentabilité des activités mais isolé des autres secteurs d'exportation moins productifs encouragera un déclin de ces secteurs. De manière générale, le syndrome peut être la conséquence **de toute forme de hausse soudaine des revenus publics ou privés issue soit d'une source exogène (aide, transferts de fonds...) soit d'un secteur d'activité enclavé (ressources naturelles...), et donc indépendante des fondamentaux de l'économie réelle et notamment de la productivité réelle des (autres) secteurs économiques**.

Toutefois, nous nous bornerons dans cette étude aux seules ressources naturelles, et ce pour plusieurs raisons. Tout d'abord, le phénomène de syndrome hollandais est généralement associé à deux canaux qui sont l'effet de dépense et l'effet de déplacement de ressources. Or, seul le premier est susceptible d'être causé par des transferts de fonds ou par l'aide internationale, contrairement à l'effet de déplacement de ressources qui peut être provoqué par le développement d'un secteur minier nécessitant travail et capital (voir chapitre 1 pour une description plus approfondie des deux mécanismes en question). Ensuite, ce travail a pour objectif de questionner les fondements de la littérature sur le syndrome hollandais, notamment dans ses hypothèses et méthodes. Pour cela, il apparait plus pertinent de rester le plus proche possible des modèles théoriques fondamentaux. Dans une logique de comparabilité entre les différents chapitres de cette thèse, il semble également préférable de se focaliser sur un seul type de source de revenus tout au long de ce travail. Enfin, les ressources naturelles représentent encore aujourd'hui une source majeure de revenus pour nombre de pays en développement. L'intensification des efforts d'exploration de gisements miniers et d'hydrocarbures ainsi que les hausses à venir du prix de plusieurs ressources (notamment énergétiques) font que la problématique de la gestion efficace des revenus des ressources naturelles risque de s'intensifier encore davantage dans les prochaines décennies.

Comment définir les ressources naturelles ?

Après avoir justifié le choix de se focaliser sur les ressources naturelles, il convient de définir précisément celles-ci. Or, cette question est loin d'être triviale. En effet, un glissement sémantique semble avoir caractérisé la littérature économique relative au syndrome hollandais ou à la malédiction des ressources. Dans les premiers travaux de cette littérature, les ressources naturelles (*natural resources*) tendaient à recouvrir toutes activités primaires hors alimentation de subsistance. Les ressources naturelles pouvaient par conséquent inclure les produits agricoles destinés à l'exportation (bois, café, cacao, caoutchouc, coton, sucre, thé…) aussi bien que les produits minéraux généralement distingués entre pierres précieuses et semi-précieuses, métaux (aluminium, cobalt, cuivre, fer, nickel, plomb, uranium…), charbon et hydrocarbures. Cette définition large des ressources naturelles est par exemple utilisée dans l'article de Sachs et Warner (1995). De même, Isham et al. (2005) distinguent les ressources naturelles localisées (*point resources*) et les ressources diffuses (*diffuse resources*) : les premières correspondent aux hydrocarbures, ressources minières et ressources agricoles produites dans des plantations de grande taille (comme le sucre), tandis que les secondes correspondent plutôt aux ressources agricoles produites dans des exploitations familiales de petite ou moyenne taille (céréales, fruits et légumes…) [5]. Cette définition large des ressources naturelles a pour fonction d'opposer les ressources primaires peu ou pas transformées, aussi appelées matières premières (*commodities*), aux biens manufacturés transformés. Une telle opposition peut se justifier pour plusieurs raisons. D'une part, elle s'inscrit dans une organisation du monde telle qu'héritée par la fin de la seconde guerre mondiale et les décolonisations entre un centre « industrialisé » spécialisé dans les activités manufacturières à forte valeur ajoutée, et des pays en développement spécialisés dans l'exportation de produits primaires ou faiblement transformés. Ensuite, cette opposition se retrouve dans les variations des prix internationaux des différents biens : il y aurait alors une distinction nette entre les « commodités » aux prix extrêmement volatils dans le court-terme et les biens manufacturés aux prix beaucoup plus stables. De plus, dans la li-

5. Cette distinction est toutefois imparfaite comme le soulignent d'ailleurs les auteurs : le café et le cacao peuvent par exemple appartenir aux deux catégories car sont produits sur des petites ainsi que des grandes exploitations.

gnée des travaux de Raúl Prebisch et Hans Singer, les prix des biens primaires seraient voués à diminuer tendanciellement comparativement aux produits manufacturés, faisant peser de fortes inquiétudes dans les capacités des pays spécialisés dans la production de ces biens à maintenir un développement économique de long-terme. Enfin, l'idée est que ces produits ne peuvent être produits qu'en certains lieux, soit parce que la ressource naturelle est très localisée, soit parce que sa production nécessite des conditions climatiques ou une nature de sol spécifique. Cette forte localisation de la production faciliterait la naissance, la prédation et la captation d'une rente ainsi que les éventuels conflits liés à son partage (Isham et al., 2005).

Plus récemment, la distinction entre les produits issus de l'agriculture d'un côté et les produits miniers et hydrocarbures de l'autre a eu tendance à s'accentuer. De fait, les analyses récentes de la malédiction des ressources naturelles se limitent généralement à l'analyse de l'impact de l'exploitation des ressources dites extractives, y compris d'ailleurs en explorant leur impact sur l'agriculture d'exportation définie comme un secteur de biens échangeables pouvant souffrir de syndrome hollandais, au même titre que les industries manufacturières. Ce glissement de sens vers une focalisation sur les activités extractives peut s'expliquer par leurs spécificités : elles sont caractérisées par des rendements très élevés, des besoins d'investissement en capital très importants (souvent financés par des investissements étrangers dans le cas des hydrocarbures) et une capacité de création d'emplois assez faible en comparaison des revenus qu'elles génèrent. De plus, les questions soulevées par l'épuisement des ressources naturelles au niveau mondial a conduit à rappeler la distinction entre ressources agricoles « produites » et ressources « extraites » du sol, les secondes étant nécessairement disponibles en quantités limitées et extraites à des coûts marginaux croissants au fur et à mesure de l'épuisement des gisements les plus anciens et les plus facilement accessibles. Il est à noter que le bois, ressource imparfaitement renouvelable, occupe une place à part dans cette typologie en étant encore fréquemment inclut dans les ressources naturelles. Ainsi, la variable « Natural resources rents » des *World Development Indicators*, mesure la plus fréquemment utilisée dans les études macroéconomiques, inclut cinq sous-catégories de ressources naturelles : les produits miniers (pierres précieuses et métaux), le charbon, le gaz naturel, le pétrole et le bois (non transformé).

Tout au long de cette thèse, nous nous intéresserons uniquement aux ressources dites extractives, c'est-à-dire recouvrant les quatre premières catégories (hors bois) des WDI. En conséquence, **l'expression « ressources naturelles » désignera dans cette thèse exclusivement les ressources d'extraction**, sauf mention contraire (c'est-à-dire dans les références à des articles adoptant une définition plus large). Afin de rester dans la continuité de la littérature existante et d'éviter toute confusion, nous emploierons également le terme « production » pour décrire les activités d'extraction de ces ressources.

En raison de son poids dans l'économie mondiale, le pétrole semble toutefois occuper une place à part parmi l'ensemble des ressources naturelles. En effet, le pétrole est aujourd'hui la principale source énergétique dans le monde (devant le charbon, le gaz, les énergies renouvelables et le nucléaire) et est plus facilement échangeable au niveau international que d'autres ressources comme le gaz naturel (nécessitant un coûteux processus de liquéfaction pour être transporté sur de longues distances). De plus, les champs pétrolifères sont le plus souvent très localisés (contrairement aux mines généralement plus dispersées), nécessitent de très importants coûts d'investissement pour être exploités (donc souvent financés par des entreprises internationales ayant signé des contrats pour l'exploitation de ces champs, contrairement à certaines mines à faibles rendements parfois exploitées de manière plus informelles) et peuvent générer des rendements considérables. Ces caractéristiques font du pétrole une ressource particulièrement à même de créer des phénomènes de rente, d'encourager la corruption ou des conflits autour de son contrôle mais surtout d'engendrer des phénomènes de syndrome hollandais. Tout cela explique donc l'attention particulière accordée par la littérature économique au pétrole, que nous lui accorderons également, sans pour autant nous y limiter.

Quelle place de l'Afrique face au syndrome hollandais ?

Enfin, il convient de justifier le choix de centrer cette étude sur le cas de l'Afrique. A l'exception du premier chapitre qui consistera en une revue de la littérature existante sur le syndrome hollandais dans les pays en développement, tous les autres chapitres porteront en effet sur des pays africains. Ce choix est motivé par plusieurs raisons.

D'une part, une importante littérature a mis en évidence que les transformations structurelles, définies comme la réallocation des facteurs de production entre secteurs, n'a pas conduit dans la plupart des pays africains à des gains de productivité. Cette réallocation semble au contraire s'être effectuée des secteurs les plus productifs vers les secteurs moins productifs, amenant à considérer l'hypothèse d'une « désindustrialisation précoce » (*premature de-industrialization*) sur le continent (McMillan et al., 2014 ; Rodrik, 2016). La place de l'Afrique dans ces processus de transformations structurelles est telle que l'article de Margareth McMillan et Dani Rodrik, initialement présenté en 2011 comme document de travail sous le titre « Globalization, Structural Change, and Productivity Growth » a finalement été publié en 2014 sous le tire « Globalization, Structural Change, and Productivity Growth, with an update on Africa » (McMillan, Rodrik et Verduzco-Gallo, 2014), le principal apport par rapport à la version originale résidant dans l'ajout d'une section consacrée spécifiquement aux pays africains. Or, l'une des hypothèses évoquées par les auteurs (bien que non approfondie dans l'article en question) est celle de la présence de ressources naturelles et de la possibilité d'un syndrome hollandais.

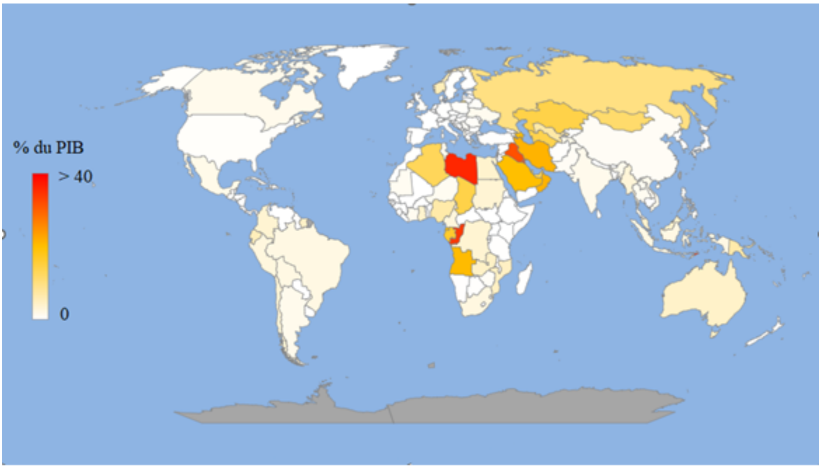
En effet, il apparait que l'Afrique est l'une des régions les plus dépendantes aux revenus tirés des mines et hydrocarbures au monde. La figure 2 ci-dessous présente le poids des ressources naturelles (hors bois) dans le PIB des pays en 2019. Il apparait que les pays les plus dépendants aux ressources naturelles sont situés en Afrique, au Moyen-Orient et, dans une moindre mesure, en Asie centrale. De fait, parmi les 15 pays où la rente pétrolière exprimée en pourcentage du PIB était la plus forte en 2019, 7 sont situés en Afrique du Nord (Libye et Algérie), ou en Afrique sub-Saharienne (République du Congo, Angola, Guinée Equatoriale, Gabon et Tchad) contre 6 au Moyen-Orient (Koweït, Irak, Oman, Arabie Saoudite, Iran et Emirats Arabes Unis), 1 au sein de la Communauté des Etats indépendants (Azerbaïdjan) et 1 en Asie du Sud-Est (Timor-Oriental). Toutefois, si le pétrole occupe une place prépondérante, les ressources minières représentent également une partie conséquente des revenus (sauf dans les pays du Moyen-Orient essentiellement marqués par leur richesse en hydrocarbures). Ainsi, deux des cinq pays les plus dépendants aux ressources minières (hors charbon) sont situés en Afrique (Zambie et République Démocratique du Congo, notamment en raison du poids du cuivre) contre un en Asie (Mongolie), un en Amérique Latine (Chili) et un en Océanie (Australie). A ces niveaux déjà élevés de dépendance aux ressources naturelles, il convient d'ajouter plusieurs découvertes de nouveaux gisements, notamment pétroliers (Sénégal) et gaziers (Egypte). De plus, beaucoup de pays disposent de réserves encore sous-exploitées, ou dont la demande mondiale risque d'augmenter considérablement (et donc les prix également) dans les prochaines années en raison des besoins liés à la transition énergétique : la République du Congo dispose des deux tiers des réserves mondiales connues de cobalt, le Rwanda d'un tiers de celles de tantale et l'Afrique du Sud de 70% des réserves de platine. Il est donc à attendre que les conséquences de l'exploitation des ressources naturelles s'accentuent encore sur le continent au fur et à mesure que les réserves seront de plus en plus exploitées.

En Afrique, il convient néanmoins de relever une forte hétérogénéité des situations vis-à-vis de la richesse et de l'exploitation des ressources naturelles. Il faut notamment distinguer les pays ayant des réserves connues de longue date et déclinantes (comme le Cameroun pour le pétrole) dont le principal enjeu des prochaines années sera d'assurer une transition et une diversification des sources de revenus, les pays en pleine situation de dépendance et dont les réserves connues sont proches de leur pic de production ou n'ont pas encore atteint un stade de déclin (Guinée Equatoriale) et les pays ayant découvert des ressources récemment ou ne les ayant pas encore pleinement exploitées (Sénégal) et dont l'objectif primordial sera de trouver des manières efficaces de gérer ces ressources le moment venu. C'est d'ailleurs pour ces pays que les connaissances tirées des expériences des pays ayant déjà connus de tels booms de ressources risquent de s'avérer les plus cruciales.

Objectifs et Plan de la Thèse

Cette thèse cherche à déterminer si des symptômes du syndrome hollandais peuvent être identifiés dans les pays africains producteurs de ressources naturelles, en distinguant d'une part les questions mo-

Figure 2 – Rente des ressources naturelles (en % du PIB) par pays en 2019



Source : Auteur à partir des données WDI (2022). La variable de rente est calculée comme la différence entre la valeur de la production aux prix internationaux et les coûts de production. Les ressources naturelles sont définies comme la somme des variables « Oil rents » (pétrole brut), « Natural gas rents » (gaz naturel), « Coal rents » (charbon) et « Mineral rents » (étain, or, plomb, zinc, fer, cuivre, nickel, argent, bauxite et phosphate).

nétaires (inflation et appréciation du taux de change réel) et d'autre part les questions de production sectorielle ou de transformations structurelles. Cette distinction correspond aux différentes étapes du syndrome hollandais. En effet, ce modèle prédit un phénomène d'appréciation du taux de change réel causé par l'exploitation des ressources naturelles, qui a son tour provoque un déclin des autres secteurs échangeables. Le choix est donc fait ici de suivre cet ordre en abordant la question monétaire (chapitres 2 et 3) avant celle des transformations structurelles (chapitre 4). La thèse porte avant tout sur les pays d'Afrique et s'intéresse aux revenus des ressources naturelles, mines et hydrocarbures, comme source potentielle de syndrome hollandais. Pour cela, les travaux empiriques mêlent études de cas sur séries temporelles (chapitre 3) et analyses en données de panel (chapitres 2 et 4), sur une période circonscrite entre 1995 et 2019. L'année 1995 est choisie comme point de départ pour toutes les études empiriques (i) car elle correspond à la mise en place d'une nouvelle parité de change pour les pays des zones Franc CFA (suite à la dévaluation de 1994), le taux de change restant ensuite fixé (face au Franc Français puis à l'Euro) sur toute la période, et (ii) car elle marque le début de la disponibilité des données pour un grand nombre de variables. Le choix d'une étude s'achevant avant l'année 2020 a pour objectif de tirer des conclusions sur les données les plus récentes possibles, dans le but d'en tirer des recommandations pertinentes en termes de politiques publiques. Ce choix nous amène à exclure les années de la crise du Covid-19 qui n'a évidemment pas épargné les pays africains et réclameraient sans doute une étude à part.

Néanmoins, plus qu'un simple objectif d'identification de la présence ou de l'absence d'un syndrome dans ces différents pays, cette thèse a pour ambition de proposer une discussion méthodologique autour de la mesure et de la détermination du syndrome hollandais. En effet, malgré une littérature empirique abondante, certaines questions importantes sont encore peu abordées, qu'elles soient liées aux hypothèses des modèles théoriques, aux canaux de transmission, aux conséquences concrètes du syndrome hollandais ou encore aux variables à utiliser pour identifier correctement un tel phénomène. Ainsi, sans pour autant chercher à remettre en cause l'intégralité du modèle de syndrome hollandais, il s'agira de proposer un aperçu des limites de ce modèle, de questionner la pertinence de ses hypothèses et d'en discuter les enjeux essentiels pour les pays en développement riches en ressources naturelles, en prenant les pays africains comme étude de cas. Nous proposons également des pistes de réflexion quant à l'identification empirique de ce phénomène, sans nous cantonner aux questions de choix de modèles ou d'estimateurs économétriques. Une telle discussion semble indispensable pour deux raisons. D'une part, il apparait que le choix des variables retenues et de leur mesure peut expliquer une importante part de l'hétérogénéité des résultats et conclusions de la littérature empirique. Proposer une discussion autour de ces choix et de leurs motivations peut donc fournir des outils méthodologiques à de futures études et donc aider des décideurs publics cherchant à identifier un éventuel syndrome hollandais ou à estimer ses conséquences possibles et les réponses à y apporter. D'autre part, discuter la pertinence de certaines hypothèses des modèles en fonction du contexte d'analyse (pays, période, type de ressource...) peut aider à identifier les caractéristiques favorisant ou au contraire freinant l'émergence d'un syndrome hollandais. Sans être explicitement mise au centre de l'un des chapitres, la question des politiques publiques et des caractéristiques structurelles favorisant ou au contraire limitant l'émergence d'un syndrome hollandais est abordée à l'aide d'analyses comparatives, notamment dans les chapitres 3 et 4.

Le chapitre 1 consiste en une revue de la littérature économique sur le syndrome hollandais, en se focalisant sur les pays en développement et sur les ressources naturelles. Nous soulignons dans un premier temps la diversité des modèles théoriques, et discutons leurs contributions respectives. Nous présentons ensuite la littérature empirique, en décrivant les méthodologies employées et les principaux résultats. Enfin, nous détaillons les discussions sur les principales politiques fiscales et monétaires possibles pour faire face au syndrome hollandais. L'objectif est à la fois de mettre en évidence un certain nombre de limites de la littérature, limites sur lesquelles s'appuieront ensuite les trois chapitres suivants, et de proposer des recommandations à destination des pays en développement riches en ressources naturelles.

Les deux chapitres suivants constituent ensemble la seconde partie de cette thèse, partie consacrée aux problématiques monétaires et de taux de change. Chacun de ces chapitres cherche à discuter une hypothèse ou une limite identifiée dans le premier chapitre de la thèse. Ainsi, le chapitre 2 questionne la mesure et la définition du taux de change réel. Nous estimons dans ce chapitre l'impact des revenus pétroliers sur cinq indicateurs différents du taux de change dans un panel de 9 pays africains exportateurs nets de pétrole entre 1995 et 2017. Les différentes mesures de taux de change sélectionnées correspondent à différentes définitions du taux de change (interne ou externe) et sont calculées séparément sur la base de l'ensemble des biens du panier de consommation, sur les biens agricoles d'exportation et sur les biens manufacturés d'exportation seulement. A partir de l'estimateur des Pooled-Mean-Group et différents tests de robustesse, l'étude conclut à un impact négatif des revenus pétroliers sur la compétitivité des produits agricoles, mais pas nécessairement des produits manufacturés. Ces résultats amènent donc à conclure que le principal secteur menacé par le syndrome hollandais dans les pays africains pourrait bien être le secteur agricole plutôt que les industries manufacturières, observation qui n'aurait pu être faite sur la base d'un indicateur synthétique de taux de change.

Le chapitre 3 s'intéresse quant à lui aux déterminants de l'inflation dans les 5 pays producteurs de pétrole de la Communauté Economique et Monétaire de l'Afrique Centrale (Cameroun, République du Congo, Gabon, Guinée Equatoriale et Tchad) qui donc partagent un régime de change fixe. L'objectif est d'identifier un phénomène de syndrome hollandais en termes de hausse des prix intérieurs plutôt qu'en termes de compétitivité externe. Le chapitre permet également de discuter une hypothèse fondamentale du modèle de Corden et Neary (1982) selon laquelle les ressources naturelles seraient entièrement exportées, hypothèse fortement critiquable notamment pour les ressources énergétiques (hydrocarbures et charbon), qui peuvent en partie satisfaire une demande intérieure. A partir d'analyses en séries temporelles multiples sur des données trimestrielles entre 1995 et 2019 basées sur des méthodes de moindres carrés ordinaires dynamiques et d'estimateurs autorégressifs, l'étude conclut à la présence d'un phénomène d'inflation causé par un mécanisme de syndrome hollandais dans seulement deux pays sur les cinq étudiés : la Guinée Equatoriale et, dans une moindre mesure, le Tchad.

Le chapitre 4 porte enfin l'attention sur la question des transformations structurelles, mesurées en valeur-ajoutées sectorielles, dans un panel de 50 pays africains entre 1995 et 2019. Il a dans un premier temps pour objectif de présenter un aperçu général de la situation des différents secteurs productifs en Afrique et d'amener une discussion autour de la définition de l'industrialisation. A partir de cette discussion initiale, nous proposons une estimation de l'impact des ressources extractives sur les différents secteurs d'activité (agriculture, manufacture, construction, services) estimés séparément en termes absolus (valeur-ajoutée par habitants) et en termes relatifs (valeur-ajoutée en pourcentage du PIB non-extractif). Le chapitre conclut à l'absence d'un phénomène de syndrome hollandais sur les industries manufacturières, mais à un possible effet négatif (au moins en termes relatifs) sur l'agriculture.

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Première partie

Le Syndrome Hollandais dans les Pays en Développement : Enjeux et Défis

L'unique chapitre qui compose cette partie est basé sur un article publié en 2021 dans la revue *Comparative Economic Studies* sous le nom « 40 Years of Dutch Disease Literature : Lessons for Developing Countries » et co-écrit avec Michaël Goujon. Cet article se veut une revue la plus exhaustive possible de la littérature sur le syndrome hollandais, distinguant clairement entre modèles théoriques, analyses empiriques et recommandations politiques. Le chapitre 1 reprend et met à jour l'article en question en y intégrant plusieurs travaux publiés en 2021 et 2022 ou qui n'avaient pu être inclus dans sa version originale.

Au sein de cette thèse, ce chapitre fournit un aperçu général de la littérature sur le syndrome hollandais, mais permet également d'en discerner les limites et angles morts. Ces limites constitueront le point de départ des chapitres suivants et peuvent être distinguées en trois grandes catégories. D'une part, les limites liées à la pertinence des hypothèses des modèles : plein emploi initial de l'économie, mobilité parfaite des travailleurs au sein du pays mais non entre pays, exportation de la totalité des ressources extraites... Ensuite, la difficulté à identifier précisément les secteurs touchés positivement ou négativement par le syndrome et surtout à quantifier ces gains et pertes. Enfin, l'absence de consensus concernant les politiques économiques les plus adaptées pour faire face au syndrome hollandais, voire même sur la question de savoir s'il est pertinent de chercher à mettre en place de telles politiques.

Le travail autour de cet article a également donné lieu au développement d'une application présentant la littérature économique du syndrome hollandais. L'application a été développée avec l'aide de Yasemin Akdag dans le cadre d'un stage à partir de données obtenues par web scrapping [6].

6. https://akdagkarakuyuproject.shinyapps.io/DutchDiseaseAPPSHINY/

Chapitre 1

40 Years of Dutch Disease Literature : Lessons for Developing Countries

1.1 Introduction

Structural transformations have played a central role in explaining economic divergence across developing countries over the last century. Nevertheless, the reasons why structural change patterns differ across countries are still not fully understood. A fairly old explanation for this difference is the extraction and exports of natural resources, which are heterogeneously distributed across the world and can strongly influence structural change through the “Dutch disease" (DD) effect. However, from the 1990s, DD progressively faded in favor of the encompassing concept of "Resource Curse" (RC) (Auty, 1993) which more generally explains why many resource-rich countries experience weak economic growth. Literature reviews that specifically focus on DD remain rare, but the study of resource curse has resulted in an abundant literature and several literature reviews, often including a section on DD, only defined as a channel of the resource curse (see for instance van der Ploeg, 2011 ; Gilberthorpe and Papyrakis, 2015 ; Badeeb, Lean and Clark, 2017). In this article, we challenge this view by considering the DD as a specific phenomenon, distinct from the resource curse. While the "curse" or "disease" concepts are arguably as negative as each other, the Dutch disease, contrary to the resource curse, should not be analyzed as an inherently growth-reducing phenomenon but rather as a driver of structural transformation. Yet, by transforming the structure of the economy, DD also durably affects average labor productivity (by reducing incentives to invest in human capital and in activities with potentially high productivity gains), fiscal policy (by shifting taxation from non-resource to resource sectors), inequalities (by shifting wealth from non-resource to resource sectors), and even demography (by encouraging urbanization). Therefore, there is a continuing interest in studying DD per se, and in understanding its main consequences and policy options.

DD has been studied for 40 years but is still the object of theoretical, empirical, and policy debates. We therefore consider there is a need for an extended review of the DD literature for both researchers and policymakers. To our knowledge, Nülle and Davis (2018) is the only survey of DD literature. However, our study differs from this survey in several ways. First, we focus on developing and emerging countries, because most of the recent empirical literature on DD has targeted these countries. Then, we extensively review the theoretical literature that emerged at the beginning of the 1980s, the diversity of DD models, and the different sets of assumptions they use, whereas Nülle and Davis follow the initial model of Corden and Neary (1982) and the model of learning-by-doing effects proposed by Torvik (2001). Finally, while they argue that the existence of DD in resource-rich countries is the exception rather than the rule, we find more mixed conclusions on this matter. We also consider the conditions which allow or prevent DD, and the public policies that can be implemented against it.

There is a large theoretical and empirical literature on DD, much more than can be covered in a single review of literature. Thus, we made two choices in this survey. First, we restrict the empirical sections to cover only developing countries. Due to a renewed interest in structural transformation issues and the observation of some cases of growth without industrialization, the DD hypothesis has regained relevance in the study of the development process, particularly in sub-Saharan Africa and Latin America (Orvoty and Jibrilla, 2019). Even if there is a large literature on some industrialized countries (such as Canada, Norway or the United Kingdom), DD appears to be more prevalent in developing countries. This is explained by the fact natural resources represent a higher share of total revenues in these countries and because they often lack political or economic institutions that can effectively prevent DD. Second, we focus on the DD caused by natural resources only. Since the 1990s, other sources of revenues have been studied as drivers of DD, for instance international aid, migrants' remittances, or tourism. However, the mechanisms behind DD can vary according to the source of the revenue inflows. Focusing on DD caused by natural resources booms allows consistent comparisons across countries, and so proposals for policy recommendations for resource-rich developing countries. Moreover, the 2000s and 2010s have seen big changes in international prices of natural resources and a multiplication of mineral and oil discoveries. This has led to new entries of small developing countries into the group of resource-rich economies, making the need to understand the impact of natural resources even more acute.

Our aim is to survey the theoretical and empirical literature related to DD caused by natural resources revenues in developing countries, outline the main policy options and present the unsolved issues. This paper is organized as follows : Section 1.2 describes the basic Corden-Neary model and its relevant variations for the study of small developing countries. Section 1.3 presents the evidence for DD in the empirical literature on developing countries. Section 1.4 presents the main lessons and policy implications. Section 1.5 concludes and discusses the main limits of the DD literature.

1.2 Modelling Dutch Disease

In an early paper which could be considered as a forerunner of DD modelling, Gregory (1976) investigated the possibility that the growing mineral sector could have driven structural change in Australia. Nevertheless, Corden-Neary (1982)'s model is the one that has drawn most of the attention and become the basis of numerous theoretical and empirical works. We first discuss this model and some refinements, then present other early classical models, and finally present more recent general equilibrium models.

1.2.1 The Original Corden-Neary Model and its Extensions

The Corden-Neary model emerged from an important development of the theoretical literature at the beginning of the 1980s (Bruno and Sachs, 1982 ; Corden and Neary, 1982 ; Corden, 1984 ; van Wijnbergen, 1984a). The framework is that of a small open economy with three sectors : energy (traditionally oil, gas or mining resources), tradables, and non-tradables. Labor is mobile between sectors, but capital is not, and neither labor nor capital are mobile internationally. Thus, DD is a purely domestic phenomenon : it cannot be "exported" to neighboring countries (through international migration for instance). Four other essential assumptions are made : balanced trade (the country cannot generate surpluses or finance imports through external debt), full employment (so that the expansion of one sector draws labor out of the other sectors), perfect flexibility of real wages, and full exports of energy (which is not consumed domestically by households or used as an input by firms). Following Corden and Neary, we call the three sectors of the economy E (energy), T (tradables or manufactures) and N (non-tradables or services). The real effective exchange rate is defined as the relative price of non-tradable to tradable goods (a rise in the real exchange rate is an appreciation). The movements of prices and quantities in N relative to T after a boom are generated through two effects (see Figure 1.1) :

1. *The Spending Effects* : Energy exports generate additional revenues for the factor owners and for the government (through taxes), increasing the demand for both N and T. Since supply is fixed in the short run (capital is not mobile), the price of N rises. However, the price of T is set on international markets (exogenous), hence the increasing demand for T must be compensated by imports. Returns to capital increase in

N, whereas wages increase in both sectors due to the perfect mobility of labor, reducing profits in T. At the end, the real exchange rate appreciates, output declines in T and increases in N.

2. *The Resource-Movement Effect* : The boom implies higher wages in E, drawing labor out of the other two sectors. This reduces the output in N and T, resulting in a gap between supply and demand for both N and T. To compensate for this difference, imports of T rise while the price of N increases, causing a real appreciation of the exchange rate, and a movement of labor out of T into N : N returns to its pre-boom level while the decline in T is reinforced. At the end, output declines in T and stagnates (or slightly declines) in N.

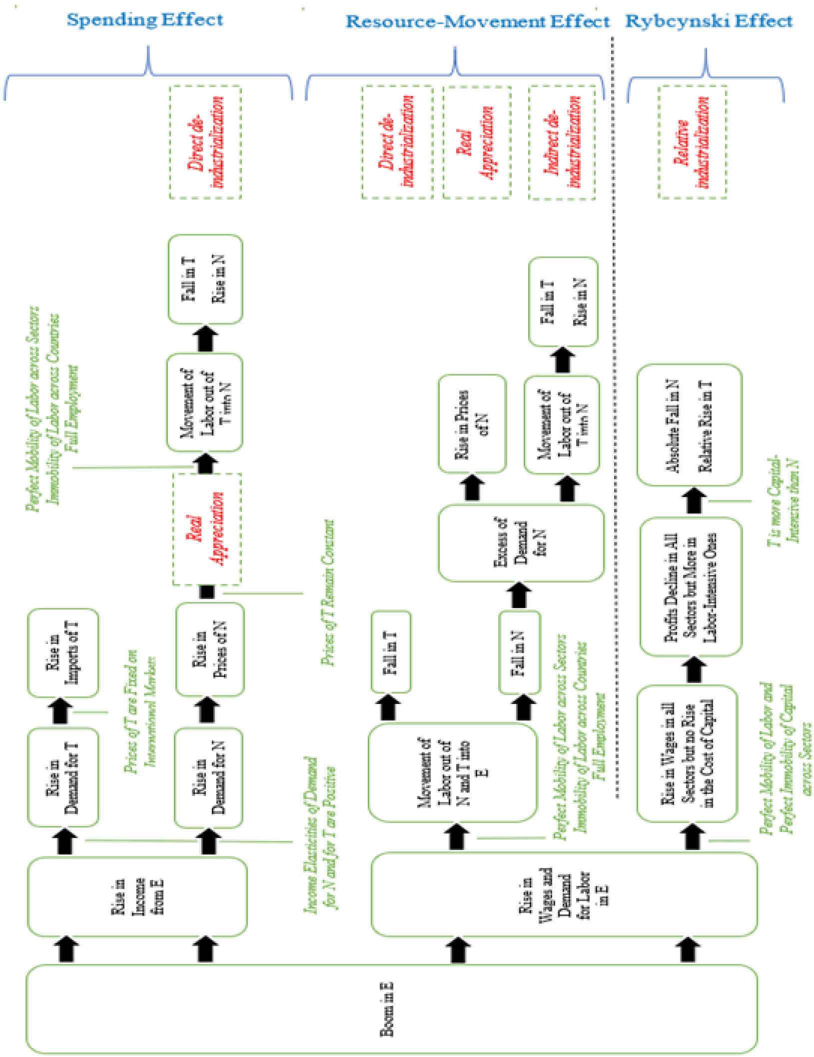
These two effects are often put forward, yet they may not both occur, or even have different effects under different assumptions. For instance, the assumption of full employment in the pre-boom equilibrium is required for the resource-movement effect, but not for the spending effect. Similarly, van der Ploeg (2011) explains that, if T is more capital-intensive than N, T benefits from the resource-movement effect due to the Rybczinski theorem, because of a lower impact of the wage increase on T (see Figure 1.1). This assumption, that T (manufacturing) is more capital-intensive than N (services) is at first sight justified but should be moderated since some T sectors can be weakly capital-intensive (for example export crops), and some N sectors can be capital-intensive (for example construction). Corden and Neary's original model aims to explain why a resource boom may generate RER appreciation and de-industrialization. This is the first and foremost, and often only, symptom recognized by works citing this model. However, these predictions are based on specific hypotheses that can be subject to interesting variations, leading to different predictions, as shown by Corden (1984). For instance, perfect capital mobility allows capital to be drawn from T into E and N, reinforcing the fall in T and the rise in E and N, but with a lower effect on the RER appreciation. Corden also details the effect of pre-existing unemployment. The magnitude of this effect depends on the level of real wages' flexibility, but overall employment increases in N and decreases in T. Additionally, immigration lowers the increase in wages, but increases the supply and the demand for N and T, with an ambiguous effect on the RER. Lastly, Corden (1984) considers the case where E is consumed domestically. If E is consumed by households, an increase in its price encourages consumers to shift from E to N and T, reinforcing the RER appreciation. If, on the opposite, E is an input for the production of N and T, a rise in price reduces profitability in N and T, limiting the spending effect.

1.2.2 Differing Approaches for Modelling Dutch Disease

Despite the importance accorded to Corden and Neary (1982)'s article, a large literature emerged at the beginning of the 1980s to explain the various impacts of DD. The seminal model of Corden and Neary only highlights the real aspects (not the monetary ones), and focuses on the domestic economy (ignoring external competitiveness and the exchange rate of the domestic currency against foreign currencies). In addition, it was developed for industrialized economies and some of its assumptions are unlikely to be met in developing countries. Other models may differ both in their perspective and assumptions. We present here a brief overview of the diversity of approaches that have been proposed in this literature.

Bruno and Sachs (1982) use a dynamic model in which the tra-

Figure 1.1 – Description of the Spending and Resource-Movement Effects



Note : E is the energy sector ; T is the tradable sector and N is the non-tradable sector. Labor is mobile while capital is immobile across sectors. *Spending effect* : the RER appreciates, the output in T falls and the output in N rises. *Resource-Movement effect* : the output in T falls. If labor is perfectly mobile across sectors, N returns to its pre-boom equilibrium ; if labor is imperfectly mobile, N falls but less than T. In both cases, there is an absolute decrease in T and a relative increase in N compared to T. *Rybczynski effect* : if T is more capital-intensive than N, the output in N falls more than in T (because labor flows to E while capital is immobile), which can partly offset the Spending and Resource-movement effects.

dable and non-tradable sectors use capital, labor, a composite input which notably includes energy, an imported good, and the output from the other sector (respectively non-tradable and tradable). They notably discuss the role of households' savings and consumption choices, assuming that some households optimize long-term consumption while others are short-term focused households. Finally, they investigate the impact of three different types of shock in an oil-exporting country : oil discovery, rise in international oil prices, and changes in public policies toward oil taxation and redistribution. They conclude that government budget policies and households' propensity to save current revenues from the oil sectors are key factors in mitigating DD effects.

Van Wijnbergen (1984a) distinguishes short- from long-term effects and introduces the possibility of short-term disequilibrium in the labor and non-traded goods markets. The author investigates three possible types of disequilibrium : repressed inflation (excess demand for labor and non-traded goods), classical unemployment (excess demand for N but not for labor because real wages adjust sluggishly to the new equilibrium), and Keynesian unemployment (excess supply of labor and of non-traded goods). The shift of the economy from the initial equilibrium to one of these situations depends on the stickiness of prices and wages and on the public policies that are implemented.

In contrast to the model of Corden and Neary, Buiter and Purvis (1980) adopt an external perspective (focusing on the external competitiveness of exports compared to imports) rather than the internal perspective (focusing on the relative incentives to produce tradables versus non-tradables). Accordingly, they use an external RER, defined as the ratio of import (foreign) prices to domestic non-resource tradable prices. Their model stresses the role of exchange rate movements on foreign exchange markets in the presence of sticky domestic prices, which was not considered in Corden and Neary's model. Several important assumptions are made. First, oil production does not require labor, implying that starting oil production does not directly affect other sectors' production through movements of workers (contrary to Corden-Neary's resource-movement effect). Second, consumption follows the permanent income hypothesis, meaning that oil revenues are not fully consumed during the exploitation period but partly saved to smooth consumption over time, affecting the long-term steady state of the economy. Both oil price increases and oil discoveries affect long-term non-oil tradable prices.

Neary (1982) introduces monetary aspects and shows the impact of DD on nominal variables. He uses a simple monetary model, firstly assuming flexibility of prices and wages where the real exchange rate is the relative price of N (services) to the price of T (measured by the nominal exchange rate when the foreign prices are fixed). Secondly, he assumes that a boom in E leads to excess demand for N (through the spending and the resource-movement effects). However, the rise in income also raises money demand, decreasing prices if the money supply is fixed. Neary calls this third effect the "*liquidity effect*". Under a floating exchange rate regime, the nominal exchange rate appreciates to reach an equilibrium in the money market, together with the appreciation of the real exchange rate (the domestic price of T falls due to the appreciation of the nominal exchange rate, but the price of N may rise or fall). This causes deflationary pressures. A fixed exchange rate delays the adjustment (the domestic price of T is fixed), but the trade surplus gradually increases the money supply (if not sterilized), causing inflationary pressures. The real appreciation is now obtained through a rise in the price of N instead of a fall in the price of T.

Neary and Purvis (1982) propose a combination of the Buiter-Purvis (1980) and Corden-Neary (1982) models. In their model, non-resource tradables require capital and labor, non-tradables require only labor, and resources (in this case, benzine) require capital and another specific factor. In this model, labor is perfectly mobile between non-tradable and non-resource tradable sectors while capital is not mobile in the short term, but mobile between resource and non-resource tradable sectors in the long term. They also include the liquidity effect described in Neary (1982), with similar conclusions.

Aoki and Edwards (1983) develop a dynamic model of DD focusing on the money market equilibrium. In oil-exporting countries, an exogenous rise in oil prices has two different effects on the money market. First, it creates a trade balance surplus, which increases the supply of money. Second, it increases domestic income, which increases the demand for money. Then, if supply and demand do not increase at the same rate, a short-term monetary disequilibrium occurs, but this disequilibrium is progressively eliminated. There might therefore be a loss in competitiveness and a subsequent "*tradables squeeze*" effect caused by oil revenues in the short-run, but not necessarily in the long-run. This result is important to understand how DD works, because it implies that DD is a disease for the economy only during the short-term disequilibrium period, and not in the long run when the new steady state equilibrium is attained.

Also following an external perspective, but using a dynamic portfolio model, de Macedo (1982) puts forward the first known DD model specifically dedicated to a developing country, namely Egypt. The author considers the specificity of a multiple foreign exchange system, with an official market rate for oil and a parallel ("grey") market rate for other tradable goods, allowing for financial flows and holding of foreign money by the residents. De Macedo finally concludes that the government should let the two different rates coexist to fight against DD.

Lastly, Edwards (1986) studies a coffee price boom in Colombia and develops a model composed of three different but interrelated blocks : a monetary block, an inflation block, and an exchange rate block. This model adds to the spending effect a monetary effect, and an effect on the nominal exchange rate (by omitting factors of production, the author does not model the resource movement effect). The coffee price impacts inflation through price increases in the non-tradable sector caused by the (real side) spending effect. It also generates an increase in money demand (because of higher income due to rent) and in money supply (foreign money inflows or increase in net foreign assets), which causes excess money demand (deflationary pressure) or excess money supply (inflationary pressure). Moreover, foreign money inflows appreciate the nominal exchange rate. This generates a short-term real exchange rate appreciation through an accumulation of foreign reserves, excess money supply, and non-tradable price increases, which exceed the equilibrium real appreciation resulting from the boom.

As shown above, the early 1980s were characterized by an extensive theoretical literature on DD modelling (see Table 1.1 for an overview). We discuss here briefly some key messages of this literature. First, DD can be caused by different types of resource booms. Even if most models investigate the impact of exogenous resource price variations or surges in resource revenues, some also assess the impact of resource discoveries (Buiter and Purvis, 1980), changes in fiscal policy towards the resource sector (Bruno and Sachs, 1982), or technological progress (Corden and Neary, 1982). Even if hydrocarbons or energy products often feature in the analyses, DD can also be driven by mining resources or agricultural commodities (such as coffee in Edwards, 1986). Second, all the models rely on some major assumptions : small open economy, full use of factors of production (no unemployment), and natural resources being fully exported. Even if the first assumption is plausible in many developing countries, the two others seem more questionable. It is also noteworthy that most models are based on an internal approach to the exchange rate defined as the ratio of tradable to non-tradable prices (e.g. Bruno and Sachs, 1982 ; Corden and Neary, 1982 ; Neary, 1982 ; Neary and Purvis, 1982 ; Aoki and Edwards, 1983 ; Van Wijnbergen, 1984a). This approach interprets DD as an explanation for structural transformations and differs from the external definition of exchange rates (ratio of domestic to foreign prices) which focuses on external competitiveness. While the former approach is dominant in the early theoretical literature, the latter approach is dominant in empirical studies, even when they directly refer to Corden-Neary as the seminal model (see section 1.3). Lastly, three channels of DD are identified : the spending effect, the resource-movement effect, and the liquidity effect. The focus in the empirical literature on the model of Corden-Neary might explain why the liquidity effect has often been neglected.

1.2.3 Extended Dutch Disease Models and Recent Approaches

While the general principles of modeling DD have been developed 40 years ago, the theoretical literature have continued to be active. We present here some more recent models that have tried to develop new approaches of DD or to capture different consequences of the DD.

Whatever the exact composition of the tradable sector, it is frequent to assume that export-oriented firms are somehow special because they benefit from economies of scale, have learning-by-doing ef-

Table 1.1 – Early Theoretical Models of Dutch Disease

Article	Sectors	Production Factors	Exchange Rate	Effects
Buiter & Purvis (1980)	***Resource*** : exported and consumed ***Tradable*** : exported and consumed ***Importable*** : consumed but not produced	***Labor*** : T and M / mobile	P_M/P_T	Spending
Bruno & Sachs (1982)	***Resource*** : exported and used as input ***Tradable*** : exported and consumed ***Non-Tradable*** : produced but not traded	***Labor*** : T and N / mobile ***Capital*** : T and N / immobile in SR ***Composite inputs*** : T and N / mobile	P_N/P_T	Spending
Corden & Neary (1982)	***Resource*** : fully exported ***Tradable*** : exported and consumed ***Non-Tradable*** : produced but not traded	***Labor*** : all sectors / mobile ***Capital*** : all sectors / immobile	P_N/P_T	Spending Resource-Movement
De Macedo (1982)	***Resource*** : fully exported ***Tradable*** : exported and consumed ***Non-Tradable*** : produced but not traded	***Labor*** : all sectors / mobile	$p = EP_T^*/\tilde{E}P_R^*$ $q = P_N/\tilde{E}P_R*$	Spending
Neary (1982)	***Resource*** : fully exported ***Tradable*** : exported and consumed ***Non-Tradable*** : produced but not traded	***Labor*** : all sectors / mobile ***Other factor*** : all sectors / immobile	P_T/P_N	Spending Resource-Movement Liquidity
Neary & Purvis (1982)	***Resource*** : fully exported ***Tradable*** : exported and consumed ***Non-Tradable*** : produced but not traded	***Labor*** : T and N / mobile ***Capital*** : R and T / immobile in SR ***Other Factor Specific to R***	P_T/P_N	Spending Resource-Movement
Aoki & Edwards (1983)	***Resource*** : fully exported, public ***Tradable*** : exported and consumed ***Non-Tradable*** : produced but not traded	***Labor*** : T and N / mobile	P_T/P_N	Spending Resource-Movement
Van Wijnbergen (1984a)	***Resource*** : fully exported ***Tradable*** : exported and consumed ***Non-Tradable*** : produced but not traded	***Labor*** : T and N / mobile ***Capital*** : T and N / immobile	P_N/P_T	Spending
Edwards (1986)	***Resource*** : fully exported ***Tradable*** : exported and consumed ***Non-Tradable*** : produced but not traded		EP_T^*/P_N	Spending Money Demand/Supply Nominal Exchange Rate

fects, or create positive spillovers for the other sectors. Thus, a decline in non-resource tradables can be detrimental to long-term economic development. For instance, van Wijnbergen (1984b) develops a dynamic model of DD with learning-by-doing effects in the tradable sector and concludes that subsidies should compensate for the crowding-out of non-oil traded sectors induced by DD. Torvik (2001) develops an augmented model of DD but with learning-by-doing in both traded and non-traded sectors and learning spillovers between sectors. He concludes that the final impact on long-term growth of exchange rate appreciation largely depends on the relative size of the learning-by-doing effects and spillovers in each sector (the larger the learning-by-doing effect in the traded sector or the spillovers from the traded sector the more likely a final drop in productivity and inversely for the non-tradable sector).

Using a dynamic growth 2-sector model, Behzadan et al. (2017) show that DD can be fueled by a shift in demand alone (without the resource-movement effect) with unequal distribution of the rent (as a pure windfall, or an enclave) that generates a gradual fall in manufacturing characterized by learning-by-doing. This finding implies that a higher level of pre-existing inequalities tends to worsen DD effects, which is crucial especially in resource-rich countries where inequalities are often high. The main intuition behind their model is that in developing countries, non-tradables (especially services) are mainly luxury goods, implying that wealthier households have a higher marginal propensity to consume these goods than poorer households. Under this assumption, if the rent generated by resource revenues is captured by wealthier households, then a high pre-existing level of inequality in the country will worsen the DD effects by increasing even more the demand for non-tradables at the expense of tradables. They also test this model on a panel of 61 developing and emerging countries between 1965 and 2008 and conclude that the more equally resource rents are distributed, the less pronounced DD is.

Bahar and Santos (2018) investigate the impact of resource revenues on export diversification through a modified model of DD. They consider that some firms are more labor-intensive than others, and so include transport costs for exporting firms in their DD model. This implies that, even within the tradable sector, only the more productive firms can export. Therefore, a resource windfall raises wages and reduces profits, which leads some firms to stop exporting (because they are no longer able to pay the transport costs) and forces the more labor-intensive firms to leave the market. At the end, the total number of exporting firms decreases, and, under a monopolistic competition framework, diversity of exports decreases. This study differs from the rest of the literature by looking at a different way through which natural resources can affect the structure of the economy based on a modified-DD mechanism.

1.2.4 General Equilibrium Models

Following these theoretical models, some authors have developed general equilibrium models and applied them to real case studies. We describe first briefly two early models that have been proposed for developing countries. Benjamin, Devarajan and Weiner (1989) study the case of Cameroon using a Computable General Equilibrium (CGE) Model with 11 sectors. Their model diverges from the original Corden-Neary (1982) on two main points. First, the authors consider three labor groups : rural, urban unskilled, and urban skilled labor. Second, they consider that tradable products are imperfect substitutes for international goods, with a coexistence within the economy of perfectly non-tradable sectors (construction and public services) and imperfectly tradable sectors (with different degrees of tradability). Given the characteristics of Cameroon, they predict that an oil boom will positively affect the sectors of construction and of capital goods, but hamper cash crop production, forestry, food processing, and public services. Kayizzi-Mugerwa (1991) also applies a multi-sector general equilibrium model to Zambia to estimate the impact of booms and busts in international copper prices on sectoral output and exports under different policy scenarios. The author distinguishes 7 sectors (agriculture, mining, manufacturing, construction, commerce, transport and communications, and services) and concludes that a boom in copper prices has a negative impact on manufacturing and transportation, but a positive impact on services (with no strong impact on other sectors) as predicted by DD. Interestingly, Kayizzi-Mugerwa also finds that a bust in copper prices is expected to depress activity in manufacture and transportation (even if the impact is lower than with a boom), implying that rises and falls in resource prices might have asymmetrical effects. Similarly, Levy (2007) who calibrates a CGE model for the Chadian economy in order to investigate the impact of oil revenues (and their use through public investment) on agriculture and infrastructure development.

More recently, the literature has been marked by a re-emergence of the interest in Dutch disease modelling, notably through the use of Dynamic General Stochastic Equilibrium (DSGE) Models. In this strand of the literature, one can mention Batté, Bénassy-Quéré, Carton and Dufrénot (2010) for Western Africa; Berg, Portillo, Yang and Zanna (2013) for CEMAC countries and Angola; Richmond, Yackovlev and Yang (2015) for Angola; Garcia-Cicco and Kawamura (2015) for Chile; or Allegret, Benkhodja and Razafindrabe (2018) for Algeria. These models typically aim at determining the most efficient fiscal/monetary policy to face DD effects. We will therefore present them in more detail in section 1.4. However, the increasing number of DSGE models in the last decade highlights that, while the general principles of DD were developed 40 years ago, the literature on DD modelling has continued to be active.

1.3 Testing Dutch Disease

Since the beginning of the 2000s, a large empirical literature has investigated DD, and generated inconclusive results. Arguably, one reason is that DD, or the predictions of DD models, are conditioned by several simplifying assumptions that do not hold in the real world. Put differently, real conditions across countries are too heterogeneous to allow a homogeneous DD symptom to emerge. A second reason is that investigations are conditioned by data quality, which is sometimes questionable when studying developing countries. Also important is the length of statistical series which can be too short to properly test for long run predictions. A third reason is that, given statistical issues, test results are sensitive to the empirical methodology, the choice of the dependent and explanatory variables, or the length of the modelled lag between the boom and the DD effects.

We present here studies which aim to test DD specifically. We do not cover RC tests (based on growth regressions), except if DD is explicitly explored as a RC channel. The testable predictions which are most frequently used can be put into two groups : (1) the impact of resource price (or resource production, discoveries, or rent) on the real exchange rate ; (2) the impact of resource price (or production, discoveries or rent) on non-resource tradable output.

1.3.1 Impact of Resources on the Real Exchange Rate

This section presents the results of a sample of empirical studies which investigate the impact of natural resource revenues on the exchange rate. One major issue when analyzing Dutch disease relates to the definition of the variables selected for the analysis. Most studies exploit the real effective exchange rate defined as the ratio of domestic to foreign prices (or the opposite). Nevertheless, other indexes can be used, such as the internal exchange rate (defined as the ratio of non-tradable to tradable prices as in Corden and Neary's model), the terms of trade, or domestic inflation. Without being exhaustive, we discuss some typical works in this field.

Studying monthly time-series for Kazakhstan for the period 1996-2003, Kutan and Wyzan (2005) observe that agriculture and industry decline when oil revenues increase, and that oil prices appreciate the RER. They employ a version of the Balassa–Samuelson model of RER, augmented to include the consumer price index and the oil price with six different time lags (using an autoregressive conditional heteroskedasticity (ARCH) model). They find unexpected results with oil prices causing a depreciation when lagged by 1 or 3 months, and an appreciation with prices lagged by 5 months. This is however not supported by Égert and Leonard (2008) for the same country over the 1995-2005 period. These authors estimate the impact of oil prices and a proxy for oil rent (oil price multiplied by oil reserves) on both nominal and real bilateral exchange rates (with the USD) based on a standard monetary model (including home and foreign money supplies, real income, and interest rates). Using Dynamic Ordinary Least Squares (DOLS) estimates and an Autoregressive Distributed Lag (ARDL) model, they find that only the real exchange rate of the entire tradable sector, including oil production, and not that of the non-oil tradable sector, appreciated following an oil boom, underlying the importance of using disaggregated data.

Dülger, Lopcu, Burgaç, and Balli (2013) and Mironov and Petronevich (2015) exploit quarterly data for Russia for the period 1995-2011 and monthly data for 2007-2013 respectively. Using different cointegration methods, both studies find strong evidence that an increase in oil price or oil revenues causes RER appreciation in the long run, but weaker evidence that it causes de-industrialization. Moreover, Mironov and Petronevich (2015) find that the long-term correlation is even stronger between the RER and oil revenues (oil price multiplied by oil exports) than between the RER and oil prices. This could indicate that, while the use of resource prices is justified by its apparent exogeneity (the argument used by a vast majority of the empirical papers), resource revenue could yield better results for detecting DD.

Botswana is one of the few resource-rich African countries that has been studied for a long time, and is often viewed as having avoided DD. This argument was however challenged by Mogotsi (2002). Based on data for the period 1976 to 1995, characterized by a significant boom in diamond production in 1982, the author compares the pre- and post-boom periods using OLS regression. In the RER equation, the explanatory variable is a simple dummy that equals 0 for 1976-1981 and 1 for1982-1987. Mogotsi finds that the RER appreciated in 1982-1987 compared to the previous period, and finds a significant effect of public and private expenditure on RER.

The case of Botswana is also explored by Pegg (2010) who does not find any impact of mining export revenues on RER for the period 1980-2004. However, the bilateral RER appreciated against the South African Rand during the 1980s, but depreciated against the USD and European currencies, underlining the sensitivity of using bilateral rather than multilateral exchange rates.

Like Botswana, Mali is often considered to have escaped from DD following a gold boom in the 2000s. Mainguy (2011) concludes that the RER did not evolve differently in Mali from the rest of the Western African Economic and Monetary Union, and that the country did not show factor movements from the other sectors into mining. Although the author argues that Mali experienced a mild form of DD, a similar conclusion to Mogotsi (2002) and Pegg (2010) for Botswana, the results seem to reject DD in favor of other channels of RC.

In their empirical study, Sala-i-Martin and Subramanian (2012) focus on Nigeria using a well-documented narrative and a set of descriptive statistics based on different measures of the RER, both internal and external, and making use of official and parallel exchange rate, production price and consumption price indices. Overall, they find no statistically significant correlation between oil prices and external RER, and a significant but inverse correlation between oil prices and the internal RER (i.e. an increase in oil prices generates depreciation). Based on these observations, they conclude that there was no DD in Nigeria, and turn to other explanations for the RC, such as rent-seeking behaviors.

Kablan and Loening (2012) apply two VAR Models to estimate the impact of oil production and oil price shocks on the GDP deflator in Chad. Using quarterly data covering the period 1985-2008, they observe a positive impact of oil price shocks on inflation (but an insignificant impact of oil production), and interpret these results as evidence of DD.

Based on annual data for Algeria for 1960-2016, Gasmi and Laourari (2017) test for the presence of a cointegrating relationship between the Algerian real effective exchange rate and a set of parameters that includes international oil prices. Using an ARDL Bound Approach, they reject the hypothesis of a cointegrating relationship among the variables, interpreted as evidence that no spending effect has occurred in Algeria. They argue that this absence of spending effect can (partly) be attributed to the exchange rate regime which maintained a stable real exchange rate against a basket of currencies.

Khinsamone (2017) investigates two potential ways through which mining resources could have generated a long run decline in other productive sectors in the Laos economy : DD and "crowding-out" of productive investment. Applying a VAR model to the period 1980-2014, Khinsamone finds that mining and utility production caused inflation in the country, consistent with the DD explanation.

The last decade has also seen the emergence of empirical studies based on panel data. For example, Égert (2012) uses the methodology of Égert and Leonard (2008) on a panel of 22 resource-rich post-soviet countries in Central and South-West Asia. This study does not support the DD theory since the relationship between oil prices and the RER is insignificant in oil-exporters in the short run. Égert however recognizes that this result may be sensitive to the number of lags in the regressions, in line with Kutan and Wyzan (2005)'s results for Kazakhstan.

Arezki and Ismail (2013) use a panel of 32 oil-producing countries for 1992-2009 to test for the DD-transmission channel of public spending. They use both static models with fixed effects and dynamic GMM estimators. They estimate first the impact of changes in the public expenditure on the real exchange rate, and then the impact of changes in international oil prices on the changes in government spending. The authors use two measures for public current spending and public capital expenditure, then test for non-linear effects of oil price increases, oil price decreases, and oil export value. They conclude that : (i) current expenditure is positively associated with RER ; (ii) oil prices are positively associated with current spending ; (iii) there is a downward stickiness in current expenditure when facing oil price variations. These results imply that negative shocks on tradable sector output caused by a resource boom might persist during the bust.

In DD models, natural resources are often fully exported. However, if this assumption can hold for luxury goods like gold or diamonds, it is less likely for energy products such as gas, coal, and oil. In the case of energy prices, a discovery of resources may help reduce firms' production costs and have pro-industrialization effects if manufacturing industries are more resource-intensive than other activities. Beverelli, Dell'Erba and Rocha (2011) test the impact of an oil discovery, a variable that takes increasing values from 1 to 7 for the 7-year period from the 3 years before the discovery to the 3 years after, on RER variations in a sample of 132 countries, looking at the existence of resource-intensive industries. They find that oil discoveries have a significant positive impact on the RER, but that the higher the share of oil-intensive industries, the less prone to DD the country is. This highlights the importance of considering both (i) the use of natural resources, and (ii) the heterogeneity of these resources between the ones that are used as inputs and the others.

Lastly, Harding, Stefanski and Toews (2020) estimate the impact of giant oil and gas discoveries on the bilateral RER in a panel of 172 countries between 1970 and 2013. They investigate the impact of the net present value of the oil and gas discovery (relative to GDP), which is assumed to be more exogenous than production or prices, on three bilateral (with the USD) sector-specific RERs : for the whole economy, for tradable goods, and for non-tradable goods only. Their results show that DD is driven by its non-tradable component (consistent with the "internal" DD with an exogenous tradable goods price). Interestingly, they also observe that appreciation begins just after the discovery and before oil production begins, which could signal significant expectations.

1.3.2 Impact of Resources on the Production of Tradable Goods

This section discusses a sample of empirical studies investigating the impact of natural resource revenues on structural transformations. We assume that natural resources are associated with a decline in other tradable sectors' outputs or exports. The empirical literature appears to have neglected the effect of resources on exports and has focused on the estimation of the impact of resources on sectoral value-added. This choice may have been motivated by the difficulty of finding accurate trade data for developing countries, or it could be linked with the difficulty to distinguish re-exports (goods imported and exported without transformation) from locally produced exports.

Some early works examined the impact of DD on the sector composition of GDP without the specific focus on manufacture found in more recent studies. For instance, Looney (1990) and Looney (1991) estimate the impact of oil resources on the value-added of several tradable and non-tradable subsectors in Saudi Arabia and Kuwait respectively. To explore channels of DD, the author uses different explanatory variables such as the bilateral RER (against the USD) and the oil sector value-added, together with anticipated Non-oil GDP and government consumption. Looney (1990), for Saudi Arabia, finds that a RER appreciation hampers Agriculture, Manufacture, Mining, and Petroleum Refining (all are exportable sectors); but benefits Construction, Wholesale and Retail Trade, Transport, Storage and Communications, and Ownership of Dwellings (mainly non-tradable sectors). Looney (1991) finds a large negative impact of oil revenue on manufacture in Kuwait but a smaller impact on agriculture. However, he never discusses the small open economy assumption, in terms of oil production and exports, which is debatable for Kuwait and Saudi Arabia. Another important article comes from Fardmanesh (1991) who investigates the impact of the share of oil revenues in total GDP on agriculture, manufacture and the non-tradable sector separately in 5 oil-exporting countries (Algeria, Ecuador, Indonesia, Nigeria and Venezuela) for the period 1966-1986. Based on OLS regressions, he observes a clear negative impact of oil revenues on agricultural output in all countries except Venezuela (where the impact is not significant), but a positive effect on the manufacturing and the non-traded sectors in all 5 countries. These results seem to support the idea that the agricultural sector is likely to be the main tradable sector in developing countries. On the contrary, manufacture appears here to be a relatively protected sector (imperfectly tradable). Despite these few articles that focus on sub-sectoral levels, most empirical analyses of DD in developing and emerging economies prefer to focus either on the de-industrialization or on the de-agriculturalization effects of the disease.

Neither Dülger et al. (2013) nor Mironov and Petronevitch (2015) could find robust evidence that oil resources generated a decline in manufacturing output in Russia, despite the obvious presence of an exchange rate appreciation. In addition, Ito (2017) also rejects DD in the case of Russia for the period 2003-2013. Using a VECM, he finds that an increase in oil price and an appreciation of the RER is associated with a slight increase in manufacturing production.

Mogotsi (2002), for Bostwana, finds that mining resources appreciate the RER by increasing public and private consumption. However, there is no absolute impact of the boom on wages and output in manufactures, but a relative decline in manufacturing output compared to non-tradables. This allows her to conclude that Botswana suffered from a “mild form” of DD, that can be explained by a high level of pre-existing unemployment before the boom, reducing the resource-movement effect.

While empirical studies have mostly focused on oil, gold or diamond revenues, Hodge (2015) studies the impact of metal prices on manufacturing output in South Africa for the period 1980-2010.

Using a vector error correction model (VECM), he observes a negative impact of REER appreciation but a small positive impact of metal prices on manufacturing output, concluding that DD did not occur. However, since the regression includes both the REER and metal prices, and since the impact of metal prices on the RER per se is not modelled, this interpretation is debatable : the estimated impact of metal prices is the residual direct impact of metal price, apart from its indirect impact through RER appreciation, which is not tested.

Having concluded that there was an absence of an appreciation effect caused by international oil prices in Algeria, Gasmi and Laourari (2017) also test the direct impact of oil prices on manufacturing sector growth. Based on an ARDL model, they find a positive impact of the real effective exchange rate on the manufacturing sector, but a negative impact of oil price on the manufacturing sector, both in the short and in the long term. They explain these results by the possibility that only a resource-movement effect might have occurred, hence that Algeria suffered only from a "partial" Dutch disease. However, they remain cautious regarding this conclusion and underline that other causes than the DD can explain this negative relationship between oil price and growth in the manufacturing sector.

López González, Torres Gómez and Giraldo González (2016) investigate the industrial decline in Colombia following the mining boom at the end of the 2000s. They use OLS and Beta regressions and find a negative impact of the share of mining revenues in total non-mining GDP on the share of industry in total GDP, and a similar negative impact of the RER. In addition to the evidence that mining resources generated inflation in Lao PDR between 1980 and 2014, Khinsamone also observes a negative long-run impact of mining resources on the manufacturing-to-services ratio with a Vector Autoregressive (VAR) model.

Taguchi and Khinsamone (2018) study five resource-rich ASEAN countries (Malaysia, Indonesia, Lao PDR, Myanmar and Vietnam) over the period 1970-2015. They estimate the impact of mining and utilities production on the manufacturing-to-services ratio using time-series VAR models for each country separately, rather than using panel data analysis, to better account for heterogeneity. They conclude that a de-industrialization process occurred caused by mining resources for Lao PDR and Myanmar, but not for Malaysia and Vietnam. They also find that Indonesia experienced a DD before 1996, but not afterwards. The authors argue that this difference is related to the quality of institutions and policies implemented by these countries. Public expenditure management and the implementation of a resource Fund are found to be highly effective against DD, as well as strategies aimed at diversifying production structures and the quality of institutions.

A few authors have recently exploited larger panel datasets to analyze the impact of resource revenues on structural transformation. Ismail (2010) uses pooled OLS and fixed-effects estimators on a panel of 90 countries for the period 1997-2004. The results reveal a negative impact of oil price shocks on manufacturing industries, but the impact increases with the openness to foreign investments and decreases with the capital intensity of the manufacturing sector, which is consistent with the Rybczynski theorem.

De-agriculturalization has also been studied as an effect of DD in developing countries. The Corden-Neary model and its extensions allowed agriculture to be a tradable sector that DD may affect negatively, which seems relevant for many developing countries. A high share of agriculture in total production and exports characterizes Sub-Saharan African and Latin American countries. One of the first empirical studies on agriculture is Scherr (1989) who compares three oil-exporting countries : Indonesia, Mexico, and Nigeria. Based on descriptive statistics, she finds evidence that oil booms led to a decline in the agricultural sector particularly in Nigeria, but less in Indonesia, suggesting that economic policies play a key role. More recently, Orvoty and Jibrilla (2019) explore the impact of DD on agriculture in Nigeria over the period 1981-2016, arguing that Nigeria is an under-industrialized economy whose agriculture mainly relies on export crops. Based on a VECM and OLS regressions, they observe a negative impact of crude oil prices on agricultural value-added and conclude that DD caused de-agriculturalization.

Mexico has drawn most of the attention in the empirical literature on DD in Latin America. For instance, Feltenstein (1992) analyses the different channels of the impact of oil price changes in

1986-1987 on the RER, on the wage differential between rural and urban areas, the subsequent rural-to-urban migration, and the impact on agriculture. Based on a simple two-period model, he concludes that DD effects caused by oil revenues hampered agricultural production and encouraged urbanization.

As seen previously, a boom can appreciate the RER but with no significant impact on manufacturing or agricultural production. Inversely, a decline in tradable sectors can occur with no strong evidence of RER appreciation. As an example, this result emerges from Mainguy (2011)'s study of a gold boom in Mali which was followed by a drop in cotton production, but with no specific RER appreciation (compared to the other WAEMU countries). Following Pegg (2010), Mainguy explains that Mali, like Botswana, could have suffered from DD without suffering the causal mechanisms identified in the DD literature, but also that the decline in agriculture could be explained by other causes (such as high fixed costs, low productivity, international competition, or the lack of adequate government investments).

Based on two VAR, Kablan and Loening (2012) investigate the impact of oil production and oil prices on manufacturing and on agricultural value-added in Chad. They do not observe any significant impact of oil booms or of oil price variations on the manufacturing sector, but a significant negative impact of energy booms on agriculture after one year, concluding that there was the presence of a disease only for agriculture.

Among the very few works on the impact of DD on agriculture that use panel data, Apergis, El-Montasser, Sekyere, Ajmi and Gupta (2014) study a sample of oil-dependent Middle East and North African countries for 1970-2011. Using a dynamic Error Correction Model (ECM) they observe negative correlation between oil rent and agricultural value-added in the long term. Another panel data analysis by Abdlaziz, Naseem and Slesman (2018) estimates the impact of oil prices on 25 developing net oil-exporting countries on agricultural value-added from 1975 to 2014. Using Fully Modified OLS, Dynamic OLS and Pooled-Mean-Group estimators, they conclude that there was a negative effect of oil prices on the agricultural sector.

Finally, a few recent studies have aimed to identify potential regional spillover effects of resource booms using geographical model and/or data. For instance, Shao, Zhang, Tian and Yang (2020) develop a spatial Durbin model to investigate the presence of a Dutch disease in China at the provincial level. For this, they first estimate the impact of a local resource boom on manufacturing output. They conclude to a negative impact of resource booms, although when decomposing between energy (fuels), metallic and non-metallic minerals, only energy products have a significant impact. Then, they try to separate the spending and resource-movement effects by investigating the impact of resource booms on movements movements of capital and inflation in both local and neighboring provinces. They conclude to the existence of both spending effect (inflation) and resource-movement effect (crowding-out of employment and capital) in China. Similarly, Pelzl and Poelhekke (2021) construct a database of all resource deposits by districts in Indonesia and investigate the impact of resource price surges on resource-rich districts and on their neighboring districts. Using firm-level data for manufacturing industries and differentiating between different categories of firms, they conclude that resource booms lead to crowding-out of manufacturing employment but only in districts with mainly labor-intensive and export-oriented manufacturing firms, and without evidence of spillover effects on neighboring areas.

1.3.3 Other Approaches to Dutch Disease

Although the DD models originally aim at explaining de-industrialization or de-agriculturalization through ER appreciation, the DD literature is not restricted to the analysis of structural transformations and ER variations only. On the contrary, the 2000s and 2010s have seen the emergence of new approaches to DD, focusing on different variables of interest. For instance, Ross (2008) has proposed natural resources and the DD effects as an explanation for the gender gap in the labor force participation. The intuition is that, if female workers are more frequently employed in non-resource traded activities (notably agriculture and export-oriented factories) and excluded from some non-traded activities (such as construction), the decline in the non-resource sector caused by the DD will rise female unemployment more than male unemployment. Based on employment data for a panel of 169 countries between 1960 and 2002 and using OLS with Fixed-Effects and First-Differences, Ross concludes that oil rents have a large and significant negative impact on female labor force participation, but also on female participation in national political institutions. These conclusions are also partially shared by Mavisakalyan and Tarverdi (2019). Following Ross' model, the authors however relax the initial assumption that female workers cannot enter the non-traded sector and propose a two-stage least squares (2SLS) estimate as an alternative to address potential endogeneity in the results. They conclude that oil revenues decrease the share of women employed in industry but increases the share of women employed in services. In addition, the authors try to estimate social impacts of oil resources on women and conclude that women in oil-rich countries tend to marry early and have more children than in other countries.

Cherif (2013) considers learning-by-doing effects in a developing country setting with a pre-existing technological gap between developing and industrialized countries. The main idea is that the higher the initial technological gap vis-à-vis the main trading partners, the higher the negative impact of a resource windfall on other exporting sectors. Based on a panel of 38 countries between 1990 and 2005, the author concludes that DD tends to widen the initial technological gap at the expense of resource-rich economies. Therefore, DD is likely to be a concern for developing countries because of potential boom/bust asymmetric effects : the losses in productivity and growth in non-resource tradable sectors during the resource boom might not be recovered after the end of the boom, leading to a long-run decline in overall production. It should be noted that such learning-by-doing effects are not restricted to manufacturing industries. Rudel (2013) describes this phenomenon in agriculture where children are unlikely to come back and contribute to agricultural production because they have not benefited from a transfer of knowledge from their parents who left the sector during a resource boom.

Using a dynamic 2-sector model, Behzadan et al. (2017) develop a theoretical model to show that a higher level of pre-existing inequalities tends to worsen DD effects (see section 1.2). They test this model on a panel of 61 developing and emerging countries between 1965 and 2008, using notably the difference and system GMM estimators. They conclude that the more equally resource rents are distributed, the less pronounced DD is, in line with their predictions. It is noticeable that natural resources are often assumed to increase inequalities, through corruption and rent-seeking behaviors. In that case, the results from Behzadan et al. could suggest the risk of a vicious circle between inequalities and DD effects in resource-rich developing countries.

Bahar and Santos (2018) apply a model with heterogeneous firms to a panel of 128 countries between 1984 and 2010 in order to test their assumption that DD effects can lead to a decline in export diversification (through a decline in the number of non-resource exporting firms). Using Fixed-Effects, 2SLS and Difference-in-Differences estimators, they conclude to a concentration effect toward capital-intensive products caused by natural resources exports.

Several lessons can be inferred from this review. First, it appears that the distinction between agriculture and manufacturing as the main exportable sector is important when investigating the presence of DD, especially in developing countries. Indeed, various studies conclude that a boom in natural resources revenues may lead to "de-agriculturalization" instead of "de-industrialization". Second, even if both steps of DD, the RER appreciation and the decline in tradable output, have been observed, they may not occur jointly, underlying the importance of investigating the different DD channels. Many empirical studies find evidence of an appreciation effect without evidence of a decline in non-resource tradable sectors, suggesting that DD might not be a disease for the real economy. On the other hand, a few studies find a negative impact on tradables without exchange rate appreciation (Mainguy, 2011 for Mali ; Gasmi and Laourari, 2017 for Algeria), indicating that only a resource-movement effect has occurred or that some classical assumptions of DD models are miss-specified. Third, the DD literature is not restricted to the analysis of de-industrialization only. On the contrary, several authors have tried to link this phenomenon to other economic or social processes, underlying the importance not to neglect this effect when studying resource-rich countries. Fourth, it appears that some underlying assumptions of DD models must (and have started to) be questioned. This is the case for the assumption that natural resources are never used as an input (see Beverelli et al., 2011) or that the effect is local and cannot be exported (Shao et al., 2020). However, further analyses are required on the subject. Finally, and paradoxically, empirical studies using large panels of countries tend to support DD, while country-case analyses generate more mixed results (see Table 1.2). Although a publication bias cannot be excluded, this overall picture may indicate that DD is a real threat, but not a curse, and can be avoided with sound public policies. This is also confirmed by multiple time-series analyses which find evidence of DD in some countries but not others. The next section investigates the policy mix options for escaping DD, based on the observations drawn from both the theoretical and empirical literature.

Table 1.2 – Main Empirical Studies on Dutch Disease

	Article	Context	Data Source	Focus on	Evidence of DD
Country-Case Studies or Multiple Time-Series	Scherr (1989)	Indonesia, Mexico, Nigeria : 1970-1982	FAO, UN, WB	Agriculture	Yes
	Looney (1990)	Saudi Arabia : 1970s-1980s	National Statistics	Manufacture	Yes
	Fardmanesh (1991)	Algeria, Ecuador, Indonesia, Nigeria, Venezuela : 1966-1986	WB	Agriculture, Manufacture	Yes (for agriculture)
	Looney (1991)	Kuwait : 1970-1986	National Statistics	Manufacture	Yes (mild form)
	Feltenstein (1992)	Mexico : 1974-1987	IFS, WB	Agriculture	Yes
	Mogotsi (2002)	Botswana : 1976-1995	IFS, National Statistics	Industry	Yes (mild form)
	Kutan & Wyzan (2005)	Kazakhstan : 1996-2003	IMF, CB, National Statistics	RER	Yes
	Égert & Leonard (2008)	Kazakhstan : 1995-2005	IMF, National Statistics	Manufacture	No
	Pegg (2010)	Botswana : 1980s-2000s	IMF	RER, Sectors	Yes (mild form)
	Mainguy (2011)	Mali : 1990s-2000s	IMF, BCEAO, French CB	RER, GDP Growth	No
	Kablan & Loening (2012)	Chad : 1985-2008	IFS, WDI, Geointelligence	Agriculture, Industry	Yes (for agriculture)
	Sala-i-Martin & Subramanian (2012)	Nigeria : 1970-2000	WDI	Prices, GDP Growth	No
	Dülger et al. (2013)	Russia : 1995-2011	National Statistics and others.	RER, Industry	Yes
	Hodge (2015)	South Africa : 1980-2010	IFS, OECD, CB	Industry	No
	Mironov & Petronevich (2015)	Russia : 1997-2013	National Statistics and others.	RER, Industry	Yes
	López González et al. (2016)	Colombia : 2000s-2010s	National Statistics	Industry	Yes
	Gasmi & Laourari (2017)	Algeria : 1960-2016	IMF, WB, National Statistics	RER, Manufacture	Yes (partial form)
	Ito (2017)	Russia : 2003-2013	EIA, IFS, National Statistics	Industry	No
	Khinsamone (2017)	Lao PDR : 1980-2014	National Statistics	CPI, Manufacture	Yes
	Orvoty and Jibrilla (2019)	Nigeria : 1981-2016	WDI, CB, National Statistics	Agriculture	Yes
	Shao et al. (2020)	China : 1994-2016	National Statistics	Manufacture	Yes
	Pelzl & Poelhekke (2021)	Indonesia : 1990s-2000s	S&P Global, National Statistics	Manufacture	Yes
Panel Data Analyses	Ross (2008)	169 countries : 1960-2002	ILO, WDI	Female Labor Force Participation	Yes
	Ismail (2010)	90 countries : 1977-2004	IFS, PWT, UNIDO	Industry	Yes
	Beverelli et al. (2011)	132 countries : 1970-2010	US Statistics, PRIO	RER	Yes
	Égert (2012)	Post-soviet Asian countries : 1992-2006	WDI	NER, RER, Manufacture	No
	Arezki & Ismail (2013)	32 countries : 1992-2009	IMF	RER	Yes
	Cherif (2013)	38 countries : 1990-2005	GGDC	Manufacture	Yes
	Apergis et al. (2014)	8 MENA countries : 1970-2011	WDI	Agriculture	Yes
	Behzadan et al. (2017)	61 countries : 1965-2008	WB	GDP	Yes
	Abdlaziz et al. (2018)	25 developing countries : 1975-2014	WDI, EIA	RER, Agriculture	Yes
	Bahar & Santos (2018)	128 countries : 1984-2010	UN, WDI, GEM, Horn (2010)	Export Concentration	Yes
	Taguchi & Khinsamone (2018)	5 ASEAN countries : 1970-2015	National Statistics	Manufacture	Yes
	Mavisakalyan & Tarverdi (2019)	169 countries : 1993-2002	Ross (2008)	Female Labor Force Participation	Yes
	Harding et al. (2020)	172 countries : 1970-2013	UN, IMF, Horn (2010)	Bilateral RER	Yes

1.4 Responding to Dutch Disease

This empirical literature review has confirmed that the seminal theoretical models of DD can help to understand some economic processes currently happening in resource-rich developing countries. However, the question remains whether appropriate public policy and efficient management of natural resource revenues can help mitigating DD. We describe in this section the lessons that can be drawn from the theoretical and empirical literature relative to the role of macroeconomic policies.

1.4.1 The Central Role of Fiscal Policy

There is a large literature relative to the role of fiscal policy in preventing (or at least mitigating) the adverse effects of DD. The main questions are usually related either to the adequate level of resource taxation, or to the most efficient use of the revenues coming from this taxation (investment, current expenditures, subsidy for declining sectors, savings, etc). However, this literature has evolved over time, from a focus on the role of taxation of resource sectors and redistribution to non-resource tradable sectors (compensation of DD effects) in the 1980s and early 1990s, to a focus on adequate public management of natural resource revenues (prevention of DD caused by public spending) in recent years. This section covers the evolution of this literature, by first describing the arguments in favor of public redistribution across sectors, and second by presenting the debate on the optimal equilibrium between spending and saving.

Can Redistribution Across Sectors Help Mitigate Dutch Disease Effects ?

When looking at the seminal models of DD, it is striking that the question of fiscal policy is mostly related to the support of the tradable non-resource sector through redistribution (elaborated as industrialization policy). Corden (1984) argues that taxation of the resource sector to subsidize the tradable sector firms and workers (compensation) can help mitigate DD. He also discusses the case of the protection of tradable sectors but shows preference for the former strategy. Indeed, protecting local industries from imports by using trade barriers might be too costly, and will protect both resource and non-resource tradable sectors. Van Wijnbergen (1984b) models the tradeoff between preventing DD by saving most of the revenues or correcting it through public redistribution (tax and subsidies) in favor of the declining sectors. According to the author, subsidies should be preferred since conditions for an efficient accumulation of Net Foreign Assets (NFA) would hardly be met. Using a CGE model inspired by Benjamin et al. (1989), Levy (2007) simulates the effect of an oil boom on the Chadian real exchange rate, GDP, and sectoral production under different scenarios of public investment. She concludes that when oil revenues are partly invested by the government in agriculture (e.g. in the irrigation system), RER appreciation can be avoided, and oil revenues can be a very powerful tool to reduce poverty, boost economic growth, and enhance agricultural productivity. Even though some predictions of this model are specific to the Chadian economy (which suffers from inefficient water management and insufficient food availability), it reveals that adequate public investment in the declining sector should be considered. Similarly, Indonesia is often presented as having avoided a decline in non-oil tradable sectors partly through efficient public investment in industrial and agricultural sectors, and has been used as a benchmark for many countries (Mogotsi, 2002 ; Pegg, 2010). The idea that the resource sector should be taxed is also shared by Bresser-Pereira (2008 ; 2020). Following a post-keynesian approach and considering that the DD can be assimilated to a sort of Ricardian rent [1], the author defends the idea of a tax on natural resources exports, if possible positively correlated with the international price of the resource in question.

However, this strategy also presents some major drawbacks which are rarely discussed in this literature. First, it requires an efficient tax system, able to tax the resource sector and redistribute revenues to other sectors without losses during the process, which might not be possible in countries with weak governance. If natural resource abundance tends to encourage corruption, then the corruption channel of RC might reduce the willingness or ability of authorities to mitigate DD effects, which in return may feed institutional corruption through redistribution of wealth and revenue across sectors. Second, redistribution requires the identification of the sectors that will suffer most from DD consequences, which necessitates an efficient information and analysis system. Otherwise, subsidies can be subject to lobbies and rent-seeking behavior in sectors that would have

1. With the difference that the resource boom still has some positive impacts on the economy in the short-run, and that the DD can be neutralized with adequate fiscal policy

declined even without DD. Finally, if the level of subsidy is directly linked to the level of resource revenues, a high volatility in international commodity prices will generate a high volatility in subsidies.

Saving or Investing ?

Instead of focusing on redistributive policy across sectors, another strategy might be to implement fiscal rules or to save a large share of resource revenues so that to prevent DD. A spending effect is partly caused by public spending (through either current consumption or investment), hence imposing rules to limit public expenditure seems an obvious strategy. In addition to limiting DD effects, saving resource revenues also has two main advantages. First, creating a liquidity buffer will help to face sudden negative shocks in resource revenues that arise from the volatility of commodity prices. Second, accumulating revenues in a fund generating interests will allow to smooth consumption even after depletion of resource reserves. Hence, savings contribute to facing the three challenges that resource-rich countries often face : revenue volatility, resource exhaustion, and DD. This explains why fiscal rules have been implemented in various contexts. The tightest fiscal rules rely on a balanced non-resource budget (government budget must be at equilibrium without accounting for resource revenues) : all resource revenues are saved or used for debt repayment. But more flexible rules exist. Saving can only concern excess revenues, that is the difference between actual revenue and "minimal" revenue, which can be estimated with a low resource price. An example is provided by the Chile structural balance budget mechanism, where excess revenues, generated by an international copper price higher than the estimated long run price, are saved to counter future negative shocks. Fiscal rules can also be based on resource wealth. For instance, Timor-Leste implemented a fiscal rule stipulating that the current non-resource public deficit cannot be more than 3% of the net present value of total natural resource wealth (AfDB/BMGF, 2015). Lastly, fiscal rules can target the non-resource primary budget including investment or specific expenditures, as in Botswana where diamond revenue can only be used to finance investment or current spending on education or health (Pegg, 2010).

The main remaining question is whether resource revenues which are not used for current expenditure should be saved or invested.

If the main goal is to prevent DD, saving excess revenues might seem optimal. Sovereign Wealth Funds (SWF) have emerged over recent decades as useful institutions for saving. For instance, Anne (2019) finds a total of 63 SWFs in 39 countries (either still in operation or not). Most of them manage revenues from hydrocarbons but others are for mining resources such as diamonds (like the Pula Fund in Botswana), or copper (the Economic and Social Stabilization Fund and the Pension Reserve Fund in Chile). Wills, Senbet and Simbanegavi (2016) review the literature on SWF and conclude that fighting against DD is one of their 6 main goals[2]. Countries can have two or three different SWFs with different goals too. For instance, in Ghana, the Ghana Stabilization Fund (aimed at smoothing oil revenue over time), the Heritage Fund (to save revenue for future generations,) and the Ghana Infrastructure Investment Fund (to finance infrastructure projects) coexist. Regarding SWFs' performance, Raymond, Coulibaly and Omgba (2017) investigate their impact on exchange rate misalignments in 24 oil- and gas-exporting

2. The 5 others being intergenerational transfer (in line with the Permanent Income Hypothesis), parking motive (hold revenues until better opportunities of investment are available), stabilization motive (consumption smoothing), political accountability motive (to avoid corruption), and portfolio diversification motive. For a detailed typology of SWF, one can also refer to Anne (2019).

countries and conclude that having a SWF reduces the volatility of RER misalignments. Instead of creating a SWF, resource revenues can also be simply accumulated by the central bank. Due to high fixed costs, a SWF should be preferred only when expected future resource revenues are large enough (AfDB/BMGF, 2015). It must also be noted that the quality of the governance of the SWF clearly matters for its success, even though this question is rarely raised in the theoretical literature. For instance, a report from the Natural Resource Governance Institute concludes that among the ten SWF assessed in Sub-Saharan Africa, only 2 achieve a good (Ghana Stabilization Fund) or satisfactory (Botswana Pula Fund) score in terms of governance, while all others reach scores lower than 40 (scores being comprised between 0 and 100) (NRGI, 2019). Three of them are even scored below 10, and ranked last in the world (the Fund for Future Generations in Equatorial Guinea, the Oil Revenue Stabilization Account in Sudan and the Excess Crude Account in Nigeria). This heterogeneity across funds in terms of governance and corruption might partly explain the difficulty to estimate precisely the efficiency of such funds in cross-sectional analyses.

However, many reasons exist for not saving all resource revenues. First, developing countries often suffer from capital scarcity, implying that resource revenues could be efficiently invested in sectors with high marginal returns. It is also noteworthy that if such investment is suitably made, they can help, better than external savings, to face future commodity price shocks or smooth consumption in the long run by increasing non-resource sectors' economic growth. Many governments in developing countries lack adequate fiscal systems, and face difficulties when trying to collect taxes, which implies a lower level of public expenditure than the economy would require : neglecting large inflows of revenues by saving them in an external fund might not be the optimal strategy to maximize welfare in the long term. Hence, some popular approaches such as the "Permanent Income" (perfect smoothing of consumption over time), or the "Bird-in-Hand" approach (all resource revenues are saved into an external fund and only interests are spent), applied in Norway might not be suitable in a developing country context. As noted by Géronimi and Mainguy (2020), the common idea that resource revenues generated by a boom must be fully saved relies on the implicit assumption that mistaking a transitory boom for a permanent one would be worse (in terms of policy efficiency) than the opposite (i.e. spending more than the optimum would be a more serious mistake than spending less than the optimum), which is questionable. This is in line with the Chilean case where most of copper revenues generated by the rise in international prices were saved due to the balance budget mechanism (Segal, 2012), which might retrospectively have led to an under-optimal level of investment considering that the boom was more durable than expected. We can also underline that, if revenues are efficiently invested in the productive structure of the economy, a contemporary fiscal deficit might gradually subside thanks to the increasing non-resource output and the subsequent non-resource fiscal revenues. This explains why Chang and Lebdioui (2020) argue that “Diversification [is] the best long-term fiscal stabilization strategy”. To support this point, they oppose the contrasting examples of Malaysia and Botswana. While Malaysia incurred important fiscal deficits until the end of the 1990s despite large oil revenues, these were used to finance productive capital assets, contributing to long-run economic diversification and reducing the country’s volatility toward oil price variations. On the contrary, the authors argue that Botswana, which has often been presented as a success story in terms of public revenues management, did not succeed in diversifying its export structure. Overall, since resource revenues may solve many of the challenges that developing countries are facing (lack of physical or human capital, low public revenues, reduced access to financial markets etc), it is not surprising that the fight against DD is looked upon as secondary in the discussion on the optimal use of resource revenues.

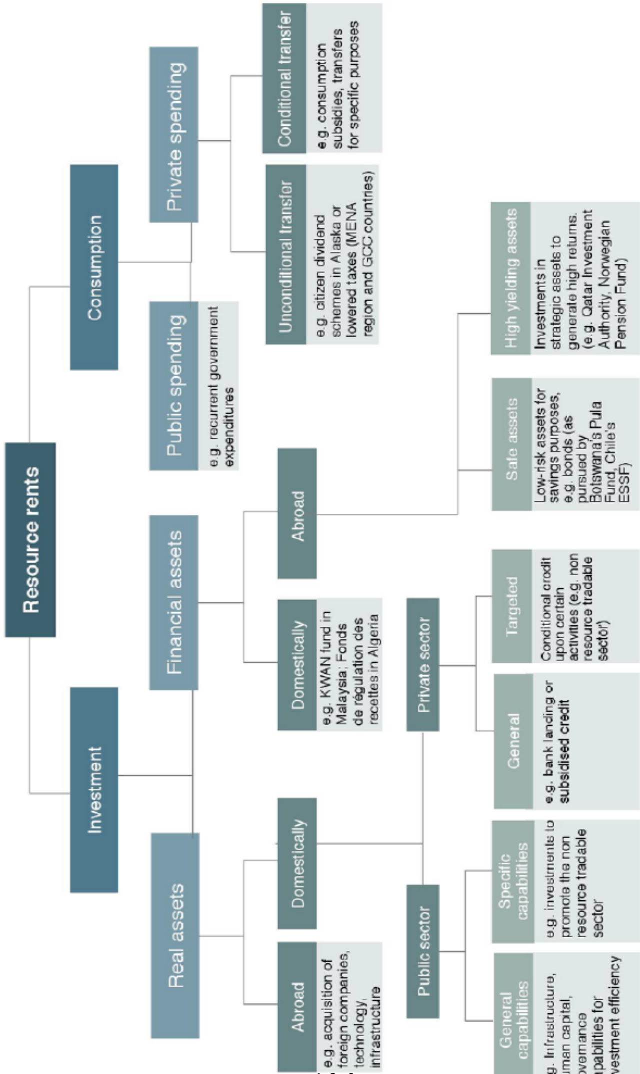
Based on these observations, some authors have tried to estimate the proper tradeoff between investment and saving. For example, Collier et al. (2010) compare different approaches related to this tradeoff based on a theoretical model suited for capital-scarce economies. They defend an intermediate solution between full spending of resource revenues (unsustainable in the long run) and the bird-in-hand approach (since part of the revenues could be efficiently invested during the boom). Van der Ploeg (2019) argues that funds or fiscal rules should target lower consumption, but higher investment goals, in developing countries than in other economies due to the greater need for physical or human capital investment. Since these prescriptions might appear quite vague for public authorities, more complete models suited for specific countries can be used. One common approach is to use dynamic stochastic general equilibrium (DSGE) models (IMF, 2012). Using a DSGE model for the Central African Economic and Monetary Community (CEMAC) and Angola, Berg et al. (2013) compare three fiscal approaches : the "all saving approach", the "all investing approach", and the "sustainable investing approach" (characterized by a stable scaling-up path of public investment). They conclude that this last approach should be preferred since it addresses both the volatility and the exhaustibility concerns. Based on a slightly different version of this model applied to Angola, Richmond et al. (2015) compare the "spending-as-you-go approach" (with no savings), the "conservative investing approach" (with constant ratios of public investment and consumption to GDP and a subsequent large accumulation of savings into a wealth fund), and the "gradual scaling-up approach" (close to the "sustainable investing approach" proposed by Berg et al., 2013). They conclude that, when resource revenues are not volatile, the "spending-as-you-go" and the "gradual scaling-up" approach are equivalent in terms of outcome, and both perform better than the "conservative investing approach". However, in the presence of commodity price volatility, the gradual scaling-up approach clearly outperforms the other two approaches.

The final question is where and how to invest. A survey of the best investment strategies would be off-topic here since it is highly country-specific. However, we can briefly underline the balance between investment in physical capital (such as public infrastructure) and in human capital (education or health). It is noticeable that well-targeted public investment can largely contribute to overcome DD effects, either by boosting overall productivity (through expenditure, for instance, in education or technology) which will benefit all sectors, including both tradable and non-tradable ones, or by improving export capacity (through investment in specific infrastructures for instance), which will particularly benefit the tradable sectors.

1.4.2 The Role of Monetary Policy and Exchange Rate Regimes

The first models of DD noted that natural resource exports tend to affect the equilibrium in the money and exchange rate markets by affecting both demand and supply of domestic money. For instance,

Figure 1.2 – Uses of Natural Resource Revenues



Source : Chang and Lebdioui (2020)

in the dynamic model developed by Aoki and Edwards (1983), a boom in resource revenue increases domestic income, creating an additional demand for money, but also produces a temporary trade balance surplus, which increases the domestic supply of money. Thus, there is a temporary disequilibrium in the money market, since it is unlikely that the increase in supply will perfectly match the increase in demand. This disequilibrium either results in an excess demand for non-tradable goods (if excess supply of money), reinforcing the real effects of Dutch disease, or in an excess supply of non-tradable goods (if excess demand for money), counterbalancing them. However, in the long term, the trade balance and the money market are assumed to return to their equilibrium determined by real factors. Neary (1982) also investigates this impact of resources on the money market but focuses on the role played by exchange rates. Under flexible exchange rates, the additional income generated by resource exports results in an excess demand for money, hence in a nominal exchange rate appreciation. This appreciation leads to a decrease in the price of tradable goods and to an appreciation of the real exchange rate (because the fall in prices only partially offsets the appreciation of the exchange rate). Under fixed nominal exchange rates and if central bank interventions are not sterilized, the trade surplus results in an excess supply of money, and so to an appreciation of the real exchange rate through inflation. If, on the other hand, interventions are sterilized, the trade balance surplus can be maintained without inflation. This sterilization can be achieved by raising the banking system's reserves requirement, which decreases domestic credit and compensates for the increase in the NFA-backed supply of money. It is also worth noting that a resource-movement effect can occur in every type of exchange rate regime.

Adopting a foreign currency in the domestic economy (the so-called "dollarization"), or belonging to a monetary union, does not prevent the appreciation of the real exchange rate occurring through domestic inflation (as can occur in a fixed nominal exchange rate regime). Gylfason (2008) notes that this remark also holds for sub-national entities or constituent states such as Greenland (which uses the Danish Krone) with its fish exports [3]. Moreover, in such cases, hard constraints on monetary policy can even limit a country's ability to prevent DD. This can be observed in Chad, which belongs

3. Vast mineral and hydrocarbon reserves have also been discovered in Greenland but they remain largely unexploited

to the CEMAC CFA Franc zone, where Kablan and Loening (2012) find evidence of inflationary pressures caused by oil prices and oil production, even though the impact in terms of structural transformations remain moderate. Another example is Lao PDR where the use of the U.S. dollar and the Thai Baht tends to prevail, and where Khinsamone (2017) observes an appreciation effect caused by mining output.

Finally, general equilibrium models can also contribute to understanding the impact of monetary policy and exchange rate regimes in different contexts. Allegret et al. (2018) apply a multi-sectoral medium-scale DSGE framework to the Algerian economy to compare the impact of an oil boom under three distinct monetary strategies : inflation targeting, fixed nominal exchange rate, and real oil price targeting (similar to an inflation targeting regime but based on the domestic price of oil rather than CPI). They conclude that a fixed exchange rate is the most efficient strategy against DD effects on the tradable sector. Using a DSGE model fit for Nigeria and the Western African Economic and Monetary Union (WAEMU), Batté et al. (2010) estimate the potential impact of Nigerian oil revenues on Nigeria and on other WAEMU countries under the scenario of an extended regional currency union. They infer that belonging to a monetary union would not protect Nigeria from DD effects caused by a positive oil price shock, with adverse spillovers on the other countries. In contrast, Nigeria would benefit more from a flexible exchange rate with fixed money supply, whereas WAEMU countries would benefit more from a fixed exchange rate. Finally, they conclude that setting up a Stabilization Fund in Nigeria could contribute to reducing the divergence between the countries' benefits in adopting different monetary regimes, revealing the specific issue of the impacts of DD in a monetary union.

Theoretical and empirical studies reveal the role of fiscal and monetary policies to avoid, or at least mitigate, DD, but conclusions on what these policies should be remain mixed. It is still unclear whether it is better to try to avoid DD (for instance by controlling the level of public spending and by accumulating foreign assets during the boom), or to compensate for it (by redistribution in favor of the tradable non-resource sector, or by efficient public investment aimed at increasing productivity or competitiveness). Similarly, it is unclear whether fixed or flexible nominal exchange rates should be preferred to avoid real exchange rate appreciation. This difficulty in inferring clear conclusions from the literature comes partly from the variety of issues governments face when experiencing a resource boom (corruption, volatility of revenues, social, or environmental consequences). Therefore, the question of the optimal management of resource revenues and of the optimal exchange rate regime and monetary policy is rarely restricted to the fight against DD.

1.5 Continuing Exploring Dutch Disease

Overall, there is strong empirical evidence that DD is a reality and should be considered seriously by resource-rich developing countries. Indeed, it has been observed that several resource exporters have experienced real exchange rate appreciation and/or a decline in tradable (agriculture or manufacture) outputs. However, these two effects do not always occur, and various counterexamples indicate that DD is not necessarily a "curse" for the economy. There is also a large literature on the fiscal and monetary policies that can be implemented against DD. Yet, no consensus has been reached regarding the most efficient ways to avoid DD or even for the question of whether governments should really try to avoid DD effects. Overall, further analyses remain necessary on several points.

First, the seminal models of DD are often not suited for the study of developing countries, which are characterized by a large share of agriculture in total output, imperfect tradability of "tradable" goods, lack of physical and human capital, high levels of unemployment, informal economy, and international migration. Despite the growing empirical literature that has emerged in recent decades to discuss these assumptions, many unknowns remain regarding the (institutional, geographical, or demographic) determinants that can exacerbate, mitigate, or even prevent DD.

Moreover, there has been very little discussion as to the most suitable empirical strategies, and the variables to choose when investigating the presence of DD : most of the knowledge about the issues related to the explanatory variable (resource rent, revenues, prices, or reserves) comes from the RC literature, in which there is little debate on the outcome.

Finally, empirical investigations are required to understand the impact of fiscal and monetary policies and how they can prevent DD, or at least offset its most negative effects, without ignoring a major source of revenues.

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Deuxième partie

Revenus pétroliers, dynamiques inflationnistes et appréciation des taux de change

Cette partie est composée de deux chapitres, ayant tous deux pour objectif de discuter les définitions/hypothèses traditionnelles des modèles de syndrome hollandais et d'en proposer une application dans le cas de pays africains exportateurs de pétrole. Le chapitre 2 reprend un article publié en 2021 dans la revue *International Economics* sous le titre « External and internal exchange rates and the Dutch disease : Evidence from a panel of oil-exporting African countries » ; le chapitre 3 est issu d'un document de travail intitulé « Impact of Oil Price and Oil Production on Inflation in the CEMAC »

Bien que divergents dans leur contexte (9 pays africains producteurs de pétrole pour le premier, 5 pays producteurs de pétrole de la CEMAC pour le second) ainsi que dans leur méthodologie (analyse en panel dynamique pour le premier, séries temporelles multiples pour le second), ces deux travaux de recherche se positionnent tous deux sur l'étude de la première étape du syndrome hollandais (l'étape monétaire ou de taux de change). Surtout, chacun de ces travaux répond à un même double objectif qui est (i) de relier la littérature du syndrome hollandais à une autre littérature économique proche, et (ii) de discuter une hypothèse ou une définition des modèles théoriques de syndrome hollandais souvent négligée dans les études empiriques, telle qu'identifiée dans la première partie de cette thèse. Ainsi, le chapitre 2 suit la littérature économique consacrée à l'estimation du taux de change d'équilibre comportemental (« *behavioral equilibrium exchange rate* »), ce qui amène à discuter la définition même du taux de change, distingué entre taux de change interne et taux de change externe. En effet, l'étude part du constat que la littérature empirique du syndrome hollandais s'est essentiellement restreinte à l'étude du taux de change réel externe, alors même que le modèle de Corden-Neary sur lequel se fondent toutes ces études privilégiait une réflexion en termes de taux de change interne. De son côté, le chapitre 3 rapproche la littérature du syndrome hollandais à celle consacrée à la transmission (« *pass-through* ») des prix internationaux de l'énergie aux prix domestiques des biens de consommation. Cela conduit notamment à discuter l'hypothèse des modèles de syndrome hollandais selon laquelle les ressources naturelles (ici le pétrole), ne seraient pas consommées domestiquement et n'auraient donc d'impact sur les prix que via l'effet de syndrome hollandais.

De plus, ces deux chapitres s'inscrivent chacun dans une approche propre : le versant production du syndrome hollandais pour le premier (taux de change défini comme un indicateur de compétitivité externe et/ou comme un indicateur de rentabilité relative entre secteurs économiques) et le versant consommation pour le second (hausse des prix des biens à la consommation pour les ménages). En raison de ce choix d'approches différentes, ces deux chapitres nous apparaissent comme complémentaires, chacun discutant une interprétation possible des conséquences du syndrome hollandais, même si la littérature empirique existante a souvent privilégié l'approche en termes de compétitivité étudiée dans le premier des deux chapitres.

Chapitre 2

External and internal exchange rates and the Dutch disease : Evidence from a panel of oil-exporting African countries

2.1 Introduction

According to models of Dutch disease (DD), extractive resources exports lead to an appreciation of the real exchange rate (RER), reducing the competitiveness of the non-resource tradable sectors (agriculture and manufacture). However, two different definitions of RER are employed in these models : the "internal" RER, defined as the ratio of the price of non-tradable to tradable products, and the “external” RER, defined as the ratio of domestic to foreign prices. This distinction matters since both indicators can be interpreted differently. The “internal” RER is a measure of the profitability differential between sectors, and hence explains structural transformations, whereas the “external” RER measures the external competitiveness of a country’s production, explaining declining export revenues in the non-resource sectors. The two indicators can thus exhibit different patterns over time, especially when a boom occurs. Yet, despite the extensive literature on Dutch disease, the preference for one approach or the other is not always justified. Internal exchange rate is usually preferred in early theoretical models, including Corden and Neary (1982), with a few exceptions, such as Buiter and Purvis (1980) (see chapter 1). Nevertheless, most empirical studies seem to have adopted the external definition of the RER, even when they directly refer to the Corden-Neary model as the core theoretical model. On this point, there appears to exist a clear and surprising gap between the importance of the discussion related to exchange rates in the early theoretical literature, and the recent empirical literature in which the external definition is predominant and the difference between both approaches hardly ever discussed. This gap can be explained by three reasons. First, the external exchange rate has now become the canonical definition of the exchange rate in the macroeconomic literature. Second, even though their definitions differ, there is a direct mathematical relationship between the two RER, justifying the choice of using one as a proxy for the other. Finally, while several institutions (World Bank, IMF, UNCTAD...) provide estimations for the external RER, reliable data for internal RER are much more difficult to obtain. This remark is particularly true for developing countries, which have attracted most of the interest in the Dutch disease literature for the last two decades.

Another major limitation of the DD literature is that theoretical models often assume the existence of a perfectly non-tradable and a perfectly nonresource tradable sector, while imperfect tradability could exist in some sectors. On the contrary, Benjamin et al. (1989) assume imperfect substitutability between foreign and domestic goods in the tradable sectors in the Cameroonian case, considering this assumption to be more relevant when studying developing countries. This remark is of great importance because it implies that a DD could have different effects on the different tradable sectors, depending on their level of substitutability on international markets.

This study intends to fill these two gap (i) by determining whether oil revenues have been associated in Africa with an appreciation of the external real exchange rate, with an appreciation of the internal real exchange rate, or both; and (ii) by investigating this appreciation effect on exchange rates computed for agricultural and manufacturing products separately in order to determine which sector is the more likely to be affected by Dutch disease. Using a panel of nine African oil-exporting countries between 1995 and 2017, we investigate the long-run impacts of oil revenues and oil prices on five different exchange rate indicators. These indicators correspond to the traditional real effective exchange rate and to four additional exchange rates computed as internal and external exchange rates for the five main agricultural and the five main manufacturing goods exported. For this analysis, we apply the Pooled-Mean-Group estimator proposed by Pesaran et al. (1999) and test its robustness by complementing it with Mean-Group estimators. We also use two different explanatory variables : oil rents expressed in % of total GDP and the international price of oil. Finally, we account for potential cross-sectional dependence by applying the Cross-Sectionally Augmented Pooled-Mean-Group estimator.

Results reveal a clear and significant appreciation of the external RER caused by oil revenues and oil prices in the sample. Regarding internal measures of the RER, only the variable for agriculture clearly reveals the presence of a disease while the other variable provides mixed results, implying that oil revenues could have more "de-agriculturalization" than "de-industrialization" effects in Africa.

The contribution of this study to the existing literature is threefold. First, it is to our knowledge the only attempt to investigate the effects of DD on different RER to account for the difference between internal and external exchange rates and between manufactured and agricultural competitiveness. Second, it focuses on a panel of nine net oil-exporting African countries, while empirical analyses of Dutch disease in Africa have focused on countries or on specific areas (such as Northern Africa or the CFA Franc Zone). Finally, this study exploits brand new data for the RER. This last point is of special interest in the analysis of internal RER, due to the frequent lack of data in developing countries.

In a first step, we briefly review the theoretical and empirical literature relative to the impact of natural resource revenues on the RER and link the Dutch disease models with the literature relative to the determinants of long-run equilibrium exchange rate (section 2.2). Then, we detail the two definitions of the RER given in this article and discuss the relationship between them (section 2.3). Third, we describe the source of the data and justify the variables used in this paper (section 2.4). Then, we detail the econometric specifications and analyze the results (section 2.5). The last section concludes and comments on the main limitations of the analysis (section 2.6).

2.2 Equilibrium Exchange Rates and the Dutch Disease

This section presents the theoretical and empirical literature relative to the Dutch disease and equilibrium exchange rates. We first describe the equilibrium exchange rate approach that will be used in this article. Then, we provide an overview of the empirical evidence that resource revenues can generate an appreciation of the exchange rate through a Dutch disease mechanism in developing countries, with a focus on Africa.

2.2.1 The Behavioural Equilibrium Exchange Rate

Since the Purchasing Power Parity theory coming back from the first half of the 20th century, there has been a large development of approaches aiming at capturing the concept of "equilibrium exchange rate" and short-run misalignment. Among them, the three most popular approaches are the Fundamental Equilibrium Exchange Rate (FEER) associated with Williamson (1994), the Natural Real Exchange Rate (NATREX) from Stein (1994), and the Behavioural Equilibrium Exchange Rate (BEER) proposed by Clark and MacDonald (1999). The FEER approach considers the equilibrium exchange rate as the exchange rate that simultaneously allows for external balance sustainability (exports equal imports) and internal balance equilibrium (the non-accelerating inflation rate of unemployment). The NATREX presents some similarities with the FEER approach but includes a distinction between the medium- and long-run by taking into account the cyclicality of the exchange rate. In this approach, the equilibrium exchange rate is defined as the one that simultaneously allows for external balance and internal equilibrium when the output is at its potential and apart from cyclical variations (Rey, 2009). On the contrary, the BEER appears as a more descriptive approach by focusing on a list of variables that are supposed to determine the long-run value of the real exchange rate. As underlined by Egert et al. (2006), this approach does not rely on a theoretical model of exchange rates but uses real variables to produce long-run estimates of the real exchange rate and estimate short-run misalignments from this long-run equilibrium. Since the seminal paper from Clark and MacDonald, a large theoretical and empirical literature has emerged, trying to determine the main fundamentals of long-run real exchange rates. These fundamentals typically include GDP per capita or any other variable allowing to capture the Balassa-Samuelson effect, terms of trade, trade openness, public expenditures, investment, foreign capital inflows or net foreign assets... Even if most models of Dutch disease do not follow the BEER approach or any specific equilibrium exchange rate approach, there has also been a large variety of empirical studies arguing that natural resources revenues could be included in this set of fundamentals, in line with the DD hypothesis. The BEER literature typically follows two steps. First, estimating the equilibrium exchange rate based on a set of fundamentals. Then, computing the short-run misalignments defined as the difference between the equilibrium exchange rate estimated as the observed exchange rate. We are here primarily interested in assessing the impact of oil revenues on long-run exchange rate. Hence, this study will be restricted to the first step (the determination of the long-run equilibrium exchange rate). Finally, it is noticeable that the equilibrium exchange rate literature focuses on the external definition of real exchange rates, which differentiates it from the internal exchange rate adopted by Corden and Neary (1982). Therefore, we try here to link these two different approaches by estimating the impact of several fundamentals on five different exchange rates, with three external and two internal exchange rates. Even if the BEER literature is based on an external definition of the RER, we use for the determination of the internal RER equilibrium the same fundamentals as for the external RER (i) for consistency and comparability between regression results and (ii) because there is a direct relationship between external and internal exchange rates (see section 2.3).

2.2.2 Exchange Rate Fundamentals and the Dutch Disease in Africa

In Africa, there is an important literature relative to the understanding of exchange rate fundamentals. For instance, Roudet et al. (2007) estimate the impact of five fundamentals (terms of trade, government expenditures, openness, Balassa-Samuelson effect, and investment) on the exchange rate of countries of the West African Economic and Monetary Union (WAEMU). For this, they first apply the Fully Modified Ordinary Least Squares (FMOLS) and the Pooled-Mean-Group (PMG) strategies to estimate the equilibrium RER for the complete panel and find similar results with both methodologies. Then, they apply the Hodrick-Prescott filter to evaluate short-run misalignments and conclude to the presence of an overvaluation of the RER before the devaluation of the CFA Franc in 1994. Finally, they apply the Johansen maximum likelihood procedure and the ARDL approach to each country of the sample, allowing them to account for the heterogeneity in the panel. Similarly, Couharde et al. (2013) estimate the long-run relationship between the RER and a set of five fundamentals (terms of trade, Balassa-Samuelson, openness, public spending and NFA) in a panel of thirteen CFA area country members using Dynamic OLS (DOLS) estimation. In another type of monetary union, Candau et al. (2014) assess the impact of three fundamentals on the real exchange rate in La Reunion Island (which as a French department belongs to the Euro Area). The fundamentals include terms of trade, the rate of growth of GDP per capita (aiming at capturing technological progress and hence the Balassa-Samuelson effect) and public transfers from the metropolis. The coefficient for the Balassa-Samuelson effect appears to be insignificant but the two other variables are positively and significantly correlated with the real exchange rate as expected. Nouira and Sekkat (2015) investigate the impact of five fundamentals (trade openness, net capital inflows, terms of trade, country debt service, government expenditures and Balassa-Samuelson effect) on the long-run equilibrium exchange rate using DOLS for a panel of 51 developing countries (among which 26 African countries) over 1980–2010. They also estimate short-run misalignments of this RER using the modified Hodrik-Prescott filter and find results that are overall consistent with the expectations. Finally, Khan Jaffur et al. (2020) apply an ARDL-bounds testing approach to multiple time-series to investigate the impact of several fundamentals (terms of trade, trade openness, real GDP per capita, investment, government expenditures, inflation, official development assistance, net foreign assets, capital inflows and money supply) in fifteen African countries. They find results that are overall consistent with the expectations (for instance a coefficient for trade openness negative and significant in most countries or a positive coefficient for terms of trade or GDP per capita) but with a large heterogeneity across countries.

In line with the DD model, an important strand of the literature has tried to estimate the impact of resource revenues on exchange rates, either by considering resource revenues as a fundamental like trade openness or productivity per capita or by focusing on short-run variations caused by natural resources discoveries or international price variations. For example, by focusing on international oil price variations in a panel of 32 developing oil-producing countries and by implementing both a first-difference and a System Generalised Method of Moments (GMM) methodology, Arezki and Ismail (2013) observe that oil prices are positively correlated with government spending which in return has an appreciation effect on the RER. This supports the evidence of a Spending effect in their panel of oil-exporting countries. Coudert et al. (2015) also investigate the impact of international commodity prices for a panel of 68 commodity exporters (including 26 developing, 37 intermediate and 5 advanced countries). Using Dynamic OLS, and accounting for cross-sectional dependence, they estimate the impact of three variables on long-run equilibrium exchange rates and short-run RER variations : workers productivity (the Balassa-Samuelson effect), Net Foreign Assets, and what they call commodity Terms of Trade which aim to capture the variations of commodity prices. They finally conclude to an appreciation effect caused by commodities exports, with a much stronger coefficient in low-income countries. In a country-case perspective, Essien and Akipan (2016) investigate the impact of a set of key fundamentals on the Nigerian equilibrium exchange rate. They include the Balassa-Samuelson effect, the size of M2 in the economy, government expenditures, net foreign assets, trade openness and the international price of oil. In line with the DD, they conclude to a positive impact of oil prices on RER, with an average coefficient even higher than NFA, public expenditures and money supply.

This article follows this empirical literature by assessing the impact of oil revenues on exchange rates in a panel of nine oil-exporting African countries, considering oil revenues as a fundamental for the equilibrium exchange rate in these countries. However, the aim here is only to determine the relationship between oil revenues and ER in oil-exporting countries. Then, the methodology implemented allows to evaluate short-run and long-run impacts of oil revenues variations on the RER but does not aim to estimate short-run misalignments from the equilibrium RER.

2.3 External and Internal Exchange Rates

The first question is the definition of the RER. As mentioned in the introduction, one can broadly define two different exchange rates. The "external" real exchange rate is the most popular interpretation of the exchange rate and corresponds to the ratio of domestic to foreign prices. On the contrary, some studies sometimes use what will be called here an "internal" exchange rate, defined as the ratio of domestic non-tradable to domestic tradable prices. It is noticeable that the seminal Corden-Neary model of Dutch disease never uses foreign prices but focuses only on the internal RER (Corden and Neary, 1982), contrary to Buiter and Purvis (1980) who prefer the external approach of the RER. However, surprisingly, most empirical studies of Dutch disease adopt the external RER, even when they directly refer to the model of Corden-Neary.

Here, we follow Candau et al. (2014) and define the internal and the bilateral external RER (respectively IRER and ERER) [1] as :

$$IRER_i = \frac{P_{i;N}}{P_{i;T}} \tag{2.1}$$

with $P_{i;N}$ and $P_{i;T}$ the index prices in non-tradable and tradable sectors respectively.

$$ERER_{i,j} = E_{i;j}\frac{P_i}{P_j} \tag{2.2}$$

with $E_{i;j}$ the nominal bilateral exchange rate between the two currencies, and P_i and P_j the price indexes in countries i and j respectively. From equation 2.2, the external real effective exchange rate is then given by :

1. By convention, we choose here to express both internal and external RER such that an increase in the index means an appreciation of the exchange rate.

$$EREER_i = \prod_{j \neq i} \left(E_{i;j} \frac{P_i}{P_j} \right)^{\gamma_j} \tag{2.3}$$

with γ_j the weights given to each partner country j. Let us now define λ_j as the share of tradables in total production of country j with $0 < \lambda_j < 1$. It follows that $P_j = P_{j;T}^{\lambda_j} \times P_{j;N}^{1-\lambda_j}$ and equation 2.3 becomes :

$$EREER_i = \prod_{j \neq i} \left(E_{i;j} \frac{P_{i;T}^{\lambda_i} P_{i;N}^{1-\lambda_i}}{P_{j;T}^{\lambda_j} P_{j;N}^{1-\lambda_j}} \right)^{\gamma_j} = \prod_{j \neq i} \left(E_{i;j} \frac{P_{i;T}}{P_{j;T}} \right)^{\gamma_j} \times \prod_{j \neq i} \left(\frac{P_{i;T}^{\lambda_i - 1} P_{i;N}^{1-\lambda_i}}{P_{j;T}^{\lambda_j - 1} P_{j;N}^{1-\lambda_j}} \right)^{\gamma_j}$$
$$= \prod_{j \neq i} \left(E_{i;j} \frac{P_{i;T}}{P_{j;T}} \right)^{\gamma_j} \times \prod_{j \neq i} \left(\frac{(\frac{P_{i;N}}{P_{i;T}})^{1-\lambda_i}}{(\frac{P_{j;N}}{P_{j;T}})^{1-\lambda_j}} \right)^{\gamma_j}$$

We finally get :

$$EREER_i = \prod_{j \neq i} \left(E_{i;j} \frac{P_{i;T}}{P_{j;T}} \right)^{\gamma_j} \times \prod_{j \neq i} \left(\frac{IRER_i^{1-\lambda_i}}{IRER_j^{1-\lambda_j}} \right)^{\gamma_j} \tag{2.4}$$

Under the Law of One Price and assuming that the IRER of foreign countries are exogenous, a rise in the domestic IRER implies a similar rise in the EREER. However, if these assumptions are not met, the two exchange rates can have different trends. The rest of this paper therefore aims to estimate the impact of oil revenues on the internal and external RER given by equations 2.1 and 2.3.

2.4 Data

We use annual data from several sources (FERDI-OCD, World Economic Outlook, World development Indicators and the UNCTAD) for nine main African oil exporting countries between 1995 and 2017 to investigate the long-run relationship between the external and internal exchange rates and the set of fundamentals. The choice of this period corresponds to the availability of data for the different measures of exchange rates. It also presents the advantage of including periods of booms and busts in oil prices and does not include the devaluation that occurred in the CFA Franc Area in 1994 (which concerns four countries of the sample : Cameroon, the Republic of Congo, Equatorial Guinea and Gabon). We selected the countries among the main oil-producers in Africa according to the World Development Indicators. Since the empirical methodology applied here requires a variation in oil rents across time within each country, we included only countries which were net oil-exporters during the whole 1995–2017 period. Due to a lack of data availability and to the political instability that could have led to poor quality of data, we excluded Libya and Sudan from the sample, keeping nine net oil exporting countries : Algeria, Angola, Cameroon, the Republic of Congo, Egypt, Equatorial Guinea, Gabon, Nigeria, and Tunisia. Data sources and descriptive statistics are provided in Table 2.1. Graphs representing the evolution of the dependent and explanatory variables for each country are also provided in Figs. 2.1–2.9. All variables (including price indexes used to construct ER) are annual period-average variables. We detail in the following subsections the justification and definition of the variables used.

2.4.1 The Dependent Variables

Five different variables are used to capture the effects of oil revenues in net oil-exporting countries, all of them coming from the Sustainable Competitiveness Observatory (OCD) of the Foundation for Studies and Research on International Development (FERDI). The first one is the traditional real effective exchange rate as defined in equation 2.3 and where the weights γ_j attributed to each partner country correspond to the share of non-oil trade between i and j in the total trade of the country i. This variable comes from the OCD for comparison purposes and because of a lack of data for some countries (particularly Angola, the Republic of Egypt and the Republic of Congo) in standard databases (such as World Development Indicators, International Financial Statistics or the UNCTAD). The four remaining dependent variables are two internal and two external RER, computed for agricultural and manufacturing goods separately [2].

Now, we present the way these four proxies have been computed [3]. Regarding the IRER, both indicators are defined as :

$$IRER_{OCD} = \frac{P}{P_X} \tag{2.5}$$

2. Agricultural products include food products either transformed or not (such as cereals, vegetables, fish, meat or dairy) as well as primary goods produced for exports (such as coffee, rubber, tobacco or wood). Manufacturing products include transformed non-agricultural goods. For Angola and the Republic of Congo which exports diamonds, the exchange rate variables have been computed by the author with the four other products using the reweighted average of the index of these products so that none of the exchange rate variables include oil or mineral products. For simplicity purpose, we will call them "agricultural" and "manufacturing" goods from now. The goods included in each exchange rate for each product are detailed in Table 2.2

3. All variables used are described in Observatoire de la Competitivite Durable (2017) and can be found at `https://competitivite.ferdi.fr/`. The indexes are constructed by the FERDI based on data from the *Centre d'Etudes Prospectives et d'Informations Internationales* (CEPII) and *International Financial Statistics* (IFS).

with P the consumer price index, and $P_X = \sum_{k=1}^{5} p_k s_k$ with p_k the country-specific export prices of the five main agricultural and five main manufactured products k exported by the country and s_k the share of each good k among these five exports. To avoid variations in the index that would not be caused by changes in prices but by changes in the share of each good among total exports, the weights s_k attributed to each good k are constant over time and based on the average composition of exports for the period 2008–2012.

The internal real exchange rates of the OCD are thus defined as the ratio of the consumer price index to respectively agricultural exports prices and manufactured exports prices. This definition differs slightly from the IRER as defined in Corden-Neary's model (noted $IRER_{CN}$), but it is easily proved that they are linked. Indeed, if we note α the share of the five main (agricultural and manufactured) exports in total domestic tradables such that $0 < \alpha < 1$ and note P_H the price index for the tradable goods that are not among the five main exports[4] such that $P_T = P_X^{\alpha} \times P_H^{1-\alpha}$, then :

4. P_H includes both goods that are exported but not among the main exports and tradable but non exported goods

$$IRER_{CN} = \frac{P_N}{P_T} = \frac{P_N}{P_X^{\alpha} P_H^{1-\alpha}} = \left(\frac{P_N}{P_X}\right)^{\alpha} \left(\frac{P_N}{P_H}\right)^{1-\alpha}$$

$$\begin{aligned} IRER_{OCD} = \frac{P}{P_X} = \frac{P_T^{\lambda} P_N^{1-\lambda}}{P_X} &= \frac{P_X^{\alpha\lambda} P_H^{(1-\alpha)\lambda} P_N^{\alpha(1-\lambda)} P_N^{(1-\alpha)(1-\lambda)}}{P_X^{\alpha\lambda} P_X^{(1-\alpha)\lambda} P_X^{\alpha(1-\lambda)} P_X^{(1-\alpha)(1-\lambda)}} \\ &= \left(\frac{P_H^{(1-\alpha)}}{P_H^{(1-\alpha)(1-\lambda)}}\right) \left(\frac{1}{P_X^{(1-\alpha)}}\right) \left(\frac{P_N}{P_X}\right)^{\alpha(1-\lambda)} P_N^{(1-\alpha)(1-\lambda)} \\ &= \left(\frac{P_H}{P_X}\right)^{(1-\alpha)} \left(\frac{P_N}{P_X}\right)^{\alpha(1-\lambda)} \left(\frac{P_N}{P_H}\right)^{(1-\alpha)(1-\lambda)} \end{aligned}$$

Thus :

$$IRER_{OCD} = \left(\frac{P_H}{P_X}\right)^{(1-\alpha)} IRER_{CN}^{(1-\lambda)}$$

Since $P_T = P_X^{\alpha} \times P_H^{1-\alpha}$, we finally get :

$$IRER_{OCD} = \frac{P_T}{P_X} IRER_{CN}^{(1-\lambda)} \tag{2.6}$$

It must be noted that the value in level for the exchange rates does not mean much, the only condition required here is that changes in our proxy follow the same patterns as changes in the Corden-Neary internal real exchange rate. The choice of using average prices (estimated by the Consumer Price Index) instead of the price of non-tradables only is justified by the difficulty to make a clear distinction between perfectly non-tradable products and other products. Indeed, while theoretical models tend to distinguish perfectly non-tradable from perfectly tradable goods, most goods are in fact imperfectly tradable and differ in their level of tradability. In that case, it can be quite challenging to identify a representative basket of perfectly non-tradable goods or services. This issue is more easily dealt with for the basket of tradable goods since it is based on export prices, the most exported goods being here assumed to be representative of the main tradable goods.

We then move to the definitions of the external real exchange rates. Like the IRER, two indexes are constructed, both following the same equation :

$$EREER_{OCD} = \sum_{k=1}^{5} \left(\sum_{j=1}^{10} \left(E_{i;j} \frac{P_{k;i}}{P_{k;j}} \right)^{\gamma_j} \right)^{s_k} \qquad (2.7)$$

with $P_{k;j}$ the price of the good k in the country j and $E_{i;j}$ the bilateral nominal exchange rate between i and j. Here, and contrary to the common definitions of the REER used by the World Bank or the IMF, the weights γ_j attributed to each foreign country correspond to the share of each country j among total exports of good k in the world for the ten main exporting countries of good k. Therefore, the weights are not based on the partner shares of each country, but on competition between i and j. It is an important distinction from traditional empirical studies, which often use an index based on partner shares, especially for countries that are specialized in primary products and that do not export products to or import them from the countries that are specialized in the same production. Because the primary goal is to assess the impact of resource revenues on external competitiveness, it seems more relevant to focus on competitors rather than trade partners. Due to the difficulty to aggregate price data from a large sample of countries, and the high imprecision that may result from the lack of data availability in many African countries, the index is restricted to the ten leading exporters for each good k. Finally, the two indexes are computed as the weighted average for the five main agricultural and the five main manufactured goods separately, with s_k the shares of each good k in exports of country i. Similarly to the IRER, the weights are constant over time and based on the shares calculated for the period 2008–2012. A major advantage of these variables is that, by focusing only on the five main agricultural and manufacturing exports, they do not include oil, contrary to traditional measures of the real effective exchange rate. Graphs showing the evolution of the five exchange rates are provided in Figs. 2.1–2.9. As expected, they tend to exhibit similar trends over time, even though there is some heterogeneity across countries. Indeed, while the five exchange rates follow very close patterns in Angola, Egypt and Nigeria, there is a much greater variability between them in Congo or Tunisia. We can also notice that the internal exchange rate for manufactured products is always the index which differs the most from the four others.

2.4.2 The Explanatory Variables

In the Dutch disease literature, three different types of explanatory variables are used. The most straightforward variable is the share of resources (here oil) in total GDP or total exports. This variable presents the advantage of directly capturing the impact of resource revenues on the economy. However, it also suffers from obvious endogeneity issues. First, for a given value of oil revenues, a poorer country will have a higher share of oil revenues in total GDP than a richer one. Reciprocally, one can assume that a more developed country will have more opportunities to develop a resource sector, or fewer incentives to do so, than a developing country. In both cases, the level of economic development affects the variable used for oil revenues. Another difficulty arising from the use of this variable is the fact that the shares of all sectors among total GDP adds up to 100%, i.e. a sudden drop or boom in one sector generates a symmetric rise or fall in the share of resource revenues in GDP even without any change in the resource sector, creating obvious reverse causality issues in empirical studies. However, this issue is particularly challenging when estimating the impact of resources on sectoral value-added, and not so much for exchange rate analysis.

The other most common strategy corresponds to the use of international prices (mainly oil prices such as the Brent or WTI crude oil price). The clear advantage of this variable relies on its supposed exogeneity [5]. However, this proxy is also subject to some key limitations. First, resource revenues do not depend only on prices but also on other variables such as reserves discoveries or the politi-

5. It is possible for some large oil exporters, such as Saudi Arabia, that the hypothesis of small economy is not verified. However, this assumption holds for most countries, and particularly for African countries that are mainly small producers at the world level.

cal will to exploit natural resources. In that case, resource revenues can be weakly correlated with prices, making it more challenging to detect Dutch disease effects. Second, the exogeneity assumption requires that domestic resource production does not react to international price variations. However, a country or a firm can reduce its production when prices are low and increase it when they are high. In that case, oil revenues tend to overreact to oil prices movements.

A final strand of the literature relies on the timing of resource discoveries to estimate the impact of booms in production on the RER (for instance Arezki and Ismail, 2013). This methodology allows the implementation of different econometric strategies, such as difference-in-difference or synthetic control methods. We will not detail this literature here since, while it is helpful to estimate the impact of large booms, it is less useful when investigating the long-run relationships between resource revenues and exchange rates. This methodology also tends to require larger datasets than other strategies.

We use here both oil revenues and international crude oil prices.

The first one is the variable "Oil rents" provided by the World Development Indicators and expressed in percentage of total GDP. Regarding international oil prices, we use the Brent and the West Texas Intermediate spot oil prices, which are the two main crude oil prices on international markets and the more likely to affect African oil prices to export. The changes in these variables are presented in figs. 2.1–2.9. Unsurprisingly, there is a clear positive correlation between oil rents and international oil prices, even if oil rents tend to be more volatile (which is expected since this variable is mainly determined by both international price shocks and domestic production shocks). We can also notice heterogeneity across countries : while the changes in oil rents follow closely the evolution of oil prices in the three northern African countries, there are more pronounced short-run shocks of oil rents in the beginning of the period in Angola, Cameroon, Congo, Gabon and Nigeria (these could be caused by exogenous production shocks or overreaction to price variations). Finally, we can notice that in Equatorial Guinea oil rents started to decline not long before the peak in international prices (due to the progressive decline in oil production).

The control variables are the traditional fundamentals of the real effective exchange rate used in the literature on exchange rate misalignments, following the Behavioural Exchange Rate (BEER) approach. We select here four fundamentals among the most frequent in the literature. The first fundamental is the degree of trade openness computed as the sum of total exports and total imports expressed in % of total GDP (from the UNCTAD). According to the theoretical and empirical literature, this index is expected to be negatively associated with exchange rates. Indeed, higher trade barriers usually result in both lower trade openness and higher prices, implying a negative correlation between trade openness and real exchange rates (Egert et al., 2006). This argument is supported by several empirical studies for the external RER (Couharde et al., 2013 ; Diop et al., 2018...) Regarding our proxies for the internal RER, trade openness is expected to reduce domestic prices (the numerator) and thus the IRER.

We also include a proxy for the Balassa-Samuelson effect constructed by the FERDI-OCD as a ratio of non-oil GDP per capita against foreign countries non-oil GDP per capita. The use of non-oil GDP is important because (i) it captures more precisely productivity gains than total GDP and (ii) it does not include oil resource booms (which would lead to underestimating the impact of our oil revenues variable). Theoretically, the expected sign of this proxy should be positive : an increase in total productivity is associated with an appreciation of the exchange rate. The empirical evidence in the literature is quite mixed but suggests overall to expect a positive sign for this variable. For instance, Coudert et al. (2015) find for a large panel of countries that an increase in productivity is associated with an appreciation in low-income countries but not in wealthier countries.

Then, we use a variable for Net Foreign Assets expressed in % GDP (from the UNCTAD). The theoretical literature suggests a positive relationship between NFA and exchange rates. However, empirical evidence remains mixed. Egert et al. (2006) argue that NFA may be negatively correlated with capital inflows in the medium-run but positively in the long-run (if foreign capital inflows are invested in the export sector, they will increase competitiveness and boost exports in the long-run). If capital inflows tend to generate an appreciation effect, one will observe a negative correlation between NFA and RER in the medium-run and a positive one in the long-run. In that case, the heterogeneity in results depends mainly on the number of periods in the sample (the size of T). In this case, the expected sign of NFA can also depend on the nature of foreign capital inflows and on the type of sector they are invested in, which depend themselves on the level of economic development. For instance, using a panel of countries with different levels of economic development, Coudert et al. (2015) observe a positive impact of NFA for developing countries (and to a lesser extent for advanced countries) but a negative coefficient for intermediate ones.

The final explanatory variable is the value of total investment (public and private) expressed in % of GDP. There is no consensus neither in the theoretical nor in the empirical literature on the expected sign for this variable. For instance, Diop et al. (2018) find a positive impact of investment on the RER in Senegal based on a Johansen and an ARDL model while Saxegaard (2007) finds a negative impact for the same country. One could expect that, in the short-run, investment plays a role in appreciating the exchange rate (like consumption) by increasing domestic prices. However, in the long-run, investment can help firms to become more productive and reduce prices, generating depreciation effects. This effect however depends on the nature of investment (public or private, foreign or domestic …) and can differ across sectors.

Except for Net Foreign Assets and Oil Rents, all variables (including dependent and explanatory variables) are in logarithms. We do not include the terms of trade (which are also a common fundamental for the exchange rate in the empirical literature) since they could partly capture the appreciation effect of the Dutch disease. Similarly, we do not include public expenditures. Indeed, it is often considered that Dutch disease effects are partly driven by public spending (i.e. the spending effect) : natural resources are assumed to increase public expenditures which in return leads to an appreciation of the real exchange rate. Assessing if Dutch disease effects are really driven by public spending (they could also be caused by private consumption) could be of interest for future research but this lies beyond the scope of this study.

2.5 Methodology and Results

Based on the variables described in section 2.4, we want to investigate the impact of oil revenues and oil prices on different exchange rates. This section presents and discusses these empirical results.

2.5.1 Integration and Co-Integration Tests

We begin by testing for the presence of unit-roots in the selected variables. For this, we apply the Panel-data unit-root test proposed by Im et al. (2003) which has proved to provide consistent estimates even in small samples (Hurlin and Mignon, 2005). To account for potential cross-sectional dependence between countries in the variables of interest, we also use the test proposed by Pesaran (2003) which has been specifically designed to deal with this issue. Since the Brent and the WTI oil prices are repeated time-series, we use the simple time-series Augmented-Dickey-Fuller and Phillips-Perron unit-root tests for these two variables. Results are reported in Table 2.3. Both integration test results clearly indicate that all (dependent and explanatory) variables are I(1).

We then test for the presence of a co-integrating relationship among the variables. For this, we apply the tests proposed by Kao (1999) and Pedroni (2004). Indeed, the Kao co-integration test has more power in small samples than other tests (Hurlin and Mignon, 2007). It provides five statistics based on the Dickey-Fuller and Augmented Dickey-Fuller statistics. However, the Pedroni co-integration test has more power in samples with a fixed N and an increasing T. This test provides seven different statistics, relying on different assumptions, and grouped into four Panel-Cointegration Statistics based on within-dimension and three Group-Mean Cointegration Statistics based on between-dimension. Results are reported in tables 2.4, 2.5 and 2.6. Overall, the results show a strong rejection of the null hypothesis of the absence of co-integration for the REER, for the two ERER and for the IRER for manufacture. Regarding the IRER for agricultural products, only four out of seven Pedroni statistics support the rejection of the null hypothesis when the main explanatory variable is oil rents and three for oil prices. Nevertheless, almost all statistics from Kao strongly suggest rejecting the null hypothesis of no co-integration, which seems more than enough to accept the hypothesis of co-integration among variables in the regressions.

2.5.2 Pooled-Mean-Group Estimation Results

Now, the aim is to estimate both the sign and the magnitude of the long-run relationships between each fundamental and the outcomes. The traditional empirical literature relative to the long-run determinants of real exchange rates in panel data has identified several econometric specifications to estimate such long-run relationships. These methods can be divided into two groups. On one side, pooling methods consist in using all data in the same regressions and therefore require the assumption of homogeneity of effects across countries. On the contrary, group-mean specifications consist of (i) estimating the coefficients separately for each country and (ii) averaging them. These methods do not require the homogeneity assumption but have very low power due to the high number of coefficients to estimate. Therefore, we choose here to implement the intermediate strategy of the Pooled-Mean-Group (PMG) estimation method developed by Pesaran et al. (1999). This estimator has a higher power than averaging methods but requires weaker assumption than pooling ones. Indeed, the PMG relies on the assumption that long-run coefficients are homogeneous but not short-run coefficients. It consists of estimating the following equation :

$$\Delta y_{it} = \varphi_i y_{i;t-1} + \beta_i x_{i;t} + \sum_{k=1}^{p-1} \lambda_{i;k} \Delta y_{i;t-k} + \sum_{k=0}^{q-1} \delta_{i;k} \Delta x_{i;t-k} + \mu_i + \varepsilon_{i;t} \tag{2.8}$$

where $y_{i;t}$ is for each country i at time t computed as the logarithm of the standard RER, of the external RER for agricultural and manufacturing goods, and of the internal RER for agricultural and manufacturing goods. $x_{i;t}$ is a set of fundamentals that include our main explanatory variable and the four other control variables presented in section 2.4 [6]. The model also estimates the error-correction term, which indicates the speed of adjustment toward the long-run equilibrium and is expected to be comprised between 1 and 0. Regressions are run first with Oil Rents and second with the two international oil prices as the main explanatory variable. The number of lags of the short-run coefficients (p and q) is selected using the Bayesian Information Criteria, as recommended by Pesaran et al. (1999), with a maximum lag length of 1. Both the AIC and the BIC

6. For simplicity purposes, all variables expressed in logarithms will be written in lower-case letters.

indicate to prefer an ARDL with one lag for the six variables in difference (one lag for the dependent variable and for each of the five explanatory variables), except for the IRER for manufacture with the Brent oil price (where a model without lag for NFA is preferred) and with the WTI oil price (model without lag neither for NFA nor for investment). The coefficients are then obtained through maximum likelihood estimation.

The PMG presents some major advantages compared to other panel data estimators. First, and contrary to a GMM estimator, it is adapted to panel with a small N and a medium-sized T. Then, the use of lags for the explanatory and explained variables helps to overcome potential reverse causality issues that are likely to arise when estimating exchange rates fundamentals. Finally, this methodology allows to distinguish short-from long-run effects. The PMG is also preferred to the Mean-Group (MG) estimator for two reasons. First, due to the higher number of coefficients estimated in the MG specification, this strategy is very likely to provide imprecise and insignificant results, especially in a limited size sample like ours. Second, according to Pesaran et al. (1999), PMG estimates also tend to be less sensitive to outliers than MG ones. They recommend comparing the long-run coefficients provided by MG and PMG specifications to ensure the validity of the second methodology. Since the Hausman test tests the null hypothesis that the long-run coefficients are not systematically different, and under the assumption that MG estimates are unbiased, it results in testing the hypothesis that the long-run PMG coefficients are unbiased. If the coefficients are observed to be significantly different from each other at 5% (if the p-value < 0.05), the PMG estimators might be biased and Mean-Group procedures are more likely to provide consistent estimates. Otherwise, we are inclined to prefer the PMG to the MG estimators. It must be underlined that this test is not a formal econometric proof that the PMG is or is not unbiased but only a piece of evidence to support the idea that the PMG results can be interpreted, since we are primarily interested in the average long-run effect of oil revenues on the exchange rates. It can also be noted that it tests the joint difference in coefficients and not the difference for each explanatory variable used separately.

First, we discuss the results for the classical REER that are displayed in the first column of Table 2.7 and the two first columns of Table 2.8. The results are as expected, with a positive coefficient for oil rents and oil prices. This suggests the presence of Dutch disease effects generated by oil rents in the sample. Regarding the other fundamentals, the results are also as expected for the Balassa-Samuelson effect (positive coefficient) and for trade openness (negative), confirming the validity of our model. The only relatively surprising result is that Net Foreign Assets are indicated to generate depreciating effects while we were expecting an appreciation. Nevertheless, it is not in total contradiction with the literature since the evidence that NFA accumulation appreciates the ER is mixed in empirical analyses (see section 2.4). Finally, the coefficient associated with investment is never significant, making it difficult to interpret. Now, we turn to the four other exchange rates.

We observe positive and highly significant correlation between oil rents and all four other exchange rates in the long-run, supporting the Dutch disease hypothesis, both for the external and the internal approaches (Table 2.7). Regarding the IRER for manufacturing goods, the coefficient appears to be smaller than the three others, probably due to a lower impact of oil rents on the manufacturing sector. However, due to the limits of the proxy used, one must remain careful about such interpretations, and more analyses are required. In addition, this is the only outcome for which the Hausman test suggests to reject the result. The results overall indicate that oil revenues are an important driver of RER fluctuations, even if the coefficient is lower than trade openness or the Balassa-Samuelson effect. For international oil prices, the results are very similar to the previous ones, with a positive and significant impact of the international Brent and the WTI oil prices on the two ERER and the first IRER (Table 2.8). However, the coefficient for manufacturing IRER, which was previously positive and significant at 5%, becomes here negative and significant at 1% in both cases. Two plausible explanations can be provided for this negative coefficient. First, one can assume that manufacture products are not perfectly tradable goods in our sample of countries, or that their degree of tradability is lower than the one of agricultural goods. Since the consumer price index used as the numerator in the construction of this variable includes tradable-goods, a negative coefficient for the internal exchange rate (i.e. a decrease in the ratio of aggregate prices to manufacturing goods prices) could reveal a low level of tradability in the manufacturing sector. Indeed, if most manufacturing goods are produced for the domestic market and/or protected from international competition (through tariffs or subsidies for instance), they may counter-intuitively be more non-tradable than tradable goods and escape Dutch disease effects. Hence, the price increase of the tradable goods that are included in the consumer price index leads to a higher increase in the total consumer price index than the increase in manufacturing goods only. Even if this result is in contradiction with traditional assumptions of DD (the tradable sector being often associated with manufacturing industries), this might apply for countries where agricultural products represent a large share of domestic output and exports. In that case, the Dutch disease would be a concern for the agricultural sector rather than for the manufacturing one. This is in line with the model developed by Benjamin et al. (1989) for Cameroon which assumes that different levels of tradability can exist across the different export sectors. Second, oil can be used as an input for the domestic production of manufacturing goods, meaning that an exogenous price increase in international markets raises the production costs and the prices of these goods (even if the country is an oil-exporter since oil-producing firms sell their production at the international market price even on domestic markets), counterbalancing the Dutch disease effects. However, the approximation used to construct the internal exchange rates is obviously imperfect and may also partly explain this surprising result.

Regarding the other fundamentals, the coefficients are mainly as expected. The variable for trade openness is always negative and significant, in line with both theoretical and empirical literature. In contrast, the Balassa-Samuelson proxy is always positive except for the external exchange rate for manufacturing products, reinforcing the idea that agriculture and manufacture should be analyzed differently when estimating equilibrium exchange rates. Even if the coefficient for trade openness seems to be quite large when comparing it with other main determinants such as the Balassa-Samuelson effect or investment, its size remains reasonable. Net Foreign Assets are associated with negative and strongly significant coefficients, confirming the results obtained with the traditional RER. However, the variable for total investment becomes positive and significant in a few regressions. Finally, the error-correction term (noted ec in the tables) has the expected negative sign and is most of the time significant.

The results for the Mean-Group estimators are displayed in Tables 2.9 and 2.10, even when the Hausman test suggests accepting the PMG. As expected, the results are mostly insignificant even if the coefficients remain of the same sign that with the PMG. The few significant coefficients ($irer_{agriculture}$ with oil rents, $erer_{manufacture}$ with WTI and $irer_{agriculture}$ with both Brent and WTI prices) also tend to support the evidence of a DD effect related to oil revenues.

2.5.3 Testing for Cross-Sectional Dependence

One common issue when dealing with panel data is the potential presence of cross-sectional dependence. This can occur when there is interdependence across countries such that a shock in each country can affect other countries, or when omitted shocks affect error terms in all countries. In that case, Pesaran et al. (1999) noted that the econometric model is likely to be misspecified. To test for the presence of cross-sectional dependence in the results, we implement the Breusch-Pagan Lagrange-Multiplier test (Breusch and Pagan, 1980). Results are available in Table 2.11 and strongly suggest the presence of cross-sectional dependence in the model with Oil Rents as the main explanatory outcome. To deal with cross-sectional dependence, we follow the recommendation made by Pesaran et al. (1999) by implementing the Cross-Sectionally Augmented Pooled-Mean-Group (CPMG) approach used in several empirical papers such as Cavalcanti et al. (2012) or Grekou (2018). This strategy consists in including the cross-sectional average over all countries at time t for the variables of interest (written $\overline{x_t} = (1/N)\sum_{i=0}^{N} x_{i;t}$) in the Pooled-Mean-Group estimation. The main drawback of this empirical strategy is that it increases the number of parameters to estimate. Due to the small size of our sample, it is unfortunately not possible to include all cross-sectional averages for all (dependent and explanatory) variables. It is noticeable that the RER and the proxy for the Balassa-Samuelson effect are defined as a base 100 index (equals to 100 in 2010 for all countries), hence the cross-sectional average (and the divergence for a given country from this average) does not make much sense here. Therefore, we restrict the regressions to include only the cross-sectional averages of three main explanatory variables, oil rents, trade openness and net foreign assets, which are the more likely to suffer from cross-sectional dependence because they are very likely to be affected by global shocks in international commodity prices. Since the international price of oil is a repeated time-series and is the same for each country, we could not apply cross-sectionally augmented empirical strategies to this variable and restrict this procedure to the equation where oil rents is the main explanatory variable. The results are displayed in Table 2.12.

The results tend to confirm the previous analyses since the coefficients associated with oil rents are positive and strongly significant for both agricultural exchange rates, but insignificant or of lower magnitude for manufacturing exchange rates. These results overall support the Dutch disease hypothesis, at least for the agricultural sector.

2.6 Conclusion

Based on brand-new data, we investigated in this chapter the long-run relationship between oil revenues and different variables for the real exchange rate in nine African net oil-exporting countries. The results clearly indicate that both the external interpretation of the Dutch disease (resource revenues weaken external competitiveness of other sectors and reduce non-resource exports) and the internal interpretation (resource revenues boost the development of non-tradable sectors at the expense of tradable ones and encourage structural transformations) are empirically confirmed for agricultural products in our panel of countries, supporting the seminal theoretical models of Dutch disease. From the external perspective, these findings imply that oil revenues tend to appreciate the exchange rate apart from its "classical" long-run fundamentals (such as trade openness or productivity per worker) and to make non-resource products less competitive on international markets. From an internal point of view, they generally confirm the model of Corden-Neary at least for agriculture, implying that oil revenues can lead to "de-agriculturalization". The evidence of a disease on both external and internal exchange rates for agricultural goods is of special interest for policy deciders by highlighting the importance for well-targeted public policies aiming at dealing with Dutch disease consequences not to neglect the agricultural sector. This is particularly relevant for African countries where agriculture often represents a higher share of the economy than manufacture, while empirical studies of

Dutch disease tend to focus on de-industrialization consequences. Another policy implication directly arises from the observation of differences between internal and external definitions of the RER. Indeed, the choice of the indicator selected to assess Dutch disease affects the results and the conclusions that can be drawn from these results. As mentioned earlier, there has been for the last decades a shift in empirical analyses toward the use of external definitions of exchange rates as the expense of internal ones. Nevertheless, the two approaches differ in their interpretation and policymakers could benefit from using both types of indexes, depending on the issues they investigate.

However, these results should be carefully interpreted, due to major data limitations. In fact, the use of proxies for the internal exchange rates that do not perfectly correspond to the Corden-Neary definition of the RER, as well as the fact these proxies are based on a few products rather than on all exports by sectors, could have resulted in noise in the results. Therefore, more analyses are required to investigate the impact of natural resources on internal exchange rates, and to determine the differential impacts of Dutch disease effects on different tradable sectors. Finally, the empirical strategy implemented here does not allow to observe potential heterogeneity across countries. This is a major issue for external approaches since all countries of the database do not share the same exchange rate and monetary targets (with four among the nine countries belonging to the common Central African CFA Franc Zone while the five others have adopted flexible nominal exchange rate policies). Further investigations relying on time-series could solve this issue and help to understand which countries in Africa are the most prone to Dutch disease.

Appendix

Table 2.1 – Descriptive Statistics

Variable	Obs	Units	Mean	Std Dev	Min	Max	Source
$REER$	207	Base 100 = 2005	107.83	30.79	43	289	FERDI
$EREER_{agriculture}$	207	Base 100 = 2005	107.79	30.77	41	326	FERDI
$EREER_{manufacture}$	207	Base 100 = 2005	106.27	32.39	42	303	FERDI
$IRER_{agriculture}$	207	Base 100 = 2005	100.15	32.73	31	309	FERDI
$IRER_{manufacture}$	207	Base 100 = 2005	125.20	37.63	36	270	FERDI
Oil Rent	207	% GDP	20.25	15.92	1.08	55.46	WDI
Brent	23	USD per barrel	54.14	33.60	12.72	111.96	IMF
WTI	23	USD per barrel	52.54	29.48	14.42	99.61	IMF
Openness	207	% GDP	86.70	41.62	21.10	268.24	UNCTAD
Balassa	207	Base 100 = 2010	96.72	31.27	6.46	219.86	FERDI
NFA	207	% GDP	16.25	21.46	-44.77	107.93	IMF
Investment	207	% GDP	28.80	15.34	8.25	115.10	IMF

Note : The exchange rate variables use period-average consumer price indexes and products prices to exports (from the WDI) translated into USD using the nominal bilateral exchange rate (from the IFS). The weights for trade partners for the variable "REER" are constructed with on non-oil exports and non-oil imports for all countries except for Algeria where only non-oil exports are used due to data limitations. Six observations are missing for "Oil Rents" for Equatorial Guinea between 2000 and 2005. These data were reconstructed using country's oil production (BEAC Central Bank) before 2000 and after 2005 and assuming similar trends. Three observations are missing for "Trade Openness" for Equatorial Guinea in 2017 and Gabon in 2016 and 2017. The data are reconstructed based on data for trade openness from the WDI and assuming similar trends. Four observations are missing for "Balassa" for Egypt between 1995 and 1998. They are reconstructed using FERDI-OCD data for the Balassa-Samuelson effect based on imports only and assuming similar trends.

Table 2.2 – Products Included in External and Internal Exchange Rates

Country	Agriculture	Manufacture
Algeria	Other vegetables Dates, Figs, Pineapple, Avocado, Guava, Mango Wheat and Meslin Sugar Water	Hydrogen and Rare gases Ammonium Acyclic alcohols Motor cars and Other motor vehicles
Angola	Fish, frozen Shellfish Coffee Animal flour Wood in the rough	Paper and Paperboard Structures of cast-iron, iron and steel Interchangeable tools for hand tools Electric generating sets and Rotary converters
Cameroon	Bananas Cocoa beans Natural rubber Wood in the rough Wood sawn	Soap Sheets for veneering Boxes, Sacks and Bags of paper Bottles, Flasks, Jars, Pots, Phials, and Other containers Bars and Rods of iron or steel, hot-rolled
Congo	Coffee Natural rubber Fuel wood in logs Wood in the rough Wood sawn	Sheets for veneering Tubes and Pipes of iron or steel, seamless Other articles of iron or steel Tools for hydrography, oceanography, hydrology, meteorology, geophysics
Egypt	Cheese Potatoes Citruses Rice Sugar	Nitrogen fertilizer Men's suits, coats, jackets, trousers and the like Women's suits, coats, jackets, dresses, skirts, trousers and the like Flat-rolled products of iron or steel, not further worked than hot-rolled Insulated wire, Cables and Other insulated electric conductors
Equatorial Guinea	Frozen fish Cocoa beans Raw wood Railway or tramway sleepers of wood Wood sawn	Acyclic hydrocarbons Acyclic alcohols Sheets for veneering Tubes and Pipes of iron or steel, seamless
Gabon	Other tobacco Rubber Wood in the rough Railway or tramway sleepers of wood Wood sawn	Sheets for veneering Plywood Hand-crafted garments Ferro-alloy Tools for hydrography, oceanography, hydrology, meteorology, geophysics
Nigeria	Milk Coconut, Cashew and Brazil nut Other nuts and Oleaginous fruits Cocoa beans Rubber	Ammonium Tanned or crust hides and Skins of bovine Other leather, without hair on, and Skins of other animals Leather further prepared after tanning or crusting of bovine Other Footwear of Rubber or Plastic
Tunisia	Shellfish Mollusks Dates, Figs, Pineapple, Avocado, Guava, Mango Olive oil Other vegetable oil	Men's suits, coats, jackets, trousers and the like Women's suits, coats, jackets, dresses, skirts, trousers and the like Footwear with outer soles Insulated wire, Cable and Other insulated electric conductors Electrical apparatus for switching or connecting electrical circuits

Note : To keep only non-mineral manufacturing products in the exchange rates for manufactured goods, we withdrew diamonds which were initially included in these two indexes for Angola and the Republic of Congo and compute the re-weighted indexes with the four remaining products.

Table 2.3 – Unit-Root Tests Results

Variables	Variables in Level		Variables in Difference	
	IPS (W_{tbar})	Pesaran (Z_{tbar})	IPS (W_{tbar})	Pesaran (Z_{tbar})
reer	0.048	1.554	-9.599***	-2.550***
	(0.519)	(0.940)	(0.000)	(0.005)
$erer_{agriculture}$	-0.602	0.581	-11.322***	-5.079***
	(0.273)	(0.719)	(0.000)	(0.000)
$erer_{manufacture}$	0.120	2.036	-11.334***	-6.158***
	(0.548)	(0.979)	(0.000)	(0.000)
$irer_{agriculture}$	-0.596	0.566	-9.346***	-4.468***
	(0.275)	(0.714)	(0.000)	(0.000)
$irer_{manufacture}$	-0.384	2.149	-8.433***	-4.745***
	(0.350)	(0.984)	(0.000)	(0.000)
OilRents	0.663	1.356	-9.560***	-5.290***
	(0.746)	(0.913)	(0.000)	(0.000)
openness	0.969	0.155	-7.725***	-4.489***
	(0.834)	(0.562)	(0.000)	(0.000)
balassa	-0.084	2.735	-8.039***	-2.376***
	(0.467)	(0.997)	(0.000)	(0.009)
NFA	-0.489	0.178	-3.897***	-3.603***
	(0.312)	(0.571)	(0.000)	(0.000)
investment	0.441	0.823	-8.891***	-3.849***
	(0.670)	(0.795)	(0.000)	(0.000)
	Augmented-Dickey-Fuller	Phillips-Perron	Augmented-Dickey-Fuller	Phillips-Perron
brent	-1.449	-1.447	-3.974***	-3.944***
	(0.559)	(0.559)	(0.002)	(0.002)
wti	-1.514	-1.501	-4.299***	-4.291***
	(0.527)	(0.533)	(0.000)	(0.001)

Note : The table reports the results for the Im-Pesaran-Shin (2003) and the Pesaran (2003) panel unit-root tests with two lags for the main dependent and explanatory variables, but the Z-statistic for the Augmented-Dickey-Fuller and the Phillips-Perron time-series unit-root tests for the logarithms of the Brent and WTI oil prices. P-values are in parentheses.

Figure 2.1 – Evolution of Exchange Rates (left side) and Oil Rents (right side) for Algeria

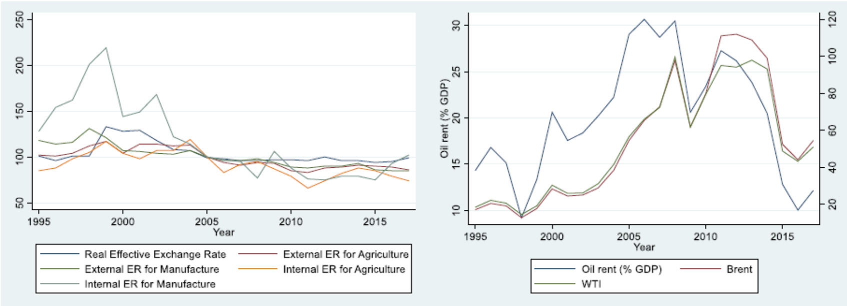

Figure 2.2 – Evolution of Exchange Rates (left side) and Oil Rents (right side) for Angola

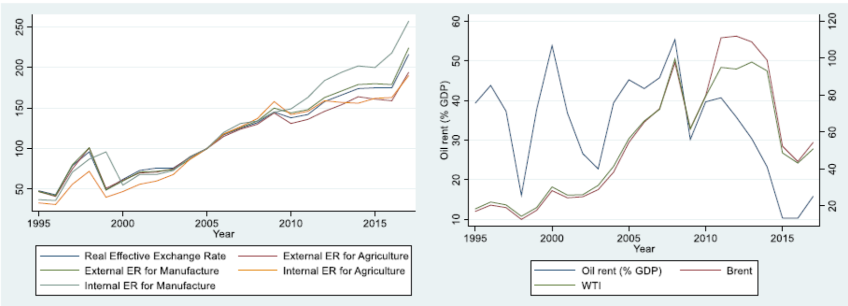

Figure 2.3 – Evolution of Exchange Rates (left side) and Oil Rents (right side) for Cameroon

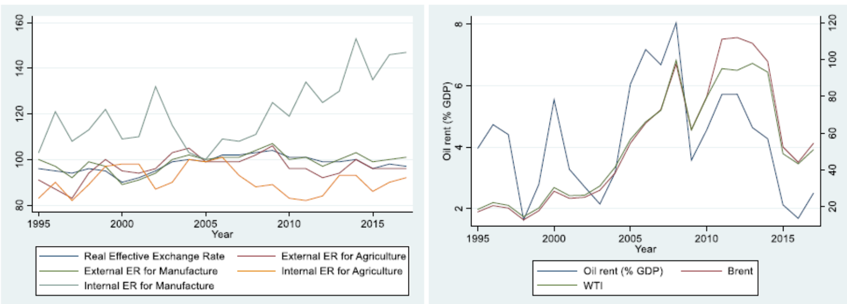

Figure 2.4 – Evolution of Exchange Rates (left side) and Oil Rents (right side) for Congo

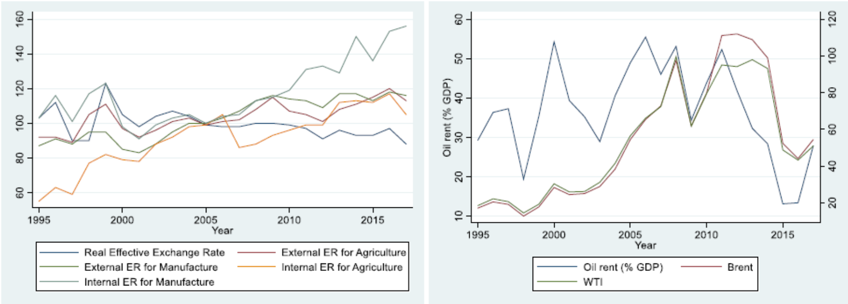

Figure 2.5 – Evolution of Exchange Rates (left side) and Oil Rents (right side) for Egypt

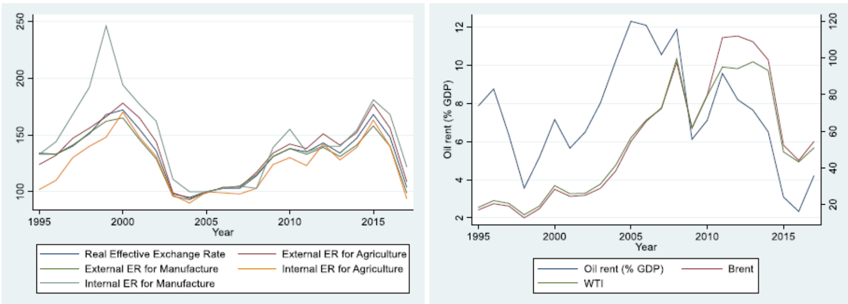

Figure 2.6 – Evolution of Exchange Rates (left side) and Oil Rents (right side) for Equatorial Guinea

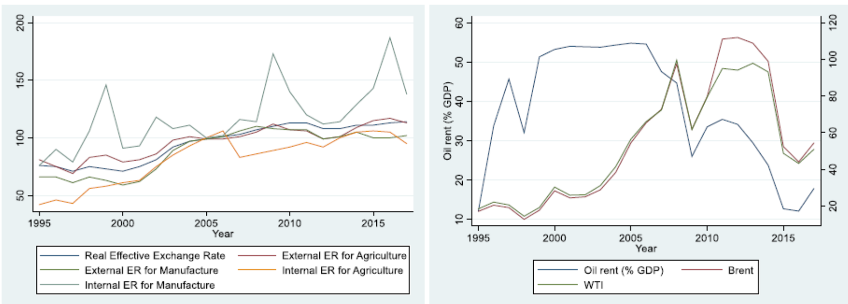

Figure 2.7 – Evolution of Exchange Rates (left side) and Oil Rents (right side) for Gabon

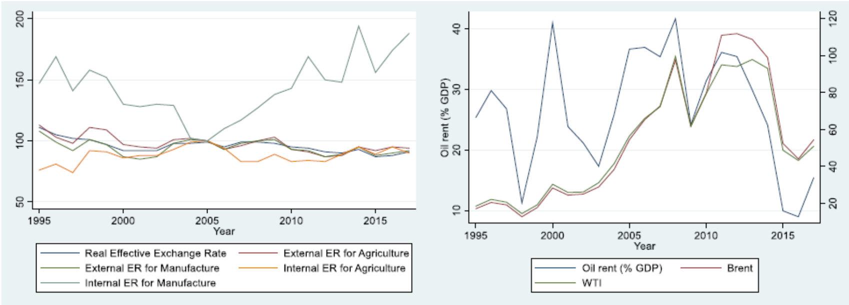

Figure 2.8 – Evolution of Exchange Rates (left side) and Oil Rents (right side) for Nigeria

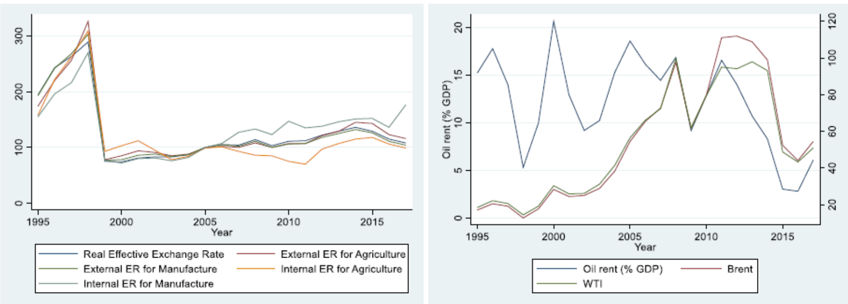

Figure 2.9 – Evolution of Exchange Rates (left side) and Oil Rents (right side) for Tunisia

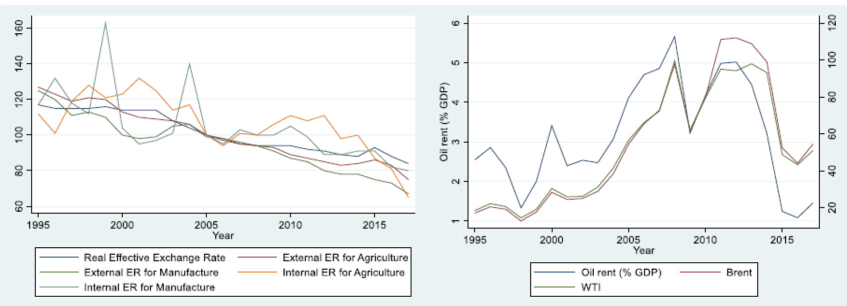

Table 2.4 – Kao and Pedroni Co-Integration Tests Results for Oil Rents

		reer	$erer_{agriculture}$	$erer_{manufacture}$	$irer_{agriculture}$	$irer_{manufacture}$
Kao	Modified DF	-0.8800	-0.2813	0.0746	-0.3357	-2.1455**
		(0.1894)	(0.3892)	(0.4703)	(0.3686)	(0.0160)
	DF	-2.6146***	-1.8768**	-1.4485*	-1.4444*	-3.3126***
		(0.0045)	(0.0303)	(0.0737)	(0.0743)	(0.0005)
	Augmented DF	-2.8386***	-2.0120**	-1.6629**	-1.9425**	-0.4079
		(0.0023)	(0.0221)	(0.0482)	(0.0260)	(0.3417)
	Unadjusted Modified DF	-4.1108***	-4.1805***	-3.2985***	-2.3623***	-4.7102***
		(0.0000)	(0.0000)	(0.0005)	(0.0091)	(0.0000)
	Unadjusted DF	-4.2679***	-4.0961***	-3.5447***	-2.6005***	-4.3357***
		(0.0000)	(0.0000)	(0.0002)	(0.0047)	(0.0000)
Pedroni	Panel v-statistic	-2.7509***	-2.5196***	-2.4835***	-2.5270***	-3.1377***
		(0.0030)	(0.0059)	(0.0065)	(0.0043)	(0.0009)
	Panel ρ-statistic	1.7402**	2.3529***	2.1765**	2.6157***	1.3567*
		(0.0409)	(0.0093)	(0.0148)	(0.0045)	(0.0874)
	Panel PP-statistic	-2.0792**	-1.4582*	-2.1528**	-0.4301	-4.1730***
		(0.0188)	(0.0724)	(0.0157)	(0.3336)	(0.0000)
	Panel ADF-statistic	-3.0145***	-3.2950***	-3.0213***	-0.9046	-4.7042***
		(0.0013)	(0.0005)	(0.0013)	(0.1828)	(0.0000)
	Group ρ-statistic	2.9338***	3.4211***	3.3993***	3.6808***	2.6627***
		(0.0017)	(0.0003)	(0.0003)	(0.0001)	(0.0039)
	Group PP-statistic	-1.3031*	-0.9804	-1.5785*	-0.0872	-3.7517***
		(0.0963)	(0.1634)	(0.0572)	(0.4653)	(0.0001)
	Group ADF-statistic	-2.4743***	-3.2032***	-2.7414***	-0.5233	-4.0278***
		(0.0067)	(0.0007)	(0.0031)	(0.3004)	(0.0000)

Note : The table presents the four statistics provided by the Kao co-integration test and the seven provided by the Pedroni co-integration test. The number of lags is chosen using the Bayesian Information Criterion. P-values are in parentheses.

Table 2.5 – Kao and Pedroni Co-Integration Tests Results for the Brent Oil Price

		reer	$erer_{agriculture}$	$erer_{manufacture}$	$irer_{agriculture}$	$irer_{manufacture}$
Kao	Modified DF	-3.5569***	-4.0486***	-2.9315***	-2.3663***	-4.1679***
		(0.0002)	(0.0000)	(0.0017)	(0.0090)	(0.0000)
	DF	-4.1934***	-4.3309***	-3.5911***	-2.8296***	-4.3784***
		(0.0000)	(0.0000)	(0.0002)	(0.0023)	(0.0000)
	Augmented DF	-4.4071***	-4.4094***	-3.7855***	-3.2548***	-3.3704***
		(0.0000)	(0.0000)	(0.0001)	(0.0006)	(0.0004)
	Unadjusted Modified DF	-4.1805***	-4.4784***	-3.4707***	-2.5866***	-4.8835***
		(0.0000)	(0.0000)	(0.0003)	(0.0048)	(0.0000)
	Unadjusted DF	-4.3802***	-4.4490***	-3.7732***	-2.9136***	-4.5749***
		(0.0000)	(0.0000)	(0.0001)	(0.0018)	(0.0000)
Pedroni	Panel v-statistic	-2.7517***	-2.5284***	-2.4701***	-2.5099***	-3.0350***
		(0.0030)	(0.0057)	(0.0068)	(0.0060)	(0.0012)
	Panel ρ-statistic	1.4798*	2.3156**	1.9807**	2.7236***	1.5457*
		(0.0695)	(0.0103)	(0.0238)	(0.0032)	(0.0611)
	Panel PP-statistic	-2.6249***	-1.6462**	-2.8720***	0.0514	-3.5787***
		(0.0043)	(0.0499)	(0.0020)	(0.4795)	(0.0002)
	Panel ADF-statistic	-3.6972***	-3.5833***	-4.9085***	-0.6076	-4.1849***
		(0.0001)	(0.0002)	(0.0000)	(0.2717)	(0.0000)
	Group ρ-statistic	2.6426***	3.4133***	3.2851***	3.8250***	2.7793***
		(0.0041)	(0.0003)	(0.0005)	(0.0001)	(0.0027)
	Group PP-statistic	-1.8650**	-1.1583	-2.2172**	0.4734	-3.8424***
		(0.0311)	(0.1234)	(0.0133)	(0.3180)	(0.0001)
	Group ADF-statistic	-2.9463***	-3.5266***	-4.1981***	-0.2719	-3.8734***
		(0.0016)	(0.0002)	(0.0000)	(0.3928)	(0.0001)

Note : The table presents the four statistics provided by the Kao co-integration test and the seven provided by the Pedroni co-integration test. The number of lags is chosen using the Bayesian Information Criterion. P-values are in parentheses.

Table 2.6 – Kao and Pedroni Co-Integration Tests Results for the WTI Oil Price

		reer	$erer_{agriculture}$	$erer_{manufacture}$	$irer_{agriculture}$	$irer_{manufacture}$
Kao	Modified DF	-3.5533***	-4.0576***	-2.9304***	-2.3678***	-4.1736***
		(0.0002)	(0.0000)	(0.0017)	(0.0089)	(0.0000)
	DF	-4.1934***	-4.3292***	-3.5902***	-2.8296***	-4.3770***
		(0.0000)	(0.0000)	(0.0002)	(0.0023)	(0.0000)
	Augmented DF	-4.4068***	-4.4062***	-3.7887***	-3.2561***	-3.3625***
		(0.0000)	(0.0000)	(0.0001)	(0.0006)	(0.0004)
	Unadjusted Modified DF	-4.1817***	-4.4811***	-3.4669***	-2.5845***	-4.8734***
		(0.0000)	(0.0000)	(0.0003)	(0.0049)	(0.0000)
	Unadjusted DF	-4.3818***	-4.4454***	-3.7714***	-2.9122***	-4.5689***
		(0.0000)	(0.0000)	(0.0001)	(0.0018)	(0.0000)
Pedroni	Panel v-statistic	-2.7125***	-2.4958***	-2.4634***	-2.5234***	-3.0371***
		(0.0033)	(0.0063)	(0.0069)	(0.0058)	(0.0012)
	Panel ρ-statistic	1.5065*	2.3364***	2.0319**	2.7144***	1.5518*
		(0.0660)	(0.0090)	(0.0211)	(0.0033)	(0.0604)
	Panel PP-statistic	-2.5424***	-1.4810*	-2.9708***	-0.0059	-3.7058***
		(0.0055)	(0.0693)	(0.0015)	(0.4977)	(0.0001)
	Panel ADF-statistic	-3.6573***	-3.5403***	-5.3150***	-0.7302	-4.2918***
		(0.0001)	(0.0002)	(0.0000)	(0.2326)	(0.0000)
	Group ρ-statistic	2.6707***	3.4585***	3.3104***	3.8056***	2.8155***
		(0.0038)	(0.0003)	(0.0005)	(0.0001)	(0.0024)
	Group PP-statistic	-1.7941**	-0.9714	-2.4230***	0.4705	-4.5122***
		(0.0364)	(0.1657)	(0.0077)	(0.3190)	(0.0000)
	Group ADF-statistic	-2.9634***	-3.4994***	-4.6273***	-0.3651	-3.9575***
		(0.0015)	(0.0002)	(0.0000)	(0.3575)	(0.0000)

Note : The table presents the four statistics provided by the Kao co-integration test and the seven provided by the Pedroni co-integration test. The number of lags is chosen using the Bayesian Information Criterion. P-values are in parentheses.

Table 2.7 – Pooled-Mean-Group Results for Oil Rents

Variables	*reer*	$erer_{agriculture}$	$erer_{manufacture}$	$irer_{agriculture}$	$irer_{manufacture}$
Long-Run :					
OilRents	0.0180***	0.0182***	0.0203***	0.0256***	0.0055**
	(0.0021)	(0.0026)	(0.0024)	(0.0033)	(0.0022)
openness	-0.8106***	-0.7986***	-0.8710***	-0.7592***	-0.6505***
	(0.0834)	(0.1060)	(0.1018)	(0.1046)	(0.1278)
balassa	0.7120***	0.6288***	0.7813***	0.9297***	0.0691
	(0.0653)	(0.0874)	(0.0750)	(0.1147)	(0.0609)
NFA	-0.0022*	-0.0030***	-0.0022***	-0.0038***	-0.0098***
	(0.0012)	(0.0010)	(0.0006)	(0.0010)	(0.0013)
investment	0.0911	0.0911	0.1599**	0.0872	0.2091***
	(0.0686)	(0.0845)	(0.0795)	(0.0699)	(0.0748)
Short-Run :					
Δ*OilRents*	-0.0006	-0.0026	0.0012	-0.0061	0.0098
	(0.0048)	(0.0044)	(0.0038)	(0.0063)	(0.0109)
Δ*openness*	-0.0837	-0.1675***	-0.1955***	-0.0147	-0.0791
	(0.1074)	(0.0622)	(0.0741)	(0.1738)	(0.1162)
Δ*balassa*	0.2981	0.3374	0.3896*	0.5060***	0.8168**
	(0.2877)	(0.2546)	(0.2221)	(0.1708)	(0.4089)
Δ*NFA*	-0.0048	-0.0044	-0.0037	-0.0032**	-0.0052*
	(0.0031)	(0.0031)	(0.0034)	(0.0015)	(0.0027)
Δ*investment*	-0.0681	-0.0935	-0.1197	0.0229	-0.0127
	(0.1688)	(0.1825)	(0.1741)	(0.1901)	(0.1221)
ec	-0.2183**	-0.1945*	-0.2056**	-0.2181**	-0.4723***
	(0.1073)	(0.1011)	(0.0984)	(0.1020)	(0.1181)
Constant	0.9551**	0.9078*	0.8215**	0.6137*	3.1867***
	(0.4820)	(0.4876)	(0.4059)	(0.3188)	(0.8021)
Hausman	0.7288	0.8853	0.8971	0.5352	0.0000
Observations	207	207	207	207	207

Note : ec is the error-correction term and represents the speed of adjustment toward long-run equilibrium. Hausman test reports the p-value for the Hausman test of PMG against MG. We prefer the Mean-Group to the Pooled-Mean-Group Estimator if $P < 0.05$. The number of lags of the model is selected using the Bayesian Information Criterion. The BIC indicates to prefer an ARDL(111111) in each case. Standard errors are in parentheses : *Significant at 10% **Significant at 5% ***Significant at 1%

Table 2.8 – Pooled-Mean-Group Results for Oil Prices

Variables	*reer* (1)	*reer* (2)	$erer_{agriculture}$ (1)	$erer_{agriculture}$ (2)	$erer_{manufacture}$ (1)	$erer_{manufacture}$ (2)	$irer_{agriculture}$ (1)	$irer_{agriculture}$ (2)	$irer_{manufacture}$ (1)	$irer_{manufacture}$ (2)
Long-Run :										
oilprice	0.0595***	0.2141***	0.0572***	0.1569***	0.4877***	0.5257***	0.0694***	0.0770***	-0.2273***	-0.2387***
	(0.0188)	(0.0331)	(0.0219)	(0.0358)	(0.0531)	(0.0548)	(0.0250)	(0.0290)	(0.0399)	(0.0466)
openness	-0.8245***	-0.4705***	-0.6383***	-0.3568***	-0.9941***	-0.9866***	-0.6580***	-0.6543***	-0.1926*	-0.2140**
	(0.0873)	(0.0927)	(0.0912)	(0.1039)	(0.0870)	(0.0847)	(0.0968)	(0.1000)	(0.1002)	(0.1016)
balassa	0.2433***	0.4870***	0.3034***	0.4532***	-0.0135	-0.0116	0.3819**	0.3875**	0.2795***	0.2728***
	(0.0803)	(0.0587)	(0.0825)	(0.0706)	(0.0926)	(0.0868)	(0.1730)	(0.1739)	(0.0412)	(0.0423)
NFA	-0.0011	-0.0042***	-0.0024**	-0.0041***	0.0005	0.0012	-0.0032**	-0.0029**	-0.0047***	-0.0047***
	(0.0010)	(0.0015)	(0.0011)	(0.0011)	(0.0033)	(0.0035)	(0.0013)	(0.0012)	(0.0011)	(0.0012)
investment	0.1035	0.0067	-0.0633	-0.0728	0.8786***	0.8026***	-0.0363	-0.0388	0.0261	0.0410
	(0.0949)	(0.0765)	(0.0966)	(0.0665)	(0.1144)	(0.1071)	(0.0684)	(0.0670)	(0.0696)	(0.0606)
Short-Run :										
Δ*oilprice*	0.1038***	0.0461*	0.0316	0.0054	0.1029***	0.1118***	0.0408	0.0525	0.0792	0.0791
	(0.0384)	(0.0275)	(0.0451)	(0.0371)	(0.0315)	(0.0218)	(0.0604)	(0.0628)	(0.0565)	(0.0526)
Δ*openness*	-0.1266	-0.1117	-0.2061***	-0.2178**	-0.2922***	-0.2867***	-0.1186	-0.1215	-0.1903*	-0.1655*
	(0.0873)	(0.1067)	(0.0665)	(0.0884)	(0.1005)	(0.1033)	(0.1420)	(0.1428)	(0.0998)	(0.0868)
Δ*balassa*	0.4004*	0.2529	0.4757**	0.3666**	0.4431***	0.4625***	0.6565***	0.6942***	0.8316***	0.7847***
	(0.2317)	(0.1811)	(0.2304)	(0.1701)	(0.1389)	(0.1298)	(0.1881)	(0.1860)	(0.2825)	(0.2821)
Δ*NFA*	-0.0051	-0.0049	-0.0046	-0.0044	-0.0061	-0.0062	-0.0024	-0.0026		
	(0.0040)	(0.0039)	(0.0037)	(0.0036)	(0.0046)	(0.0045)	(0.0019)	(0.0019)		
Δ*investment*	-0.0449	-0.0336	-0.0384	-0.0302	-0.0946	-0.0993	0.0835	0.0750	-0.0381	
	(0.1507)	(0.1488)	(0.1610)	(0.1556)	(0.1646)	(0.1622)	(0.1714)	(0.1749)	(0.1073)	
ec	-0.2269**	-0.2384**	-0.2524***	-0.2807***	-0.0632	-0.0668	-0.2282**	-0.2277**	-0.3823***	-0.3885***
	(0.1021)	(0.1026)	(0.0876)	(0.0894)	(0.0821)	(0.0869)	(0.0993)	(0.0992)	(0.1443)	(0.1413)
Constant	1.4908**	0.9087**	1.5272***	1.0728***	0.2732	0.2943	1.2467**	1.2281**	2.0394***	2.1179***
	(0.6680)	(0.4040)	(0.5373)	(0.3500)	(0.3646)	(0.3921)	(0.5551)	(0.5487)	(0.7779)	(0.7803)
Hausman	0.3095	0.3493	0.8254	0.8674	0.1989	0.3699	0.9906	0.9952	0.1658	0.0756
Observations	207	207	207	207	207	207	207	207	207	207

Note : Column (1) shows the results for the logarithm of the Brent oil price and column (2) for the logarithm of the WTI oil price. ec is the error-correction term and represents the speed of adjustment toward long-run equilibrium. Hausman test reports the p-value for the Hausman test of PMG against MG. We prefer the Mean-Group to the Pooled-Mean-Group Estimator if $P < 0.05$. The number of lags of the model is selected using the Bayesian Information Criterion. The BIC indicates to prefer an ARDL(111111) in each case except for the internal ER for manufacture where an ARDL(111101) is preferred with the Brent oil price and an ARDL(111100) with the WTI oil price. Standard errors are in parentheses : *Significant at 10% **Significant at 5% ***Significant at 1%

Table 2.9 – Mean-Group Results for Oil Rents

Variables	*reer*	$erer_{agriculture}$	$erer_{manufacture}$	$irer_{agriculture}$	$irer_{manufacture}$
Long-Run :					
OilRents	0.1274	0.0986	0.1479	0.0366**	0.0174
	(0.1241)	(0.0933)	(0.1413)	(0.0178)	(0.0355)
openness	-2.0074	-1.5141	-2.4172	-0.7439***	-0.6932
	(1.6449)	(1.2587)	(1.8689)	(0.2433)	(0.5856)
balassa	-2.8537	-2.0839	-3.2506	-0.2342	-1.0715
	(2.9321)	(2.2985)	(3.4109)	(0.5385)	(0.8580)
NFA	-0.0802	-0.0615	-0.0899	-0.0206	-0.0178
	(0.0801)	(0.0624)	(0.0916)	(0.0127)	(0.0210)
investment	0.2886	-0.0651	0.3248	-0.0993	-0.3419
	(0.3120)	(0.1292)	(0.2695)	(0.4513)	(0.3400)
Short-Run :					
$\Delta OilRents$	0.0024	0.0004	0.0026	-0.0063	0.0157*
	(0.0059)	(0.0066)	(0.0056)	(0.0069)	(0.0083)
$\Delta openness$	0.0244	-0.0976	-0.0006	0.0792	-0.0411
	(0.1184)	(0.1043)	(0.1048)	(0.1773)	(0.1316)
$\Delta balassa$	0.7049*	0.6298	0.6782	0.5124*	0.8590**
	(0.4177)	(0.4513)	(0.4346)	(0.3083)	(0.4155)
ΔNFA	-0.0031*	-0.0031*	-0.0024	-0.0004	-0.0062**
	(0.0018)	(0.0018)	(0.0020)	(0.0018)	(0.0024)
$\Delta investment$	-0.0667	-0.0167	-0.0772	0.0410	0.1183
	(0.1284)	(0.1360)	(0.1301)	(0.1097)	(0.0927)
ec	-0.7133***	-0.5731***	-0.6511***	-0.5058***	-0.8524***
	(0.1040)	(0.0869)	(0.1152)	(0.0516)	(0.1221)
Constant	5.1591***	4.0536***	4.9786***	3.4268***	8.4159***
	(1.1938)	(1.3196)	(1.1768)	(1.2783)	(2.5267)
Observations	207	207	207	207	207

Note : ec is the error-correction term and represents the speed of adjustment toward long-run equilibrium. Standard errors are in parentheses : *Significant at 10% **Significant at 5% ***Significant at 1%

Table 2.10 – Mean-Group Results for Oil Prices

Variables	*reer*		$erer_{agriculture}$		$erer_{manufacture}$		$irer_{agriculture}$		$irer_{manufacture}$	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Long-Run :										
oilprice	-0.0062	0.0122	0.0726	0.0793	0.1440	0.1581*	0.1642*	0.1844*	-0.0886	-0.1336
	(0.0671)	(0.0697)	(0.0744)	(0.0716)	(0.1018)	(0.0901)	(0.0946)	(0.1004)	(0.1221)	(0.1301)
openness	-0.4787**	-0.4245**	-0.1931	-0.2044	-0.2809	-0.3023*	-0.5375***	-0.5971***	-0.5026**	-0.4677**
	(0.1993)	(0.1674)	(0.1773)	(0.1601)	(0.1927)	(0.1654)	(0.2077)	(0.2051)	(0.2013)	(0.2158)
balassa	-0.0568	-0.0174	0.2267	0.2405	0.3090	0.2932	0.4154	0.4861	-0.0709	-0.0177
	(0.2534)	(0.2289)	(0.2003)	(0.2113)	(0.2779)	(0.2580)	(0.4042)	(0.4339)	(0.5578)	(0.5415)
NFA	0.0047**	0.0036**	0.0018	0.0017	0.0046*	0.0038*	-0.0059	-0.0064	0.0067	0.0087
	(0.0023)	(0.0017)	(0.0019)	(0.0016)	(0.0026)	(0.0020)	(0.0055)	(0.0057)	(0.0065)	(0.0072)
investment	-0.5943	-0.5774	-0.4213	-0.4393	-0.6396	-0.6122	-0.2572	-0.2962	-0.4944	-0.4580
	(0.7215)	(0.6730)	(0.5903)	(0.5699)	(0.7108)	(0.6614)	(0.5964)	(0.6054)	(0.6780)	(0.6460)
Short-Run :										
$\Delta oilprice$	0.1600***	0.1320***	0.0775	0.0641	0.1109**	0.0877**	0.0345	0.0202	0.1745	-0.1076
	(0.0425)	(0.0357)	(0.0503)	(0.0461)	(0.0461)	(0.0417)	(0.0487)	(0.0451)	(0.1085)	(0.1224)
$\Delta openness$	-0.0612	-0.0519	-0.2050**	-0.1960*	-0.1384	-0.1238	-0.0863	-0.0710	0.1206	0.0666
	(0.1092)	(0.1140)	(0.0959)	(0.1009)	(0.0957)	(0.1018)	(0.1611)	(0.1538)	(0.1741)	(0.1765)
$\Delta balassa$	0.4317*	0.3465	0.4032	0.3639	0.3400	0.3052	0.4166**	0.4471***	0.9738*	0.6475*
	(0.2578)	(0.2244)	(0.2547)	(0.2253)	(0.2768)	(0.2430)	(0.2061)	(0.1740)	(0.5244)	(0.3644)
ΔNFA	-0.0068	-0.0063	-0.0064	-0.0062	-0.0071	-0.0067	-0.0022	-0.0021	-0.0109*	-0.0104*
	(0.0050)	(0.0047)	(0.0047)	(0.0045)	(0.0049)	(0.0047)	(0.0028)	(0.0028)	(0.0057)	(0.0060)
$\Delta investment$	0.0408	0.0488	0.0954	0.0952	0.0735	0.0733	0.1336	0.1266	0.0215	0.0337
	(0.0581)	(0.0577)	(0.0718)	(0.0701)	(0.0658)	(0.0660)	(0.1262)	(0.1112)	(0.0789)	(0.0912)
ec	-0.7308***	-0.7311***	-0.6387***	-0.6323***	-0.7126***	-0.7160***	-0.4935***	-0.4737***	-0.8537***	-0.8268***
	(0.1220)	(0.1130)	(0.1071)	(0.0893)	(0.1503)	(0.1462)	(0.0679)	(0.0606)	(0.1265)	(0.1088)
Constant	4.3778***	4.3343***	3.0732***	3.0003***	3.0347***	3.0754***	2.4045**	2.2858**	8.7363***	7.9304***
	(0.9907)	(0.9096)	(0.9734)	(0.9513)	(1.0482)	(0.9200)	(1.1329)	(1.1034)	(2.9894)	(2.3717)
Observations	207	207	207	207	207	207	207	207	207	207

Note : Column (1) shows the results for the logarithm of the Brent oil price and column (2) for the logarithm of the WTI oil price. ec is the error-correction term and represents the speed of adjustment toward long-run equilibrium. Standard errors are in parentheses : *Significant at 10% **Significant at 5% ***Significant at 1%

Table 2.11 – Breusch-Pagan Test for Cross-Sectional Dependence

		reer	$erer_{agriculture}$	$erer_{manufacture}$	$irer_{agriculture}$	$irer_{manufacture}$
OilRents	Without trend	86.48***	91.71***	105.20***	98.10***	84.78***
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
	With trend	94.53***	102.90***	112.80***	89.98***	80.19***
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)

Note : The table presents the results for the Breusch-Pagan (1980) test of cross-sectional dependence based on Lagrange-Multiplier. A p-value lower than 0.05 indicates to reject the hypothesis of error cross-sectional independence. P-values are in parentheses.

Table 2.12 – Cross-Sectionally Augmented Pooled-Mean-Group Results

Variables	*reer*	$erer_{agriculture}$	$erer_{manufacture}$	$irer_{agriculture}$	$irer_{manufacture}$
Long-Run :					
OilRents	0.0025	0.0035***	0.0024	0.0934***	0.0063*
	(0.0019)	(0.0011)	(0.0018)	(0.0076)	(0.0033)
openness	-0.3176***	-0.2626***	-0.2453***	-0.9288***	-0.7958***
	(0.0786)	(0.0752)	(0.0295)	(0.0881)	(0.1765)
balassa	0.1185***	0.0927***	0.2853***	-0.5604***	-0.0946
	(0.0215)	(0.0176)	(0.0540)	(0.1419)	(0.0777)
NFA	-0.0026**	-0.0022***	-0.0053***	-0.0203***	0.0093***
	(0.0010)	(0.0009)	(0.0012)	(0.0016)	(0.0017)
investment	-0.0292	-0.0352	-0.0242***	1.4123***	0.0281
	(0.0361)	(0.0364)	(0.0083)	(0.0720)	(0.1186)
$\overline{OilRents}$	-0.0129***	-0.0143***	-0.0046***	-0.0157***	-0.0373***
	(0.0041)	(0.0031)	(0.0010)	(0.0019)	(0.0074)
$\overline{openness}$	0.5486***	0.4778***	0.1279***	-0.7811***	1.8616***
	(0.1192)	(0.1096)	(0.0376)	(0.0836)	(0.2601)
$\overline{NFA}$	0.0074***	0.0031**	0.0033***	0.0032**	0.0197***
	(0.0017)	(0.0014)	(0.0008)	(0.0016)	(0.0035)
Short-Run :					
$\Delta OilRents$	-0.0064	-0.0014	0.0087	-0.0047	-0.0142
	(0.0057)	(0.0059)	(0.0082)	(0.0167)	(0.0113)
$\Delta openness$	-0.2831	-0.4518*	-0.4712**	-0.2279	-0.1776
	(0.2428)	(0.2544)	(0.2342)	(0.2800)	(0.3251)
$\Delta balassa$	0.0251	0.0226	0.2969*	0.2225	0.1788
	(0.1453)	(0.1022)	(0.1551)	(0.3350)	(0.1570)
ΔNFA	-0.0079	-0.0078	-0.0084	-0.0023	-0.0110*
	(0.0064)	(0.0065)	(0.0066)	(0.0069)	(0.0063)
$\Delta investment$	-0.0554	-0.0619	-0.1059	-0.3759	0.0092
	(0.1808)	(0.1886)	(0.1860)	(0.2824)	(0.1427)
$\Delta\overline{OilRents}$	0.0053	-0.0004	-0.0006	0.0073	0.0047
	(0.0036)	(0.0045)	(0.0041)	(0.0060)	(0.0072)
$\Delta\overline{openness}$	0.5739	0.6589	0.7802	0.0737	0.2779
	(0.5860)	(0.7195)	(0.6062)	(0.6361)	(0.9265)
$\Delta\overline{NFA}$	0.0019	0.0014	0.0012	-0.0024	0.0019
	(0.0020)	(0.0016)	(0.0022)	(0.0046)	(0.0046)
ec	-0.3996***	-0.3716***	-0.4286*	-0.3010	-0.4421***
	(0.1216)	(0.1240)	(0.2224)	(0.2035)	(0.1274)
Constant	1.3400***	1.3389***	1.6182*	-0.5811**	0.4525***
	(0.4103)	(0.4480)	(0.8293)	(0.2929)	(0.1284)
Observations	207	207	207	207	207

Note : ec is the error-correction term and represents the speed of adjustment toward long-run equilibrium. Standard errors are in parentheses : *Significant at 10% **Significant at 5% ***Significant at 1%

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Chapitre 3

Impact of Oil Price and Oil Production on Inflation in the CEMAC

3.1 Introduction

Previous empirical works have supported evidence that natural resources booms can generate inflation and/or exchange rates appreciation in resource-rich countries through Dutch disease effects. Since the early 1980s, the model of Corden-Neary (1982) has led to an extensive empirical literature, either focusing on real exchange rate appreciation or on the decline in non-resource tradable sectors considered as the main consequence of this appreciation (see chapter 1). However, these discussions have neglected some key dimensions, notably regarding the model's underlying assumptions.

This paper aims to question the classical assumption that natural resources are fully exported, hence that international resource prices affect domestic prices and real exchange rates through Dutch disease effects only. Indeed, even in developing countries, natural resources -particularly energy such as oil, gas or coal- can be domestically consumed by households or used as inputs in other goods' production. In addition, international energy prices can affect the price of international manufacturing or agricultural goods, impacting domestic consumer price indexes in countries that import these goods, even when they do not produce them. We call here "Pass-through" the fact that international oil prices directly influence domestic inflation through production costs or by entering the basket of goods and services used to estimate price indexes. Our goal is to disentangle the Dutch disease (DD) from the Pass-through (PT) price effects in five Central African oil-producing countries : Cameroon, Chad, Congo, Equatorial Guinea, and Gabon.

This selection of countries is motivated by several factors. First, crude petroleum oil represents a large share of their total exports (from 36% in Cameroon to 74% in Chad in 2019 [1]) but none of them is a large exporter at the world level. Hence, we consider these countries as price takers and oil price changes as exogenous. Furthermore, they are developing countries with low levels of industrialization. Therefore, they seem at first sight to meet the traditional assumptions of DD models, where energy is assumed to be fully exported, which is precisely the assumption we intend to discuss here. Then, they belong (with the Central African Republic) to the Central African Economic and Monetary Community (CEMAC) : they share a common currency (the XAF CFA Franc), monetary policy, and trade policy. This allows consistent comparisons across countries based on their divergence in oil production patterns. Finally, the CFA Franc being fixed to the Euro (to the French Franc before 1999), DD effects can occur only through domestic inflation and not through nominal exchange rate appreciation (nominal bilateral exchange rate changes against foreign currencies are exogenous, being determined by variations of the Euro against these other currencies). These characteristics allow us to estimate the impact of oil produc-

1. https://oec.world

tion and international oil prices on the consumer price index and to investigate for each country whether oil-driven CPI variations are caused by Dutch disease, pass-through, or a combination of both. Our results show clear evidence of a Pass-Through effect in Cameroon, Chad and the Republic Congo and mixed evidence of such an effect in Equatorial Guinea. They also suggest a Dutch Disease effect in Equatorial Guinea and, to a lesser extent, in Chad. Results remain inconclusive for Gabon. These results notably call for more interactions between two strands of the economic literature that are the DD and the PT literature, and which have very often neglected each other.

This article contributes to different strands of the economic literature on several points. First, it contributes to the Dutch disease literature by questioning one key assumption of theoretical models (natural resources are fully exported). This point matters for the understanding of Dutch disease effects since this assumption is rarely discussed in empirical analyses. This article also contributes to this literature by focusing on inflation, and therefore on the impact of natural resources on households that do not directly benefit from these revenues, rather than on firms' competitiveness. Indeed, the DD is frequently perceived as being only negative for external competitiveness (due to real exchange rate appreciation caused either by nominal exchange rate appreciation or by domestic inflation), while the inflation effect caused by the increase in spending from agents benefiting from the resource boom might also have a negative impact on the real wages of agents that do not benefit from it. This article also contributes to the literature by linking the DD and the PT literature, two strands of economic research that rarely interact with each other. Finally, it provides a better understanding of the determinants of inflation in CEMAC countries, a region that has often been neglected in empirical studies. On this point, it is noticeable that, at the time of discussion about the suppression of the Western CFA Franc, the understanding of inflation dynamics in oil-exporting countries of the Central CFA Franc area can also be of great interest for recent or future oil-producers in the West African Economic and Monetary Union (e.g. Senegal).

The paper is organized as follows. Section 3.2 presents the literature on PT and DD and briefly discusses their respective methodologies. Section 3.3 provides a theoretical framework to explain the two effects and describes the main assumptions of this study. Section 3.4 describes the history and dynamics of the oil sector in the countries of interest. Section 3.5 presents the empirical methodology and the results. Section 3.6 concludes.

3.2 Why Should International Oil Price Translate into Domestic Inflation ? Pass-Through and Dutch Disease Literature

This section details the arguments for both the pass-through and Dutch disease explanations of the impact of oil shocks on prices. It also presents and compares the empirical literature of these two fields of the literature.

3.2.1 The Pass-Through from Oil Prices to the Domestic Consumer Price Index

International price variations in natural resources such as hydrocarbons or mining resources can result in variations in domestic consumer price indexes (CPI) in exporting and importing resources countries for two reasons. First, if the basket of goods used to compute the aggregate CPI includes the resource, a change in the resource's price is expected to generate a change in the CPI proportional to the weight of this resource in the basket. This is notably relevant for energy products that can be used for cooking, lighting, heating or transportation. Second, if the resource is used as an input in the production of other goods or services, a price increase will raise the price of the final product or reduce its producer's profit (or more likely a combination of both). This includes energy products but also metals and minerals that can be used to produce manufactured goods or artificial fertilizers used in agriculture. However, due to the central importance of petroleum products on international trade markets and in production processes, it is not surprising that most empirical articles that have investigated this pass-through effect have focused on international crude oil price variations. It might also be noticed that such PT between international resource prices and domestic CPI might only imperfectly occur. Indeed, it depends on the price elasticity of the goods and services that use this resource in their production function. In addition, domestic policy can react to surges in international prices to avoid excessive inflation through subsidies, price controls, or reduced import tariffs.

The empirical literature on the pass-through from international commodity prices on domestic inflation in commodity consuming countries dates back at least 40 years, usually associated with Hamilton (1983). In this study, the author investigates the impact of international crude oil prices on different macroeconomic indicators in the United States, including notably inflation, economic growth or unemployment. Since then, various studies have tried to verify or falsify this PT effect in the USA or in other industrialized economies. However, due to a frequent lack of data availability, it is only recently that empirical studies have started to focus on developing and emerging economies. For instance, based on quarterly data over 1996-2010, Caceres et al. (2012) investigate the impact of global energy and food prices on the consumer price index in four countries of the CEMAC area (Cameroon, the Central African Republic, the Republic of Congo, and Gabon). Applying a Vector Auto Regressive (VAR) methodology, Dynamic Ordinary Least Squares (DOLS) and Fully Modified Ordinary Least Squares (FMOLS), they conclude that energy prices have a positive and significant effect on inflation in Cameroon and Gabon, while the significance of the impact in the Central African Republic (CAR) and Congo highly depends on the econometric model (VAR, DOLS or FMOLS). On the contrary, the coefficients associated with food prices are mostly insignificant, except for Gabon with a VAR and for the CAR with DOLS. This underlines the impact of global prices, particularly of energy prices, on inflation in the CEMAC area and the heterogeneity that may exist across countries even within a monetary union. Sakashita and Yoshizaki (2016) investigate the impact of different international oil shocks (demand and supply shocks) on the consumer price index in the United States and five emerging economies (Brazil, Chile, India, Mexico, and Russia) between 1994 and 2016. Based on a structural VAR with two blocks of variables (a "global oil market block" and a "domestic aggregate economy block"), they conclude to the absence of solid impacts of oil supply shocks on domestic economies' CPI, and to significant but heterogeneous effects of oil demand shocks : an increase in oil demand generates inflation in the United States, Chile, and India but disinflation in Brazil, Mexico, and Russia. This highlights both the fact that oil-importing (such as India) and oil-exporting countries (such as Mexico or Russia) are vulnerable to exogenous shocks on international oil markets and that the effects of these shocks largely differ across countries. Husaini et al. (2019) estimate the impact of energy subsidy and the international Brent crude oil price on both the consumer price index and the production price index in Malaysia. Based on an Autoregressive Distributed Lag (ARDL) model, they conclude to a long-term positive and significant effect of international oil prices on CPI and PPI (with a larger effect for PPI), but also observe that energy subsidy can contribute to reducing this pass-through effect by cutting down inflation. Following a Phillips curve model augmented by supply-side oil prices, Lacheheb and Sirag (2019) assess the effects of oil price changes on inflation in Algeria between 1970 and 2014. Using a nonlinear ARDL (NARDL) approach, they conclude to a significantly positive impact of positive oil price shocks on inflation but to an insignificant effect for negative shocks, and explain this heterogeneous impact by the existence of fuel subsidies. Similarly, Nusair (2019) apply multiple NARDL models to the six countries of the Gulf Cooperation Council (Bahrain, Saudi Arabia, Kuwait, Qatar, Oman and the United Arab Emirates) between the 1970s and 2016. They conclude to a long-run positive impact of oil price shocks on inflation in all countries, but to a positive and significant impact of negative shocks only in Oman. Finally, Fasanya and Awodimila (2020) compare the impact of energy and non-energy commodity prices on inflation in Nigeria and South Africa. They also examine separately the impact of positive and negative changes in commodity prices to account for potential asymmetries in the effects. Even if commodity prices appear to be good predictors of inflation, they observe heterogeneity between the two countries since the best forecast for inflation is when the Phillips curve is augmented with energy prices for Nigeria but with non-energy prices for South Africa.

Among panel data studies, Crowley (2010) investigates the impact of a set of variables on inflation in 25 countries in the Middle East, North Africa and Central Asia (MENACA) over 1997-2008. The determinants of inflation used include notably the U.S. nominal effective exchange rate, the country's nominal effective exchange rate, local interest rate, GDP growth and (fuel and non-fuel) commodity prices. The author finally observes a positive impact of non-fuel commodity prices on inflation but surprisingly no significant impact of fuel prices, in contradiction with the expectations. However, this panel-based methodology does not account for potential heterogeneity across countries of the sample, which seems of particular interest here since the sample includes both net oil-importers (such as Jordan, Lebanon, or Tunisia) and net oil-exporters (such as Algeria, Kazakhstan, or Saudi Arabia). Bala and Chin (2018) investigate the impact of oil prices on inflation in a panel of four African OPEC members countries (Algeria, Angola, Libya, and Nigeria) between 1995 and 2014. Using Pooled-Mean-Group and Mean-Group approaches, they also account for potential asymmetric effects by including a variable for positive oil price shocks and one for negative oil price shocks in the regressions. They finally conclude to a clear long-run impact of oil price shocks on inflation with asymmetrical effects, and a significant effect only of positive shocks in the short-run. Raheem et al. (2020) investigate the dynamics of inflation in a panel of 10 net oil exporting and 10 net oil importing countries between 1986 and 2017. They conclude to a positive correlation between international oil prices and domestic inflation but with heterogeneous impact between the two groups of countries. Overall, this empirical literature clearly suggests that PT effects occur both in exporting and in importing countries, even if such effects can be partly balanced by specific policy measures (such as price controls or energy subsidy).

3.2.2 The Dutch Disease Impact of Oil Prices

However, there is another reason why international resource price increases can lead to domestic inflation in resource-exporting countries : the "Dutch disease". As seen in chapter 1, there has been a large empirical literature investigating the presence of a DD, particularly in oil-exporting countries, even if all types of natural resources can drive DD. It is noticeable that most empirical studies focus on the real effective exchange rate (defined as the product of nominal exchange rate and the ratio of domestic and foreign prices) as the main outcome to detect the presence of a DD. However, there might be justification for DD analyses looking at domestic prices rather than real exchange rates (RER). First, the RER reveals a relative evolution of domestic prices compared to foreign prices and might be unable to detect DD effects if trading partners also suffer from DD (or from PT effects). Then, classical variables of RER suffer from endogeneity issues. Indeed, the weights associated with each trading partner are re-estimated regularly (on a three-year basis for the IMF for instance), whereas the external competitiveness of a country and the types of products it exports or imports affect the share of each foreign country in its total trade, and consequently the way the RER is estimated. Finally, in a fixed nominal exchange rate regime, RER appreciation can only occur through price increase.

Kablan and Loening (2014) estimate the impact of oil prices and oil production shocks separately on inflation (based on the GDP deflator) in Chad between 1985 and 2008, in line with the DD model. Based on a structural VAR model, they conclude to a positive and significant impact of oil prices and a less significant impact of oil production on inflation. This allows them to conclude to inflationary pressures caused by DD effects in the Chadian economy. Khinsamone (2017) applies a VAR model to investigate the relations between a set of key variables in the Lao economy between 1980 and 2014 : mining and utility production, manufacturing-service ratio, investment-consumption ratio, inflation (based on the consumer price index), and real GDP per capita. Regarding the determinants of inflation, they observe that the value-added in the mining sector has a significant and positive effect on prices. This result is confirmed by the Granger causality test, which indicates to reject the null hypothesis that mining and utility production does not Granger cause inflation and is interpreted as evidence in favor of the DD hypothesis by the author. Mukhtarov et al. (2019) apply a Vector Error Correction Model (VECM) to annual data over 1995 and 2017 to determine the impact of oil prices and exchange rates on inflation in Azerbaijan. They find a positive impact of oil prices on inflation and conclude to the evidence of DD effects, even if the impact of exchange rates on prices appears to be stronger. Nasir et al. (2018) apply multiple Time-Varying Structural VAR models and estimate the impact of international oil prices on economic growth, domestic inflation, and trade balance in five emerging countries : Brazil, China, India, Russia, and South Africa. They notably distinguish between the two net-oil exporting countries (Russia and Brazil) for which oil prices are assumed to positively affect prices through both DD and production costs and the three net-oil importers (China, India, and South Africa) for which the two channels (production costs and trade) are supposed to have opposite effects on the CPI. However, they find that oil prices affect long-run inflation positively in Brazil (oil exporter) and India (oil importer) but negatively in Russia (oil exporter), China, and South Africa (oil importers). This does not seem to support neither DD nor PT but underlines the heterogeneity across countries in the vulnerability toward external shocks. Finally, we must underline the contribution of Beverelli et al. (2011) who investigate the possibility that oil could be used for domestic production. Based on a large panel of 132 countries, they conclude that oil discoveries generate lower DD effects in countries with higher shares of oil-intensive industries. However, due to their focus on large oil discoveries, instead of oil production or prices, they do not try to disentangle DD-caused price increases from other sources of oil-shocks driven inflation. In addition, they focus on the use of oil as an input for industrial production, while we focus here on consumer price indexes, considering that oil can enter the CPI as a final consumption good or as an input for other goods or services (such as transportation).

3.2.3 Dutch Disease or Pass-Through ?

It is striking that both Dutch disease and Pass-through studies often use very similar methodologies (estimating the impact of international resource prices or revenues on the RER or the CPI) but with very different interpretations. Indeed, analyses of the pass-through effect often neglect the Dutch disease hypothesis even when they focus on resource-exporting countries, making the implicit assumption that the impact of resource prices on domestic inflation depends only on the relationship between international and domestic resource prices and on the importance of resource consumption (either as a final good or as an input) in the economy. For instance, Fasanya and Awodimila (2020) do not mention potential Dutch disease effects even after observing that energy prices have a stronger effect on domestic inflation in Nigeria (which is an oil-exporting country) than in South Africa (which is an oil-importing country). Similarly, Bala and Chin (2018) find a positive impact of oil prices on inflation in four oil-exporting countries but do not investigate the DD hypothesis to explain this result. We can also mention Lacheheb and Sirag (2019) or Nusair (2019) who do not mention the DD when observing an asymmetric effect of oil prices on inflation in oil exporting countries (asymmetric effect that could be attributed to an asymmetry in public or private spending) but prefer to explain this heterogeneity by domestic subsidies.

Conversely, Dutch disease theoretical models and empirical analyses assume that resources are fully exported and never domestically consumed. It is particularly noticeable that, while the small-open economy (or price-taking country) assumption is almost always explicitly mentioned and usually justified, the assumption of no domestic resource consumption is often implicit and very rarely discussed. This is an issue when interpreting a positive relationship between international resource prices and domestic CPI inflation or RER appreciation as evidence of DD. We can also notice that even if the country does not consume this resource, it can import goods that have required it in their production, and PT effects can still occur.

Overall, it appears that while the PT effect is mainly driven by the price of refined oil imports and the DD by the price of crude oil exports, most studies use an international crude oil price (most often the Brent crude oil price) as a proxy. Indeed, international crude oil prices present the main advantage of being easily available (contrary to domestic import or export prices) and are more likely to be exogenous for small open economies. However, the use of the same proxy in these two types of studies reinforces the issues arising from the attribution of domestic inflation to one or the other effect. Even if some DD studies use oil discoveries (as in Beverelli et al., 2011), oil production, oil rents (expressed in % of total GDP), or oil exports rather than international oil prices, the presence of a positive correlation between these variables and oil prices might imply that PT effects can affect the interpretation of the results. Therefore, the lack of interaction between the DD literature focusing on the demand side and the PT literature focusing on the supply side might lead researchers and policymakers to wrongly conclude to DD or to PT effects when observing a correlation between the dynamics in international markets and domestic inflation in countries that are both consumers and net-exporters of natural resources. In this article, we argue that any complete model should consider both interpretations. We therefore aim to disentangle the inflation effect caused by energy PT from the inflation effect caused by DD effects in a set of crude oil-exporting countries within a monetary area with a fixed nominal exchange rate. Our focus on the oil sector is motivated by the fact hydrocarbons often provide large revenues in countries endowed with this resource and because petroleum products are often used by households or firms as a source of energy (contrary to luxury goods such as gold or diamonds for instance). Hence, this resource is likely to give birth to both DD and PT effects.

3.3 Analytical Framework

We propose in this section an overview of the three main effects that are investigated in this study : the pass-through effect (caused by international oil prices), the spending effect (caused by oil revenues), and the resource-movement effect (caused by oil production).

Our framework relies on some main assumptions in line with a modified version of the model proposed by Corden and Neary (1982). The first assumption is the small open economy. The consequences of this assumption are twofold. First, it implies that the domestic production of energy does not affect international prices. This is very likely to hold in our situation since none of the CEMAC country members are large oil-exporters on international markets. Then, it also implies that the share of domestic energy production that is not consumed is always exported abroad (i.e. there is no overproduction). This is important because it implies that an increase in oil production (if prices are constant) increases revenues coming from the oil sector. The second central assumption is that the country produces and consumes oil. This differs from the traditional model of Corden-Neary which considers that energy is fully exported. More precisely, the country exports crude oil and consumes refined imported oil (the domestic refinement industries being negligible), but we consider international spot crude oil prices (denoted from now "oil price") as proxies for both the price of oil exports and of oil consumption. Finally, the nominal bilateral exchange rate is exogenous. This is an essential condition since nominal exchange rates affect revenues coming from oil exports. Here, this relates to our focus on the CEMAC area, where the nominal exchange rate is fixed with the Euro [2].

We note :

$$P = P_N^{\alpha} P_T^{\beta} P_E^{\gamma} \tag{3.1}$$

With P the CPI, P_N the price of non-tradable products, P_T the price of tradable non-energy products, P_E the price of energy pro-

2. Even if we use the expression "fixed nominal exchange rate", it is fixed only with the Euro but varies with other currencies such as the USD in which international oil prices are denominated. However, these variations can be considered as exogenous as they are determined by the Euro/USD international forex market

ducts and $\alpha + \beta + \gamma = 1$. We also note N the nominal bilateral exchange rate[3] and P_i^* the price of i ($i \in \{T; E\}$) on international markets. Under the assumption that the country is price taker on international markets and with free competition :

$$P_T = P_T^* \times N$$

And :

$$P_E = P_E^* \times N$$

On the other side, $P_N = f(\text{total income, factors of production costs})$ depends on the domestic supply-demand equilibrium. If energy is required to produce non-tradable goods, P_N depends positively on P_E. Similarly, P_T^* depends positively on energy prices (because at the world level, energy is an input for the production and transportation of tradables). We present here three different effects (see Figure 3.1) :

1. *Pass-Through Effect* : An increase in international oil prices leads to domestic inflation if oil (or an energy index based

3. Defined as the number of domestic currency units into one foreign currency unit : an increase in N means a currency depreciation.

partly on oil) is included in the basket of goods and services used to estimate the consumer price index. In addition, it raises production costs of goods that use oil as an input, encouraging inflation.

2. *Spending Effect* : An increase in international oil prices (for a given level of oil production) or an increase in oil production (for a given level of price) leads to an increase in the revenues collected from oil exports (under the assumption that domestic consumption remains constant). These revenues are then shared between private agents and public authorities depending on the institutional arrangements and the level of taxation, and each agent is assumed to spend a fraction of these revenues in non-tradable and tradable expenditures. This increasing demand for tradable is compensated either by increasing imports, or by increasing production in tradable goods, which prices are assumed to be exogenous because fixed on international markets. However, non-tradable goods and services cannot be imported, hence prices must rise in this sector, leading to increases in aggregate CPI and in the ratio between non-tradable and tradable prices.

Even if this effect is often associated with public expenditures, which are assumed to be biased towards non-tradable goods, the original model of Corden-Neary considers that both public and private expenditures can lead to this price increase. Indeed, the spending effect does not require a bias toward non-tradable to be effective.

3. *Resource-Movement Effect* : If labor (or any other factor of production) is mobile across sectors but immobile across countries, an oil boom causes movements of workers out of the two other sectors into the oil sector, reducing non-oil production. Since non-oil production is now below domestic demand, imports of non-oil tradables increase (financed by oil exports) while non-tradables' prices rise. This leads to new movements of workers out of the tradable non-oil sector into the non-tradable sector (which partially offsets the price increase). The final equilibrium depends on the elasticity of non-tradables : if consumption of non-tradables cannot decrease, there is no price increase but a double decline in tradable production ; but if expenditures are partially redirected toward tradable goods, the decline in the tradable

sector is limited at the expense of a price increase in the non-tradable sector. Empirical studies often neglect this resource-movement because it is assumed to have a lower impact than the spending effect.

Hence, the pass-through effect depends directly on international prices, the spending effect on international revenues (determined by both prices and production), and the resource-movement effect by production only. The Dutch Disease is simply the combination of the spending and resource-movement effects. This leads us to two main assumptions :

Assumption 1 : For a given level of oil prices, a rise in production leads only to Spending and Resource-Movement (hence Dutch disease) effects

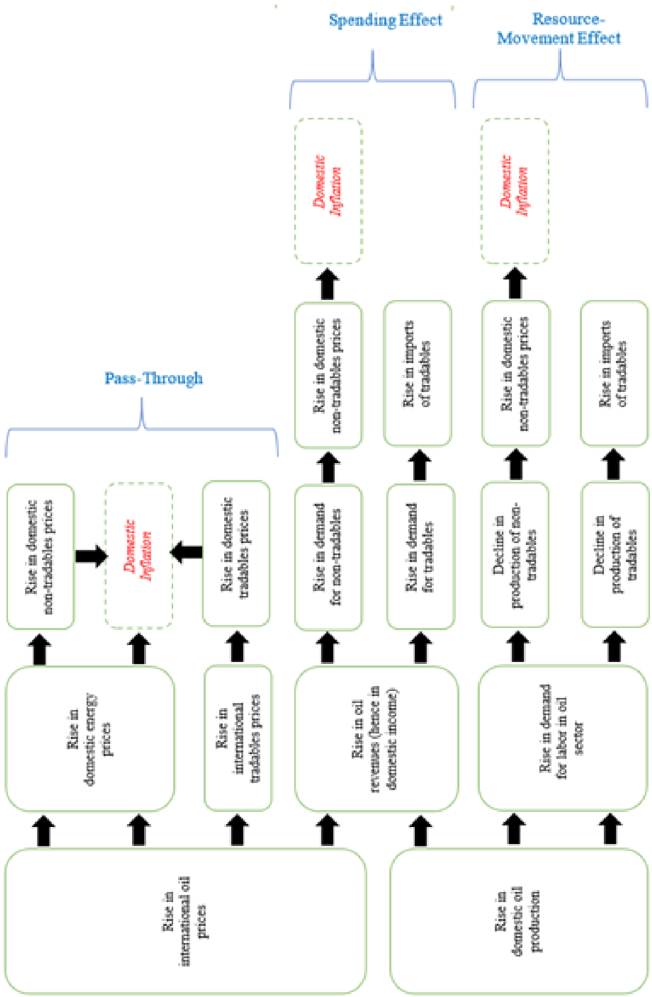
Assumption 2 : For a given level of oil production, a rise in international prices leads only to Pass-through and Spending effects

Due to the small open economy assumption, international prices are exogenous and do not react to domestic oil production shocks. However, oil production can adjust to oil price variations. In that case, prices can *indirectly* cause a resource-movement effect through a rise in production. It must be noted that there might be a positive correlation between international crude oil prices and oil production (if the country or the exploiting firms decide to reduce oil production when prices are low to keep reserves for an expected price increase) but also a negative one (if oil revenues directly finance current public expenditures, a fall in international prices might be compensated by a rise in oil production to keep the financing of current spending constant). Finally, if an increase in oil production requires new investments in capital (for example to exploit a reserve that was already known but unexploited when prices were low), an increase in prices can lead to an increase in production but only after a few lags.

3.4 Oil-Exporting Countries in the CEMAC

We apply the previous framework to the five net-oil exporting countries belonging to the Central African Economic and Monetary Community (CEMAC) : Cameroon, Chad, the Republic of Congo, Equatorial Guinea, and Gabon. The CEMAC is a monetary and trade area between six countries (the five mentioned above and the Central African Republic which is excluded from this study, being not an

Figure 3.1 – Presentation of the Pass-Through, Spending and Resource-Movement Effects



Source : Author

oil producer). The six countries share a common currency -the XAF CFA Franc- pegged with the Euro at a level of 1 Euro = 655.957 CFA Francs, and a common Central Bank -the BEAC-. The only devaluation of the currency occurred in 1994, justifying the assumption that nominal exchange rate variations with the US Dollar are exogenous over the period 1995-2019. Since the countries are engaged in a monetary union with a common central bank, we can consider that monetary policies are homogeneous within the zone. Thus, heterogeneity in inflation dynamics can be attributed to other macroeconomic or institutional differences across countries. Indeed, despite the belonging to a common monetary and trade area, the five countries of interest diverge in their history, in their oil production trends, in their management of oil revenues and in their oil refinery capacities. Investigating the heterogeneity across countries can therefore contribute to understanding the key role of structural parameters and fiscal policy in avoiding or mitigating DD effects. In this section, we describe the history and current situation of each country's oil sector (oil production trends for each country are also presented in Figure 3.2 in the Appendix).

3.4.1 Oil Production in the CEMAC

Oil production began in Cameroon in 1977, five years after the first oil discoveries in the Rio del Rey basin. To manage oil revenues, in 1980 was created the *Société Nationale des Hydrocarbures* (SNH), a publicly funded organization which primary goals are to monitor the activities of firms exploiting hydrocarbon fields and to sell on domestic and international markets the share of oil production reserved for the State. Oil revenues then increased until the peak of 1985 (when total oil production amounted to 186,000 barrels per day), and suddenly dropped after international prices fell, leading to ten years of negative economic growth. Since the middle of the 1990s, economic growth has progressively recovered but oil production has varied between 60,000 and 120,000 barrels per day with a long-run declining trend attributable to the exhaustion of known reserves and the progressive wear of infrastructures. Today, oil production is mainly offshore and regrouped around the Rio del Rey and the Douala and Kribi-Campo areas. In 2019, oil rents represented less than 3% of GDP but around a third of the country's total exports [4] and more than 15% of government revenues. The only oil re-

4. Oil rents in GDP data are from the World Development Indicators and oil exports are from the Observatory of Economic Complexity.

finery is located in Limbe and is publicly managed (through the *Société Nationale de Raffinage* - SONARA) but appears to be largely under-exploited in comparison with Cameroon oil extraction capacities. Cameroon has joined the Extractive Industries Transparency Initiative (EITI) in 2007 and has been a member since then (for oil, gas and mining resources). According to a report from the Natural Resource Governance Institute (NRGI, 2019), Cameroon achieves the highest score in resource revenues management among 31 Sub-Saharan African countries assessed (based on budget transparency, fiscal rules, subnational revenue sharing mechanisms and Sovereign Wealth Funds).

The presence of oil resources in Chad have been known since 1992. However, due to difficulties to access international sources of financing and to the necessity to negotiate with the neighboring Cameroon for the construction of a pipeline from Chadian oil fields to the harbor of Kribi, it is only in 2003 that oil extraction began in Komé, Miandoum and Bolobo. Oil production then sharply increased, reaching a peak of 200,000 barrels per day in 2004, representing one third of total GDP. Oil production then before progressively decreased and finally stabilized between 100,000 and 130,000 barrels during the 2010s. Oil resources are exploited by foreign firms and contribute to the Chadian government budget mainly through royalties and taxation. In 2019, oil revenues represented 18% of GDP but almost 75% of total exports, making the country highly vulnerable to international shocks on the oil market. Chad has joined the EITI in 2010 (for oil and mining).

The field of Pointe Indienne was the first oil field in the Republic of Congo, since its exploitation started in 1957. Oil production then rose during the following decades but experienced some turmoil, particularly during the 1990s due to several violent conflicts (notably in 1993, 1997 and 1999). It is only with the return of a relative political stability after 1999 that the economy started to recover. It is also at this period (in 1998) that the government created the *Société Nationale des Pétroles du Congo* (SNPC). The SNPC oversees the exploration of potential fields, of oil extraction (in joint-venture with private firms) and of oil refinery in the site of Pointe-Noire. Regarding oil production, it has varied between 200,000 and 400,000 barrels per day between 1999 and 2019 with a peak around 2010-

2011 when oil revenues represented more than half of total GDP. Contrary to Cameroon, various oil reserves have been discovered in the last decades, compensating for the depletion of old fields. In 2019, oil rents represented 43% of total GDP and 60% of its exports, the Republic of Congo being the fifth largest crude petroleum oil exporter in Africa (after Nigeria, Angola, Libya and Algeria) and the first in Central Africa. Like Cameroon, the Republic of Congo has been a member of the EITI since 2007.

Oil exploitation began in the early 1990s in Equatorial Guinea with the discovery of an offshore field close to the island of Bioko. However, production remained below 20,000 barrels per day until 1996, and it is only during the second half of the 1990s that the oil sector really expanded, reaching a daily production of 200,000 barrels in 2001 and 400,000 in 2004. This sudden surge in oil production contributed to the country's high economic growth, and encouraged public authorities to implement a Sovereign Wealth Fund (the Fund for Future Generations) in 2002. However, this SWF has been criticized for a lack of transparency and for the poor quality of its governance, being ranked 31st among 33 SWF assessed in the world by the NRGI, with a score of 7/100 (NRGI, 2019). Oil production started to decrease after 2005 and stabilized around 160,000 barrels at the end of the 2010s. Even if oil production remains lower than in Gabon and approximately half than of Congo, the smaller size of Equatorial Guinea (less than 1.5 million inhabitants) makes it highly dependent on oil revenues, which represent more than 20% of GDP and more than 70% of exports in 2019. Equatorial Guinea joined the EITI in 2008 but, contrary to the previous countries, left the initiative in 2010 due to a lack of transparency in the information provided. Equatorial Guinea is ranked last in the zone and second last in Sub-Saharan Africa (just above Eritrea) for its resource revenues management (NRGI, 2019).

The history of oil is quite old in Gabon since the first fields were identified during the colonization era, while exploitation began in the 1950s and rapidly expanded until representing half of Gabonese GDP at the end of the 1970s. However, as in many neighboring countries, oil revenues have been highly volatile due to international oil price variations, which encouraged authorities to implement a Fund for Future Generations in 1998. Oil production has been following a clearly declining trend since the beginning of the 2000s, mostly attributable to the exhaustion of known reserves, from 340,000 barrels per day in 2000 to 200,000 at the end of 2010s. Yet, oil revenues still represent 20% of GDP and two thirds of exports. Gabon has also an oil refinery based in Port Gentil, but with much lower refining capacities than other countries of the zone (0.5 million of tons per year compared to 1Mt/year for Chad and Congo and more than 2Mt/year in Cameroon [5]). Gabon joined the EITI in 2007, but was delisted in 2013 and re-joined in 2021 (for oil, gas and mining).

Based on each economy's dependence on oil revenues and their vulnerability to shocks on oil markets, Cameroon appears to be the less prone to suffer from DD effects in the area. On the opposite, if we consider that mismanagement of resource revenues tends to encourage DD, Equatorial Guinea is more likely than other countries to suffer from DD effects. Now, we still need to investigate the role of oil products subsidies to assess each country's vulnerability towards PT effects.

5. https://www.euro-petrole.com/re_06_geolocalisation_sites_petroliers.php

3.4.2 Oil Products Subsidy in the CEMAC

Subsidies are quite common in developing countries, and might explain why international price shocks do not translate into domestic inflation through a PT effect. On this point, accurate and reliable data are much more difficult to obtain, particularly for long periods. However, the OECD and the International Institute for Sustainable Development (IISD) [6] provide annual estimates for fossil fuel subsidies between 2010 and 2019. They indicate very low levels of subsidies on refined petroleum products for Cameroon, Chad and the Republic of Congo (below 1 USD per capita per year on average over this period) but much higher for Equatorial Guinea (14 USD per capita on average with a peak at 48 USD in 2018) and Gabon (35 USD per capita on average with a peak at 77 USD in 2014). Even if such data must be interpreted cautiously, they overall suggest that we are less likely to observe PT effects in Gabon and in Equatorial Guinea due to higher state intervention. Yet, public subsidies might be insufficient to prevent imported inflation. Hence, we cannot exclude that these two countries have experienced PT effects.

6. Data are available at https://fossilfuelsubsidytracker.org/

3.5 Empirical Analyses

3.5.1 Presentation of the Data

We use quarterly data for the period 1995q1-2019q4 from different sources. The consumer price index, the deposit interest rate, and the nominal bilateral exchange rate come from IMF International Financial Statistics Database. Oil price is the Brent spot crude oil price from IMF Commodity Prices Database. Finally, oil production is the number of barrels produced from U.S. Energy Information Administration. All variables are in logarithm, apart from the deposit interest rate. For Chad and Equatorial Guinea, the sample is restricted to the period when the country is a net-oil exporter (respectively 2004q2-2019q4 and 1997q3-2019q4). For Congo, the sample is restricted to 1999q1-2019q4 due to missing data for the CPI [7].

The evolution of the brent crude oil price and of each country's oil production are provided in Figure 3.2. They reveal a large heterogeneity in oil production patterns across countries, motivating the use of multiple time-series rather than panel data. They also sug-

7. A civil war occurred in Congo in 1997, hence data series begin in 1998 only. To avoid the reconstruction period, we start here at the beginning of 1999 (however, the inclusion of the year 1998 does not affect the results).

Table 3.1 – Descriptive Statistics

		Cameroon	Chad	Congo	Equatorial Guinea	Gabon	Unit	Source
CPI	Mean	93	104	98	90	95	Base 2010=100	IMF
	Std Dev	16	13	17	25	14		
Brent	Mean	55	75	62	59	55	USD/barrel	IMF
	Std Dev	33	25	31	32	33		
Oil Production	Mean	83	130	258	242	261	Thousand barrels/day	EIA
	Std Dev	18	23	43	86	55		
Interest	Mean	3.97	3.31	3.73	3.81	3.97	Units	IMF
	Std Dev	1.11	0.88	1.05	1.06	1.11		
NBER	Mean	555	522	557	559	555	CFA/USD	IMF
	Std Dev	77	49	82	80	77		
Sample Period		1995q1 2019q4	2004q2 2019q4	1999q1 2019q4	1997q3 2019q4	1995q1 2019q4		

Note : The Brent oil price (*Brent*), deposit interest rate (*Interest*) and nominal bilateral exchange rate with the USD (*NBER*) are common to all countries. The variations across countries are due to differences in sample periods.

gest that oil production dynamics do not directly follow international price variations but react to other shocks, such as oil fields discoveries or exhaustion of known reserves.

3.5.2 Unit-Root Tests and Co-Integration Tests

Before proceeding to the econometric analyses, we need to investigate whether the variables are stationary or not. Indeed, Ordinary Least Square estimates are known to be inconsistent in time-series when the variables have a unit-root. For this, we implement the classical Augmented-Dickey-Fuller (ADF) and Philipps-Perron (PP) unit-root tests. Results are displayed in Table 3.2 and indicate that all variables are I(1).

Table 3.2 – Unit-Root Tests

Variable		Cameroon		Chad		Congo		Equatorial Guinea		Gabon	
		I(0)	I(1)	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
cpi	ADF	-2.55	-7.64***	-3.36*	-4.66***	-2.75	-5.22***	-0.52	-9.27***	-2.06	-9.36***
	PP	-2.52	-9.01***	-3.03	-16.30***	-3.21*	-11.40***	-0.33	-9.24***	-2.08	-10.07***
oilproduction	ADF	-2.50	-9.35***	-2.22	-7.88***	-3.01	-9.04***	-3.09	-8.08***	-1.98	-10.23***
	PP	-1.87	-9.35***	-3.07	-6.09***	-2.40	-9.06***	-3.38*	-8.32***	-1.97	-10.29***
brent	ADF	-2.05	-7.16***	-2.80	-6.11***	-2.17	-7.02***	-1.97	-6.89***	-2.05	-7.16***
	PP	-1.50	-7.57***	-2.53	-6.08***	-2.23	-7.23***	-1.43	-7.27***	-1.50	-7.57***
interest	ADF	-2.00	-10.08***	-1.58	-7.62***	-2.00	-8.49***	-2.08	-8.88***	-2.00	-10.08***
	PP	-2.14	-10.08***	-1.64	-7.62***	-2.21	-8.49***	-2.25	-8.88***	-2.14	-10.08***
nber	ADF	-2.24	-7.23***	-2.26	-5.77***	-1.86	-6.42***	-1.88	-6.91***	-2.24	-7.23***
	PP	-1.71	-7.11***	-2.11	-5.75***	-1.52	-6.56***	-1.50	-6.73***	-1.71	-7.11***
5%	ADF/PP	-3.46		-3.48		-3.46		-3.46		-3.46	

Note : The number of lags is selected with the Akaike Information Criterion with a maximum of 4 lags. A constant and a time trend are included. Variables brent, interest and nber are common to all countries but the unit-root tests are run on the sub-samples of interest for Chad (63 observations), Congo (84 observations) and Equatorial Guinea (90 observations).

Since our variables are integrated of order 1, we want to determine whether there is a co-integrating relationship between them or not. We thus proceed to the Johansen co-integration tests for our combinations of five variables (the cpi and the four explanatory variables). Results are displayed in Table 3.3. Overall, there seems to exist at least one cointegrating relationship among the variables in every country.

Table 3.3 – Johansen Co-Integration Tests

	Cameroon	Chad	Chad (full sample)	Congo	Equatorial Guinea	Gabon
Trace statistics	96.04*** (0.00)	108.08*** (0.00)	80.06** (0.03)	85.28** (0.01)	105.24*** (0.00)	81.83** (0.02)
Nb of cointegrating relationships (at 5%)	1	2	1	1	1	1

Note : Trace statistic indicates statistic from the unrestricted cointegration rank test (null hypothesis of at least one cointegrating equation). A constant is included. P-values are in parentheses. The number of cointegrating relations is decided when considering the rejection of the null hypothesis of at most n equations at the 5% level.

3.5.3 Main Results

We now estimate the impact of our set of explanatory variables using two different approaches. First, we estimate the Dynamic Ordinary Least Square (DOLS) proposed by Stock and Watson (1993). This estimation strategy is justified by the existence of at least one relation of co-integration among the variables in all our time series. However, we also implement the Autoregressive Distributed Lag (ARDL) Bounds Tests approach proposed by Pesaran et al. (2001). Indeed, this methodology presents the main advantage of providing consistent estimates of long-run regressors even with a combination of I(0) and I(1) variables (which is justified by the limitations of the traditional ADF and PP unit-root tests in small samples) or if some regressors are endogenous. We run regressions over the sample period described in Table 3.1 for each country except Chad for which we separately estimate the coefficients for the sample period (when it is a net-oil exporter) and for the entire sample period.

Results for the DOLS estimators are provided in Table 3.4. To check the robustness of the results, we also apply the Jarque-Bera test of normality on the residuals. For Cameroon and the Republic of Congo, the negative coefficients associated with oil production are unexpected and seem in opposition with the Dutch disease hypothesis. In contrast, the positive coefficients for the Brent oil price strongly support the PT hypothesis, in line with our second assumption. Regarding Congo, the Jarque-Bera normality test indicates to reject the null hypothesis of normality of the residuals at 10% but not at 5%, and encourages to remain cautious when interpreting these results but without invalidating them. For Chad, the coefficient for the Brent oil price is positive and significant in both regressions, whereas the coefficient associated with oil production is positive and significant at 10% only in full sample and insignificant in the restricted sample. One possible interpretation is that the sudden beginning in oil production had a positive impact on prices but without any strong relationship (or even a negative one as for Cameroon and Congo) between variations in oil production and variations in oil prices afterward. Equatorial Guinea is the only country of the sample for which both coefficients for oil prices and oil production are positive and significant (at respectively 5% and 1%). Since we expect a DD to lead to a positive impact of oil production (through spending and resource-movement effects according to assumption (1) and of oil prices (through spending effect only according to assumption (2) on domestic CPI, these two positive significant coefficients (the coefficient for oil production being even higher and more significant than the coefficient for oil prices) strongly suggest a DD in Equatorial Guinea, with no firm evidence of a PT effect. Finally, the absence of any significant coefficient for Gabon seem to indicate that neither DD nor PT occurred in this country. However, we must remain cautious with such interpretations due to the potential measurement issues in the estimation of the CPI. Coefficients for the control variables are as expected : negative and significant in all regressions for the interest rate and positive for the bilateral exchange rate (yet not significant in Equatorial Guinea and Gabon). It is noticeable that the coefficient for domestic interest rate is particularly high in Chad (compared with other countries) and in Cameroon and

Congo (compared with other variables).

Table 3.4 – DOLS Results

	Cameroon	Chad	Chad (full sample)	Congo	Equatorial Guinea	Gabon
brent	0.0495***	0.0773**	0.0614**	0.0882**	0.0941**	0.0006
	(0.0169)	(0.0308)	(0.0258)	(0.0370)	(0.0425)	(0.0252)
oilproduction	-0.0782**	-0.1182	0.0149*	-0.1697**	0.1360***	-0.0941
	(0.0335)	(0.0750)	(0.0076)	(0.0722)	(0.0370)	(0.0931)
interest	-0.1316***	-0.0927***	-0.1345***	-0.1577***	-0.2315***	-0.1106***
	(0.0053)	(0.0140)	(0.0122)	(0.0122)	(0.0180)	(0.0108)
nber	0.2206***	0.5172***	0.3059***	0.2949**	0.1874	0.0580
	(0.0385)	(0.1113)	(0.0835)	(0.1211)	(0.1197)	(0.1079)
constant	3.8070***	1.9554***	2.8255***	3.8753***	3.0792***	5.1515***
	(0.4174)	(0.8135)	(0.5921)	(0.9023)	(0.8596)	(1.1877)
Observations	100	63	100	84	90	100
Jarque-Béra Prob.	0.94	0.78	0.81	0.06*	0.52	0.26

Note : The number of lags is selected with the Akaike Information Criterion with a maximum of 4 lags. Jarque-Bera indicates the p-value associated with the normality test of Jarque-Bera (null hypothesis of normality of the residuals). Standard errors are in parentheses : *Significant at 10% **Significant at 5% ***Significant at 1%

We also apply the ARDL Bounds Test approach, as complementary results. The results for the F-Bound Tests (which investigate the presence of a long-run co-integration relationship among variables) are provided in Table 3.5 and support the evidence of a relation of cointegration in Cameroon, Chad (in restricted sample), Equatorial Guinea and Gabon at 1%. For Chad in full sample and the Republic of Congo, the null hypothesis is rejected at 10% only, making the results harder to interpret. However, we still provide the long-run coefficients of the ARDL estimation regression for comparison purposes. Long-run coefficients for the variables of interest are reported in Table 3.6 for each country, as well as different validity tests : the Jarque-Bera normality test, the LM-test of serial correlation and the Breusch-Pagan-Godfrey test for heteroskedasticity. ARDL estimates slightly moderate the previous results for Chad and Equatorial Guinea. Indeed, the coefficient for oil production is now negative and significant at 10% for Chad in restricted sample and insignificant in the full sample, while both coefficients for oil prices and oil production are now significant at 10% in Equatorial Guinea. Results remain insignificant for Gabon. Regarding Cameroon, the coefficient associated with the Brent oil price remains highly significant and positive, while the coefficient for oil production becomes positive and insignificant. Then, both coefficients become insignificant for Congo. The results for the different tests on the residuals support the validity of our results in all cases, except Cameroon (BP-test) and Equatorial Guinea (Jarque-Bera). Since the interpretations of our results for these two countries do not differ from the discussion of the DOLS estimates, this does not seem to invalidate our main conclusions. Finally, controls remain consistent with the expectations, except for Congo for which the nominal exchange rate becomes insignificant.

Table 3.5 – F-Bound Tests

	Cameroon	Chad	Chad (full sample)	Congo	Equatorial Guinea	Gabon
F-Statistics	9.42***	7.65***	3.31*	3.64*	13.00***	5.57***
	I(0)			I(1)		
Finite Sample	10%	5%	1%	10%	5%	1%
Size N=80	2.30	2.67	3.60	3.22	3.70	4.79

Note : F-Statistic indicates the statistic from the F-Bounds Test (null hypothesis of no levels relationship).

Overall, there is strong evidence of a PT effect in Cameroon and Chad and weaker evidence of such effect in Congo and Equatorial Guinea, while there is strong evidence of a DD effect in Equatorial Guinea only. It must be noticed that this result is consistent with the fact that Equatorial Guinea is the most dependent country on oil revenues of our sample. The absence of any significant impact of oil prices on inflation in Gabon is also in line with the fact that this country has the highest level of fossil fuels subsidies of the zone (at least at the end of the period of interest). In addition, the results for Cameroon and Congo are in line with Caceres et al. (2012) who find a positive impact of international energy prices with Dynamic OLS and Fully-Modified OLS estimates in these countries and interpret their results as evidence of a pass-through effect. Our results for Gabon are quite unexpected since neither the two variables of interest nor the bilateral exchange rate used as control are significant in any regression, in opposition with Caceres et al. (2012) who find a strongly positive impact of energy prices on inflation in this country. Finally, the results for Chad are also consistent with Kablan and Loening (2012) who find a positive and significant effect of oil price shocks on GDP deflator-based inflation and an insignificant effect of oil production shocks.

Table 3.6 – ARDL Results

	Cameroon	Chad	Chad (full sample)	Congo	Equatorial Guinea	Gabon
brent	0.1326***	0.0821***	0.1463**	0.0545	0.1531*	0.0989
	(0.0431)	(0.0261)	(0.0603)	(0.0766)	(0.0861)	(0.0624)
oilproduction	0.0718	-0.1191*	0.0006	-0.0766	0.1545*	0.1795
	(0.0857)	(0.0626)	(0.0160)	(0.1324)	(0.0786)	(0.2281)
interest	-0.0884***	-0.0984***	-0.1017***	-0.1422***	-0.1719***	-0.1322***
	(0.0173)	(0.0120)	(0.0250)	(0.0290)	(0.0399)	(0.0280)
nber	0.2140**	0.4950***	0.4016**	-0.0615	0.4493*	0.3807
	(0.0973)	(0.0962)	(0.1748)	(0.2743)	(0.2687)	(0.2323)
constant	2.7859***	2.0924***	1.8479	5.7805***	1.0109	1.3532
	(1.0385)	(0.7095)	(1.2771)	(2.0759)	(1.9750)	(2.6968)
Observations	100	63	100	84	90	100
Selected Model	3,2,0,0,1	2,0,0,0,1	3,0,2,3,0	3,1,0,0,0	1,0,0,0,2	1,0,2,0,4
Jarque-Béra Prob.	0.60	0.83	0.95	0.84	0.00***	0.67
LM Prob.	0.64	0.30	0.15	0.51	0.32	0.52
BP Prob.	0.00***	0.44	0.32	0.10	0.20	0.54

Note : The number of lags is selected with the Akaike Information Criterion with a maximum of 4 lags. Jarque-Bera indicates the p-value associated with the normality test of Jarque-Bera (null hypothesis of normality of the residuals). LM indicates the p-value associated with the LM-Test for serial correlation (null hypothesis of no serial correlation). BP indicates the p-value associated with the Breusch-Pagan-Godfrey test for heteroskedasticity (null hypothesis of homoskedasticity). Standard errors are in parentheses : *Significant at 10% **Significant at 5% ***Significant at 1%

3.5.4 Robustness Tests

To ensure the validity of our results, we proceed to several robustness checks. All results are available in the appendix. First, we implement another empirical strategy, the Fully-Modified Ordinary Least Square, which is a commonly used non-parametric alternative to DOLS estimates. FMOLS estimates are very close to DOLS ones, with only a positive and significant (at 5%) coefficient for oil production for Chad in full sample and a negative and significant one for oil production in Gabon.

Second, while the Brent crude oil price is the most common in both the DD and PT literature, it is mostly a reference for sweet light crude oil prices. On the opposite, the Dubai crude oil price is a reference for medium sour oil prices, and its tendency has slightly diverged from the Brent one around 2004-2005 and 2011-2014 due to changes in international demand. If our countries are mainly consumers of light oil products and since they tend to export a combination of light and medium crude oil, there is a possibility that the Brent oil price is more suited to capture PT than DD effects. Therefore, we proceed to the same empirical analyses with the Dubai instead of the

Brent spot crude oil price. With DOLS, results slightly differ from the baseline analysis only for Chad in full sample where the coefficient for oil production becomes more significant and for Congo where coefficients for oil price and oil production both become less significant. For ARDL, results remain the same for all countries except Equatorial Guinea where only the coefficient for oil production remains significant (at 5%).

Third, we include the bilateral nominal exchange rate with the Chinese Yuan instead of the US Dollar in the set of control variables. This choice is motivated by the increasing role of China in world markets and as a trade partner for African countries. Due to the large size of Chinese economy compared to CEMAC countries, it also seems relevant to consider this bilateral exchange rate as exogenous. The coefficients for the Brent oil price and oil production are very close to original results. The coefficients for the bilateral exchange rate with the Chinese Yuan (CNY) are also positive (as expected), even if they tend to be slightly less significant than the exchange rate with the USD, encouraging to prefer the original model.

Finally, we investigate the possibility of seasonality in our variables that could drive the results. For this, we include seasonal dummies in the baseline regressions. This does not affect the magnitude or the significance of the coefficients. In addition, these dummies are never significant at 5% in any DOLS regression, and significant only for Chad (and to a lesser extent in Congo) for ARDL estimates. Overall, this suggests that seasonality is not a concern in our sample.

3.6 Conclusion

There is evidence of a pass-through effect in Cameroon, Chad, and Congo and of a Dutch disease in Equatorial Guinea. If we exclude Gabon for which the results seem impossible to analyze properly, the implications of these results are threefold.

First, it appears that the classical assumption of DD models that natural resources are fully exported and do not affect domestic prices other than through spending or resource-movement effects is debatable even in low-income countries. This remark is particularly true for energy products such as oil, gas or coal. We argue here that the key underlying assumptions of theoretical models must be questioned before proceeding to empirical analyses and case-studies, which is rarely done in the DD literature.

Then, the results suggest that empirical analyses could wrongly conclude to DD effects when interpreting a positive correlation between international resource prices or resource revenues (that can be caused by either prices or production) and domestic inflation if they do not consider the simpler explanation of a PT effect. Reciprocally, studies investigating a potential PT from international commodity prices to domestic consumer prices should consider DD models when focusing on commodity-exporting countries. This is a crucial point for economic research but also, and perhaps more importantly, for policymakers in resource rich countries. Indeed, the understanding of the causes of inflation remains fundamental when trying to address this issue. These results therefore advocate for more interactions between these two strands of the economic literature.

Finally, we observed that, even within a monetary area (here the CEMAC) with five net oil-exporting countries, the heterogeneity in inflation dynamics across countries remains large. This heterogeneity can depend on their level of resource production (Cameroon is the lowest oil-producer of the group) or on their history toward resource production (Chad began to produce oil after 2003), but also potentially on different macroeconomic policies (level of taxation, use of public oil revenues, international trade policies, industrialization strategies…). The coefficients for international oil prices and nominal exchange rates also indicate that some countries (particularly Chad and Congo) are highly vulnerable to external shocks and might reveal the obstacles to reaching an optimal monetary zone. This heterogeneity across countries is to be taken seriously by monetary authorities.

Appendix

Table 3.7 – FMOLS Results for the Baseline Specification

	Cameroon	Chad	Chad (full sample)	Congo	Equatorial Guinea	Gabon
brent	0.0469*	0.0815**	0.0648***	0.0479	0.0847**	-0.0291
	(0.0240)	(0.0313)	(0.0233)	(0.0347)	(0.0737)	(0.0312)
oilproduction	-0.0917*	-0.1270	0.0163**	-0.0750	0.1610**	-0.2168**
	(0.0488)	(0.0760)	(0.0068)	(0.0627)	(0.0711)	(0.1034)
interest	-0.1329***	-0.0917***	-0.1250***	-0.1693***	-0.2467***	-0.1039***
	(0.0091)	(0.0146)	(0.0110)	(0.0123)	(0.0284)	(0.0153)
nber	0.2241***	0.5593***	0.3401***	0.1663	0.3394	0.0169
	(0.0695)	(0.1150)	(0.0761)	(0.1164)	(0.2171)	(0.1035)
constant	3.8566***	1.7104**	2.5680***	4.3711***	2.0734	6.1695***
	(0.6560)	(0.8484)	(0.5406)	(0.8901)	(1.5829)	(1.1278)
Observations	100	63	100	84	90	100
Jarque-Béra Prob.	0.55	0.83	0.58	0.23	0.83	0.18

Note : The number of lags is selected with the Akaike Information Criterion with a maximum of 4 lags. Standard errors are in parentheses : *Significant at 10% **Significant at 5% ***Significant at 1%

Table 3.8 – Unit-Root Tests for the Dubai Oil Price

Variable		Cameroon		Chad		Congo		Equatorial Guinea		Gabon	
		I(0)	I(1)	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
dubai	ADF	-1.60	-7.58***	-2.57	-6.17***	-2.54	-7.08***	-1.58	-7.28***	-1.60	-7.58***
	PP	-1.55	-7.92***	-2.63*	-6.20***	-2.55	-7.27***	-1.67	-7.58***	-1.55	-7.92***

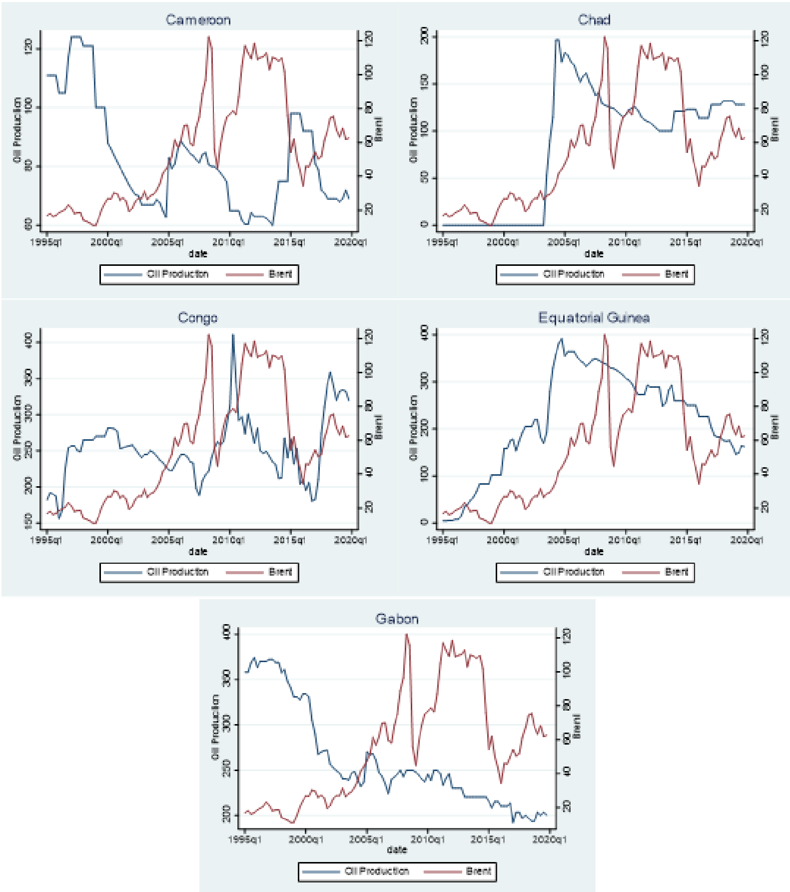
Note : The number of lags is selected with the Akaike Information Criterion with a maximum of 4 lags.

Table 3.9 – Johansen Co-Integration and F-Bound Tests with the Dubai oil price

	Cameroon		Chad		Chad (full sample)		Congo		Equatorial Guinea		Gabon	
	Trace	F	Trace	F	Trace	F	Trace	F	Trace	F	Trace	F
Statistics	95.35***	9.13***	109.31***	7.41***	79.27**	3.52*	81.97**	3.62*	104.33***	12.74***	80.87**	5.38***
Nb of relations	1		2		1		1		1		1	

Note : Trace indicates the statistic from the unrestricted co-integration rank test. A constant is included. The number of co-integrating relations is decided when considering the rejection of the null hypothesis of at most n equations at the 5% level, based on the Trace Statistics. F-Statistic indicates the statistic from the F-Bounds Test.

Figure 3.2 – Evolution of Oil Production and Brent Oil Price by Country



Note : Oil Production is expressed in thousand barrels per day (source : EIA) and Brent crude oil price is expressed in international USD per barrel (source : IMF).

Table 3.10 – DOLS Results with the Dubai Oil Price

	Cameroon	Chad	Chad (full sample)	Congo	Equatorial Guinea	Gabon
dubai	0.0460***	0.1215**	0.0585**	0.0558	0.0834*	0.0004
	(0.0170)	(0.0448)	(0.0263)	(0.0353)	(0.0428)	(0.0246)
oilproduction	-0.0858**	-0.1318	0.0155**	-0.1337*	0.1453***	-0.0923
	(0.0341)	(0.1247)	(0.0077)	(0.0720)	(0.0367)	(0.0898)
interest	-0.1319***	-0.0575***	-0.1344***	-0.1616***	-0.2337***	-0.1112***
	(0.0055)	(0.0201)	(0.0129)	(0.0123)	(0.0187)	(0.0107)
nber	0.2184***	0.8246***	0.3056***	0.1758	0.1764	0.0611
	(0.0397)	(0.1669)	(0.0872)	(0.1191)	(0.1233)	(0.1066)
constant	3.8707***	-0.2041***	2.8387***	4.5820***	3.1526***	5.1241***
	(0.4274)	(1.1340)	(0.6205)	(0.9049)	(0.8886)	(1.1560)
Observations	100	63	100	84	90	100
Jarque-Béra Prob.	0.99	0.99	0.82	0.34	0.50	0.33

Note : The number of lags is selected with the Akaike Information Criterion with a maximum of 4 lags. Standard errors are in parentheses : *Significant at 10% **Significant at 5% ***Significant at 1%

Table 3.11 – ARDL Results with the Dubai Oil Price

	Cameroon	Chad	Chad (full sample)	Congo	Equatorial Guinea	Gabon
dubai	0.1437**	0.0766***	0.1379***	0.0590	0.1366	0.0896
	(0.0573)	(0.0254)	(0.0508)	(0.0778)	(0.0888)	(0.0597)
oilproduction	0.0850	-0.1240*	0.0066	-0.0833	0.1722**	0.1442
	(0.1109)	(0.0627)	(0.0129)	(0.1328)	(0.0816)	(0.2176)
interest	-0.0785***	-0.0958***	-0.0904***	-0.1411***	-0.1717***	-0.1281***
	(0.0242)	(0.0121)	(0.0240)	(0.0301)	(0.0428)	(0.0272)
nber	0.2054*	0.4938***	0.3504**	-0.0484	0.4394	0.3502
	(0.1203)	(0.0980)	(0.1527)	(0.2664)	(0.2843)	(0.2240)
constant	2.7249**	2.1426***	2.1529*	5.7155***	1.0562	1.7655
	(1.3230)	(0.7196)	(1.1107)	(2.0098)	(2.0964)	(2.5703)
Observations	100	63	100	84	90	100
Selected Model	3,2,0,0,0	2,0,0,0,1	3,3,2,4,0	3,1,0,0,0	1,0,0,0,2	1,0,2,0,4
Jarque-Béra Prob.	0.75	0.77	0.97	0.84	0.00***	0.68
LM Prob.	0.91	0.33	0.42	0.50	0.31	0.52
BP Prob.	0.00***	0.32	0.40	0.12	0.21	0.55

Note : The number of lags is selected with the Akaike Information Criterion with a maximum of 4 lags. Standard errors are in parentheses : *Significant at 10% **Significant at 5% ***Significant at 1%

Table 3.12 – Unit-Root Tests for the Nominal Exchange Rate with the Chinese Yuan

Variable		Cameroon		Chad		Congo		Equatorial Guinea		Gabon	
		I(0)	I(1)	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
cny	ADF	-2.42	-7.32***	-2.40	-5.93***	-1.75	-6.54***	-2.18	-6.97***	-2.42	-7.32***
	PP	-1.94	-9.01***	-2.16	-6.08***	-1.80	-6.65***	-1.80	-6.79***	-1.94	-9.01***

Note : The number of lags is selected with the Akaike Information Criterion with a maximum of 4 lags.

Table 3.13 – Johansen and F-Bound Tests with the Chinese Yuan Exchange Rate

	Cameroon		Chad		Chad (full sample)		Congo		Equatorial Guinea		Gabon	
	Trace	F	Trace	F	Trace	F	Trace	F	Trace	F	Trace	F
Statistics	93.75***	8.85***	107.54***	7.54***	85.56***	3.85**	77;59**	3.67*	107.04***	13.64***	80.75**	4.86***
Nb of relations	1		2		1		1		1		1	

Note : Trace indicates the statistic from the unrestricted co-integration rank test. A constant is included. The number of co-integrating relations is decided when considering the rejection of the null hypothesis of at most n equations at the 5% level, based on the Trace Statistics. F-Statistic indicates the statistic from the F-Bounds Test.

Table 3.14 – DOLS Results with the Chinese Bilateral Exchange Rate

	Cameroon	Chad	Chad (full sample)	Congo	Equatorial Guinea	Gabon
brent	0.0397*	0.0586**	0.0431*	0.0635**	0.0868**	-0.0222
	(0.0200)	(0.0277)	(0.0225)	(0.0298)	(0.0350)	(0.0193)
oilproduction	-0.0758*	0.0257	0.0184**	-0.2057**	0.1282***	-0.1681*
	(0.0446)	(0.0723)	(0.0079)	(0.0837)	(0.0355)	(0.0886)
interest	-0.1160***	-0.0825***	-0.1049***	-0.1401***	-0.2201***	-0.1108***
	(0.0089)	(0.0169)	(0.0152)	(0.0175)	(0.0189)	(0.0111)
cny	0.1729***	0.4165***	0.3037***	0.2701**	0.0898	-0.0770
	(0.0500)	(0.1006)	(0.0886)	(0.1179)	(0.1053)	(0.1105)
constant	4.4166***	2.7332***	3.3883***	4.7878***	3.8985***	6.3446***
	(0.4522)	(0.6991)	(0.4471)	(0.6377)	(0.5610)	(0.9430)
Observations	100	63	100	84	90	100
Jarque-Béra Prob.	0.54	0.26	0.94	0.01***	0.42	0.27

Note : The number of lags is selected with the Akaike Information Criterion with a maximum of 4 lags. Jarque-Bera indicates the p-value associated with the normality test of Jarque-Bera (null hypothesis of normality of the residuals). Standard errors are in parentheses : *Significant at 10% **Significant at 5% ***Significant at 1%

Table 3.15 – ARDL Results with the Chinese Yuan Exchange Rate

	Cameroon	Chad	Chad (full sample)	Congo	Equatorial Guinea	Gabon
brent	0.1275**	0.0588**	0.0959**	0.0504	0.1428*	0.0407
	(0.0563)	(0.0254)	(0.0419)	(0.0632)	(0.0744)	(0.0453)
oilproduction	0.0782	0.0121	0.0126	-0.0749	0.1507**	-0.1546
	(0.1189)	(0.0664)	(0.0132)	(0.1315)	(0.0743)	(0.1384)
interest	-0.0686**	-0.0785***	-0.0639**	-0.1521***	-0.1338***	-0.0868***
	(0.0308)	(0.0158)	(0.0292)	(0.0356)	(0.0484)	(0.0274)
cny	0.1554	0.4350***	0.4737***	-0.1086	0.3920	0.0594
	(0.1309)	(0.0948)	(0.1588)	(0.2480)	(0.2493)	(0.1567)
constant	3.4043***	2.7045***	2.3356***	5.9071***	2.0593	5.4006
	(1.1884)	(0.6635)	(0.8419)	(1.4969)	(1.3993)	(1.2576)
Observations	100	63	100	84	90	100
Selected Model	3,2,0,0,0	2,0,0,0,1	3,0,2,3,1	3,1,0,0,0	1,0,0,0,2	1,0,2,0,0
Jarque-Béra Prob.	0.53	0.79	0.89	0.84	0.00***	0.53
LM Prob.	0.86	0.14	0.18	0.51	0.25	0.61
BP Prob.	0.00***	0.17	0.30	0.09*	0.20	0.54

Note : The number of lags is selected with the Akaike Information Criterion with a maximum of 4 lags. Jarque-Bera indicates the p-value associated with the normality test of Jarque-Bera (null hypothesis of normality of the residuals). LM indicates the p-value associated with the LM-Test for serial correlation (null hypothesis of no serial correlation). BP indicates the p-value associated with the Breusch-Pagan-Godfrey test for heteroskedasticity (null hypothesis of homoskedasticity). Standard errors are in parentheses : *Significant at 10% **Significant at 5% ***Significant at 1%

Table 3.16 – DOLS Results with Seasonal Dummies

	Cameroon	Chad	Chad (full sample)	Congo	Equatorial Guinea	Gabon
brent	0.0498***	0.1190**	0.0611**	0.0925**	0.0956**	-0.0087
	(0.0172)	(0.0455)	(0.0259)	(0.0425)	(0.0438)	(0.0340)
oilproduction	-0.0770**	-0.0835	0.0173**	-0.1968**	0.1362***	-0.1127
	(0.0341)	(0.1274)	(0.0077)	(0.0869)	(0.0378)	(0.1172)
interest	-0.1315***	-0.0621***	-0.1263***	-0.1599***	-0.2315***	-0.1082***
	(0.0054)	(0.0204)	(0.0125)	(0.0149)	(0.0184)	(0.0117)
nber	0.2213***	0.7358***	0.2895***	0.3287**	0.1934	0.0187
	(0.0393)	(0.1710)	(0.0846)	(0.1373)	(0.1242)	(0.1558)
constant	3.7975***	0.1424	2.8904***	3.8036***	3.0290***	5.5280***
	(0.4249)	(1.1126)	(0.6014)	(1.0404)	(0.8938)	(1.6692)
Q1	-0.0003	-0.0199	-0.0159	0.0007	0.0107	-0.0024
	(0.0068)	(0.0179)	(0.0198)	(0.0185)	(0.0272)	(0.0137)
Q2	-0.0042	-0.0002	0.0123	-0.0114	0.0075	-0.0035
	(0.0078)	(0.0202)	(0.0214)	(0.0202)	(0.0301)	(0.0151)
Q3	-0.0018	0.0328*	0.0318	-0.0095	0.0049	0.0013
	(0.0068)	(0.0186)	(0.0202)	(0.0200)	(0.0274)	(0.0131)
Observations	100	63	100	84	90	100
Jarque-Béra Prob.	0.91	0.64	0.52	0.08*	0.45	0.43

Note : The number of lags is selected with the Akaike Information Criterion with a maximum of 4 lags. Standard errors are in parentheses : *Significant at 10% **Significant at 5% ***Significant at 1%

Table 3.17 – ARDL Results with Seasonal Dummies

	Cameroon	Chad	Chad (full sample)	Congo	Equatorial Guinea	Gabon
brent	0.1338***	0.0678**	0.1047***	0.0669	0.1746*	0.0922
	(0.0460)	(0.0319)	(0.0389)	(0.0629)	(0.0885)	(0.0625)
oilproduction	0.0708	-0.1439*	0.0077	-0.0546	0.1420*	0.1643
	(0.0906)	(0.0770)	(0.0104)	(0.1076)	(0.0774)	(0.2317)
interest	-0.0853***	-0.0954***	-0.1164***	-0.1488***	-0.1661***	-0.1326***
	(0.0192)	(0.0148)	(0.0162)	(0.0216)	(0.0408)	(0.0290)
nber	0.2011*	0.4403***	0.3282***	0.0373	0.4853*	0.3607
	(0.1021)	(0.1169)	(0.1255)	(0.2010)	(0.2706)	(0.2346)
constant	2.8502**	2.5642***	2.3611**	5.0811***	0.7108	1.5664
	(1.0901)	(0.8619)	(0.9109)	(1.5398)	(1.9986)	(2.7283)
Q1	-0.0018	0.0163	0.0213**	-0.0080*	0.0087**	0.0001
	(0.0021)	(0.0111)	(0.0098)	(0.0046)	(0.0037)	(0.0031)
Q2	0.0019	0.0358***	0.0591***	-0.0228***	-0.0008	0.0050
	(0.0022)	(0.0107)	(0.0096)	(0.0046)	(0.0037)	(0.0031)
Q3	0.0029	0.0391***	0.0541***	-0.0075	0.0010	0.0044
	(0.0022)	(0.0097)	(0.0081)	(0.0046)	(0.0036)	(0.0031)
Observations	100	63	100	84	90	100
Selected Model	3,2,0,0,1	2,0,0,0,0	2,0,0,4,0	1,0,0,0,0	1,0,0,0,2	1,0,2,0,4
Jarque-Béra Prob.	0.33	0.45	0.81	0.85	0.00***	0.51
LM Prob.	0.46	0.75	0.21	0.30	0.40	0.58
BP Prob.	0.00***	0.36	0.12	0.35	0.53	0.71

Note : The number of lags is selected with the Akaike Information Criterion with a maximum of 4 lags. Standard errors are in parentheses : *Significant at 10% **Significant at 5% ***Significant at 1%

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Troisième partie

Ressources naturelles et changement structurel

Cette partie est composée d'un chapitre inspiré d'un document de travail co-écrit avec Michaël Goujon et intitulé « Are Natural Resources a Deep Determinant of Industrialization in Africa ? ». Bien que reprenant l'essentiel de la structure et de la méthodologie du document d'origine, ce chapitre élargit la discussion en étudiant l'impact des ressources naturelles sur quatre secteurs productifs (et donc sans se focaliser sur l'industrialisation en particulier) : agriculture, manufacture, construction et services.

Ce chapitre pose comme point de départ l'absence de discussion approfondie dans la littérature empirique du syndrome hollandais sur la mesure des transformations structurelles. Pour cela, il distingue entre valeur ajoutée sectorielle en termes absolus et en termes relatifs. Il propose également une analyse de la situation actuelle et des tendances récentes des différents secteurs d'activités en Afrique. L'objectif principal du chapitre est d'estimer l'impact de l'exploitation des ressources naturelles sur les valeurs ajoutées sectorielles dans un panel de 50 pays africains entre 1995 et 2019. Sur le plan méthodologique, ce chapitre se distingue des deux précédents en étendant l'analyse à tout le continent africain et en privilégiant une approche plus descriptive basée sur des méthodes économétriques statiques sur moyennes quinquennales. Ce choix s'explique par la relative inertie temporelle des séries de production et de valeur ajoutée, encourageant à privilégier une analyse transversale dans l'identification du syndrome hollandais au détriment de la dimension temporelle. Le chapitre conclut à un impact faiblement positif des ressources extractives sur le développement du secteur manufacturier et plus fortement sur les secteurs des services et de la construction. Au contraire, les ressources extractives semblent encourager un déclin du secteur agricole, en accord avec les résultats du chapitre 2. Le chapitre ajoute également une discussion sur les pays des deux zones Franc CFA, et conclut à l'absence d'éléments supportant l'idée d'un syndrome hollandais dans la zone CEMAC, en lien avec les résultats du chapitre 3.

Chapitre 4

Are Natural Resources a Deep Determinant of Structural Transformations in Africa ?

4.1 Introduction

The role of structural transformations, defined as the reallocation of factors of production across sectors, as a driver for long-run economic development has long been emphasized in the economic literature (Page, 2011 ; McMillan et al., 2014 ; Rodrik, 2016). Yet, many observers have argued that such growth-enhancing structural change has not been observed in most African countries (McMillan et al., 2014 ; Rodrik, 2016). In addition, overall productivity does not seem to have increased in African countries as much as in other regions for the last decades. These remarks call for a deep analysis of sectoral value added dynamics and of their determinants. Indeed, many deep and proximate determinants have been proposed in the economic literature to explain the relative lack of dynamism of African economies, such as adverse geography, poor institutional quality, political instability, bad investment climate, inefficient taxation and fiscal policies, lack of physical infrastructure and human capital, or overvalued exchange rates. Among these, the Dutch disease is often seen as an appealing explanation for premature de-industrialization. Yet, as seen in chapter 1, the theoretical and empirical literature on Dutch disease in developing countries has provided mixed results regarding this effect for the last 40 years. Indeed, in addition to the heterogeneity across regions and countries, results have proven to be sensitive to the empirical econometric specification and the choice of dependent and explanatory variables used to investigate Dutch disease.

In this study, we aim at providing new insights on the subject by exploring the impact of natural resources on non-resource sectoral value added (VA) in a panel of 50 African countries between 1995 and 2019. Our contribution to the existing literature is threefold. First, we do not restrict our study to (de-)industrialization only but investigate the impact of natural resources on agriculture, manufacture, construction and services. Second, we propose a set of "deep determinants" of structural transformations (in the sense of Rodrik, 2003 : geography, integration, institutions), and include natural resources as one of these determinants, following the Dutch disease hypothesis. As seen in chapter 1, the DD predicts (i) an absolute and a relative decline in non-resource tradable sectors, and (ii) a relative (but not necessarily absolute) rise in non-tradable sectors [1]. Finally, we provide a discussion on the choice of the underlying empirical model and on the definition and measurement of the (dependent and explanatory) variables, such discussion being often overlooked in empirical analyses. We notably study the dynamics of sectoral value added both in "absolute" (value added per capita) and "relative" (value added as a share of GDP) terms. This distinction is impor-

1. The spending effect implies an absolute rise in the non-tradable sector while the resource-movement effect implies an absolute decline in this sector but lower than in the non-resource tradable one

tant when investigating the impact of natural resources because DD effects are expected to have different impacts on non-resource tradable and on tradable sectors, implying that a sector might decline in absolute terms but not in relative ones (if it declines at a relatively lower rate than other sectors) and reciprocally. This distinction can also explain part of the heterogeneity in results across studies on the subject.

We conclude to the absence of any evidence that natural resources have led to an absolute decline in manufacturing output, even if this sector did not benefit from these revenues as much as the construction or service sectors. On the contrary, exploitation of natural resources seems to be associated with a decline in the agricultural sector. In line with the DD hypothesis, our results therefore suggest that agriculture is likely to be the main non-extractive tradable sector instead of manufacture in African countries and that DD is therefore likely to encourage de-agriculturalization rather than de-industrialization.

The study is organized as follows. We first describe the current situation and recent trends in sectoral outputs and natural resources revenues in Africa (section 4.2). Then, we review the empirical literature on the determinants of structural transformations in developing countries (section 4.3). Third, we motivate our selection of explanatory variables and detail their construction (section 4.4). Finally, we provide and discuss the impact of natural resources on agriculture, manufacture, construction and services (section 4.5). Section 4.6 concludes.

4.2 Stylized Facts on Sectoral value added in Africa

In this section, we briefly present the current situation and recent dynamics of sectoral value added in Africa between 1995 and 2019. Due to data availability and in order to have consistent comparison over time, the values presented are estimated based on five-year averages for 50 African countries (all African countries except Eritrea, Somalia, Sudan, and South Sudan). Structural transformations are usually estimated by the share of sectoral value added in GDP. However, changes in a specific sector value added to GDP ratio can also be caused by the dynamics in other sectors, because all sector shares of GDP add up to 100% every year. Therefore, we also discuss the dynamics in sectoral value added per capita.

4.2.1 Stylized Facts on Extractive Resources

We use here resource value-added (resource VA) measured by the difference between "Mining, Manufacturing, Utilities (ISIC C-E)" and "Manufacturing (ISIC D)"[2] value added from the UNSD, in current USD per capita and in percent of total GDP (Table 4.1). In the rest of this paper, we will use this variable as a measure of resource value added.

Between the end of the 1990s and the end of the 2010s, the average value of resource VA followed an inversed-U shape curve in Africa, which is wider in per capita than in percent of GDP. In USD per capita, resource VA is higher in 2015-19 than in 1995-19 in a vast majority of African countries (46), while in percent of GDP the diagnosis is less clear-cut, since it is higher in 27 countries but

2. We consider that the size of "Utilities" remains sufficiently low in African countries not to affect the interpretation of the results. This assumption is also supported by the high correlation between the variable from the UNSD and the resource rents variable from the WDI (discussed in section 4.4 and in Table 4.10)

lower in 23 countries. However, heterogeneity across African countries must be underlined in terms of level and evolution. In 1995-99, resource VA is higher than 1000 USD per capita in only three countries : Botswana (1067 USD per capita), Gabon (2066) and Libya (1802), and all three show a higher level in 2015-19 ; but resources in percent of GDP decreased in Botswana (from 35 to 20%) and in Gabon (from 45 to 37%), while being stable in Libya. As extreme cases, resource VA in Equatorial Guinea increased from 508 in 1995-19 to 2689 in 2015-19 (but it decreased in percent of GDP from 50% to 27%) ; and in Chad from almost zero in 1995-19 to 82 in 2015-19 due to the beginning of oil production in 2003. A hand of countries stayed behind : Burundi (from 1 to 3 USD per capita), Ethiopia (from 3 to 7), Guinea-Bissau (from 7 to 6), Mali (from 6 to 7), while Central African Republic decreased from 20 to 3 USD per capita, due notably to the diamond embargo started in 2013. In percent of GDP, other countries with very low resource VA (around 1 or 2%) include Benin, Comoros, Gambia, Liberia, Mauritius, São Tomé and Príncipe, Eswatini and Seychelles. Finally, is also appears that in Africa, hydrocarbons represent the main type of extractive resource in terms of revenues. For instance, among the seven countries where resources represented more than one third of total GDP in at least one period, resource revenues are driven almost exclusively by the oil sector in six of them (Algeria, Angola, the Republic of Congo, Equatorial Guinea, Gabon and Libya), while only one (Botswana) is a large diamond and gold producer.

Table 4.1 – Resource VA per capita versus in % of GDP

	Resource VA (Current USD per capita)					Resource VA (% of GDP)				
	1995-99	2000-04	2005-09	2010-04	2015-19	1995-99	2000-04	2005-09	2010-04	2015-19
Mean	173	259	631	660	340	10.3	11.2	13.0	12.6	9.6
Median	29	27	60	96	93	4.9	5.5	5.4	5.5	5.7
Std. Dev.	407	650	1825	1662	662	13.3	15.2	16.9	13.7	8.8

Nb countries where VA has increased between 1995-1999 and 2015-2019	46	Nb countries where VA has increased between 1995-1999 and 2015-2019	27

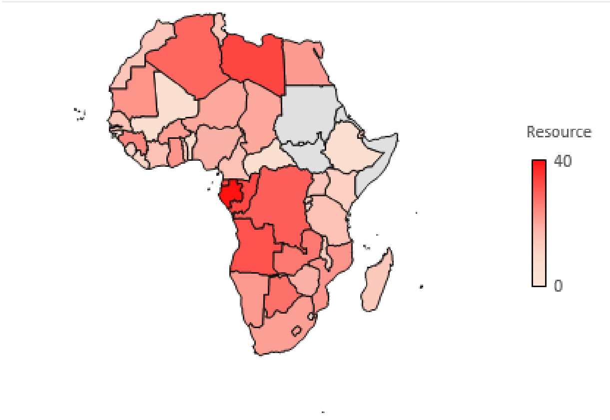
Note : Descriptive statistics on five 5-years periods for 50 African countries.
Source : United Nations Statistics Division.

4.2.2 Stylized Facts on Non-Resource Sectors

We then focus on non-resource sectors, and specifically distinguish agriculture, manufacture, construction and services. We present the dynamics of these different sectors both in Constant 2015 USD per capita and in shares of non-resource GDP.

Agriculture still represents an important part of the economy in African countries, but this part tends to decrease over time. Indeed,

Figure 4.1 – Share of Natural Resources in GDP (Period 2015-2019)



Source : Author from UNSD

agricultural value added per capita has overall increased since the 1990s, but at a lower rate than other sectors, explaining why agriculture as a share of non-resource GDP has declined in almost 80% of countries (from 26.5% of non-resource GDP in 1995-1999 on average to less than 22% in 2015-2019) (see table 4.2. However, heterogeneity across countries remains large : agriculture represents in 2015-2019 less than 10% of non-resource GDP in 14 countries (Djibouti, the Seychelles, South Africa, Botswana, Equatorial Guinea, Mauritius, Libya, Zambia, Lesotho, Cape Verde, Gabon, Namibia, Eswatini and Zimbabwe) but more than half in two countries (Sierra

Leone and Liberia). Overall, agriculture as a share of (non-resource) GDP declines when income per capita rises, as predicted by classical economic theory. Indeed, we usually expect the share of agriculture in the economy to decline as GDP rises, and manufacture first to expand (at the expense of agriculture) and then to decline (in favor of services). It is thus noticeable that the countries with the higher agricultural value added per capita are usually those with higher value added per capita in all sectors, and in which agriculture remains relatively low when expressed as a share of GDP.

Table 4.2 – Agriculture VA per capita versus in % of Non-Resource GDP

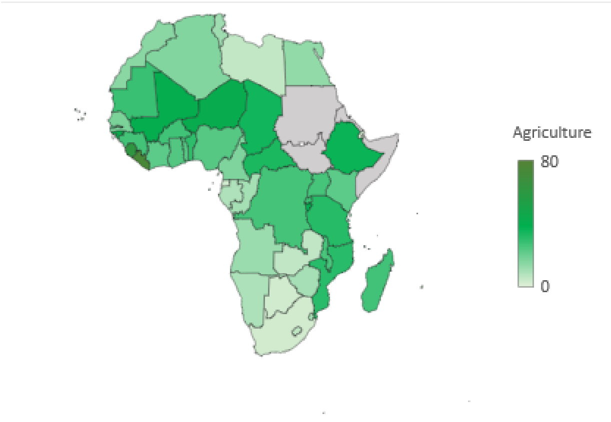
	Agriculture VA (Constant USD per capita)					Agriculture VA (% of Non-Resource GDP)				
	1995-99	2000-04	2005-09	2010-04	2015-19	1995-99	2000-04	2005-09	2010-04	2015-19
Mean	203	209	216	230	241	26.5	24.7	23.4	22.4	21.8
Median	176	206	194	196	223	25.0	24.2	23.1	22.8	22.9
Std. Dev.	100	97	103	110	119	15.5	14.7	15.2	15.5	15.3

Nb countries where VA has increased between 1995-1999 and 2015-2019	31	Nb countries where VA has increased between 1995-1999 and 2015-2019	11

Note : Descriptive statistics on five 5-years periods for 50 African countries.
Source : United Nations Statistics Division.

Despite an average increase of 50% in constant USD per capita between the 1990s and the early 2010s, manufacturing output remains relatively small compared to the other sectors, and has even started to decline since 2010 when expressed a share of GDP. Contrary to the expectations, manufacture as a share of GDP does not seem to

Figure 4.2 – Share of Agriculture in Non-Resource GDP (Period 2015-2019)



Source : Author from UNSD

increase with income per capita in Africa. However, as for agriculture, there is an important heterogeneity across countries in manufacturing development. Indeed, the mean of manufacturing VA per capita has clearly diverged from its median value for the last decades whereas no such divergence has occurred when looking at manufacture as a share of GDP (see Table 4.3. This indicates that the average increase was partly driven by a set of countries characterized by a rapid absolute rise in manufacture VA per capita. More precisely, a group of 13 countries showing different characteristics and heterogeneous levels of manufacture VA per capita have more than doubled their level of manufacture VA per capita between 1995-99 and 2015-2019 : Angola (from 106 to 251 USD per capita), Djibouti (28 to 85), Ethiopia (9 to 36), Equatorial Guinea (314 to 1927), Liberia (2 to 26), Lesotho (83 to 193), Mali (30 to 116), Mozambique (19 to 48), Malawi (24 to 62), Rwanda (27 to 57), Togo (49 to 102), Tanzania (34 to 83), and Uganda (60 to 135). In the meantime, 5 countries have experienced a loss of more than 20% in their manufacture VA per capita during the same period : Burundi (from 39 to 30 USD per capita), Benin (154 to 111), the Democratic Republic of Congo (153 to 87), Gambia (47 to 35), and Mauritania (154 to 115). While in 2015-2019 manufacture VA was on average lower than 300 USD per capita in Africa, it was comprised between 900 and 2000 in four countries of the sample : Equatorial Guinea, being the most extreme case, Eswatini (former Swaziland), the Seychelles and Mauritius. The main question here is whether these high values represent a real over-development of manufacturing industries compared to the rest of the African sample, or reveal a problem in measurement (or in the definition of the manufacturing sector). We can discuss this by using more detailed information on manufacturing production and trade data in these countries (from various institutions' country reports and the Observatory of Economic Complexity). Mauritius is a well-known case of successful industrialization, transforming the economy from monocrop (sugar) to diversified activities such as seafood and agri-processing, textile and apparel, and more sophisticated segments. In Seychelles, despite a declining trend, the manufacturing sector is still a good performer in fish (tuna)-processing activities (exported to the EU [3]), but also in food and beverages for the domestic market (AFDB, 2014). In Eswatini, the manufacturing sector is dominated by wood pulp production, food and beverages-processing but also by more sophisticated activities such as (declining) textile and apparel, machinery and electronic equipment, with exports composed mainly by chemical products and foodstuffs exported mostly to South Africa. Regarding Equatorial Guinea, the exceptional trend in manufacture seems correlated to large oil and gas production, especially the production of "liquefied natural gas and alcohols, phenols, halogen derivatives and sulfones, liquefied propane, and butane", but also "ships, boats and floating devices", "petroleum gases and other gaseous hydrocarbons", thanks to the building of new installations, and finally in "wood and fish processing

3. All exports data come from the Observatory of Economic Complexity

industries" (AFDB, 2018). The oil windfall has thus seemingly enabled the country to modernize its infrastructure over the past two decades, allowing for starting economic diversification. However, Equatorial Guinea exports remain dominated by crude oil (73% in 2020) and petroleum gas (20%). Then, despite a notable rise in timber processing industries, a large share of manufacture VA in Equatorial Guinea's GDP comes above all from the transformation of hydrocarbons (gas) into methanol/acyl alcohol/liquefied gas, a class that is included in the manufacturing sector (ISIC Code 3520 - Manufacture of Gas; Distribution of Gaseous Fuels Through Mains). It is not excluded that some other oil-rich countries (such as Cameroon or Gabon) are also concerned but to a lesser extent. This class of manufacturing sectors depends on natural resources and differs from what economists may implicitly think of when referring to industrialization. They are, however, processed products that correspond to the first step of a downstream development of the natural resource sector, beyond the unprocessed crude oil and petroleum gas. Moreover, arguably, these types of processing activities allow for greater job creation than extraction only and are presumably less sensitive to international price variations. This transformation contributes to (vertical) diversification to a limited but certain extent. While this point deserves attention, we consider that there is little argument to exclude this segment as not being sufficiently “manufacturing” (and hence to exclude Equatorial Guinea from the sample).

Table 4.3 – Manufacture VA per capita versus in % of Non-Resource GDP

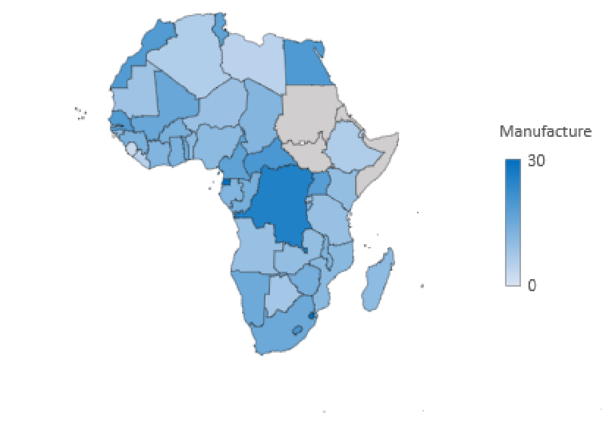
	Manufacture VA (Constant USD per capita)					Manufacture VA (% of Non-Resource GDP)				
	1995-99	2000-04	2005-09	2010-04	2015-19	1995-99	2000-04	2005-09	2010-04	2015-19
Mean	181	199	243	274	275	13.6	13.8	13.6	12.8	12.5
Median	120	114	98	121	125	12.1	12.6	12.7	11.1	12.0
Std. Dev.	214	243	340	414	367	6.8	6.7	6.7	6.6	6.3

Nb countries where VA has increased between 1995-1999 and 2015-2019	41	Nb countries where VA has increased between 1995-1999 and 2015-2019	17

Note : Descriptive statistics on five 5-years periods for 50 African countries.
Source : United Nations Statistics Division.

The sector of construction does not contribute to African GDP as much as the other sectors, and is often included along with manufacture in the industrial sector. However, we consider the construction sector to differ from manufacturing activities and to deserve its own analysis for two main reasons. First, construction is largely non-tradable, whereas the manufacturing sector is often assumed to be mainly tradable. An empirical investigation of the DD must therefore clearly distinguish these two types of activities. Second, many resource-rich African countries have experienced construction booms during resource booms. Resource-caused construction

Figure 4.3 – Share of Manufacture in Non-Resource GDP (Period 2015-2019)



Source : Author from UNSD

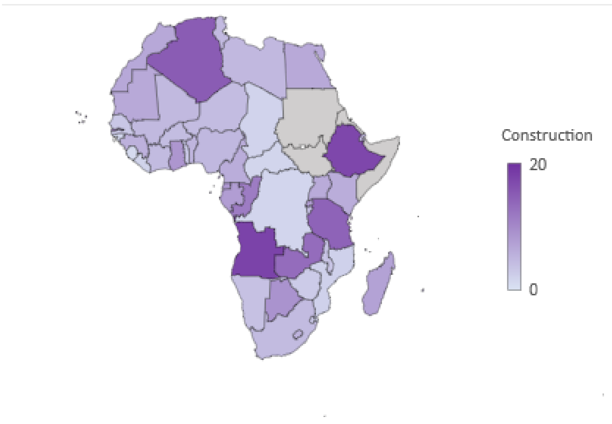
booms are mainly attributed to two elements : (i) the construction of infrastructure directly used for resource extraction (e.g. mines), transportation, processing (e.g. oil refinement) and storage ; and (ii) public investment in infrastructure allowed by the increase in public revenues from resource taxation. Such (potentially temporary) booms must be considered when estimating the impact of extractive resources on structural transformations. Overall, construction value added per capita has doubled between 1995-1999 and 2010-04, but slightly decreased after. However, it remains the smallest non-resource sector in the economy, ranging from 1% of non-resource GDP (in Sierra Leone) to 18% (in Angola) in the last period.

Table 4.4 – Construction VA per capita versus in % of Non-Resource GDP

	Construction VA (Constant USD per capita)					Construction VA (% of Non-Resource GDP)				
	1995-99	2000-04	2005-09	2010-04	2015-19	1995-99	2000-04	2005-09	2010-04	2015-19
Mean	84	96	131	160	136	5.1	5.3	6.1	6.4	6.1
Median	37	39	46	56	81	4.5	5.0	5.3	5.4	4.8
Std. Dev.	157	167	230	294	150	3.2	2.8	3.6	4.4	4.1
Nb countries where VA has increased between 1995-1999 and 2015-2019					44	Nb countries where VA has increased between 1995-1999 and 2015-2019				30

Note : Descriptive statistics on five 5-years periods for 50 African countries.
Source : United Nations Statistics Division.

Figure 4.4 – Share of Construction in Non-Resource GDP (Period 2015-2019)



Source : Author from UNSD

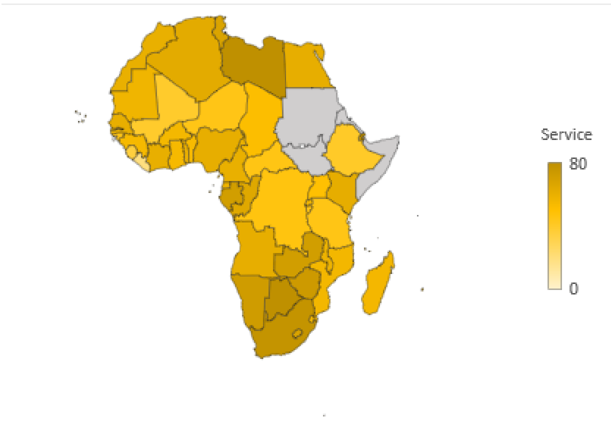
Finally, services appear to constitute the first sector in terms of value added in most African countries. Indeed, in 2015-2019, value added in services is higher than in all other non-resource sectors in 47 countries, agriculture being the first sector in only three countries (Liberia, Mali and Sierra Leone). In addition, service value added has increased over time, both in output per capita and in shares (see Table 4.5). In absolute value, the sector of services seems to have declined between 1995 and 2019 in only five countries of the zone (the Central African Republic, the Democratic Republic of Congo, Gambia, Madagascar and Niger). Contrasting with agriculture, it also appears that the higher the level of GDP per capita and the higher the share of services in the economy. These remarks seems to support the "premature de-industrialization" hypothesis supported by McMillan et al. (2014) according to which most African countries have shifted from agriculture-based to service-based economies without following the industrialization/de-industrialization steps experienced by most advanced economies. On average, the category "Wholesale, retail trade, restaurants and hotels (ISIC G-H)" represents approximately one third of the sector of services in terms of value added, twice as much as "Transport, storage and communication (ISIC I)". The rest is composed by all other activities of services (ISIC J to P).

Table 4.5 – Service VA per capita versus in % of Non-Resource GDP

	Service VA (Constant USD per capita)					Service VA (% of Non-Resource GDP)				
	1995-99	2000-04	2005-09	2010-04	2015-19	1995-99	2000-04	2005-09	2010-04	2015-19
Mean	803	885	1073	1327	1468	54.8	56.1	56.9	58.4	59.6
Median	450	462	509	648	721	55.4	55.9	56.5	58.7	58.6
Std. Dev.	1050	1143	1401	1745	1969	13.0	12.4	12.7	13.7	13.9
Nb countries where VA has increased between 1995-1999 and 2015-2019					45	Nb countries where VA has increased between 1995-1999 and 2015-2019				36

Note : Descriptive statistics on five 5-years periods for 50 African countries.
Source : United Nations Statistics Division.

Figure 4.5 – Share of Service in Non-Resource GDP (Period 2015-2019)



Source : Author from UNSD

4.3 Review of Literature

In this section, we review recent typical cross-section and panel data analyses of the determinants of structural transformations in developing countries, with a focus on those including natural resources. Even if most studies investigate patterns of industrialization, we also include studies providing a comparative analysis between agricultural, manufacturing and/or service sectors' development.

Before proceeding to the literature review, however, one must justify the focus on sectoral value added. Indeed, in macro-empirical studies, the level of industrialization, as the dependent variable, is measured through three types of variables : value added, exports and employment. The use of exports of manufactured goods (for instance Iwanow and Kirkpatrick, 2009 ; Nouira et al., 2011) aims at analyzing competitiveness on foreign markets. However, it does not allow to explore the internal competitiveness of products since it excludes "exportable" products that are not actually exported but satisfy internal demand (and are in competition with foreign imported products). Industrialization through import-substitution or domestic market-oriented strategies are then excluded, restricting the analysis to export-oriented manufacturing production only. In addition, trade flows are often mis- or underreported in developing countries. Finally, when exogenous shocks (such as large changes in commodity prices) affect the economy, the different impacts on the production from different domestic sectors must be known to infer policy implications. On the contrary, using employment at the sectoral level would allow an analysis of both external and internal competitiveness and of sectoral impacts of exogenous shocks. However, while frequently used for advanced economies, sectoral employment data are often unavailable in developing countries, and are characterized by large measurement errors. Therefore, we focus here on structural transformations defined as the variations in sectoral value added across countries and over time.

Different strands of the empirical literature could be considered as basis for recent works. The first one is probably the seminal regression of Chenery (1960), which used population and income per capita (and their square) as explanatory variables. Extending these early analyses, and taking advantage of the improvement in data availability, recent works have investigated other determinants (eventually including income as one of these determinants), which can be decomposed into "proximate determinants" (investment, trade and fiscal policy, FDI, financialization...) and "deep determinants" (geography, institutions, human capital...) (Rodrik, 2003). We will preferably rely on the deep determinants' literature since we are primarily interested in cross-country comparisons, and consider that even if resource revenues can be highly volatile, their impact on structural transformations is likely to occur only in the medium to long-run. In addition, natural resources endowment is mainly driven by geography, allowing to consider natural resources revenues as a deep determinant of structural transformations in a cross-country perspective. Most of the empirical articles use manufacturing VA in percent of GDP as the indicator of manufacturing performance, and a few of them have extended the tests to agriculture and services also expressed in percent of GDP (see Jha and Afrin, 2017 ; Alssadek and Benhin, 2021). Fardmanesh (1991) adopts this approach but differs by expressing agriculture, manufacture and service as a share of non-oil GDP rather than total GDP (to avoid endogeneity caused by the use of oil rents as a share of total GDP in the explanatory variables). However, some of them differ from this choice. For instance, Guillaumont-Jeanneney and Hua (2018) use MVA, Isaksson (2009) uses MVA per capita, Jalilian and Weiss (2000) use both MVA in % of GDP and MVA growth while Haraguchi et al. (2019) use a dummy for growth episodes in the manufacturing sector.

Regarding the explanatory variables, population and income per capita (and their squared) is the point of departure from Chenery (1960), took over by Rodrik (2016), and Haverkamp and Clara (2019) for instance (augmented by a set of dummies - unobservable fixed effects). Both variables are positively correlated with industrialization in developing countries. Indeed, total population is linked with urbanization, while income per capita aims at capturing demand effects (the demand for manufactured goods increases as income increases). It is often assumed that, when income increases, the share of MVA in GDP first increases at the expense of agriculture and then decreases in favor of services. For low-income countries, MVA is thus assumed to increase with total income. Jalilian and Weiss (2000) only add an openness index as well as regional and period dummies to these variables. While trade liberalization is expected to have a positive impact on industrialization, they do not find any significant coefficient for this variable. Another usual determinant relates to the quality of institutions, frequently measured by Worldwide Governance Indicators from the World Bank or by the Polity2 index from the Center for Systemic Peace. WGI is used for example in Horvath and Zeynalov (2016), Mijiyawa (2017), or Guillaumont-Jeanneney and Hua (2018). In all three papers, it is found to have a positive impact on MVA. Proxies for human capital such as the Human Assets Index or the average number of years of education are also frequently used to capture productivity of the labor force. This has been done by Jha and Afrin (2017) or Mijiyawa (2017) for African countries. Even though the expected impact of education on the manufacturing sector is positive, coefficients might not be significant when GDP per capita is also included as an explanatory variable (as in Jha and Afrin, 2017) since real GDP already captures labor force productivity. Geographical variables (such as being a landlocked country) can be included. However, they are often left out because, as time-invariant variables, geographic characteristics are often considered to be captured by fixed effects. Finally, natural resources endowment, often proxied by the share of natural resources in GDP or in total exports, is sometimes included in regressions, in line with the Dutch disease hypothesis. For instance, Fardmanesh (1991) finds a negative impact of oil rents on agricultural share of non-oil GDP in Algeria, Ecuador, Indonesia and Nigeria but a surprisingly positive one on manufacture in these four countries and in Venezuela. Similarly, Apergis et al. (2014) find a negative impact of oil rents on agricultural development in a panel of Middle East and North African countries. On the contrary, Horvath and Zeynalov (2016) (resource exports per capita), Jha and Afrin (2017), (natural resources to GDP), Haraguchi et al. (2019) (mining rents to GDP) and Alssadek and Benhin (2021) (oil production and oil revenues) conclude that natural resources tend to impede the development of the manufacturing sector.

Table 4.6 – Empirical Literature on the Determinants of Sectoral value added

Articles	Sample	Dependent Variable	Explanatory Variables	Method
Fardmanesh (1991)	5 countries 1970-1982	AVA (% non-oil GDP) MVA (% non-oil GDP) SVA (% non-oil GDP)	Oil Rents (% GDP) Manufacture/Agriculture Price	OLS
Jalilian & Weiss (2009)	86 countries 1975-1993	MVA growth MVA (% GDP)	GDP/GDPPC Population Sachs & Warner Openness Index	OLS FE LSDV
Isaksson (2009)	79 countries	MVA per capita (USD) MVA per capita growth	Electricity Capacity AVA per capita Manufacture Exports Economic Freedom Average Education Level	OLS RE FE
Apergis et al. (2014)	14 MENA countries 1970-2011	AVA (% GDP)	Oil Rents (% GDP)	VAR
Horvath & Zeynalov (2016)	15 post-soviet countries 1996-2010	MVA (% GDP)	NR Exports PC WGI NR Exports PC * WGI EBRD trade liberalization Trade openness Average tax rate External debt Population growth Initial GDPPC	FE
Jha & Afrin (2017)	53 African countries 1970-2014	AVA (% GDP) MVA (% GDP) SVA (% GDP)	Land area Population Population >64 & <15 GDPPC & GDPPC Square Secondary Enrollment rate Trade openness Credit to GDP External Debt NR Rents GFCF Public Investment	OLS LAD
Mijiyawa (2017)	41 African countries 1995-2014	MVA (% GDP)	Population GDPPC & GDPPC Square Nominal Exchange Rate FDI Stock Largest City (% Population)	RE GMM

Table 4.6 - Empirical Literature on the Determinants of Sectoral value added (Continued)

Articles	Sample	Dependent Variable	Explanatory Variables	Method
Haraguchi, Martorano & Sanfilippo (2019)	126 countries 1970-2014	MVA growth episodes	GDPPC Investment Credit (% GDP) Real Exchange Rate Kao Openness Index Average Education Political Stability Mineral Rents Landlocked	OLS
Guillaumont-Jeanneney & Hua (2018)	40 African countries 2000-2015	MVA (USD)	Market Size Infrastructure Index M3 (% GDP) Secondary School Enrollment WGI Manufacturing Imports Real Exchange Rate	GMM
Haverkamp & Clara (2019)	139 countries 1970-2016	MVA (% GDP)	GDPPC & GDPPC Square Population & Population Square	OLS FE
Alssadek & Benhin (2021)	36 oil-rich countries 1970-2016	AVA (% GDP) MVA (% GDP) SVA (% GDP)	Oil production (Barrels) Oil revenues (USD) GFCF FDI Inflows Public Expenditures Trade Openness GDP	FE

Note : AVA agriculture value added, MVA manufacturing value added, SVA service value added, NR natural resources, WGI Worldwide governance index, GFCF gross fixed capital formation, FDI Foreign direct investment, PC per capita.

4.4 Variables and Data

We gathered data for a panel of 50 African countries (excluding Eritrea, Somalia, Sudan, and South Sudan) between 1995 and 2019 from several sources to estimate the impact of the exploitation of natural resources on non-resource sectors in Africa. The primary source of data for sectoral value added is the United Nations Statistics Division (UNSD), but explanatory variables data are drawn from the UNESCO, the World Bank and the Fondation pour les Etudes et Recherches sur le Développement International (FERDI). We start by discussing the choice and definition of dependent variable, and in a second step we present the deep determinants of structural transformations used here.

4.4.1 How to Measure Structural Transformations ?

As seen in section 4.3, most studies use the share of manufacturing (or agricultural, service...) value added in GDP to estimate the degree of industrialization that a country has achieved. This choice is usually motivated because this variable directly measures the importance of the sector within a country's total economic activity, or the direct contribution of this sector to the economic activity. However, since it is a share, in a computational way, changes in this ratio are not caused by the dynamics of this sector only but also by dynamics in other sectors (Haraguchi and Rezonja, 2013). In fact, because all sector shares of GDP add up to 100% every year, their variations over time mechanically reflect relative changes compared to other sectors. For instance, an increase in export crops prices will mechanically be associated with an increase in agricultural VA and with a decline in manufacture or service VA in relative terms, even if these two sectors are not directly affected. This is especially problematic when investigating the impact of natural resources revenues since a rise in this explanatory variable will necessarily lead to a fall in non-resource VA in percent of GDP even though there is no absolute decline in their output. The use of value added in percent of total GDP can then lead to wrongly conclude to the presence of a Dutch disease. To overcome this last issue, one should prefer to estimate the impact of natural resources on sectoral VA expressed in % of non-resource GDP, as done by Fardmanesh (1991). However, this strategy only allows to identify relative sectoral dynamics, rather than absolute declines in output.

Another measure is sectoral VA per capita (to adjust for country/population size), which is widely used in UNIDO reports for measuring industrialization (see for instance Andreoni and Upadhyaya, 2014). Contrary to the previous indicator, VA per capita in one sector is not computationally impacted by the dynamics of the other sectors. It also presents the advantage of capturing absolute production dynamics in the sector. However, because it does not provide any direct comparison with the other sectors (and does not account for the heterogeneity in productivity across countries), it has some shortcomings too. More precisely, more productive countries may have higher VA per capita in all sectors, which can lead cross-country regressions to wrongly conclude to positive correlations across sectors' outputs, even when there is no direct causality relationship between them. In that case, the risk is to underestimate the negative impacts of natural resources revenues on other sectors. This issue can partly be overcome by controlling for potential sources of productivity (such as human capital or institutional quality) or by including GDP per capita as an explanatory variable (see discussion in the next subsection).

Here, we follow Jalilian and Weiss (2000) by considering these two approaches as complementary and we use both indicators. A final question relates to the use of current or constant prices when estimating sectoral value added (discussed for instance by Lavopa and Szirmai, 2015). The use of value added in constant terms allows to focus on production and to avoid overestimating an increase in revenues caused by inflation. However, when investigating relative dynamics, we compare the different sources of revenues within the country, while the use of sectoral VA in constant terms based on different deflator indexes does not allow comparison across sectors and countries. In that case, the ratio of sector VA to (non-resource) GDP should be expressed in current terms. Hence, we use constant 2015 USD when estimating sectoral VA per capita and current USD when using shares of non-resource GDP.

We investigate the impact of natural resources on four non-resource sectors [4] : Agriculture ("Agriculture, hunting, forestry, fishing (ISIC A-B)"), Manufacture ("Manufacturing (ISIC D)"), Construction ("Construction (ISIC F)") and Services (computed as the sum of "Wholesale, retail trade, restaurants and hotels (ISIC G-H)", "Transport, storage

4. All classifications are based on ISIC 3.

and communication (ISIC I)" and "Other Activities (ISIC J-P)"). Agriculture and manufacture are considered as being mostly tradable sectors (even if part of their production is also oriented towards domestic markets) while construction and services are mainly non-tradables. We therefore expect a negative impact (in both relative and absolute terms) of extractive industries on agriculture and manufacture and a positive (at least in relative terms) on construction and services, in line with the DD hypothesis.

4.4.2 Deep Determinants of Structural Transformations

This study intends to question the role of the exploitation of extractive resources (mining resources and hydrocarbons) as a deep determinant of structural transformations in Africa. The value of extractive resources revenues is subject to the same issues as mentioned above regarding its measurement (in % GDP or USD per capita). However, we consider here that what matters is the impact of resource revenues rather than resource production. Indeed, the Dutch disease is attributable to an increase in resource revenues that can be caused either by a surge in production or in prices. Therefore, we estimate separately the impact of resources VA per capita in current prices on sectoral VA per capita in constant prices, and the impact of resource VA in percent of total GDP on sectoral VA in percent of non-resource GDP. We proxy resources value added by the difference between the variable "Mining, Manufacturing, Utilities (ISIC C-E)" and the variable "Manufacturing (ISIC D)" from the UNSD. To ensure that our results are robust to alternative definitions and sources of data, we also use data from the World Bank WDI on the extractive resource rents (sum of "Oil Rents", "Natural Gas Rents", "Mineral Rents" and "Coal Rents").

In addition to natural resources revenues or rents, we include a set of key structural variables. The empirical literature has identified different categories of such variables. For instance, Isaksson (2009), following Rodrik (2003), lists the "deep determinants" of industrialization as primarily including institutions, geography, human capital, and international integration. We follow this literature and select the following variables :

- *Average number of years of education of the workforce (Education)* : this variable is provided by the UNESCO Institute for Statistics which extends the original database from

Barro and Lee (2013). It is intended to capture human capital. Contrary to the current enrollment rate of children, this variable presents the advantage of being the output of past investments in education and does not depend on current public expenditures (thus reducing the reverse causation issue between economic development and human capital). Moreover, the workforce's education must have a direct impact on economic productivity while current children's health or education will have an impact on productivity only later when they join the workforce. It is expected to have a positive impact on economic development through productivity, and particularly on manufacture, which, arguably, needs more skilled workers than other sectors.

- *Government effectiveness (WGI2)* : this variable is one of the six Worldwide Governance Indicators (WGI) and measures the quality of institutions [5]. According to Kaufmann et al. (2010), "[It captures] perceptions of the quality of public services, the quality of the civil service and the degree of

5. In a preliminary work, we used every other five WGI variables and found similar results, which can be explained by the high correlation between the six WGI indicators.

its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies". It is measured on a scale from -2.5 (low quality) to 2.5 (high quality). Institutional quality is also expected to positively affect all sectors VA in absolute terms.

- *Victims of natural disasters (Disasters)* : This variable is a component of the Economic Vulnerability Index (EVI), which is one of the three criteria used by the United Nations to identify Least Developed Countries. It is assumed to captures geographical factors and to reflect vulnerability to natural shocks (weather and climate-related disasters, such as floods, landslides, storms, droughts and extreme temperatures, as well as geophysical disasters, such as earthquakes or volcanoes). It is estimated as the average share of the population hurt (killed or affected) by natural disasters and then normalized on a scale [0-100] (a lower score reflecting a better situation). Retrospective series of this index are provided by the FERDI based on calculations from OFDA/CRED International Disasters Database (EM-DAT) (Feindouno and

Goujon, 2016). Natural disasters are expected to negatively impact agriculture, manufacture and services in absolute terms, and agriculture in relative terms (because this sector is likely to be more affected than the two others by natural shocks). The impact on construction might however be positive by encouraging the re-construction of buildings and infrastructure.

- *Distance to the World markets (Remoteness)* : It is another component of the United Nations's EVI, defined as the trade-weighted minimum average distance to reach 50% of the world markets, which is time-dependent since the world distribution of economic activity changes over time. It thus appears as an alternative to the dummy for landlocked countries sometimes used in empirical studies (e.g. Haraguchi et al., 2019). Remoteness is normalized on a [0-85] scale and adjusted for the additional handicap of being a landlocked country by adding 15 to obtain a final index between 0 and 100. The retrospective series of this variable are also provided by the FERDI (Feindouno and Goujon, 2016). Remoteness aims at capturing the geographical component of external competitiveness of exports. By increasing the cost of imports and of exports, it is expected to have a negative impact on sectors oriented towards exports (agriculture or manufacture) but also on sectors dependent on the imports of foreign inputs (such as fertilizers for agriculture or cement for construction).

- *Central African Economic and Monetary Community (CEMAC) and Western African Economic and Monetary Union (UEMOA) Membership* : these two dummy variables aim at capturing regional integration through membership to one of the two CFA Franc areas. They can be considered as deep determinants since the constitution of these areas goes back much earlier in history compared to our study period. CEMAC countries are Cameroon, Central African Republic, Chad, the Republic of Congo, Equatorial Guinea, and Gabon. They share a common currency (the XAF CFA Franc) pegged to the Euro and common external tariff on imports from non-CEMAC countries. UEMOA countries are Benin, Burkina Faso, Cote d'Ivoire, Guinea-Bissau (since 1997), Mali, Niger, Senegal, and Togo. They also share a common currency (the XOF CFA Franc) pegged to the Euro as well as common trade policies. In both unions, capital can move freely within the zone. Therefore, these binary variables aim to capture a monetary framework (fixed exchange rate regime between members) as well as intra-regional trade arrangement. In both areas, countries share a customs union and a currency union, which can generate a stable macroeconomic environment and favor sub-regional economic integration, conducive to the development of tradable sectors. According to Page (2011), regional integration is one of the three tools (with investment in infrastructure and education) related with the investment climate that African countries should focus on to promote industrialization and manufacturing exports. However, due to the fixed exchange rate between the CFA franc and the euro, CEMAC and UEMOA are suspected to favor deflationary policies and weaken competitiveness of member countries.

- *Non-Resource GDP per capita (NRGDPPC)* : this variable is constructed as the difference between total GDP and resource value added (as defined earlier) from the UNSD and expressed in current USD per capita. It intends to capture country size (for regressions with VA in USD per capita) and demand effect (for all regressions). Indeed, it has been argued in the literature that when revenues per capita increase, demand for manufacturing goods increase higher than demand for agricultural ones, as predicted by the so-called Engel's Law. According to traditional models of economic development, we usually expect that when GDP per capita increases, the share of manufacture in total GDP will first increase at the expense of agriculture, and then decrease while the service sector expands [6]. This explains why various empirical studies have included GDP per capita in their estimations as a determinant of structural change (Jalilian and Weiss, 2000 ; Jha and Afrin, 2017 ; Mijiyawa, 2017 ; Haverkamp and Clara, 2019…). However, the inclusion of this variable raises two issues. First, there is an obvious risk of reverse causality effect (since non-resource sectors are all in-

6. It is noticeable that this demand effect might be limited if increasing demand for manufactured goods is compensated by additional imports rather than by increasing domestic production. This is particularly true when income is driven by natural resources, which are mostly exported, since the subsequent export revenues can be used to finance manufacturing imports.

cluded in total GDP). Second, resource VA is also included in total GDP, so that including both in the same regression would not allow to directly have an estimate of the full impact of resource revenues on sectoral outputs. It could then lead to underestimate the full impact of extractive resources and even to wrongly conclude to a negative impact. To solve this issue, we use non-resource GDP per capita rather than total GDP per capita and present separately regressions with and without this variable.

Definitions and descriptive statistics for all variables can be found in Table 4.7 and correlation matrices between variables in Tables 4.8, 4.9 and 4.10 in the appendix.

4.4.3 Empirical Approach

We compute five 5-year period averages (1995-1999 ; 2000-2004 ; 2005-2009 ; 2010-2014 ; 2015-2019) for all variables. This choice is motivated by three main reasons. First, we intend to provide a comparative analysis of the structural determinants of sectoral VA between countries and use time-invariant variables or variables that sluggishly vary over time. In the same vein, even if resource revenues tend to vary over time, Dutch disease effects in terms of structural transformations are expected to occur in the middle- rather than in the short-run. We therefore consider that year-by-year variations might not be efficient to capture these effects. Using five-years averages allows to mainly focus on the cross-sectional dimension rather than on the time dimension. Second, unit-roots are often an issue in time-series or panel when time dimension is large. However, with a panel of five periods (of five years), unit-roots are not a concern anymore. Finally, although the UN Statistical Database is a very common source of data in the empirical literature, it may include some observations that are not directly measured but reconstructed by the UN (usually through linearization). Year-by-year variations must then be interpreted cautiously, while using five-years averages contributes to overcome this potential issue. We therefore end up with a balanced panel of 250 observations from 50 countries and five 5-year periods. Coefficients are then estimated using Ordinary Least Squares and Least Absolute Deviations. Indeed, since our explanatory variables are mostly invariant or sluggish over time (since they are "deep" determinants), the use of dynamic estimators (such as first-difference or GMM) would not allow to capture the long-run impact of these variables. This choice is also in line with the use of five-years averages instead of yearly variables. Due to the low level of time dimension (five periods), we do not worry about potential unit-roots in the variables, which is the first motivation for the use of dynamic models. However, to overcome some econometric issues arising from the use of panel data, we also apply cross-section OLS for each time period and the Fixed-Effects Filtered method proposed by Pesaran and Zhou (2018) as robustness checks.

4.5 Natural Resources and Sectoral value added

4.5.1 Main Results

We first investigate the impact of resource revenues on structural transformations using Ordinary Least Squares but with different combinations of variables. Table 4.11 provides the results for the impact of resource value added in current USD per capita on sectoral value added in constant USD per capita (the “absolute” impact) for the four non-resource sectors. Table 4.12 provides the results for the impact of resource revenues as a share of GDP on sectoral value added in % of non-resource GDP (the "relative" impact). The results reveal a positive and significant impact of resource VA per capita on manufacture, construction and service value added. It is however noticeable that when non-resource GDP per capita is included, the coefficients sizably decrease, although they remain significant. This difference could be attributed to the fact that dividing sectoral VA by total population does not entirely capture country-size (in line with the large size and significance of the coefficient for non-resource revenues). This explanation must however be taken cautiously since non-resource GDP per capita are likely to generate reverse causality. On the contrary, the impact of natural resources is null for agriculture without non-resource GDP per capita and significantly negative when it is included. When looking at sectoral dynamics in relative terms (Table 4.12), it appears that construction and services clearly benefit more from resource booms than the other sectors while agriculture decline in comparison with the other sectors. Regarding manufacture, the coefficients for resources are negative in both regressions but insignificant, and thus cannot support nor falsify the DD theory. It is also noticeable that the impact of non-resource GDP is insignificant, and that the inclusion of this variable does not affect neither the size nor the significance of the impact of extractive resources. This seems to invalidate the idea of a demand effect (i.e. the increase in domestic revenues leads to an increase in demand for manufacturing goods and thus to industrialization) but also to support the idea that the inclusion of this variable contributed in the previous table to account for country-size effects.

Overall, these results are in contradiction with a de-industrialization effect of natural resources through DD, since we find a positive (even though weakly significant) absolute impact and a negative (but not significant) relative impact of resource VA on manufacture VA, while the DD model would predict a decline in tradable output both in relative and in absolute terms. These results are yet in line with the DD if we consider agriculture rather than manufacture as the main tradable sector, and construction and service sectors as largely non-tradables. These results are also in line with previous empirical work suggesting that Dutch disease effects could result in a decline in the agricultural sector (rather than the manufacturing one) in developing countries (see for instance Fardmanesh, 1991 and Apergis et al., 2014 mentioned in section 4.3) [7].

7. Even if Corden and Neary (1982) investigated the de-industrialization ef-

Regarding the other explanatory variables, education has a positive impact on manufacturing VA per capita and on services when non including non-resource GDP per capita, while institutional quality has -as expected- a strong positive impact on all sectoral outputs except agriculture (non-significant) in absolute terms. The fact these coefficients decrease (or even become negative as for education in the case of the construction sector) when including non-resource VA per capita seems to indicate a positive correlation between these three variables. This becomes even more obvious when sectoral value added are expressed in shares : education clearly benefits to manufacture and services more than to the other sectors (hence a negative coefficient for agriculture and construction) while institutional quality benefits to manufacture, construction and especially services more than to agriculture. These results are also in line with the empirical literature since we usually expect human capital to be associated with productive gains in the manufacturing and service sectors. Natural disasters have a negative impact on manufacturing

fect of DD because they focused on industrialized economies, it is noticeable that Corden (1984) already mentioned the possibility that the DD may have de-agriculturalization effects in other countries

VA but do not seem to contribute much to the sectoral composition of the economy, while remoteness has a negative effect on all sectors except manufacture. This negative coefficient might capture either the higher cost to exports and the subsequent lower competitiveness of export sectors (more likely for agriculture) or the higher costs to import inputs (applicable to all sectors). The positive coefficient for manufacture could suggest that manufacturing activities are for the most part not oriented toward exports but to domestic consumption. In that case, remoteness from the world market could act as a protection from international markets for low-productivity domestic firms by increasing the price of imported goods. Belonging to the CFA Franc area also seems to be positively correlated with industrialization, as seen in section 4.2. As expected, the coefficient for non-resource GDP per capita is positive for all sectors in absolute terms (but clearly lower for agriculture than for the other sectors) but negative for agriculture when variables are expressed in shares. This supports the traditional idea that the share of agriculture in the economy declines when income rises. However, in this case, the decline in agriculture is not associated with a development of manufacturing industries but with a rise in other non-tradable sectors that are construction and services. This is in line with the “premature de-industrialization” hypothesis, whereby most African and Latin American countries have started to shift from economies dominated by agriculture to economies driven by services without experiencing the industrialization process that is usually supposed to precede the development of services (McMillan et al., 2014 ; Rodrik, 2016).

4.5.2 Robustness Tests and Complementary Analyses

We now proceed to several robustness tests. First, to ensure that our results are robust to the use of alternative definitions and sources of data, we replace the variable “Resource value added” from UNSD by a variable from the World Development Indicators (WDI) of the World Bank. This variable that called “Resource Rents” in the rest of the study is constructed as the sum of the variables “Oil Rents”, “Natural Gas Rents”, “Mineral Rents” and “Coal Rents” provided by the WDI (and is hence assumed to capture most of extractive natural resources revenues) [8]. These two variables (from the UNSD

8. This variable therefore differs from the variable “Total Natural Resource Rents” from the WDI which also includes “Forest Rents”. We restrict ourselves to the four extractive resource rents mentioned above to remain consistent with the data from UNSD and because forests are also included in the agricultural sector.

and from the WDI) are both assumed to capture extractive resources revenues (and hence there should be a high positive correlation between them) but they slightly differ in their definition and the way they are estimated. To make sure of this, we estimate the coefficient of correlation between both, expecting it to be high but not exactly equal to one. The correlation matrix between "resource value added", "resource rents" and the four components of resource rents is provided in Table 4.10 and indicates that the correlation between UNSD' and WDI's variables equals 0.9086, which is in line with the expectations. When looking at pairwise correlations between the components of resource rents, we also observe that most of the variations of this variable are driven by oil rents. Regression results with "Resource rents" as the main explanatory variable are provided in Table 4.13 and 4.14. Results are very close to the original results, with the exceptions that the negative impact on agriculture and the positive one on services of resource rents per capita when including non-resource GDP per capita is not significant anymore. Overall, the choice of the source of variable used to measure resource revenues does not seem to strongly affect the results.

However, the use of WDI variables also allows us to investigate whether different natural resources may have different effects on non-resource sectoral value added. Natural gas and coal provide very small rents (always below 5% and 4% of GDP respectively) compared to mineral (up to 16% of GDP in Mauritania) [9] and oil (up to 60% of GDP in Equatorial Guinea and Libya). We therefore investigate in Tables 4.15 and 4.16 the impact of mineral rents and oil rents separately on sectoral value added. Interestingly, we observe that results seemed to be driven by oil rents almost exclusively, the coefficients for mineral rents being insignificant in all regressions (except at 10% for the construction sector with variables in shares). This could be attributed to the lower size of mineral revenues compared to oil revenues in most countries, but also to the fact that hydrocarbon rents can more easily get captured by public or private agents (being less diffuse than mining resources) and tend to lead to more public revenues through taxation (being more heavily taxed and always managed by formal firms contrary to mines). This result overall confirms the first observations made in section 4.2.

9. Minerals included are tin, gold, lead, zinc, iron, copper, nickel, silver, bauxite, and phosphate.

As mentioned earlier, the cross-sectional dimension of our database largely overcomes the time dimension, since one primary goal of this study is to investigate the structural determinants of industrialization in Africa and to provide a comparison across African countries. However, there remains a possibility that our results can partly be explained by general increasing or decreasing trends in the variables. To test for this possibility, and to investigate whether the relationships we observed have changed over time, we estimate cross-sectional regressions for each time-period separately. Results are provided in Tables 4.17 and 4.18. Interestingly, the coefficients of interest for natural resources remain mostly significant and close to the results in panel. However, the relative increase in the sector of services is significant only at the beginning of the period whereas the negative relative impact on agriculture and the positive relative impact on construction overall increase over time (even if they are strongly significant in every period). This point seems to require further analyses because it could indicate an increasing tendency for African countries to suffer from DD. We can also notice that the positive impact of belonging to a CFA Franc area on manufacturing value added per capita is small and insignificant at the beginning of the sample period (significant only after 2000 for the UEMOA and after 2010 for the CEMAC). This suggests that time dynamics should be considered when investigating the impact of the CFA Franc in panel data. However, the relatively low level of observations requires to interpret all these results cautiously.

Descriptive statistics have shown that some small African countries could be outliers when expressing variables in value added per capita. To ensure that these countries do not explain the differences in results between regressions, we apply the same regressions to a restricted sample of all countries that have more than one million inhabitants in each period (thus excluding the Comoros, Cape Verde, Djibouti, Equatorial Guinea, Eswatini, São Tomé and Príncipe and the Seychelles). Results are reported in Table 4.21. Results for both the main explanatory variable and the control variables are very close to the original regressions, meaning that the results were not driven by these specific countries.

As additional robustness tests, we also apply two other econometric estimators. First, we apply the Least Absolute Deviation (LAD) method, which is a specific type of quantile regression. The choice of this empirical strategy is motivated by the fact that, by reporting median rather than average effects, and by minimizing the absolute value of residuals rather than its square, LAD estimators are less sensitive to outliers than OLS ones. This is thus another way to ensure that results are not driven by outliers. Results are reported in Tables 4.19 and 4.20. Second, we apply the Fixed-Effects Filtered (FEF) method proposed by Pesaran and Zhou (2018). This econometric specification aims at solving the issue caused by the impossibility of traditional OLS with country fixed-effects to estimate the impact of time-invariant variables (in our case : Remoteness, CEMAC and UEMOA). FEF consists in estimating the impact of time-variant variables on explanatory variables using FE estimators, averaging the residuals by country, and finally estimating the impact of time-invariant variables on the time-averaged residuals using cross-sectional OLS. Since the coefficients for the time-varying variables are estimated through simple Fixed-Effets, we still require the variables of interest (both dependent and explanatory) to have significant variations across time (and not only across countries), which is the case when variables are expressed in value added per capita. Results are reported in Table 4.22. It is noticeable that none of these alternative specifications affect our results. Therefore, all results support the hypothesis of a negative impact of extractive resources on agriculture but a positive one on non-tradable sectors (construction and services). In addition, they also suggest that a large part of the variations across economic studies regarding the impact of natural resources on structural transformations might arise from the specification of the economic model (i.e. the definition of the variables used and the choice of controls included), rather than from the econometric methodology applied. This implies that future analyses should carefully choose and detail their variables depending on their specific question.

Finally, we intend to discuss if belonging to one of the CFA Franc areas has an impact on the emergence of a DD. In fact, CFA Franc membership is often included in empirical analyses, and both coefficients for the CEMAC and the UEMOA are significant here, but this does not tell us whether countries belonging to one of these areas are more or less affected by DD than other regions. This point matters since belonging to a common monetary (and trade) area with a fixed nominal exchange rate regime can contribute to mitigate DD effects, which essentially occur through a monetary channel. In addition, most of these countries are rich in natural resources (mostly hydrocarbons for the CEMAC and mining resources for the UEMOA). Tables 4.23 and 4.24 provide the core regression results but with the inclusion of an interaction term between natural resources and CFA membership [10]. Overall, we observe a positive absolute impact of natural resources on agriculture in CEMAC countries, relative to the rest of the continent, but without any other effect on manufacture, construction or services. This seems to support the results obtained in chapter 3 concluding to the absence of DD effects in most countries of the zone. On the opposite, in the western CFA Franc area there appears to be a negative impact of resources, compared with other African countries, on manufacture and construction (both in value added per capita and in shares), and to some extent on services (even if the coefficient is significantly negative only for variables expressed in per capita and without the inclusion of non-resource GDP per capita). However, this does not suggest the presence of a DD in this region (since construction is expected

10. These results are mainly provided for descriptive purposes because the limited level of data availability does not allow us to go much further in the discussion.

to be mainly a non-tradable sector), but more probably implies that this region is less affected by revenues from the resource sector that other regions in Africa. More importantly, these remarks suggest a divergence between the two zones, emphasizing the importance of considering them separately in empirical analyses.

4.6 Conclusion

This study assessed the impact of natural resources on structural transformations in African economies. Its results and contribution to the existing literature are twofold. First, while recognizing the huge heterogeneity across African countries, we find evidence that natural resources have a structural impact on the other sectors of the economy in most countries. This is consistent with the Dutch disease, but with “de-agriculturalization” rather than “de-industrialization” DD effects. Indeed, we do not find any evidence that natural resources impede industrialization in Africa. If any, there even seems to be a positive effect of natural resources on manufacturing industries, even if this effect comes mainly through the increase in income (thus does not contradict Dutch disease models) and is much lower than the positive impact of resources on the construction and service sectors. On the opposite, natural resources are associated with a decline in the agricultural sector, both in relative terms and in absolute terms when accounting for the increasing income effect. This finding is consistent with the Dutch disease if one considers agriculture rather than manufacture as the primary non-resource tradable sector, and construction and service sectors as the main non-tradable sectors. This conclusion therefore calls for further analyses of structural transformation dynamics at the sub-sectoral level. Indeed, it is likely that all types of agricultural products are not similarly impacted by extractive resources. This is particularly crucial in African countries where agricultural sectors are often characterized by a distinction between food crops destined to local consumption, and export crops oriented to international markets. This remark also holds for manufacturing activities, as evidenced by the difficulty in identifying precisely what activities should be included when measuring industrialization.

Second, these findings contribute to future investigations on the deep determinants of structural change in developing countries by highlighting the sensitivity of results to the definition and measurement of the variables used. This issue is especially crucial due to the renewed interest from researchers and policymakers in structural transformations dynamics, and particularly industrialization, and their role for sustained economic growth in developing countries, not only in Africa but also in Latin American or Southern and Eastern Asian countries. This highlights the importance of the discussion on the definitions and variables used when investigating structural transformations and/or the Dutch disease in developing countries, a discussion that is unfortunately often neglected in empirical analyses.

Appendix

Table 4.7 – Description of Variables

Variable	Unit	Mean	Std. Dev.	Min.	Max.	Definition	Source
Agriculture	2015 USD PC	220	106	38	571	"Agriculture, hunting, forestry, fishing" (ISIC A-B)	UNSD
	% NRGDP	23.75	15.23	1.45	75.28		
Manufacture	2015 USD PC	234	324	2	2460	"Manufacture" (ISIC D)	UNSD
	% NRGDP	13.26	6.86	1.14	35.93		
Construction	2015 USD PC	122	207	1	1911	"Construction" (ISIC F)	UNSD
	% NRGDP	5.81	3.68	0.61	22.12		
Service	2015 USD PC	1111	1512	79	11014	"Wholesale, retail trade, restaurants and hotels" + "Transport, storage and communication" + "Other activities" (ISIC G-P)	UNSD
	% NRGDP	57.18	13.16	18.68	90.96		
Resource	USD PC	413	1200	0	9358	"Mining and Utilities" (ISIC C and E)	UNSD
	% GDP	11.33	13.81	0.01	69.40		
NRGDPPC	USD PC	1582	2020	87	12705	GDP - "Mining and utilities" (ISIC C and E)	UNSD
Resource Rents	USD PC	266	940	0	7424	"Coal rents" + "Mineral rents" + "Natural gas rents" + "Oil rents"	WDI
	% GDP	6.15	11.75	0	61.22		
Education	Years	4.63	2.07	0.98	10.18	Years of education received by people aged 25 and older	UNESCO
WGI2	Index	-0.67	0.60	-1.82	0.94	Government Effectiveness	WGI
Disasters	Index	59	29	0	99	Population affected by natural disasters	FERDI
Remoteness	Index	56	23	0	99	Trade-weighted distance to reach 50% of world markets	FERDI
CEMAC	=1 for Cameroon, Central African Republic, Chad, the Republic of Congo, Equatorial Guinea, and Gabon						
UEMOA	=1 for Benin, Burkina Faso, Cote d'Ivoire, Guinea-Bissau, Mali, Niger, Senegal, and Togo						

Note : The values are estimated based on a sample of 250 observations (50 countries over five-year periods). The four countries excluded from the sample are Eritrea, Somalia, Sudan, and South Sudan. Due to missing values, data for the variable "education" have been reconstructed for 10 countries for the period 1995-1999 based on the first observations available and assuming linear trends. Due to missing values from the WDI, data for the variable "oil rents" have been reconstructed for Equatorial Guinea for the period 2000-2005 based on national statistics data.

Table 4.8 – Matrix of Correlation Between Variables in USD Per Capita

	Agriculture	Manufacture	Construction	Service	Resource	Education	WGI2	Disasters	Remoteness	NRGDPPC
Agriculture	1									
Manufacture	0.2616	1								
Construction	0.1930	0.6948	1							
Service	0.3016	0.7100	0.6450	1						
Resource	0.1165	0.5013	0.7544	0.4237	1					
Education	0.2333	0.5016	0.4179	0.6555	0.2949	1				
WGI2	0.1059	0.3218	0.1204	0.4203	-0.1301	0.3995	1			
Disasters	-0.3077	-0.2888	-0.3691	-0.2758	-0.3826	-0.1928	0.1269	1		
Remoteness	-0.4105	-0.0053	-0.2054	-0.0877	-0.2238	0.0546	0.0827	0.5470	1	
NRGDPPC	0.3161	0.8115	0.7430	0.9572	0.4961	0.6415	0.3886	-0.2868	-0.0912	1

Note : Agriculture, Manufacture, Construction and Service are expressed in Constant 2015 USD. Resource is expressed in Current USD.

Table 4.9 – Matrix of Correlation Between Variables in Shares

	Agriculture	Manufacture	Construction	Service	Resource	Education	WGI2	Disasters	Remoteness	NRGDPPC
Agriculture	1									
Manufacture	-0.3195	1								
Construction	-0.4173	-0.0955	1							
Service	-0.8802	-0.1041	0.2511	1						
Resource	-0.3844	0.0120	0.4377	0.3163	1					
Education	-0.6322	0.1422	0.2073	0.6022	0.3326	1				
WGI2	-0.4867	0.1538	0.1222	0.4518	-0.1635	0.3995	1			
Disasters	0.1417	-0.1089	-0.1154	-0.0772	-0.3424	-0.1928	0.1269			
Remoteness	0.0321	0.0756	-0.1122	-0.0436	-0.2193	0.0546	0.0827	0.5470	1	
NRGDPPC	-0.5864	0.1407	0.2204	0.5463	0.2436	0.6415	0.3886	-0.2868	-0.0912	1

Note : Agriculture, Manufacture, Construction and Service are expressed in % of non-resource GDP. Resource is expressed in % GDP.

Table 4.10 – Matrix of Correlation Between Extractive Resources Variables

	Resource VA (UNSD)	Resource Rents (WDI)	Oil Rents (WDI)	Mineral Rents (WDI)	Gas Rents (WDI)	Coal Rents (WDI)
Resource VA (UNSD)	1					
Resource Rents (WDI)	0.9086	1				
Oil Rents (WDI)	0.8821	0.9801	1			
Mineral Rents (WDI)	0.0732	0.0455	-0.1398	1		
Gas Rents (WDI)	0.3858	0.4167	0.3786	-0.1157	1	
Coal Rents (WDI)	0.0097	-0.0389	-0.0944	0.0426	0.0802	1

Note : All variables are expressed in % GDP.

Table 4.11 – Impact of Resource VA on Sectoral VA (in USD per capita)

Variables	Agriculture		Manufacture		Construction		Service	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Resource	-0.0000	-0.0756***	0.2449***	0.0754**	0.4484***	0.2504***	0.3091***	0.1153***
	(0.0209)	(0.0241)	(0.0341)	(0.0332)	(0.0401)	(0.0441)	(0.0232)	(0.0285)
Education	0.0332	-0.0165	0.1649***	0.0536*	0.0422	-0.0878***	0.1505***	0.0232
	(0.0214)	(0.0237)	(0.0282)	(0.0280)	(0.0352)	(0.0332)	(0.0245)	(0.0156)
WGI2	0.0859	-0.0453	0.6218***	0.3277***	0.7490***	0.4055***	0.5004***	0.1641***
	(0.0617)	(0.0703)	(0.0783)	(0.0819)	(0.1128)	(0.0840)	(0.0735)	(0.0358)
Disasters	-0.0026*	-0.0022	-0.0075***	-0.0067***	0.0002	0.0011	-0.0020	-0.0011
	(0.0015)	(0.0016)	(0.0016)	(0.0016)	(0.0022)	(0.0018)	(0.0016)	(0.0010)
Remoteness	-0.0083***	-0.0069***	0.0029	0.0059**	-0.0074***	-0.0039*	-0.0038**	-0.0004
	(0.0017)	(0.0016)	(0.0027)	(0.0024)	(0.0025)	(0.0020)	(0.0018)	(0.0010)
CEMAC	-0.0147	-0.0256	0.4032***	0.3786***	0.2515	0.2228	-0.0335	-0.0616
	(0.0869)	(0.0829)	(0.1175)	(0.1033)	(0.1844)	(0.1605)	(0.0955)	(0.0753)
UEMOA	-0.0350	-0.1086	0.5509***	0.3860***	-0.2955*	-0.4882***	0.0202	-0.1684***
	(0.0813)	(0.0772)	(0.1100)	(0.0988)	(0.1551)	(0.1298)	(0.0788)	(0.0499)
NRGDPPC		0.2957***		0.6627***		0.7740***		0.7578***
		(0.0668)		(0.0883)		(0.0887)		(0.0581)
Constant	5.7883***	4.1482***	3.5966***	-0.0788	2.7527***	-1.5405***	5.0620***	0.8589***
	(0.1384)	(0.4139)	(0.2412)	(0.5812)	(0.2541)	(0.5044)	(0.1523)	(0.3104)
R2	0.24	0.32	0.67	0.76	0.70	0.78	0.79	0.91
N	250	250	250	250	250	250	250	250

Note : The outcomes are agriculture, manufacture, construction and service value added per capita in constant 2015 USD (UNSD) (in logarithm). Resource is resource value added per capita in current USD (UNSD) (in logarithm). Standard errors are in parentheses : *Significant at 10% **Significant at 5% ***Significant at 1%

Table 4.12 – Impact of Resource VA on Sectoral VA (in Shares)

Variables	Agriculture		Manufacture		Construction		Service	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Resource	-0.3275***	-0.2708***	-0.0303	-0.0359	0.1267***	0.1204***	0.2312***	0.1863***
	(0.0502)	(0.0437)	(0.0329)	(0.0333)	(0.0224)	(0.0211)	(0.0463)	(0.0454)
Education	-2.9407***	-0.6022	0.4992**	0.2693	-0.1719	-0.4302**	2.6134***	0.7630
	(0.3508)	(0.4202)	(0.2279)	(0.3833)	(0.1222)	(0.1740)	(0.3493)	(0.4992)
WGI2	-10.3627***	-6.2601***	1.9061**	1.5029	1.3732***	0.9201**	7.0833***	3.8372***
	(1.4672)	(1.2747)	(0.7635)	(1.0268)	(0.3592)	(0.4243)	(1.3497)	(1.4058)
Disasters	-0.0126	-0.0247	-0.0347**	-0.0335*	0.0042	0.0056	0.0431	0.0526
	(0.0339)	(0.0305)	(0.0176)	(0.0180)	(0.0075)	(0.0073)	(0.0368)	(0.0332)
Remoteness	0.0172	-0.0580**	0.0437*	0.0511*	-0.0088	-0.0005	-0.0521	0.0074
	(0.0347)	(0.0293)	(0.0235)	(0.0292)	(0.0105)	(0.0115)	(0.0359)	(0.0342)
CEMAC	-4.1639**	-1.8096	4.4213***	4.1899***	-0.1141	-0.3741	-0.1434	-2.0062
	(1.7159)	(1.7161)	(1.2034)	(1.1837)	(0.7507)	(0.7370)	(1.6014)	(1.6820)
UEMOA	-2.4247	-0.4851	4.4473***	4.2566***	-1.5338***	-1.7481***	-0.4888	-2.0234
	(1.6816)	(1.5439)	(0.9129)	(0.9791)	(0.4752)	(0.4861)	(1.4606)	(1.3857)
NRGDPPC		-7.8569***		0.7722		0.8679**		6.2168***
		(0.8485)		(1.0819)		(0.3645)		(1.2977)
Constant	34.7591***	83.8258***	10.9577***	6.1352	6.5944***	1.1745	47.6888***	8.8645
	(2.6667)	(5.7777)	(2.0220)	(7.5258)	(0.9162)	(2.4238)	(2.3313)	(8.5457)
R2	0.56	0.66	0.14	0.14	0.25	0.27	0.47	0.55
N	250	250	250	250	250	250	250	250

Note : The outcomes are agriculture, manufacture, construction and service value added in % of non-resource GDP (UNSD). Resource is resource value added in % of total GDP (UNSD). Standard errors are in parentheses : *Significant at 10% **Significant at 5% ***Significant at 1%

Table 4.13 – Impact of Resource Rents on Sectoral VA (in USD per capita)

Variables	Agriculture		Manufacture		Construction		Service	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Resource	0.0157	-0.0026	0.1055***	0.0472***	0.1739***	0.0933***	0.0906***	0.0177
	(0.0165)	(0.0182)	(0.0224)	(0.0159)	(0.0347)	(0.0263)	(0.0240)	(0.0158)
Education	0.0231	-0.0342	0.2419***	0.0597**	0.1943***	-0.0581	0.2737***	0.0455***
	(0.0205)	(0.0235)	(0.0272)	(0.0278)	(0.0378)	(0.0354)	(0.0283)	(0.0157)
WGI2	0.0985	-0.0192	0.7039***	0.3301***	0.9216***	0.4038***	0.6076***	0.1393***
	(0.0688)	(0.0820)	(0.0811)	(0.0774)	(0.1310)	(0.0969)	(0.0902)	(0.0415)
Disasters	-0.0026*	-0.0022	-0.0075***	-0.0064***	-0.0003	0.0011	-0.0025	-0.0012
	(0.0015)	(0.0017)	(0.0016)	(0.0016)	(0.0026)	(0.0018)	(0.0019)	(0.0010)
Remoteness	-0.0076***	-0.0061***	0.0012	0.0061**	-0.0109***	-0.0041*	-0.0072***	-0.0011
	(0.0020)	(0.0019)	(0.0027)	(0.0024)	(0.0033)	(0.0023)	(0.0024)	(0.0011)
CEMAC	-0.0491	-0.0928	0.4865***	0.3479***	0.4699**	0.2778	0.1886	0.0149
	(0.0856)	(0.0810)	(0.1277)	(0.1055)	(0.2248)	(0.1723)	(0.1229)	(0.0833)
UEMOA	-0.0415	-0.0849	0.4797***	0.3420***	-0.3961***	-0.5870***	-0.0308	-0.2034***
	(0.0825)	(0.0811)	(0.1068)	(0.0961)	(0.1501)	(0.1275)	(0.0859)	(0.0528)
NRGDPPC		0.2177***		0.6913***		0.9577***		0.8661***
		(0.0665)		(0.0723)		(0.0775)		(0.0472)
Constant	5.7750***	4.4302***	4.1595***	-0.1115	3.8217***	-2.0951***	5.8309***	0.4800
	(0.1326)	(0.4324)	(0.2165)	(0.5269)	(0.2740)	(0.5041)	(0.1534)	(0.2947)
R2	0.24	0.30	0.63	0.77	0.60	0.76	0.69	0.90
N	248	248	248	248	248	248	248	248

Note : The outcomes are agriculture, manufacture, construction and service value added per capita in constant 2015 USD (UNSD) (in logarithm). Resource is resource rents per capita in current USD (WDI) (in logarithm). Standard errors are in parentheses : *Significant at 10% **Significant at 5% ***Significant at 1%

Table 4.14 – Impact of Resource Rents on Sectoral VA (in Shares)

Variables	Agriculture		Manufacture		Construction		Service	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Resource	-0.4323***	-0.3109***	0.0010	-0.0108	0.1536***	0.1426***	0.2778***	0.1791***
	(0.0563)	(0.0538)	(0.0382)	(0.0378)	(0.0315)	(0.0305)	(0.0585)	(0.0614)
Education	-2.9722***	-0.8442**	0.4181*	0.2114	-0.1337	-0.3263*	2.6879***	0.9591**
	(0.3401)	(0.4279)	(0.2252)	(0.3848)	(0.1258)	(0.1764)	(0.3267)	(0.4843)
WGI2	-11.4208***	-7.0422***	2.0623***	1.6372	1.6980***	1.3018***	7.6604***	4.1032***
	(1.5045)	(1.3917)	(0.7831)	(1.0643)	(0.3587)	(0.4458)	(1.3662)	(1.4928)
Disasters	-0.0169	-0.0264	-0.0340*	-0.0331*	0.0055	0.0064	0.0454	0.0531
	(0.0343)	(0.0313)	(0.0174)	(0.0178)	(0.0077)	(0.0075)	(0.0368)	(0.0332)
Remoteness	-0.0072	-0.0673**	0.0473*	0.0531*	-0.0013	0.0041	-0.0388	0.0101
	(0.0359)	(0.0305)	(0.0245)	(0.0294)	(0.0116)	(0.0125)	(0.0370)	(0.0352)
CEMAC	-3.5181**	-1.9585	4.0185***	3.8670***	-0.2102	-0.3513	-0.2902	-1.5572
	(1.6442)	(1.6272)	(1.2211)	(1.2190)	(0.7630)	(0.7544)	(1.5762)	(1.6597)
UEMOA	-2.3529	-0.4745	4.4945***	4.3121***	-1.5751***	-1.7451***	-0.5665	-2.0926
	(1.6705)	(1.5544)	(0.9070)	(0.9782)	(0.4607)	(0.4772)	(1.4890)	(1.4241)
NRGDPPC		-7.4548***		0.7239		0.6746*		6.0564***
		(0.9060)		(1.0859)		(0.3782)		(1.3276)
Constant	34.6614***	81.1597***	10.8885***	6.3735	6.6522***	2.4445	47.7979***	10.0223
	(2.7444)	(6.0296)	(2.0418)	(7.5684)	(0.9456)	(2.5097)	(2.3841)	(8.6997)
R2	0.56	0.65	0.14	0.14	0.24	0.25	0.47	0.54
N	250	250	250	250	250	250	250	250

Note : The outcomes are agriculture, manufacture, construction and service value added in % of non-resource GDP (UNSD). Resource is resource rents in % of total GDP (WDI). Standard errors are in parentheses : *Significant at 10% **Significant at 5% ***Significant at 1%

Table 4.15 – Impact of Oil and Mineral Rents on Sectoral VA (in USD per capita)

Variables	Agriculture		Manufacture		Construction		Service	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Oil	0.0278	0.0107	0.1116***	0.0549***	0.2414***	0.1648***	0.1268***	0.0575***
	(0.0168)	(0.0184)	(0.0259)	(0.0209)	(0.0394)	(0.0312)	(0.0254)	(0.0200)
Mineral	-0.0030	-0.0078	0.0309	0.0150	0.0076	-0.0139	-0.0390	-0.0585***
	(0.0226)	(0.0220)	(0.0302)	(0.0219)	(0.0373)	(0.0263)	(0.0278)	(0.0118)
Education	0.0215	-0.0364	0.2514***	0.0594**	0.1953***	-0.0644**	0.2845***	0.0497***
	(0.0199)	(0.0234)	(0.0278)	(0.0278)	(0.0367)	(0.0323)	0.0274)	(0.0148)
WGI2	0.1118	-0.0030	0.7188***	0.3379***	1.0041***	0.4890***	0.6570***	0.1913***
	(0.0688)	(0.0812)	(0.0806)	(0.0807)	(0.1283)	(0.0979)	(0.0859)	(0.0427)
Disasters	-0.0023	-0.0021	-0.0069***	-0.0062***	0.0013	0.0024	-0.0014	-0.0004
	(0.0016)	(0.0017)	(0.0017)	(0.0016)	(0.0026)	(0.0018)	(0.0018)	(0.0010)
Remoteness	-0.0069***	-0.0056***	0.0025	0.0070***	-0.0061*	-0.0000	-0.0050*	0.0005
	(0.0022)	(0.0021)	(0.0030)	(0.0025)	(0.0035)	(0.0023)	(0.0027)	(0.0012)
CEMAC	-0.0968	-0.1318	0.4163***	0.3003***	0.1590	0.0022	-0.0052	-0.1470
	(0.0886)	(0.0842)	(0.1263)	(0.1088)	(0.2286)	(0.1888)	(0.1177)	(0.0907)
UEMOA	-0.0292	-0.0779	0.5202***	0.3588***	-0.2948**	-0.5132***	0.0461	-0.1513***
	(0.0822)	(0.0826)	(0.1117)	(0.0994)	(0.1485)	(0.1219)	(0.0895)	(0.0500)
NRGDPPC		0.2104***		0.6981***		0.9440***		0.8535***
		(0.0644)		(0.0734)		(0.0690)		(0.0425)
Constant	5.7432***	4.4544***	4.0768***	-0.1991	3.5840***	-2.1981***	5.6982***	0.4705*
	(0.1308)	(0.4143)	(0.2375)	(0.5318)	(0.2754)	(0.4601)	(0.1623)	(0.2582)
R2	0.24	0.30	0.63	0.77	0.62	0.78	0.70	0.92
N	248	248	248	248	248	248	248	248

Note : The outcomes are agriculture, manufacture, construction and service value added per capita in constant 2015 USD (UNSD) (in logarithm). Oil and mineral are oil rents and mineral rents per capita in current USD (WDI) (in logarithm). Standard errors are in parentheses : *Significant at 10% **Significant at 5% ***Significant at 1%

Table 4.16 – Impact of Oil and Mineral Rents on Sectoral VA (in Shares)

Variables	Agriculture		Manufacture		Construction		Service	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Oil	-0.4379***	-0.3172***	-0.0125	-0.0248	0.1530***	0.1418***	0.2974***	0.2002***
	(0.0556)	(0.0529)	(0.0385)	(0.0386)	(0.0325)	(0.0314)	(0.0562)	(0.0591)
Mineral	-0.2484	-0.1539	0.1105	0.1009	0.1908*	0.1820*	-0.0529	-0.1290
	(0.3114)	(0.2858)	(0.1263)	(0.1334)	(0.1045)	(0.1054)	(0.2738)	(0.2434)
Education	-3.0492***	-0.8874**	0.4284*	0.2088	-0.1135	-0.3147*	2.7343***	0.9932**
	(0.3469)	(0.4343)	(0.2226)	(0.3795)	(0.1252)	(0.1778)	(0.3320)	(0.4863)
WGI2	-11.2573***	-6.9051***	2.0560***	1.6139	1.6890***	1.2841***	7.5123***	4.0071***
	(1.5207)	(1.3962)	(0.7736)	(1.0786)	(0.3629)	(0.4549)	(1.3800)	(1.5177)
Disasters	-0.0183	-0.0278	-0.0354**	-0.0345*	0.0051	0.0059	0.0487	0.0563*
	(0.0358)	(0.0325)	(0.0178)	(0.0183)	(0.0079)	(0.0077)	(0.0376)	(0.0338)
Remoteness	-0.0046	-0.0660**	0.0462*	0.0524*	-0.0019	0.0038	-0.0396	0.0098
	(0.0358)	(0.0307)	(0.0244)	(0.0293)	(0.0119)	(0.0129)	(0.0368)	(0.0351)
CEMAC	-3.2453**	-1.6924	4.3068***	4.1491***	-0.1629	-0.3074	-0.8987	-2.1493
	(1.6337)	(1.5790)	(1.2372)	(1.2356)	(0.7903)	(0.7766)	(1.5525)	(1.6672)
UEMOA	-2.3947	-0.5046	4.4540***	4.2620***	-1.5860***	-1.7619***	-0.4732	-1.9955
	(1.6939)	(1.5693)	(0.9147)	(0.9845)	(0.4604)	(0.4771)	(1.5074)	(1.4311)
NRGDPPC		-7.4898***		0.7608		0.6968*		6.0323***
		(0.9069)		(1.0907)		(0.3900)		(1.3230)
Constant	34.7555***	81.4524***	10.9201***	6.1768	6.6312***	2.2868	47.6932***	10.0839
	(2.7841)	(6.0290)	(2.0516)	(7.6074)	(0.9359)	(2.5837)	(2.4457)	(8.6776)
R2	0.56	0.65	0.14	0.14	0.24	0.25	0.47	0.55
N	250	250	250	250	250	250	250	250

Note : The outcomes are agriculture, manufacture, construction and service value added in % of non-resource GDP (UNSD). Oil and mineral are oil rents and mineral rents in % of total GDP (WDI). Standard errors are in parentheses : *Significant at 10% **Significant at 5% ***Significant at 1%

Table 4.17 – Impact of Resource Rents on Sectoral VA for Each Time Period

	Agriculture									
	Variables in USD per capita					Variables in Shares				
	1995-99	2000-04	2005-09	2010-14	2015-19	1995-99	2000-04	2005-09	2010-14	2015-19
Resource	0.0145	-0.0135	0.0051	0.0106	-0.0419	-0.2498**	-0.3682***	-0.3476***	-0.3483**	-0.4814**
	(0.0567)	(0.0549)	(0.0517)	(0.0461)	(0.0608)	(0.1193)	(0.1143)	(0.1181)	(0.1349)	(0.1925)
Education	0.0312	0.0397	0.0181	0.0160	0.0491	-2.3726*	-1.7655*	-2.3622**	-3.5974***	-3.6432***
	(0.0709)	(0.0580)	(0.0538)	(0.0423)	(0.0488)	(1.2528)	(1.0383)	(1.1065)	(0.9674)	(0.8452)
WGI2	0.0870	0.0575	0.0953	0.1112	0.1747	-13.5751***	-14.0046***	-10.1887***	-8.2395**	-7.6558***
	(0.1319)	(0.1468)	(0.1561)	(0.1422)	(0.1365)	(4.1314)	(4.2160)	(3.6772)	(3.0587)	(2.6626)
Disasters	-0.0052	-0.0043	-0.0019	-0.0017	-0.0006	-0.0097	0.0484	0.0638	-0.0394	-0.0736
	(0.0031)	(0.0044)	(0.0038)	(0.0040)	(0.0034)	(0.0742)	(0.0974)	(0.0847)	(0.0975)	(0.0931)
Remoteness	-0.0045	-0.0059	-0.0086*	-0.0103**	-0.0124***	0.0544	-0.0422	-0.0674	0.0275	0.0456
	(0.0032)	(0.0044)	(0.0044)	(0.0048)	(0.0039)	(0.0822)	(0.1012)	(0.1034)	(0.0915)	(0.0818)
CEMAC	-0.0526	-0.0454	-0.0032	-0.0495	0.1068	-5.3907	-1.5963	-0.4546	-4.1197	-6.0308
	(0.1608)	(0.1972)	(0.2298)	(0.2073)	(0.2340)	(3.2216)	(3.4807)	(4.2464)	(4.9065)	(4.6235)
UEMOA	-0.0887	-0.1618	-0.1155	-0.0311	0.1629	-0.9812	-2.0121	-2.0483	-3.6730	-2.7151
	(0.1997)	(0.1933)	(0.1902)	(0.1766)	(0.1866)	(3.3846)	(2.8755)	(4.2493)	(4.9540)	(4.4512)
Constant	5.6695***	5.7633***	5.8262***	5.9211***	6.0444***	27.9185***	27.4781***	32.0586***	41.1233***	44.1397***
	(0.2496)	(0.3069)	(0.3201)	(0.3162)	(0.3868)	(6.2535)	(5.9239)	(7.2723)	(8.6458)	(9.1483)
R2	0.25	0.22	0.24	0.26	0.28	0.60	0.61	0.55	0.54	0.55
N	50	50	50	50	50	50	50	50	50	50

	Manufacture									
	Variables in USD per capita					Variables in Shares				
	1995-99	2000-04	2005-09	2010-14	2015-19	1995-99	2000-04	2005-09	2010-14	2015-19
Resource	0.2505**	0.1842**	0.2655***	0.2436***	0.2389***	-0.0925	-0.0609	-0.0126	-0.0742	-0.0146
	(0.1042)	(0.0893)	(0.0677)	(0.0741)	(0.0819)	(0.0800)	(0.0729)	(0.0751)	(0.0758)	(0.1191)
Education	0.1193	0.1803***	0.1728**	0.2046***	0.2173***	1.2426*	0.7864	0.7700	0.6127	0.5189
	(0.0950)	(0.0656)	(0.0656)	(0.0694)	(0.0736)	(0.6235)	(0.5272)	(0.5704)	(0.4851)	(0.5292)
WGI2	0.8182***	0.7499***	0.5406***	0.5251***	0.4688***	3.2501**	3.0675*	0.9944	-0.1951	-0.5102
	(0.2326)	(0.1788)	(0.1903)	(0.1647)	(0.1400)	(1.6089)	(1.7366)	(1.9229)	(1.5816)	(1.7163)
Disasters	-0.0112***	-0.0130***	-0.0093**	-0.0045	-0.0014	-0.0067	-0.0433	-0.0480	-0.0559	-0.0301
	(0.0033)	(0.0043)	(0.0039)	(0.0036)	(0.0045)	(0.0371)	(0.0443)	(0.0452)	(0.0434)	(0.0426)
Remoteness	0.0029	0.0060	0.0052	0.0016	-0.0015	-0.0148	0.0434	0.0589	0.0594	0.0691
	(0.0064)	(0.0064)	(0.0068)	(0.0065)	(0.0062)	(0.0460)	(0.0579)	(0.0647)	(0.0568)	(0.0571)
CEMAC	0.1271	0.1650	0.2907	0.6725**	0.6791**	3.4342	2.7189	3.3094	6.2419*	5.6528*
	(0.2787)	(0.2510)	(0.2641)	(0.3208)	(0.2958)	(2.2729)	(2.2177)	(2.7225)	(3.0934)	(2.9506)
UEMOA	0.4295	0.5413**	0.5986**	0.6298**	0.6341**	6.4353***	5.6773***	4.6053**	3.7385*	3.5829*
	(0.2650)	(0.2401)	(0.2640)	(0.2677)	(0.2361)	(1.9195)	(2.0477)	(2.1616)	(2.0838)	(1.9292)
Constant	4.1685***	4.0575***	3.3823***	3.1142***	3.0439***	11.6695***	11.9989***	9.2994*	9.1277*	6.2915
	(0.5380)	(0.6109)	(0.6233)	(0.6052)	(0.6352)	(3.9566)	(3.9671)	(5.1918)	(4.9906)	(5.6030)
R2	0.69	0.68	0.68	0.68	0.68	0.30	0.21	0.14	0.19	0.17
N	50	50	50	50	50	50	50	50	50	50

Note : Standard errors are in parentheses : *Significant at 10% **Significant at 5% ***Significant at 1%

Table 4.18 – Impact of Resource Rents on Sectoral VA for Each Time Period (Continued)

Construction	Variables in USD per capita					Variables in Shares				
	1995-99	2000-04	2005-09	2010-14	2015-19	1995-99	2000-04	2005-09	2010-14	2015-19
Resource	0.5039***	0.4723***	0.4431***	0.4291***	0.4155***	0.1106***	0.1157***	0.1147**	0.2126***	0.2028**
	(0.1010)	(0.1017)	(0.0902)	(0.0932)	(0.0975)	(0.0304)	(0.0253)	(0.0476)	(0.0584)	(0.0824)
Education	-0.0578	-0.0084	-0.0151	0.0573	0.0387	-0.5098	-0.5739*	-0.3198	-0.3159	-0.5382
	(0.0951)	(0.0951)	(0.1005)	(0.0895)	(0.0891)	(0.3534)	(0.2917)	(0.3080)	(0.2557)	(0.4320)
WGI2	0.7933**	0.6488**	0.8990***	0.8552***	0.8718***	1.5129*	1.8720**	1.5771*	2.5666***	2.5176***
	(0.3080)	(0.3104)	(0.2884)	(0.2385)	(0.2323)	(0.8711)	(0.6944)	(0.8511)	(0.8296)	(0.8470)
Disasters	0.0013	-0.0026	-0.0020	-0.0000	0.0001	-0.0030	-0.0161	-0.0063	0.0055	0.0074
	(0.0049)	(0.0068)	(0.0058)	(0.0054)	(0.0048)	(0.0149)	(0.0171)	(0.0193)	(0.0189)	(0.0168)
Remoteness	-0.0064	-0.0052	-0.0044	-0.0063	-0.0095*	0.0003	0.0055	0.0045	0.0067	-0.0212
	(0.0063)	(0.0062)	(0.0062)	(0.0059)	(0.0052)	(0.0302)	(0.0211)	(0.0243)	(0.0237)	(0.0254)
CEMAC	0.1076	-0.0952	0.4453	0.6571	0.2386	-2.0243	-1.5116	0.3615	2.7492	-0.8713
	(0.5044)	(0.4447)	(0.4054)	(0.4077)	(0.3474)	(1.2355)	(1.1053)	(1.7620)	(2.2501)	(1.8094)
UEMOA	-0.5447	-0.2867	-0.3562	-0.2725	-0.3254	-2.3414**	-1.6886	-1.3828	-1.0073	-3.2286**
	(0.4165)	(0.3849)	(0.3383)	(0.3404)	(0.3488)	(1.1315)	(1.1099)	(1.2048)	(1.0763)	(1.5843)
Constant	2.7287***	2.8718***	3.1028***	2.7627***	3.2871***	7.5754***	8.6710***	7.4569***	6.3533***	10.2729***
	(0.6044)	(0.7054)	(0.7228)	(0.5136)	(0.6521)	(1.8862)	(1.7749)	(2.3701)	(1.8944)	(3.2460)
R2	0.66	0.69	0.70	0.75	0.73	0.24	0.35	0.28	0.50	0.26
N	50	50	50	50	50	50	50	50	50	50

Service	Variables in USD per capita					Variables in Shares				
	1995-99	2000-04	2005-09	2010-14	2015-19	1995-99	2000-04	2005-09	2010-14	2015-19
Resource	0.3061***	0.3278***	0.3349***	0.3126***	0.3066***	0.2316**	0.3133***	0.2455**	0.2100	0.2933*
	(0.0583)	(0.0615)	(0.0498)	(0.0566)	(0.0633)	(0.1042)	(0.0964)	(0.1099)	(0.1354)	(0.1680)
Education	0.1262*	0.1222*	0.1150*	0.1872***	0.1882***	1.6399	1.5530	1.9119*	3.3006***	3.6626***
	(0.0659)	(0.0626)	(0.0640)	(0.0592)	(0.0578)	(1.2167)	(1.1230)	(0.9556)	(0.8102)	(0.7717)
WGI2	0.4641***	0.4704***	0.5597***	0.5057**	0.4985**	8.8121**	9.0651**	7.6172**	5.8680*	5.6485*
	(0.1528)	(0.1559)	(0.1792)	(0.1887)	(0.1952)	(3.3758)	(3.4668)	(3.1167)	(2.9193)	(3.0744)
Disasters	-0.0019	-0.0043	-0.0044	0.0002	0.0007	0.0193	0.0110	-0.0094	0.0898	0.0963
	(0.0035)	(0.0042)	(0.0039)	(0.0048)	(0.0041)	(0.0833)	(0.1044)	(0.0920)	(0.1031)	(0.0927)
Remoteness	-0.0043	-0.0007	-0.0005	-0.0058	-0.0068	-0.0398	-0.0067	0.0039	-0.0936	-0.0934
	(0.0038)	(0.0045)	(0.0048)	(0.0051)	(0.0041)	(0.0801)	(0.0995)	(0.0955)	(0.0963)	(0.0909)
CEMAC	0.0244	-0.2273	-0.1614	0.0292	0.1051	3.9809	0.3889	-3.2163	-4.8713	1.2493
	(0.2054)	(0.1791)	(0.1902)	(0.2469)	(0.2531)	(3.1930)	(2.5249)	(3.9112)	(4.9188)	(4.2351)
UEMOA	-0.1320	-0.0239	0.0068	0.1583	0.1479	-3.1127	-1.9765	-1.1743	0.9418	2.3609
	(0.2079)	(0.1803)	(0.1719)	(0.1928)	(0.1832)	(3.2043)	(2.8433)	(3.3129)	(4.1209)	(3.8674)
Constant	5.2214***	5.1096***	5.0704***	4.7519***	4.8874***	52.8366***	51.8520***	51.1851***	43.3957***	39.2960***
	(0.3518)	(0.3890)	(0.3918)	(0.3930)	(0.3833)	(5.4681)	(5.7210)	(5.7657)	(7.4975)	(7.6665)
R2	0.79	0.80	0.79	0.78	0.78	0.46	0.52	0.47	0.47	0.49
N	50	50	50	50	50	50	50	50	50	50

Note : Standard errors are in parentheses : *Significant at 10% **Significant at 5% ***Significant at 1%

Table 4.19 – Impact of Resource VA on Sectoral VA (in USD per capita) using Least Absolute Deviation

Variables	Agriculture		Manufacture		Construction		Service	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Resource	0.0046	-0.0566*	0.1981***	0.0721**	0.3866***	0.2347***	0.2671***	0.0820***
	(0.0302)	(0.0302)	(0.0359)	(0.0343)	(0.0290)	(0.0497)	(0.0245)	(0.0189)
Education	0.0464*	-0.0318	0.1820***	0.0714**	0.0754**	-0.0678	0.1817***	0.0348**
	(0.0262)	(0.0249)	(0.0383)	(0.0317)	(0.0341)	(0.0451)	(0.0239)	(0.0163)
WGI2	0.0838	-0.2402***	0.6318***	0.3173***	0.5129***	0.2901**	0.4814***	0.1210***
	(0.0763)	(0.0716)	(0.0958)	(0.0819)	(0.0791)	(0.1149)	(0.0651)	(0.0345)
Disasters	-0.0019	-0.0009	-0.0064***	-0.0069***	-0.0034	-0.0009	-0.0025*	-0.0020***
	(0.0015)	(0.0012)	(0.0021)	(0.0018)	(0.0023)	(0.0025)	(0.0013)	(0.0006)
Remoteness	-0.0086***	-0.0059***	-0.0051*	0.0030	-0.0038	-0.0024	-0.0073***	0.0005
	(0.0014)	(0.0013)	(0.0027)	(0.0028)	(0.0024)	(0.0027)	(0.0017)	(0.0010)
CEMAC	-0.0760	-0.2365**	0.3877***	0.3796***	-0.1285	-0.0083	0.0383	-0.1308
	(0.1506)	(0.1135)	(0.1317)	(0.1157)	(0.1049)	(0.1766)	(0.0887)	(0.1075)
UEMOA	-0.1021	-0.1968***	0.5458***	0.2647**	-0.6681***	-0.6712***	0.2138**	-0.1832***
	(0.0714)	(0.0642)	(0.1524)	(0.1109)	(0.1162)	(0.1804)	(0.0892)	(0.0592)
NRGDPPC		0.3714***		0.5821***		0.7414***		0.8222***
		(0.0741)		(0.0636)		(0.1045)		(0.0305)
Constant	5.7097***	3.4498***	4.0746***	0.6158	2.8056***	-1.2987**	5.2061***	0.4437**
	(0.1357)	(0.4557)	(0.2517)	(0.4114)	(0.2137)	(0.6546)	(0.1630)	(0.1850)
R2	0.19	0.24	0.47	0.54	0.50	0.55	0.60	0.75
N	250	250	250	250	250	250	250	250

Note : The outcomes are agriculture, manufacture, construction and service value added per capita in constant 2015 USD (UNSD) (in logarithm). Resource is resource value added per capita in current USD (UNSD) (in logarithm). The coefficients represent the median impact of the explanatory variables estimated through least absolute deviation (quantile regression). Standard errors are in parentheses : *Significant at 10% **Significant at 5% ***Significant at 1%

Table 4.20 – Impact of Resource VA on Sectoral VA (in Shares) using Least Absolute Deviation

Variables	Agriculture		Manufacture		Construction		Service	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Resource	-0.2639***	-0.1922***	-0.0325**	-0.0266	0.1015***	0.1073***	0.2448***	0.1896***
	(0.0468)	(0.0400)	(0.0142)	(0.0201)	(0.0263)	(0.0269)	(0.0523)	(0.0368)
Education	-2.8711***	-0.9780**	0.3789**	0.5102*	-0.1902*	-0.3839**	3.0820***	0.7495*
	(0.3761)	(0.3987)	(0.1891)	(0.2826)	(0.1107)	(0.1501)	(0.3641)	(0.4417)
WGI2	-9.8907***	-5.2220***	3.2937***	3.5789***	1.6727***	1.3800***	6.7369***	3.0328***
	(1.1504)	(0.9546)	(0.6465)	(0.8223)	(0.3247)	(0.3843)	(1.0908)	(1.1372)
Disasters	-0.0100	0.0110	-0.0234	-0.0291	0.0010	0.0005	0.0503**	0.0254
	(0.0269)	(0.0177)	(0.0187)	(0.0185)	(0.0070)	(0.0078)	(0.0227)	(0.0230)
Remoteness	0.0426	-0.0037	0.0266	0.0052	-0.0022	-0.0002	-0.0467*	0.0441*
	(0.0268)	(0.0195)	(0.0248)	(0.0256)	(0.0098)	(0.0110)	(0.0282)	(0.0248)
CEMAC	-5.3617***	-2.7784	4.5547***	3.7839***	0.5874	0.4447	1.6281	-1.5857
	(1.8126)	(2.3220)	(0.9095)	(0.9918)	(0.9096)	(0.9007)	(2.1759)	(2.6571)
UEMOA	-1.6902	0.2951	5.1034***	3.9821***	-1.5910***	-1.7571***	1.5576	-2.7761
	(1.7766)	(1.3297)	(0.8911)	(1.2568)	(0.4788)	(0.4804)	(1.7103)	(1.7703)
NRGDPPC		-6.2750***		-1.0514***		0.4564		5.9863***
		(0.8502)		(0.3349)		(0.2977)		(0.9811)
Constant	31.8564***	69.0371***	11.5688***	20.1267***	6.2582***	3.8672*	43.7123***	10.1460
	(2.7441)	(5.6424)	(2.4804)	(3.3849)	(0.8635)	(2.0482)	(2.7685)	(6.7162)
R2	0.42	0.49	0.10	0.11	0.14	0.14	0.35	0.41
N	250	250	250	250	250	250	250	250

Note : The outcomes are agriculture, manufacture, construction and service value added in % of non-resource GDP (UNSD). Resource is resource value added in % of total GDP (UNSD). The coefficients represent the median impact of the explanatory variables estimated through least absolute deviation (quantile regression). Standard errors are in parentheses : *Significant at 10% **Significant at 5% ***Significant at 1%

Table 4.21 – Impact of Resource VA on Sectoral VA (in USD per capita) Excluding Small Countries

Variables	Agriculture		Manufacture		Construction		Service	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Resource	0.0081	-0.0684***	0.1892***	0.0976***	0.4093***	0.2482***	0.2949***	0.1588***
	(0.0225)	(0.0243)	(0.0302)	(0.0371)	(0.0413)	(0.0528)	(0.0236)	(0.0329)
Education	0.0159	-0.0361	0.1689***	0.1066***	0.0546	-0.0549	0.1362***	0.0436**
	(0.0217)	(0.0244)	(0.0263)	(0.0270)	(0.0350)	(0.0406)	(0.0192)	(0.0169)
WGI2	0.1214**	-0.0630	0.7608***	0.5399***	0.7876***	0.3990***	0.5824***	0.2541***
	(0.0582)	(0.0715)	(0.0787)	(0.0853)	(0.1223)	(0.1065)	(0.0690)	(0.0452)
Disasters	-0.0011	-0.0002	-0.0079***	-0.0069***	0.0003	0.0021	-0.0036***	-0.0020**
	(0.0014)	(0.0013)	(0.0017)	(0.0017)	(0.0024)	(0.0021)	(0.0013)	(0.0009)
Remoteness	-0.0117***	-0.0095***	-0.0027	-0.0001	-0.0095***	-0.0048**	-0.0049***	-0.0009
	(0.0016)	(0.0015)	(0.0021)	(0.0021)	(0.0025)	(0.0023)	(0.0014)	(0.0010)
CEMAC	0.0422	-0.0103	0.4314***	0.3685***	0.2860	0.1753	0.0685	-0.0250
	(0.0851)	(0.0826)	(0.1043)	(0.0963)	(0.1834)	(0.1632)	(0.0842)	(0.0652)
UEMOA	-0.0605	-0.1755**	0.5760***	0.4382***	-0.1607	-0.4031***	0.1572**	-0.0476
	(0.0812)	(0.0771)	(0.1041)	(0.1014)	(0.1561)	(0.1426)	(0.0676)	(0.0496)
NRGDPPC		0.3349***		0.4013***		0.7061***		0.5966***
		(0.0710)		(0.0899)		(0.1446)		(0.0786)
Constant	5.9437***	3.9865***	4.1350***	1.7899***	2.8271***	-1.2988	5.2202***	1.7342***
	(0.1443)	(0.4501)	(0.1984)	(0.5606)	(0.2614)	(0.8426)	(0.1366)	(0.4284)
R2	0.38	0.45	0.76	0.78	0.72	0.76	0.88	0.92
N	215	215	215	215	215	215	215	215

Note : The outcomes are agriculture, manufacture, construction and service value added per capita in constant 2015 USD (UNSD) (in logarithm). Resource is resource value added per capita in current USD (UNSD) (in logarithm). Countries excluded from the sample are the Comoros, Cape Verde, Djibouti, Equatorial Guinea, Eswatini, São Tomé and Príncipe and the Seychelles. Standard errors are in parentheses : *Significant at 10% **Significant at 5% ***Significant at 1%

Table 4.22 – Impact of Resource VA on Sectoral VA (in USD per capita) using FE Filtered

Variables	Agriculture		Manufacture		Construction		Service	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Resource	0.0487	0.0128	0.1907***	0.0523	0.4085***	0.2306***	0.1501***	0.0293
	(0.0314)	(0.0372)	(0.0506)	(0.0475)	(0.0830)	(0.0745)	(0.0343)	(0.0318)
Education	0.0432	0.0172	0.0826**	-0.0173	0.1675**	0.0390	0.1905***	0.1033***
	(0.0259)	(0.0387)	(0.0407)	(0.0457)	(0.0630)	(0.0626)	(0.0293)	(0.0296)
WGI2	0.1585*	0.1376	0.2171*	0.1366	0.6044***	0.5009***	0.1710*	0.1007
	(0.0799)	(0.0825)	(0.1208)	(0.1257)	(0.1538)	(0.1564)	(0.0908)	(0.0784)
Disasters	-0.0021	-0.0021	-0.0006	-0.0008	0.0007	0.0004	0.0002	0.0000
	(0.0013)	(0.0013)	(0.0016)	(0.0015)	(0.0021)	(0.0020)	(0.0009)	(0.0009)
Remoteness	-0.0076**	-0.0073***	-0.0023	-0.0011	-0.0084**	-0.0069**	-0.0085***	-0.0075***
	(0.0029)	(0.0027)	(0.0052)	(0.0046)	(0.0035)	(0.0031)	(0.0030)	(0.0026)
CEMAC	-0.0185	-0.0028	0.3852	0.4457	0.2575	0.3353	0.0339	0.0867
	(0.1399)	(0.1298)	(0.2667)	(0.2711)	(0.2726)	(0.2348)	(0.2206)	(0.2324)
UEMOA	0.0777	0.0222	0.1513	-0.0626	-0.0778	-0.3527	-0.2032	-0.3899***
	(0.1469)	(0.1378)	(0.2401)	(0.2130)	(0.2959)	(0.2489)	(0.1625)	(0.1384)
NRGDPPC		0.1038		0.3996***		0.5138***		0.3488***
		(0.1007)		(0.1080)		(0.1090)		(0.0711)
Constant	5.0930***	4.6446***	3.8141***	2.0879***	1.7838***	-0.4353	4.9706***	3.4639***
	(0.1768)	(0.5324)	(0.2109)	(0.5216)	(0.3352)	(0.5921)	(0.1469)	(0.3343)
R2	0.14	0.16	0.32	0.46	0.51	0.60	0.61	0.74
N	250	250	250	250	250	250	250	250

Note : The outcomes are agriculture, manufacture, construction and service value added per capita in constant 2015 USD (UNSD) (in logarithm). Resource is resource value added per capita in current USD (UNSD) (in logarithm). The variables “Resource”, “Education”, “WGI2”, “Disasters” and “NRGDPPC” are estimated through Fixed-Effects. The variables “Remoteness”, “CEMAC” and “UEMOA” are estimated through cross-section OLS on the residuals of the previous Fixed-Effects model. The R-Square provided is the R-Square from the Fixed-Effect model. Standard errors are in parentheses : *Significant at 10% **Significant at 5% ***Significant at 1%

Table 4.23 – Impact of Resource VA on Sectoral VA (in USD per capita)

Variables	Agriculture		Manufacture		Construction		Service	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Resource	0.0012	-0.0784**	0.2828***	0.1254***	0.4709***	0.2791***	0.3278***	0.1141***
	(0.0266)	(0.0316)	(0.0373)	(0.0441)	(0.0434)	(0.0568)	(0.0255)	(0.0382)
Education	0.0315	-0.0183	0.1502***	0.0439	0.0283	-0.0953***	0.1428***	0.0199
	(0.0222)	(0.0235)	(0.0273)	(0.0277)	(0.0354)	(0.0329)	(0.0247)	(0.0157)
WGI2	0.0885	-0.0508	0.6173***	0.3395***	0.7579***	0.4256***	0.4991***	0.1470***
	(0.0623)	(0.0724)	(0.0764)	(0.0850)	(0.1124)	(0.0839)	(0.0732)	(0.0347)
Disasters	-0.0026*	-0.0019	-0.0079***	-0.0067***	-0.0001	0.0012	-0.0022	-0.0012
	(0.0016)	(0.0016)	(0.0016)	(0.0016)	(0.0023)	(0.0018)	(0.0016)	(0.0010)
Remoteness	-0.0082***	-0.0070***	0.0039	0.0066***	-0.0067***	-0.0035*	-0.0033*	-0.0001
	(0.0018)	(0.0017)	(0.0028)	(0.0025)	(0.0025)	(0.0021)	(0.0019)	(0.0010)
CEMAC	-0.0821	1.5688**	0.5883**	0.1995	0.0449	0.5379	0.0320	1.6744**
	(0.1291)	(0.6374)	(0.2808)	(1.1269)	(0.4150)	(1.1263)	(0.2150)	(0.7980)
UEMOA	0.1050	-1.5522**	1.3665***	-0.5625	0.6865*	-1.3414	0.4609***	-0.0658
	(0.1847)	(0.6298)	(0.2210)	(0.6952)	(0.3552)	(1.2951)	(0.1460)	(0.5891)
CEMAC $\times$ Resource	0.0121	0.1361***	-0.0448	-0.0830	0.0317	0.0612	-0.0173	0.1036
	(0.0269)	(0.0503)	(0.0613)	(0.0841)	(0.0730)	(0.0990)	(0.0392)	(0.0814)
UEMOA $\times$ Resource	-0.0499	-0.0599	-0.2801***	-0.2518***	-0.3452***	-0.2990**	-0.1520***	-0.0382
	(0.0566)	(0.0529)	(0.0678)	(0.0720)	(0.1152)	(0.1218)	(0.0503)	(0.0535)
NRGDPPC		0.3048***		0.6172***		0.7382***		0.7865***
		(0.0721)		(0.0998)		(0.0998)		(0.0650)
CEMAC $\times$ NRGDPPC		-0.3334***		0.0832		-0.0958		-0.3310**
		(0.1219)		(0.2166)		(0.2099)		(0.1679)
UEMOA $\times$ NRGDPPC		0.2553**		0.2679**		0.2710		0.0016
		(0.1096)		(0.1227)		(0.2231)		(0.1090)
Constant	5.7916***	4.0904***	3.4731***	0.0402	2.7102***	-1.3890**	5.0038***	0.6648**
	(0.1521)	(0.4382)	(0.2626)	(0.6410)	(0.2695)	(0.5397)	(0.1599)	(0.3220)
R2	0.24	0.34	0.68	0.77	0.71	0.79	0.79	0.92
N	250	250	250	250	250	250	250	250

Note : The outcomes are agriculture, manufacture, construction and service value added per capita in constant 2015 USD (UNSD) (in logarithm). Resource is resource value added per capita in current USD (UNSD) (in logarithm). Standard errors are in parentheses : *Significant at 10% **Significant at 5% ***Significant at 1%

Table 4.24 – Impact of Resource VA on Sectoral VA (in Shares)

Variables	Agriculture		Manufacture		Construction		Service	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Resource	-0.3396***	-0.3152***	-0.0393	-0.0330	0.1178***	0.1194***	0.2611***	0.2288***
	(0.0679)	(0.0565)	(0.0334)	(0.0353)	(0.0263)	(0.0259)	(0.0611)	(0.0507)
Education	-2.9219***	-0.5393	0.4762**	0.3063	-0.1822	-0.4072**	2.6279***	0.6402
	(0.3543)	(0.4314)	(0.2280)	(0.3668)	(0.1236)	(0.1692)	(0.3502)	(0.4612)
WGI2	-10.4119***	-6.2682***	1.9165**	1.8843*	1.3678***	1.1249***	7.1277***	3.2591**
	(1.5068)	(1.2976)	(0.7720)	(1.0084)	(0.3607)	(0.4140)	(1.3685)	(1.3308)
Disasters	-0.0138	-0.0256	-0.0318*	-0.0301*	0.0058	0.0065	0.0397	0.0492
	(0.0343)	(0.0319)	(0.0173)	(0.0176)	(0.0074)	(0.0073)	(0.0373)	(0.0337)
Remoteness	0.0162	-0.0643**	0.0417*	0.0465	-0.0103	-0.0028	-0.0476	0.0206
	(0.0362)	(0.0319)	(0.0233)	(0.0293)	(0.0104)	(0.0112)	(0.0370)	(0.0336)
CEMAC	-4.5001*	-9.1505	3.2445**	-17.6363	-0.9661	-13.4621***	2.2217	40.2489***
	(2.5605)	(11.1439)	(1.6201)	(13.4031)	(0.7161)	(4.3569)	(2.3303)	(13.8159)
UEMOA	-3.8588*	4.4971	6.3338***	2.9943	-0.6587	1.4584	-1.8163	-8.9498
	(2.2226)	(11.9022)	(1.2510)	(8.5853)	(0.6856)	(3.9196)	(1.8827)	(9.9131)
CEMAC $\times$ Resource	0.0179	0.0935	0.0526	-0.0713	0.0388	-0.0411	-0.1092	0.0188
	(0.0886)	(0.0991)	(0.0777)	(0.1016)	(0.0476)	(0.0489)	(0.0846)	(0.0941)
UEMOA $\times$ Resource	0.3207	0.2456	-0.4636***	-0.4659***	-0.2230***	-0.2308***	0.3659	0.4510*
	(0.3304)	(0.3214)	(0.1412)	(0.1441)	(0.0830)	(0.0840)	(0.2837)	(0.2700)
NRGDPPC		-8.0263***		0.2495		0.5903*		7.1865***
		(0.9436)		(1.0716)		(0.3378)		(1.1972)
CEMAC $\times$ NRGDPPC		0.7949		3.4294		2.0497***		-6.2741***
		(1.7429)		(2.2079)		(0.7078)		(2.1579)
UEMOA $\times$ NRGDPPC		-1.0006		0.4983		-0.3630		0.8653
		(1.8425)		(1.3554)		(0.5853)		(1.5567)
Constant	34.8936***	85.5445***	11.1029***	9.7814	6.7226***	3.1699	47.2809***	1.5041
	(2.7289)	(6.5102)	(2.0638)	(7.6030)	(0.9277)	(2.3061)	(2.3644)	(8.0584)
R2	0.56	0.66	0.15	0.17	0.26	0.30	0.47	0.58
N	250	250	250	250	250	250	250	250

Note : The outcomes are agriculture, manufacture, construction and service value added in % of non-resource GDP (UNSD). Resource is resource value added in % of total GDP (UNSD). Standard errors are in parentheses : *Significant at 10% **Significant at 5% ***Significant at 1%

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Conclusion Générale

Cette thèse a eu pour objectif principal de souligner les limites des hypothèses des modèles traditionnels de syndrome hollandais et d'en discuter la pertinence dans le cas des pays africains producteurs de ressources naturelles. Pour cela, elle s'est appuyée sur une revue la plus exhaustive possible de la littérature théorique et empirique du syndrome hollandais et sur trois analyses empiriques. Le chapitre 1 a cherché à mettre en lumière l'importance de la littérature économique consacrée au syndrome hollandais dans les pays en développement mais également les angles morts de cette littérature ainsi que la déconnexion progressive qui semble s'être instaurée entre les modèles théoriques fondateurs issus des années 1980 et les travaux empiriques plus récents. Le chapitre 2 a discuté l'une de ces divergences portant sur la définition du taux de change réel en évaluant l'impact des revenus pétroliers sur différentes mesures de taux de change dans un panel de neuf pays africains exportateurs nets de pétrole. Il en a conclu à un phénomène d'appréciation du taux de change réel et de baisse de la compétitivité des produits agricoles pour les pays de la zone, mais avec un impact plus difficilement interprétable pour les produits manufacturiers. Le chapitre 3 a questionné la pertinence de l'hypothèse selon laquelle les ressources seraient entièrement exportées en comparant l'impact des variations de prix et de production de pétrole sur l'inflation des biens de consommation dans cinq pays exportateurs de pétrole de la zone CEMAC. Les résultats ont conclu à la présence d'un syndrome hollandais en Guinée Equatoriale et ont souligné l'importance de la prise en considération de cette hypothèse pour l'interprétation des résultats et des canaux de transmission entre prix internationaux du pétrole et inflation domestique dans les pays producteurs. Enfin, le chapitre 4 a proposé une analyse plus descriptive des relations entre production de ressources naturelles (mines et hydrocarbures) et valeurs ajoutées sectorielles dans un panel de 50 pays africains entre 1995 et 2019. Cela a conduit à remettre en question l'hypothèse d'un phénomène de désindustrialisation provoquée par les ressources naturelles dans le contexte africain, mais a au contraire souligné la possibilité d'un phénomène de désagriculturalisation dans ces pays, phénomène déjà observé dans le chapitre 2. Ce dernier chapitre a aussi mis en évidence la spécificité de certains pays et de certaines activités (notamment la Guinée Equatoriale dans le cas des industries de transformation des hydrocarbures) et donc l'importance de la prise en compte des contextes nationaux (histoire, institutions, politiques fiscales et monétaires, structure de l'économie...) dans les analyses du syndrome hollandais, importance déjà évoquée dans le chapitre 3.

Implications pour la recherche et les politiques publiques

Sur le plan de la recherche en économie, cette thèse appelle à plus de discussions sur les hypothèses des modèles théoriques de syndrome hollandais et leur pertinence dans le cadre des pays en développement. Cela apparait particulièrement vrai pour les analyses empiriques pour lesquelles les hypothèses du modèle de Corden-Neary sont rarement questionnées. De plus, cette remarque concerne également la définition et le choix des variables utilisées pour identifier la présence d'un syndrome hollandais ou d'un de ses canaux. Les conclusions des chapitres 2 et 3 incitent également à encourager le rapprochement entre la littérature sur le syndrome hollandais et d'autres champs complémentaires de la littérature économique.

Du point de vue des politiques publiques, plusieurs constats peuvent également être faits. Tout d'abord, il apparait que, bien que le syndrome hollandais semble une réalité pour nombre de pays riches en ressources naturelles (comme mis en évidence dans les chapitres 1 et 2 notamment), les craintes concernant les conséquences d'un tel phénomène ne doivent pas être surestimées pour autant (le chapitre 3 en arrive ainsi à la conclusion que le syndrome hollandais n'est pas le principal moteur de l'inflation au sein de la CEMAC tandis que le chapitre 4 encourage à rejeter l'idée que les ressources extractives soient associées à un processus de désindustrialisation en Afrique). Ensuite, il semblerait que le principal secteur potentiellement menacé par le syndrome hollandais soit le secteur agricole et non le secteur manufacturier. Ce constat a été fait ici pour le cas des pays africains mais peut aussi s'appliquer à d'autres pays en développement. Ce point est particulièrement important pour le cas où les autorités chercheraient à instaurer des politiques de soutien aux secteurs en déclin. Enfin, il apparait que les spécificités propres à chaque pays jouent un rôle crucial dans le développement d'un syndrome hollandais ou dans les conséquences économiques que celui-ci pourrait avoir, même si de plus amples analyses sur le sujet semblent requises. Plus particulièrement, les politiques publiques au sens large jouent un rôle crucial sur ce point : méthode d'exploitation des ressources, fiscalité et partage de la rente entre entreprises exploitant les ressources et Etat, choix entre épargne et utilisation des revenus publics tirés de ces ressources, politiques monétaires et régime de change, politiques commerciales... Ce dernier point appelle notamment les autorités des pays en développement ayant récemment démarré l'exploitation de ressources naturelles à s'inspirer des exemples des autres pays riches en ressources afin d'en tirer des préconisations.

Prolongements et limites

Plusieurs pistes semblent cependant envisageables afin de prolonger et compléter les principales conclusions de cette thèse. Premièrement, une comparaison avec d'autres régions du monde pourrait permettre non seulement de vérifier si certains des résultats observés ici sont spécifiques au continent africain ou non, mais permettrait également de mieux appréhender les principales caractéristiques favorisant l'émergence d'un syndrome hollandais dans une logique comparative. Dans la même veine, des études spécifiques sur certains pays encore peu présents dans la littérature du syndrome hollandais pourraient jouer un tel rôle. De telles études contribueraient notamment à améliorer l'efficacité des politiques publiques de gestion des ressources naturelles en fournissant une meilleure compréhension des conséquences macroéconomiques de ces politiques. Ensuite, peu d'importance a été accordée tout au long de ce travail à la diversité et à l'hétérogénéité des ressources naturelles pouvant être la cause d'un syndrome hollandais, cette thèse s'étant en effet essentiellement intéressée au cas des hydrocarbures. Toutefois, certains des résultats du chapitre 4 semblent révéler un impact beaucoup plus fort du pétrole que des ressources minières sur les transformations structurelles, légitimant d'ailleurs le choix des chapitres 2 et 3 de s'intéresser à cette ressource spécifique. Les ressources minières continuant de représenter une part conséquente des revenus publics et privés de nombre de pays en développement, il semble utile de prendre en considération la diversité des ressources naturelles ainsi que leurs spécificités propres dans les analyses empiriques du syndrome hollandais (ou de la malédiction des ressources) reposant sur un large panel de pays. Enfin, d'autres hypothèses et limites des modèles théoriques n'ont pas été discutées ici et mériteraient une discussion approfondie dans de futures études. Loin de chercher à simplement remettre en question les modèles de syndrome hollandais, de telles discussions sur les hypothèses sous-jacentes et leurs implications contribueraient à améliorer la compréhension de ce phénomène et des raisons pour lesquelles les pays riches en ressources naturelles semblent diversement affectés par le syndrome hollandais.