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40 Years of Dutch Disease Literature: Lessons for Developing Countries

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Abstract

This paper surveys the literature on the “Dutch disease” caused by natural resources revenues in developing countries. It describes the original model 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. There is evidence that the Dutch disease is still a topical issue for many developing countries, particularly in Africa. However, there remains large gaps in the theoretical and empirical literature in the understanding of the most adequate policy instruments to cope with, specifically in the least developed countries that are new producers of commodities.

Keywords

Dutch disease; Natural resources; Resource curse; Structural transformations; Real exchange rate.

JEL Codes

013, 014, 023, Q23

1. Introduction

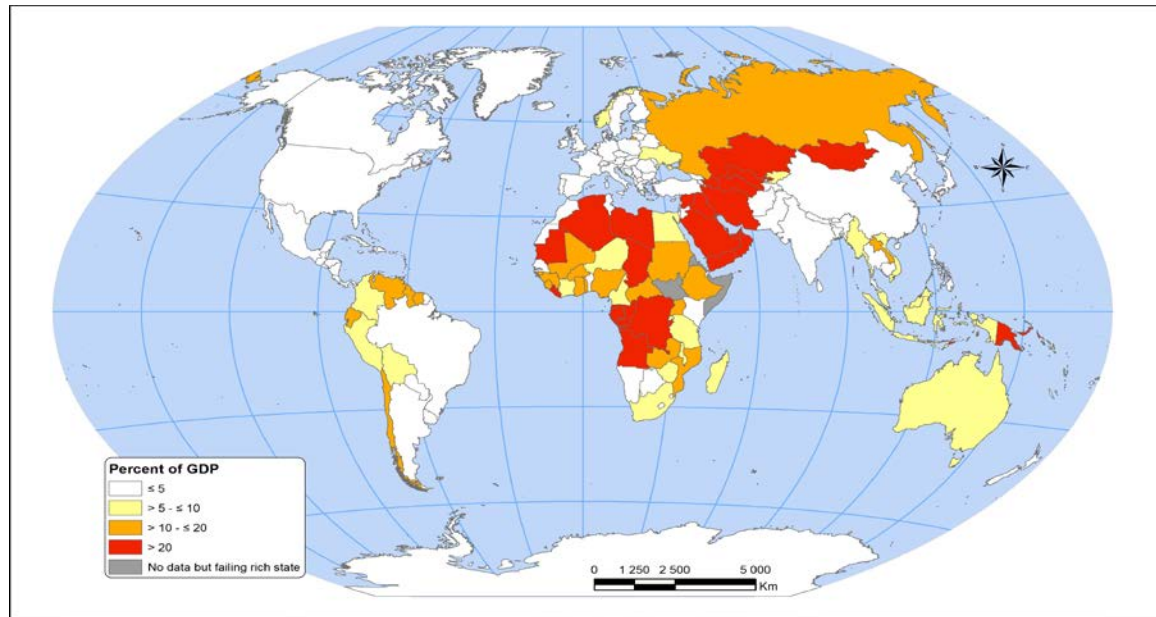
Structural transformation, defined as the reallocation of productive factors across sectors in the economy and the subsequent change in the sectoral shares of value-added in the GDP, has played a central role in explaining divergence of economic development across developing countries for the last decades (Page, 2011; Cadot et al., 2016; McMillan et al., 2014; Rodrik, 2016). Yet, while integration into the globalization is a commonly followed process, the reasons why structural change patterns differ across countries are still not fully understood. A fairly old explanation is the exploitation and the exports of natural resources, which are heterogeneously distributed across the World, and that can strongly influence structural change through the so-called “Dutch disease” (DD). Broadly explained, DD occurs when a resource boom reduces the internal incentives to produce and/or the international competitiveness of domestically produced non-resource tradable (exportable and importable) goods. According to classical DD models (Corden and Neary, 1982), a natural resource boom generates a spending effect and a resource-movement effect, associated with a real exchange rate appreciation, which induce a structural transformation of the economy in the form of a relative or absolute decline of the non-resource tradable sector. If the non-resource tradable good sectors consist mainly in (manufacturing) industries, DD would impede industrialization, or even feed a de-industrialization process in those countries that developed a nascent industry before the boom. DD was a popular explanation for the decline in manufacturing experienced by several resource-rich developed countries in the 1970s and 1980s. However, from the 1990s, DD progressively faded in favor of the encompassing concept of “Resource Curse” (Auty, 1993) that more generally explains why many resource-rich developing countries experience a weak economic growth.

Reviews that specifically focus on DD remain rare while the study of Resource curse has resulted in an abundant literature and several literature reviews, which usually include a section on DD considered as a channel of the curse (van der Ploeg, 2011; Gilberthorpe and Papyrakis, 2015; Badeeb et al., 2017). The “curse” or “disease” concepts are arguably as negative as each other, but DD, contrary to the resource curse, should not be analyzed as an inherently growth-reducing phenomenon but rather as a driver of structural transformation. Therefore, the interest remains in studying DD per se. Moreover, DD has been studied from forty years but is still the object of theoretical, empirical, and policy debates.

Due to a renewed interest on structural transformation issues, and the observation of some cases of growth without industrialization, DD hypothesis has regained relevance in the study of the development process in sub-Saharan Africa and, to a lesser extent, Latin America (Orvoty and Jibrilla, 2019). Also important is the fact that DD affect tradable sectors that would not consist in manufacturing only, but also in the agricultural sector that is a common specialization of low-income countries. Moreover, the 2000s and 2010s have seen large changes in international prices of natural resources and a multiplication of mineral and oil field discoveries, leading to new entries of small and developing countries into the group of resource-rich economies. Due to their low initial level of GDP, these countries tend to be more dependent on natural resources revenues than high income countries. This explains why most resource dependent countries are localized in Africa, Middle East or Central Asia and Latin America (see Figure 1)¹. However, this implies that they are also more likely to suffer from DD.

¹ Natural-resource dependence can be measured using different ratios, which typically report the natural resources rent to GDP or to total exports, and different thresholds. Ratios to exports are typically more volatile

Figure 1: Natural resources-rich countries in the world



Source: Authors from WDI data. Total natural resources rents (% of GDP), average over 2002-2018. Total natural resources rents are the sum of oil rents, natural gas rents, coal rents, mineral rents, and forest rents.

Our aim is to survey the theoretical and empirical literature related to the DD caused by natural resources revenues in developing countries, to draw the main policy options and to present the unresolved issues. This paper is organized as follows: section 2 sums up the history of the DD issues and recalls the difference between DD and the natural resource curse, explaining why DD remains relevant in the understanding of structural transformation. Section 3 describes the basic Corden-Neary model and its main relevant variations for the study of small developing countries. Section 4 presents the mixed evidence of DD in the empirical literature on developing countries. Section 5 presents the main lessons and policy implications that can be drawn from these reviews.

2. Brief History

The term “Dutch disease” (DD) has first been used by the Journal *The Economist* (1977) to explain the industrial decline that was observed in the Netherlands after the discovery of gas reserves in the North Sea during the 1960s, then in the United Kingdom and Australia, and finally in many other countries. Despite the early interest in this phenomenon from journalists and policy makers, it is only at the beginning of the 1980s that theoretical economic models emerged to explain and disentangle the channels of this apparent paradox. Corden and Neary (1982) is often referred to as the seminal paper of DD but there was a burgeoning theoretical literature on the topic at this time. A list of important contributions would also include Buiter and Purvis (1980), Bruno and Sachs (1982), de Macedo (1982), Eastwood and Venables (1982), Neary and Purvis (1982), Aoki and Edwards (1983), Golub (1983), Corden (1984), van Wijnbergen (1984a and 1984b), Edwards (1986), etc. Despite the heterogeneity in assumptions

than ratios to GDP leading to debate about relevant thresholds. We then proceed with the ratio of rent to GDP and different thresholds (5%, 10%, 20%). According to this ratio, highly resource-dependent countries are localized in three regions: Africa, Middle East and Central Asia.

and focuses, these models generally state that a resource boom generates revenues that feed national (both public and private) expenditures, leading to an appreciation of the real exchange rate, the relative price of the non-tradable to tradable². Therefore, non-tradable sectors (i.e. isolated from international competition) expand whereas tradable industries (i.e. exposed to international competition) decline, either in outputs or in exports, leading to a de-industrialization process.

2.1 The Dutch Disease and the Resource Curse

Both concepts of DD and “Natural Resource Curse” (or “Resource Curse” - RC) are often employed interchangeably but they differ in their origins. The term RC has first been used by Auty (1993) to explain the absence of high or sustained economic growth during the 1980s and 1990s in many resource-rich developing countries. The concept of RC is therefore more recent than the concept of DD but finally has absorbed it, since DD is now, most of the time, analyzed as one of the RC’s channels (Frankel, 2010; van der Ploeg, 2011; Sala-i-Martin and Subramanian, 2012)³.

Even though the concept of RC is recent, Davis (1995) notices that the idea that natural resources can have negative effects on the rest of the economy is quite old (for instance used to describe Argentina in the 1930s). He also underlines that, contrary to the DD, RC primarily belongs to development economics literature. RC is in opposition with the Smith and Ricardo’s traditional analyses of the gains from international trade and economic specialization, and also with Rostow theories of economic development, which were dominant in the 1950’s and 1960’s decades and that considered natural resources as a basis for any industrialization process (Badeed et al., 2017). RC has a certain resonance with the “Prebisch-Singer hypothesis” which states that commodity prices follow a long-term declining trend, contrary to manufacture goods, implying that specializing in natural resources is a “bad deal” (Frankel, 2010). This explains why Auty’s work has been followed by an abundant empirical and theoretical literature trying to disentangle the different effects (either positive or negative) of the exploitation of natural resources. The seminal empirical paper that has concluded to the existence of a negative impact of natural resources rents on economic growth was written by Sachs and Warner (1995). Although their results have been extensively criticized afterwards, this study has been followed by a large range of papers trying to replicate and refine their results (Gylfason et al., 1999; Manzano and Rigobon, 2001; Brunnschweiler and Bulte, 2008; van der Ploeg and Poelhekke, 2010 etc).

RC is a multidimensional concept. It was defined by Budina et al. (2007, pp.10-11) as the fact that “resource-rich countries are characterized by slow or stagnating growth, de-industrialization, low savings, lagging human and physical capital accumulation, and stagnating or declining productivity”. The literature identifies numerous channels of RC: For instance, three in Sala-i-Martin and Subramanian (2012) five in Pegg (2010) and Badeeb et al. (2017),

² In the 1990s, other than natural resources “windfalls” sources of revenues have been studied as drivers of DD, such as international aid (Rajan and Subramanian, 2011 and on African countries Adenauer and Vagassky, 1998 and Fielding and Gibson, 2012) or migrants remittances (Acosta et al., 2012). However, arguably, these other sources would not generate all the effects that we can expect from a natural resource-based DD. At least, if these other resources probably have a spending effect, the direct resource-movement effect is less likely to be caused directly by aid or remittances since such flows do not require domestic labor or capital to be produced. Thus, our review covers only DD caused by natural resource booms.

³ Seemingly anecdotally, DD is reported as one of the economic effects of RC in Wikipedia: https://en.wikipedia.org/wiki/Resource_curse

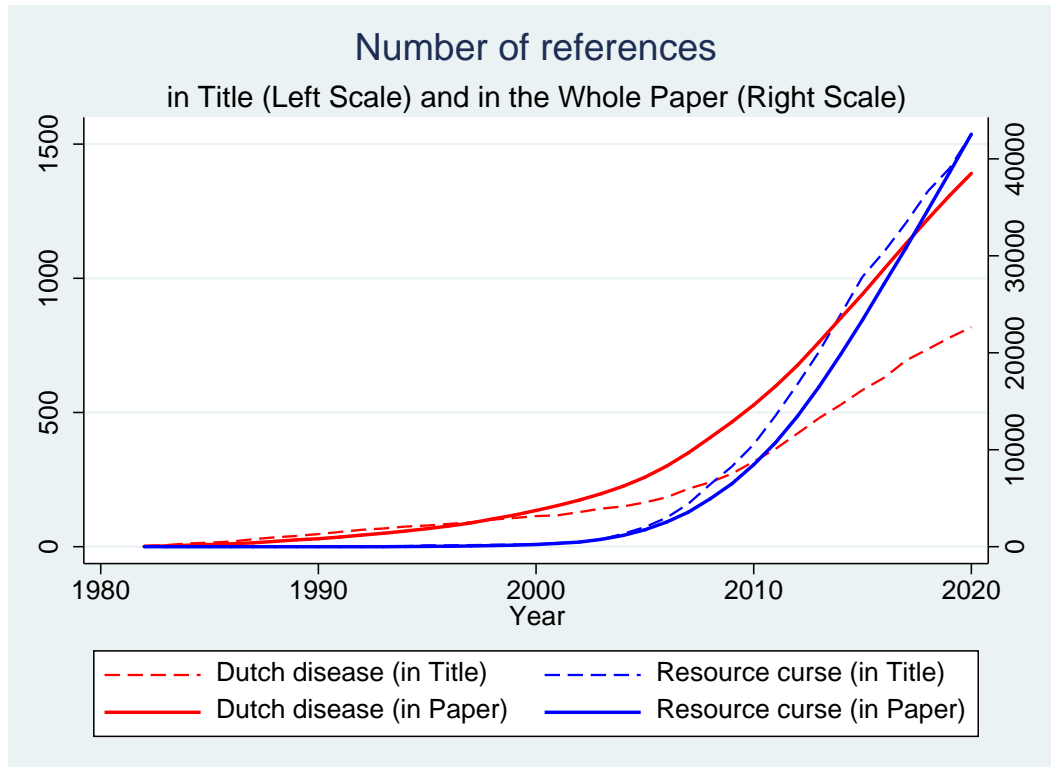
six in Frankel (2010), and seven in Collier and Goderis (2008). These channels are usually categorized in either economic or political areas, with the possibility that the different channels may interact. Economic explanations include the DD effect; but also the volatility of revenues generated by the volatility of international prices; overinvestment and excessive borrowing also called “Debt Overhang” (Manzano and Rigobon, 2001; Hausman and Rigobon, 2003; Budina et al., 2007); increasing inequalities; crowding-out of investments from other growth-promoting sectors; reduced incentives to invest in human capital; or low effort from governments to improve tax systems. Political explanations are related to corruption; weak quality of governance and institutions; rent seeking behavior; the incidence of domestic conflicts or international wars (Robinson et al., 2006). As emphasized by Hausmann and Rigobon (2003), although there is a general empirical evidence of RC (a negative correlation between natural resources revenues and economic growth, or non-resource economic growth), the channels through which it occurs are more difficult to identify.

Arguably, the renewed interest in studying RC as an encompassing concept has partly eclipsed the analysis of DD. Figure 1 below shows the number of articles mentioning the terms “Dutch disease” or “resource curse” in their title or in the text using Google Scholar database. It reveals that RC has finally attracted much more attention in the literature since the mid-2000s (we might also notice that, while DD is restricted mainly to the economic literature, RC has also been investigated in other fields such as political sciences). We can also observe a divergence in the number of articles with reference to the “DD” in their title and in their text, which increased after the rise in studies referring to the “RC”: this is in line with our previous statement that the DD is today frequently referred to as a channel for the RC, rather than a specific focus⁴.

However, the DD is an explanation for structural changes, but not necessarily for low economic growth, as are other “RC” channels. Indeed, as stressed by Davis: “There is nothing inherently growth-inhibiting in mineral booms and any resulting DD phenomena. The DD is simply a description of the causes and structural effects of boom-induced growth.” (Davis, 1995, p. 1768). Similarly, Edwards (1986) explains that the de-industrialization effect process, being “a real phenomenon [...] can hardly be referred to a disease” when the boom is permanent and in the absence of transformation rigidities. It seems then more relevant to investigate the DD as a specific concept, that may or may not act as a true “disease” for the economy, and to disentangle it from the RC.

⁴ This statement is reinforced in noticing that some of the articles dedicated to DD investigate the disease caused by other revenues than natural resources (international aid, remittances...)

Figure 2: Cumulated number of papers referring to “Dutch disease” and “Resource curse”



Source: Google Scholar

2.2 Should We Fear the Dutch Disease?

The fact that DD is fading away in favor of RC in the literature does not imply that DD, as a driver of structural transformation, is losing importance for policymaking. Although it has not been cleared up which sectors should be developed in priority for ensuring economic development, the impact that natural resources can have on the other sectors (in promoting some and hampering others) must be considered, even if the boom is permanent and there are no costly rigidities.

The de-industrialization process that would be caused by DD attracts the most attention. Page (2011) argues that industrialization is a crucial step for economic development, mainly by promoting diversification and sophistication. Other arguments in favor of industry are put forward for Africa by Rodrik (2016). Therefore, if natural resources have de-industrialization effects through DD, they can be growth-reducing in the long-run. However, Corden (1984) already argued that industries can show imperfect tradability. Tradability is not only a technical characteristic (that would characterize construction and infrastructure for instance), since potentially tradable products subject to binding quantitative restrictions should be treated as non-tradables. Then, domestic manufactures may produce imperfect substitutes for imports and can partly be considered as non-tradables, which could benefit from the spending effect. This argument should be particularly important for developing countries where a significant share of manufacturing production is country specific or highly protected from imported goods. Corden (1984) also underlines that the tradable sector does not consist only in manufacturing industry. After examining the cases of Australia and Nigeria where tradable export-oriented agriculture suffered from DD, he concludes that “the term “de-industrialization” can thus be misleading”. Thus, DD would remain a threat for several developing countries like African

countries that, while weakly industrialized, are specialized in the tradable agriculture. However, some agricultural activities (subsistence agriculture, self-consumption goods) may be considered as non-tradable and would then benefit from DD effects. Heterogeneity in the effect of DD on demand and supply of agricultural goods, and the subsequent rural emigration, is empirically documented by Scherr (1989) for Indonesia, Mexico and Nigeria and by Feltenstein (1992) for Mexico. Globally the agricultural sector has a very ambiguous place in both theoretical and empirical literature on DD since agricultural commodities can also be regarded as the booming sector and then the source of RC and DD (Frankel, 2010).

Whatever the exact composition of tradable sector, it is frequent in the literature to assume that export-oriented firms generate positive spillovers for the rest of the economy, explaining why the decline in tradables caused by resource revenues can be detrimental to long-term economic development. This theory has notably been explored by Torvik (2001) and then assumed in various studies as a justification for the study of DD. Yet, the empirical evidence that tradable sectors have inherent growth-enhancing properties remains mixed (Magud and Sosa, 2010). Then, DD would have growth-reducing consequences only for specific countries.

Another hypothesis is the existence of learning-by-doing effects in the tradable sector, which would explain why a decline in this sector in the short-run could have long-run negative consequences, because of the loss in skills and know-how in the tradable sectors during the boom. This risk is notably explored by van Wijnbergen (1984b) who develops a dynamic model of DD with learning-by-doing effects in the tradable sector. 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 that left the sector during a boom. Then, DD can reduce economic diversification making resource-dependent countries even more vulnerable to global shocks (i.e. the volatility effect). Cherif (2013) considers both learning-by-doing effects and technological gaps and concludes that DD widens pre-existing technological gaps between developing resource-rich countries and advanced countries, explaining why DD is more likely to be a threat for developing countries. Therefore, DD can be a concern for long-run development because of the resource boom-bust asymmetric effects (i.e., when the boom is temporary): the losses in productivity and growth of non-resource tradable sectors during the resource boom will not be recovered after the end of the boom.

Furthermore, DD adverse effects can be worsened in specific conditions linked to other channels of the RC. For instance, DD can be generated by an uncontrolled increase in public expenditures when governance is weak. It also has been documented long ago that elites in authoritarian regimes tend to promote exchange rate overvaluation to favor urban consumers at the expense of rural producers to reduce the risks of urban revolts (Bates, 1981). Thus, more corrupted and less democratic governments may have lower incentives to implement effective policies against an overshooting appreciation of the exchange rate caused by DD.

Also important are rising inequalities in resource-rich countries, even if the average effect of natural resources on growth is positive (i.e. if the direct and indirect gains from resource revenues are higher than the losses due to the drop of the tradable sector). Inequalities may increase when the high-income population show a higher propensity to consume non-tradable goods (see Behzadan et al., 2017). This is also the case when imperfect mobility of labor between the booming and declining sectors (for instance if only skilled workers can move) increases unemployment and poverty for workers in the declining sector.

3. Modelling Dutch Disease

Theoretical models of DD developed at the beginning of the 1980s present different focuses and different frameworks and assumptions⁵. In an early paper that could be considered as a forerunner of DD modelling, Gregory (1976) already investigated the possibility that in Australia the growing-mineral sector could lead structural change through price increases⁶. Nevertheless, the Corden-Neary (1982)'s model is the one that has drawn most of the attention and become the basis of numerous theoretical refinements and empirical works⁷. However, Buiters and Purvis (1980), while less recognized, is one of the first models investigating the consequences of DD from the perspective of export competitiveness, which is not explicitly modelled in Corden and Neary (1982)⁸, but which is the perspective of numerous empirical works on DD.

3.1 The Original Corden-Neary's Model and its Extensions

The Corden-Neary's model emerged from an important development of the theoretical literature at the beginning of the 1980's decade (Bruno and Sachs, 1982; Corden and Neary, 1982; Corden, 1984; and van Wijnbergen, 1984a). This model's framework is a small open economy with three sectors: energy (traditionally oil, gas or mining resources), a tradable sector and a non-tradable sector⁹. Labor is mobile between sectors while capital is not, and both factors are immobile internationally. Thus, DD is here considered as a purely domestic phenomenon: it cannot be "exported" to neighboring countries through international migration or generate externalities to other countries. Three other important 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); and perfect flexibility of real wages.

Following Corden and Neary, we call the three sectors of the economy E (energy), T (tradable manufactures) and N (non-tradable 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 following a boom are generated through two effects (see Figure 2):

1. *The Spending Effect*: Energy exports generate additional revenues for the factor owners and for the government (through taxes), increasing the demand for both N and T. Supply being fixed in the short-run (capital is immobile), the price of N rises. The price of T is set on international markets (i.e. is exogenous), and the increasing demand for T is therefore compensated by additional imports. Returns to capital increase in N, whereas

⁵ Corden (1984) classifies theoretical models by whether they have a spending effect only, or whether they also have a resource movement effect.

⁶ He builds a simple model, based on the elasticity approach, that describes the impact of mineral exports in Australia, through a change in the relative price of the traded goods to non-traded goods, on the domestic supply of agricultural exports and the demand for manufacturing imports.

⁷ Cited by more than 3800 papers in Google Scholar at the end of March 2020.

⁸ Anecdotaly, in Corden and Neary (1982)'s article, the term « competitiveness » has only one occurrence, in the bibliography that includes Buiters and Purvis (1980)' paper titled "Oil, Disinflation and Export Competitiveness: a Model of the Dutch Disease".

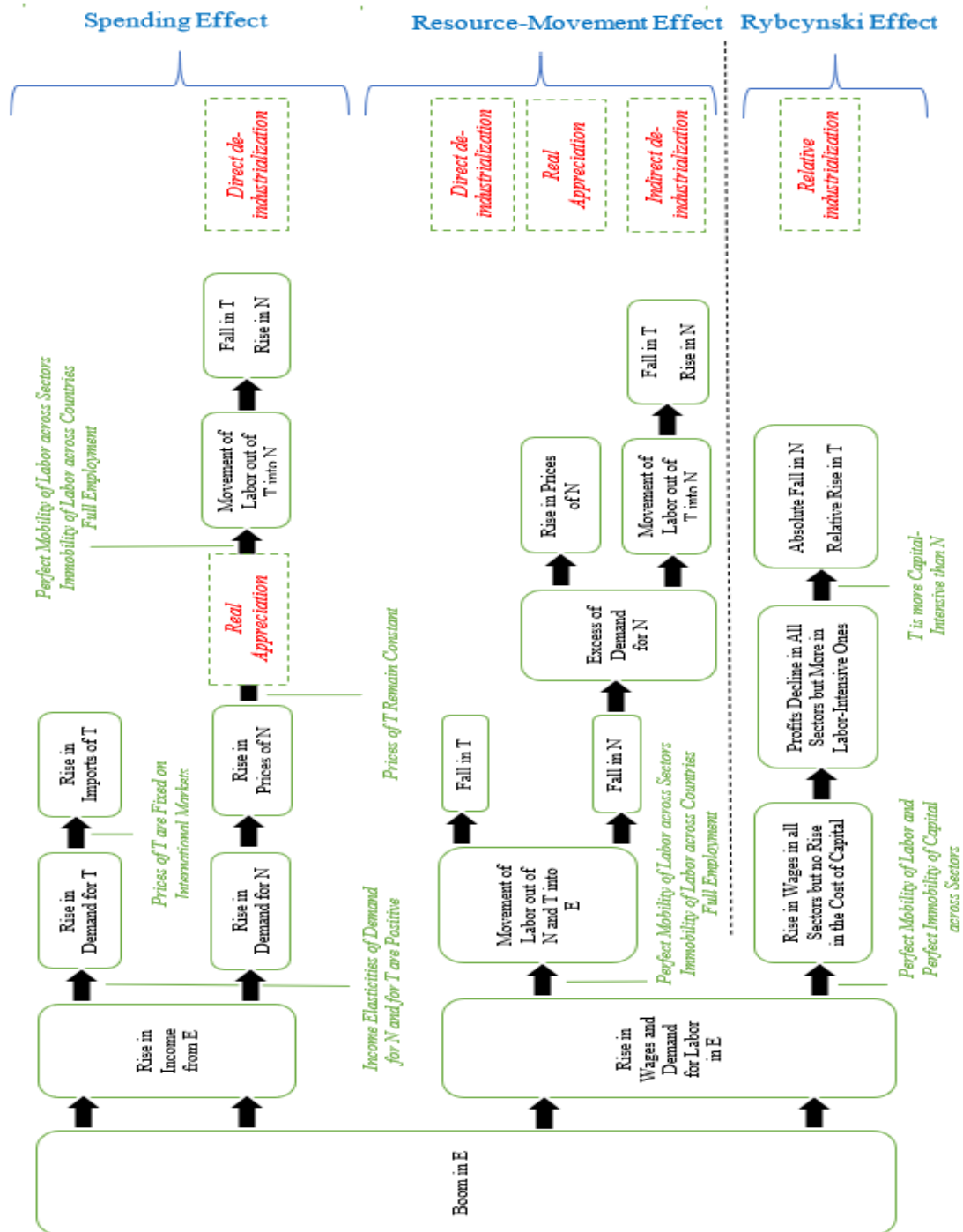
⁹ Neary (1982) proposes a generalization of the model to more factors and goods and show that the predictions remain.

wages increase in both sectors due to the perfect mobility of labor, reducing profits in T. The main consequences are an appreciation of the real exchange rate, a fall in the output in T and an increase in the output in N.

2. *The Resource-Movements 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 rise as substitute for T while price of N increases, causing a real appreciation of the exchange rate, and a new movement of labor from T into N: N may return to its pre-boom level whereas the decline in T is reinforced. At the end, T output has faced an absolute decline but contrary to the Spending Effect, the resource-movement effect does not explain an absolute increase in the output of N (but only a relative increase compared to T). As Neary (1982) recalls, the resource-movement effect requires the reasonable assumption that the booming sector must make use of factors that are in limited supply, at least in the short-run, generating additional costs on T.

These two effects are often put forward, yet they may not both occur, or even have different effects under different assumptions. For instance, van der Ploeg (2011) explains that, if T is more capital-intensive than N, T benefits from the resource-movement effect due to Rybczinski theorem, because of a lower impact of the wage increase on T (see Figure 4). This assumption that T (manufacturing) is more capital-intensive than N (service) is at first sight justified but should be moderated since some T sector can be weakly capital-intensive, and some N sectors can be capital-intensive (such as construction for instance).

Figure 3: Description of the Spending and Resource-Movement Effects



Note: Boxes are for the main explanatory and channel variables; red for the main result variables; in green the main hypotheses; E is the energy (or booming) sector; T is the tradable sector and N is the non-tradable sector. We follow Corden and Neary (1982) and use the term “de-industrialization” to describe the fall in the tradable sector even if DD can result in “de-agriculturalization”. Spending effect: there is an appreciation of RER ($N \text{ Price} / T \text{ Price}$), and an absolute decline in T and an absolute increase in N. Resource-Movement effect: the output in T falls due to direct and indirect de-industrialization effects. 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. Capital is immobile in the C-N model and if T is more capital-intensive than N, then de-industrialization effects can (at least partly) be offset following the Rybczynski effect. On the contrary, if capital is mobile across sectors, capital movements follow labor movements and reinforces direct and indirect de-industrialization.

The original model of Corden and Neary's aims at explaining why a NR boom may generate RER appreciation and deindustrialization. This is first and foremost, and often only, what is recognized by works citing this model. However, these predictions are based on specific hypotheses that can be subjected to interesting variations leading to different predictions, as showed early by Corden (1984) by, for instance, allowing for capital mobility and the existence of unemployment. These variations are likely to be relevant according to the conditions in emerging and developing countries. 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 then details the effect of pre-existing classical unemployment. The importance of such unemployment depends on the level of flexibility of real wages, but the main conclusion is that employment will increase in N but decrease in T. Immigration can lower the increase in wages, but increase the supply and the demand for N and T, with an ambiguous effect on the RER but deindustrialization effect remain due to the migrants' spending in N. Corden (1984) also notes that when the rent from E is captured by the government to lower other taxes and increase public expenditure, this can attract migrants into T and N, offsetting the expected effects of DD (the Alberta effect).

Corden also considers the case where the E product is consumed domestically. In this case, the results of an increase in E price depends on the relative propensities to consume goods, but consumers would shift from E to N and T, leading to a RER appreciation, reinforcing the expected effects of DD. When E is an input for the production of N and T, a rise of the price of E has a negative effect on profitability of N and T leading to a negative effect on spending and complex resource movements depending on N and T relative intensity in E (the higher the intensity, the worst effect). For most developing countries however, oil and mining resources are essentially exported and not domestically consumed. Corden (1984) finally discusses several refinements of the core model. For instance, the resource movements have redistributive effects on income and so on the relative demand for N goods, at constant relative prices, when propensity to consume N are different across winners and losers. Specifically, N may suffer from DD if the propensity to consume N goods is sufficiently lower for the winners than for the losers (Corden, 1984, footnote 5).

3.2 Differing Approaches for Modelling the Dutch Disease

Despite the importance that has been accorded to the article of Corden and Neary (1982), a large literature emerged at the beginning of the 1980s to explain the various impacts of DD. The seminal model of Corden and Neary highlights only real aspects (not the monetary aspects), and focuses on the domestic economy (no regard to external competitiveness or the exchange rate of the domestic currency against foreign currencies). In addition, it has been developed for industrialized countries and some of its assumptions are very unlikely to be met in developing countries. Other models may differ both in their perspective and assumptions. For instance, Bruno and Sachs (1982) or van Wijnbergen (1984a) consider a dynamic rather than a static model, while Buiter and Purvis (1980) adopt an external perspective and consequently a different definition of the real exchange rate. Early, Neary (1982) analyses different issues about DD notably by including monetary and exchange rate aspects that influence the adjustment of the real economy following a boom towards the new long-run equilibrium (fixed vs floating exchange rate ; and introducing sticky prices and wages leading to exchange rate overshooting amplifying DD). We try to present here a brief overview of the diversity of approaches that have been proposed in this literature.

The Core model of Corden-Neary assumed capital to be immobile across sectors, which is a plausible assumption in the short-run. On the contrary, Bruno and Sachs (1982) use a dynamic model where capital is immobile in the short run but mobile in the long run, leading a boom in E to have a negative long-run impact on T. This, however, does not affect much the results since a boom in the energy sector still reduces the long-run output in other tradable sectors. The main determinants that can mitigate this impact are government budget policies and household propensity to save current revenues from the oil sectors for future consumption.

Van Wijnbergen (1984a) also distinguish short-run from long-run effects but introduces the possibility of short-run disequilibrium in the labor and non-traded goods markets. Three possible types of disequilibrium are investigated: repressed inflation (excess demand for labor and nontraded 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 nontraded goods). The shift of the economy from the equilibrium to one of these situations depends on the stickiness of prices and wages and of the public policies that are implemented.

In contrast with the model of Corden and Neary, Buiters 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 foreign prices to domestic prices, which is the now most common definition of the RER in empirical studies and economic policies. Indeed, according to Neary and Purvis (1982), this model wipes the resource movement effect out, considering that the booming sector and the other tradable do not compete directly for factors. Instead, it stresses the role of the exchange rate movements on the foreign exchange market, in the presence of sticky domestic prices allowing disequilibrium, which is not considered in the Corden and Neary's model. This model consists in a three-tradable goods economy: oil, a non-oil exported good and a non-oil imported (foreign) good. The real exchange rate is then defined as the relative price of non-oil imports to the price of the domestic non-oil good (i.e. the number of units of non-oil domestic goods the country must export to import one unit of foreign good). Several important assumptions are made. First, oil production does not require labor, implying that starting oil production does not directly affect the other sector production through workers' movement (contrary to the 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-run steady-state of the economy. After an oil reserve discovery, domestic demand for the domestically produced non-oil good must rise, leading to a permanent appreciation of the RER. In the case of a boom in international oil prices, the RER must appreciate in the long-run due to the increase in the relative price of oil in terms of non-oil imports if the country is an oil-exporter.

The Corden-Neary model is a static real model highlighting the spending and resource-movement real effects of a boom (with perfect adjustment of real prices and wages). Neary (1982), introduce monetary aspects showing the impacts of DD on nominal variables (see also Neary and Purvis, 1982). Neary (1982) uses a simple monetary model (assuming first flexibility of prices and wage 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). A boom in E leads to an excess demand of N (through the spending and the resource-movement effects). However, the rise in income also raises money demand that would make price falling if money

supply is fixed. Neary calls this third effect of DD the liquidity effect. Under a floating exchange rate regime, the nominal exchange rate must appreciate to get 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 then must gradually increase money supply (if no sterilization), 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.

Similarly, 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 this market. First, it creates trade balance surplus, which increases the supply of money. Second, it rises domestic income, which increases the demand for money. Then, if supply and demand do not increase at the same rate, a short-run monetary disequilibrium occurs, but this disequilibrium is progressively eliminated in the long-run. This result is important for the understanding of DD since it might imply that DD would be a “disease” only during the short-run disequilibrium period, 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) is seemingly the first model of DD specifically dedicated to the analysis of a developing country, namely Egypt. The author considers the specificity of 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. The main conclusion is that the government should let the two different rates coexist to fight against DD.

Edwards (1986) also develops a model for the Colombian economy to analyze a boom in coffee price that is composed of three different but interrelated blocks: a monetary block, an inflation block and an exchange rate block. This model allows to add to the spending effect (the resource movement effect is not modelled) a monetary effect, and an effect on the nominal exchange rate. Coffee price has an impact on inflation through the (real side) spending effect causing non-tradable good price increase. It also causes an increase of money demand (because of higher income thanks to the rent) and of money supply (foreign money inflows or increase in net foreign assets), that would cause a money excess demand (deflationary) or excess supply (inflationary). Moreover, foreign money inflows would appreciate the nominal exchange rate. This generates a short-run real exchange rate appreciation through accumulation of foreign reserves, excess money supply and non-tradable price increase, which would exceed the “equilibrium” real appreciation resulting from the boom.

Another application of a model of Dutch disease to a developing country is made by Benjamin et al. (1989). They 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 finally conclude that an oil boom positively affects the sectors of construction and of capital goods, but hampers cash crops production, forestry, food processing and public services. Kayizzi-Mugerwa (1991)

also applies a multisector 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 seven sectors (agriculture, mining, manufacturing, construction, commerce, transport and communications, and services) and conclude 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, a bust in copper prices also depresses activity in manufacture and transportation (even if the impact is lower than with a boom), implying that drops and falls in resource prices might have asymmetrical effects.

3.3 A Recent Renewed Interest in Dutch Disease Modelling?

While the general principles of modeling DD have been developed 40 years ago, the theoretical literature have continued to be active, particularly in the last years. We present here some recent models that try to develop new approaches of DD.

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 generate 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 richer 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 richer 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. More precisely, they consider that some firms are more labor-intensive than others and include transport costs for exporting firms. This implies that, even among 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 incur transport costs) and forces the more labor-intensive firms to leave the market. Therefore, the total number of exporting firms decreases and, under a monopolistic competition framework, diversity of exports decreases. This study therefore differs from the rest of the literature by looking at another way in which natural resources can affect the structure of the economy through a modified-DD mechanism.

4. Testing Dutch Disease

Mostly since the beginning of the 2000s, a large empirical literature has investigated DD, initially based on country-case studies and estimates of reduced-form equations, which generated inconclusive results. Arguably, the primary reason would be that DD, or the predictions of DD models, are conditioned by several simplifying assumptions that would not hold in the real World. Put differently, real conditions across countries are too heterogeneous

for allowing a homogenous symptom of DD to emerge. A second reason is that the tests of the predictions are conditioned on data quality and on the measures of the variables of interest (proxies of resource rent, real exchange rate and tradable/non-tradable output), which are questionable, especially when studying developing countries. Also important is the length of statistical series that can be too short to properly test for long-run predictions. A third reason is that, given statistical issues, test results are sensible to the empirical methodology, the choice of the dependent and explanatory variables or even the length of the modelled lag between the boom and the DD effects.

We present here studies that aim to test DD specifically. We do not cover RC tests (based on growth regressions), except if DD is explicitly explored as a channel of RC¹⁰. Testable predictions that are most frequently used can be grouped in: (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 the non-resource tradable output.

$$(1) RER = f(NR; X)$$

$$(2) Y = f(NR; X)$$

For the sake of simplicity, the subscripts *i* for country and/or *t* for time have been left out of the formula. RER is the real exchange rate. NR is natural resource revenues proxied by resources value-added, resources exports or international price of resources (considered exogenous) and *Y* is sectoral output (or its relative share in total GDP) for the non-resource tradable (typically agriculture or manufacture) and non-tradable (services) sectors. *X* are a vector of control variables. These two equations can be nested with (1) as a first stage regression and with (2) replaced by (3):

$$(3) Y = f(RER; X)$$

It should be noted that in this case only the expenditure effect is tested, since the resource-movement effect implies a decline in tradables without necessarily an appreciation of the RER. Some papers also use intermediary variables that allow testing a specific channel of DD, such as a spending effect (with private and public expenditure as a channel variable). In that case, the regression with the proxy used for the channel of DD as the dependent variable is often run separately. Macroeconomic studies usually do not use labor or wages data because data are missing or of poor quality, particularly in developing countries.

DD is a dynamic phenomenon that requires the use of time dimension of statistical series. Typically, empirical studies use a wide variety of estimators, broadly grouped between time series estimators (cointegration analysis) for single-equation specifications, static (such as Pooled OLS or Fixed-Effects) or dynamic (such as Dynamic OLS or Mean-Group) models for small sample-size panel data and even general method of moments (GMM) for panel data with

¹⁰ Sala-i-Martin and Subramanian (2012) is a very famous empirical studies of RC (cited more than 1600 times in Google Scholar as of April 2020). Their econometric tests are based on growth regressions for a large sample of countries, with explanatory variables include exports of natural resources and some intermediary variables capturing the channels of RC, of which institutions and overvaluation of the exchange rate. Only institutions are suspected to be endogenous and instrumented. Coefficient for overvaluation is not significant in their regressions.

a large number of countries. The increasing number of papers using panel data reflect the advantage of using a larger sample of observations and the aim of testing a general or common model of DD, while allowing to restrict the studies to regional groups on smaller number of countries. However, the increasing availability of statistical data in the time dimension would give more opportunity to individual country-case studies, escaping from the complexity in taking heterogeneity into account in large panel estimates of a common model.

4.1 Impact of Resource on the Real Exchange Rate

This section presents the results of a sample of empirical studies testing equation (1), i.e. investigating the impact of natural resources revenues on the exchange rate. One major issue when estimating Dutch disease relates to the definition of the variables selected for this analysis. Most studies exploit the real effective exchange rate defined as the ratio of domestic over foreign prices (or foreign over domestic prices). Yet, other indexes can be used, such as the internal exchange rate (defined as the ratio of non-tradable over tradable prices that are related to Corden and Neary's model), the terms of trade or the consumer price index. While not with the aim of being exhaustive, we discuss typical works produced in this field.

A hand of seminal theoretical papers includes econometric tests to test model's predictions. An example is given by Edwards (1986) on Colombia, who finds evidence that higher coffee prices appreciate the RER (in a simple Balassa-Samuelson type model) using annual data over 1957-1983, and further disentangling the effects of coffee price on money creation (through the monetization of international reserves), inflation and nominal exchange rate appreciation.

Studying monthly time-series for Kazakhstan over 1996-2003, Kutan and Wyzan (2005) observe that agriculture and industry sectors declined when oil revenues increase and that oil prices appreciate the RER. They employ a version of the Balassa-Samuelson model of RER, expanded to include consumer price index and oil price with six lags of the variables (using an autoregressive conditional heteroskedasticity (ARCH) model). They find unexpected signs with higher oil prices lagged by 1 month and 3 months causing a depreciation of the domestic currency, and an appreciation only with prices lagged by 5 months. However, this result is not supported by Égert and Leonard (2008) for the same country over the 1995-2005 period. They estimate the correlation between oil prices and both nominal and real bilateral exchange rate (with the USD) using specifications based on standard monetary model for the exchange rate (including home and foreign money supplies, real incomes, interest rates) and a measure of oil rent (oil price multiplied by oil reserves). They use three alternative cointegration tests: the Engle-Granger cointegration tests, 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 tradable sector excluding oil production appreciated following a limited rise in the oil variable in the medium term, showing the interest to use disaggregated data.

Dülger et al. (2013) and Mironov and Petronevich (2015) use similar quarterly data for Russia over 1995-2011 and monthly data over 2007-2013 respectively. Using different cointegration methods, both studies find a strong evidence that an increase of oil price or of oil revenues causes an RER appreciation in the long run, but less strong evidence that it causes de-industrialization. Moreover, Mironov and Petronevich (2015) find that the long-run correlation is even stronger between the RER and oil revenues (oil price multiplied by the quantity of oil exports) than between the RER and oil prices. This could indicate that, while the use of resource

prices is justified by the apparent exogeneity of this variable (the argument of a vast majority of empirical papers), the use of resource revenues could yield better results for the detection of DD. DD is, by definition, generated by additional revenues and international price variations may not directly translate into similar variations in revenues (either because production adapts to international prices or because of the existence of asymmetric effects).

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

The Angolan case is explored by Pegg (2010) who does not find any impact of mining exports revenues on the RER over 1980-2004. However, he observes an appreciation of the bilateral RER against the South African Rand during the 1980s, but a depreciation against the USD and European currencies, underlining the sensitivity to 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 compared to 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 finally argues that Mali has 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 the 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 and consumption price indices. Overall, they find no statistically significant correlation between oil prices and external RER, and a significant but in the wrong direction correlation between oil prices and the internal RER (i.e. an increase in oil prices generates a depreciation). Based on these observations, they conclude to the absence of a DD in Nigeria, and turn to other explanations for the RC, such as rent-seeking behaviors.

Based on annual data for Algeria over 1960-2016, Gasmi and Laourari (2017) test for the presence of a cointegration relationship between the Algerian real effective exchange rate and a set of parameters that includes international oil prices. Using an ARDL Bound Approach, they finally reject the hypothesis of a cointegration relationship among the variables, interpreted as the evidence that no spending effect has occurred in this oil-exporting country, due to the adoption of an exchange rate regime that maintain 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 Lao economy: the DD and a “crowding-out” of productive investment. Applying a VAR model to the period 1980-2014,

the author finds that mining and utility production caused inflation consistent with the DD theory.

The last decade has also seen the emergence of empirical studies based on panel data, allowing to test an homogeneous DD hypothesis across groups of countries. 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. He does not find strong support for the DD theory since the relationship between oil prices and the RER is not significant in oil-exporters in the short-run. Égert however recognizes that this result can be sensitive to the number of lags in the regressions, in line with Kutan and Wyzan results (2005) on Kazakhstan.

Arezki and Ismail (2013) use a panel of 32 oil-producing countries over 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 expenditures on the real exchange rates, and then the impact of changes in international oil prices on the changes in government spending. They use two measures for the public current and capital expenditure and test for non-linear effects of increases and decreases of oil price (measured by oil unit export value) and oil export value. They conclude (i) that current expenditures are positively associated with the RER ; (ii) that oil prices are positively associated with current spending ; and (iii) that there is a downward stickiness in current expenditures when facing oil price variations. These results would imply that the negative shock on tradables output caused by a resource boom might persists during the bust with a long-term appreciation of the RER.

In the main theoretical models, natural resources are always fully exported and never used domestically, in households' consumption or as an input by firms. Nevertheless, if this assumption can hold for luxury goods like gold or diamonds, this is more unlikely for other mineral products such as gas, coal or petroleum oil that can enter in the production process of other domestic goods and services. In that case, a discovery of such resources may help reducing the production costs of firms, and have pro-industrialization effects if manufacturing industries are more oil- or -gas intensive than the other activities. Beverelli et al. (2011) test the impact of an oil discovery, a variable that takes increasing values from 1 to 7 over the 7-year period from the three years before the discovery to the three years after, on RER variations on a sample of 132 countries, taking into account the existence of resource-intensive industries. They found that oil discoveries have a significant positive impact on the RER, but that the higher the share of oil-intensive industries in a given country, the less prone to DD the country is. This remark highlights the importance of considering both (i) the use of natural resources, and (ii) the heterogeneity of these resources, between the ones that can be used as an input and those that cannot.

Finally, Harding et al. (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 oil and gas discovery (relative to GDP), which is expected to be more exogenous than production or prices, on three bilateral (with the USD) sector-specific RER: 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 exogenous tradable good price). Interestingly, they also observe that the appreciation begins just after the discovery, and before the oil production starting, which could signal significant expectations.

4.2 Impact of Resources on the Production of Tradable Goods

Some early works examined the impact of DD on the sector composition of GDP without a specific focus on manufacture that one can find in more recent studies. For instance, Looney (1990) and Looney (1991) estimates 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) on Saudi Arabia finds that a RER appreciation hampers Agriculture, Manufacture, Mining, and Petroleum Refining (all are exportable sectors) ; but benefits to Construction, Wholesale and Retail Trade, Transport, storage and communications, and Ownership of Dwellings (mainly non-tradable sectors). Looney (1991) finds for Kuwait a large negative impact of oil revenues on manufactures but a smaller one on agriculture. However, the author never discussed the small open economy assumption in terms of oil production and exports that is questionable for Kuwait and Saudi Arabia, casting doubt on the validity of his results. Another important article comes from Fardmanesh (1991) that tries to investigate the impact of the share of oil revenues in total GDP on agriculture, manufacture and the non-tradable sector in five oil-exporting countries (Algeria, Ecuador, Indonesia, Nigeria and Venezuela) separately for the period 1966-1986. Based on OLS regressions, the author observes a clear negative impact of oil revenues on agricultural output in all countries except Venezuela (where the impact is insignificant) but a positive effect on the manufacturing and the non-traded sectors in all five 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) on international markets. Despite these few articles that focus on sub-sectoral levels, most empirical analyses of the DD in developing and emerging economies prefer to focus either on de-industrialization or on de-agriculturalization effects of the disease.

More recent works might have focused on the prediction of the de-industrialization effect of DD. As mentioned above, 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 exchange rate appreciation. In addition, Ito (2017) also rejects DD in the case of Russia over 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 of manufacturing production.

Mogotsi (2002) on Botswana finds that mining resources appreciate the RER probably through an increase in public and private consumption. However, he fails to find a clear impact of the boom on wages and output in manufactures and non-tradable sectors. He then questions the assumption of full employment made in theoretical DD models, observing a large unemployment in Botswana before the boom. Finally, since the results indicate a relative decline in manufacture output compared to non-tradables, Mogotsi (2002) finally concludes that Botswana suffered from a “mild form” of DD.

While empirical studies have tended to focus on oil, gold or diamond revenues, Hodge (2015) studies the impact of metal prices on manufacturing output in South Africa over 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. The author concludes that this result contradicts DD. However, since the regression includes both the

REER and metal prices, and that 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. The test then does not allow to estimate the overall impact of metal price on manufacturing.

After having concluded to the 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 surprisingly find a positive impact of the real effective exchange rate on the manufacturing sector (in opposition with the hypotheses of the Dutch disease model), but a negative impact of oil prices on this sector, both in the short- and long-run. They explain these results by the possibility that only a resource-movement effect might have occurred in the country, hence that Algeria has suffered from a “partial” Dutch disease only. However, they remain cautious regarding this conclusion and underline that other causes than the DD can explain this negative relationship between oil prices and growth in the manufacturing sector.

Lopez Gonzalez et al. (2016) investigate the industrial decline in Colombia following the mining boom at the end 2000s while this country was not considered as resource-dependent (after the boom, mining resources do not account for more than 10% of total GDP). The authors 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 with a Vector Autoregressive (VAR) model a negative long-run impact of mining resources on the manufacturing-service ratio.

Taguchi and Khinsamone (2018) study five resource-rich ASEAN countries (Malaysia, Indonesia, Lao PDR, Myanmar and Vietnam) over 1970-2015. They estimate the impact of mining and utilities production on the manufacture-to-service ratio using time-series VAR models for each country separately, rather than using panel data analysis, to better account for heterogeneity. They authors conclude to a de-industrialization process 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 show that this difference in performances depends on the quality of institutions and policies implemented by these countries. Public expenditures management and the implementation of a resource Funds are found to be highly effective against DD, as well as strategies aiming to diversify the 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 over 1997-2004. Results show 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 focused as effect of DD in developing countries. The Corden-Neary model and its extensions allowed the agriculture to be a tradable sector that may be hit by DD, which seems relevant for many developing countries. Specifically, a high share

of agriculture in total production and exports characterizes Sub-Saharan Africa and Latin American countries. One of the first known empirical study of agriculture hit by DD is Scherr (1989) who compare three oil-exporting countries: Indonesia, Mexico and Nigeria. Based on descriptive statistics, the author finds evidence that oil boom 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 1981-2016, arguing that Nigeria is an under-industrialized economy where agriculture mainly rely 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 wage differentials between rural and urban areas and the subsequent rural-urban migrations and impact on agriculture. Based on a simple two-periods model, Feltenstein concludes that DD effects caused by oil revenues hampered agricultural production, generated migrations out of agriculture and encouraged an urbanization process in the country.

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 happen with no strong evidence of a RER appreciation. For instance, this result emerges from Mainguy (2011)'s study on gold boom in Mali that has been 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 following the causal mechanisms identified in the DD literature, but also 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).

Kablan and Loening (2012) apply two VAR Models to estimate the impact of oil production and oil prices on manufacturing and on agricultural value-added in Chad. Using quarterly data covering the period 1985-2008, they do not observe any significant impact neither of oil booms nor of oil price variations on the manufacturing sector, but a significant negative impact of energy booms on agriculture after one year, concluding to the presence of a disease for agriculture only in the Chadian economy.

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

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 have led to “de-agriculturalization” instead of “de-industrialization”, even though both effects can coexist. Second, even if both steps of DD, the RER appreciation and the decline in tradable output, may have been observed, they may not occur jointly, underlying the importance of investigating the different DD channels. Finally, and somewhat paradoxically, empirical studies relying on large panel of countries tend to clearly support DD, while country-case analyses generate more mixed results (see table 1). Although one cannot exclude a publication bias, this overall picture seems to indicate that DD is still a real threat, but not a curse, for developing countries, it might be avoided with sound public policies. The next section investigates therefore the literature related to the policy mix options aiming at escaping DD.

Table 1: Presentation of the Empirical Literature on Dutch Disease in Developing Countries

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

5 Responding to Dutch Disease

This empirical literature review confirmed the idea that the seminal theoretical models of DD can contribute to the understanding of the economic processes that happened in developing resource-rich countries. However, the question remains whether an appropriate public policy and an efficient management of natural resource revenues might help mitigating the 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.

5.1 The Central Role of Fiscal Policy

Overall, there has been a large literature relative to the role of fiscal policies to prevent (or at least reduce) 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...). However, this literature has evolved over time, from a focus on the role of taxation of resource sectors and redistribution in favor of non-resource tradable ones (compensation of DD effects) in the 1980s and early 1990s to adequate public management of natural resources revenues (prevention of DD and more precisely prevention of the public-caused spending effect) in recent years. This section covers the evolution of this literature by describing in a first step the arguments in favor of public redistribution across sectors and then by presenting the discussion relative to the determination of the optimal equilibrium between spending and savings.

5.1.1 Can Redistribution Across Sectors Help Mitigating Dutch Disease Effects?

When looking at the seminal models of DD, it is striking that the question of fiscal policy is related to the support of the tradable non-resource sector through redistribution (elaborated as industrialization policy). In other words, the main recommendation is simply to use a share of resource revenues to subsidize the tradable non-resource sector. Corden and Neary (1982) do not discuss policy in their seminal model. They only comment that “the manner in which the government spends its extra revenues is a crucial element in determining the magnitude and direction of the spending effect”. However, Corden (1984) argues that taxation of the resource sector to subsidize the tradable sector firms and workers (compensation) can help mitigating DD. The author also discusses the case of tradable sector protection but shows preference for the former strategy. Indeed, protecting importable industries by using trade barriers is considered to be too costly and ineffective for the exportable industries, and would protect both resource and non-resource tradable sectors. Van Wijnbergen (1984b) models the government trade-off between preventing DD by saving most of the resource revenues (NFA accumulation), or to correct it through public redistribution (tax and subsidies) in favor of the declining sectors. He concludes that subsidies should be preferred since conditions for an efficient NFA accumulation would be hardly met. Bruno and Sachs (1982) as well as Feltenstein (1992) also advocate that redistributive policies in favor of the declining sector could be efficient to mitigate DD effects on output, even if they cannot prevent the currency appreciation. 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. The author concludes that when oil revenues are partly invested by the government in agriculture (in the irrigation system), the 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 consequences of this model are specific to the Chadian economy (which suffers from inefficient water management and insufficient food availability), it shows that adequate public investment in the declining sector should be considered.

However, this strategy of public redistribution also presents some major drawbacks that are not often discussed in this literature. First, it requires an efficient tax system, able to tax the resource sector and to redistribute revenues to other sectors without losses during the process, which might be hardly met in countries where corruption prevails. Second, redistribution requires to identify perfectly what sectors will suffer most from DD consequences, otherwise subventions can be subject to corruption and political pressures and risk to create a rent for sectors that would have declined even without DD. Finally, if the level of subvention is directly linked to the level of resource revenues, then the high volatility in international commodity prices will generate a high volatility in subventions.

5.1.2 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. Indeed, the spending effect is partly caused by public spending (through either current consumption or investment) hence imposing rules to limit public expenditures seems an obvious strategy. In addition to limiting DD effects, saving resource revenues into an external fund also presents two main advantages. First, by creating a liquidity buffer, it will help to face sudden negative shocks in resource revenues that arise from the volatility of commodity prices. Second, accumulating revenues into a fund generating interests will allow to maintain a certain level of revenues and to smooth consumption even after depletion of NR reserves. Hence, savings contribute to take up three challenges that resource-rich countries often face: revenues volatility, resources exhaustion and DD.

However, there also exist many reasons why the main objective of resource-rich developing countries would not be saving all NR revenues. First, developing countries are often capital-scarce economies, implying that NR revenues could be efficiently invested in sectors with high marginal returns. It is also noticeable that if such investment is adequately made, they can help, better than external savings, to face future commodity price shocks or to smooth consumption in the long-run by increasing non-resource sectors economic growth. Then, many governments in developing countries lack adequate fiscal systems and face difficulties when trying to collect taxes, implying a lower level of public expenditures than the economy would require. In such a case, neglecting a large source of revenues coming from natural resources by saving them entirely in an external fund might not be the optimal strategy to maximize welfare in the long-run. Finally, developing countries often have a limited access of borrowing on to international markets, while a large endowment in NR can be an asset to benefit from lower interest rates. Resource-rich developing countries face a considerable variety of challenges, either issues arising from resource dependence (volatility, exhaustibility, DD) or challenges relative to most developing countries. Since resource revenues can help to solve these challenges (low level of physical or human capital, low public revenues and expenditures, low access to financial markets), it is obvious that in the discussion on the optimal use of resource revenues, the fight against DD can be secondary.

Therefore, the first question is to determine the adequate tradeoff between current expenditures, investment and savings (or most likely between investment and savings since

most authors advise not to use highly volatile resource revenues to finance current consumption). Collier et al. (2010) compare different approaches related to this tradeoff based on a theoretical model suited for capital-scarce economies¹¹. They advise to avoid both to spend too much of resource revenues during the boom (considering that this increased consumption will be unsustainable in the long run) but also to save too much of these revenues (considering that part of these revenues could be efficiently invested during the boom). Van der Ploeg (2019) discusses the main policy prescriptions regarding the use of natural resources by comparing developing and industrialized countries. The conclusion is that, due to the need of investment in physical capital in most developing countries, funds or fiscal rules in developing countries should target lower consumption but higher investment goals in the short run than other countries. Due to a reduced access to international markets for developing countries, resource revenues should also be used to reduce the cost of borrowing and to promote domestic investment, rather than be invested in foreign assets.

However, these prescriptions might appear to be quite vague for public authorities. In that case, more complete models suited for specific countries can be used. To that aim, one common approach is to use dynamic stochastic general equilibrium (DSGE) models (IMF, 2012), that have become increasingly frequent in the economic literature in the last decade. Based on a DSGE model adapted for the Central Economic and Monetary Community (CEMAC) and for 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). The authors finally conclude that this last approach overcome the two other approaches by addressing both the volatility and the exhaustibility issues. Based on a slightly different version of this model and applied only to Angola, Richmond et al. (2015) also compare three different approaches: 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 quite equivalent in terms of outcome and both overcome the last one. However, in presence of commodity price volatility, the gradual scaling-up approach clearly outperforms the other two approaches.

Once the equilibrium between investment and savings has been established, two questions remain. The first one relates to how revenues can be saved. The most common possibility is to save resource revenues in a Fund independent from the central government. It is noticeable that Sovereign Wealth Funds (SWF) have often been implemented in resource-rich countries to prevent DD or RC, but with mixed results¹². Wills et al. (2016) review the literature relative to the effects and types of SWF and observe that the fight against DD is one of the six main goals that these Funds have¹³. In their empirical study, Raymond et al. (2017) try to establish the

¹¹ Among the most popular approaches that are compared, one can cite the Permanent Income Hypothesis (based on a perfect smoothing of consumption over time), the Bird-in-Hand approach (all revenues from the boom are saved in an external fund and only interests are spent) or the Scaling Up of Public Spending (where the government sets a maximum in the increase of public spending).

¹² We will here simply review the main conclusions that can be drawn from Sovereign Wealth Funds experiences and not detail the differences between all different Funds. For a detailed typology of SWF, one can refer to Anne (2019).

¹³ The five 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.

impact of the existence of SWF on exchange rates misalignments in 24 oil- and gas-exporting countries (of which 8 countries without any SWF and 16 that have implemented a Fund at different time periods). Based on several dynamic panel estimators, they advocate that SWF contribute to reduce the volatility of RER misalignments. However, revenues from natural resources exports can also simply be accumulated by the central bank as reserves. A report from the African Development Bank and the Bill & Melinda Gates Foundation compares these two ways of saving NR revenues and argues that, due to the high fixed costs associated with the implementation of a SWF, this strategy should be preferred only when expected future resource revenues are large enough (AfDB/BMGF, 2015).

The final question is where and how to invest. A survey of the best government investment strategies in resource-rich developing countries would be off-topic here, but we can briefly underline that this question involves both 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 the DD effects, either by boosting overall productivity (through expenditures in education or in technology for instance) which will benefit to all sectors, including both tradable and non-tradable ones, or by improving exports capacities (through investment in specific infrastructures for instance), which will particularly benefit to tradable sectors.

5.2 The Role of Monetary Policy and Exchange Rates Regimes

The first models of DD noted that natural resources exports tend to affect the equilibrium in the money and exchange rate markets by affecting both demand and supply of domestic money. For instance, in the dynamic model developed by Aoki and Edwards (1983), an increase in resource revenues rises 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 disequilibrium in the money market in the short-run, 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 for non-tradable goods (if excess demand for money), counterbalancing them. However, in the long-run, 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 money market but focuses on the role played by exchange rates. Under flexible exchange rates, the additional income generated by resource exports results 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 offset the appreciation of the exchange rate). Under fixed nominal exchange rates, the trade surplus results in an excess supply of money if central bank interventions are not sterilized, hence to an appreciation of the real exchange rate through inflation. Therefore, even if in both cases the monetary aspect of Dutch disease leads to a real exchange rate appreciation, the nature of this appreciation depends on the exchange rate regime. It is noticeable that in these models, resource exports are assumed to create a trade balance surplus, at least in the short-run, and do not lead to an equivalent increase in imports (which would prevent pressures on the money market). Finally, under a fixed nominal exchange rate, the trade balance surplus could be maintained without inflation through sterilization. Neary (1982) mentions this “exchange-rate protection” strategy but does not discuss it. This sterilization could be achieved through a rise of the banking system’s

reserves requirement for instance, which compensates the increase in NFA-backed supply of money by a decrease in domestic credit).

Restrictive monetary policies can also be used to avoid inflation and RER appreciation, with the risk that deflationary pressures lead to recession, but there is no obvious consensus on the most adequate monetary policy to implement for resource-rich countries. For instance, Allegret et al. (2018) apply a multi-sectoral medium-scale DSGE framework to Algerian economy so that to compare the impact of an oil boom under three distinct monetary strategies in combination with fiscal policy: inflation targeting regime, fixed nominal exchange rate regime 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 the fixed exchange rate rule is the most efficient in combatting DD leading to the best results for the tradable sector. It is also the only rule under which a boom in oil prices leads to welfare gains. They explain for instance that “On the one hand, the exchange rate rule impedes the distortions due to the spending effect. On the other hand, as the real exchange rate does not appreciate after the oil shock, the resource movement effect does not play”. On the contrary, Lama and Medina (2012) perform a cost-benefit analysis of the effects of an exchange rate devaluation as a strategy against DD under a New Keynesian small open economy framework calibrated for the Canadian economy (but applicable to other countries). They conclude that even if an exchange rate stabilization policy can contribute mitigating DD effects, it also results in a costly misallocation of resources and to welfare loss, even in the presence of learning-by-doing in the tradable sector. Therefore, they argue that optimal monetary policies should allow the real exchange rate to appreciate, consistent with the absence of intervention from the Canadian central bank.

Empirically, the study from Usui (1997) helps to understand that, even if monetary policies can be useful, they are insufficient to address DD if it is not accompanied by adequate fiscal policies. Indeed, the author concludes that the two devaluations implemented in Indonesia and Mexico led to clearly different results in each country. The explanation proposed is that Indonesian government spending was oriented toward investment rather than current consumption and avoided the creation of large public deficit and debt. The author also notices that even under a fixed nominal exchange rate regime, real appreciation can be avoided by accumulating budget surpluses and foreign exchange reserves. Therefore, monetary tools such as devaluations in fixed nominal exchange rate regimes can be implemented to mitigate DD, but their effectiveness will depend on other macroeconomic policies. However, there is overall a clear lack of empirical studies addressing the particular role of monetary policies against DD.

Using a DSGE model fit for Nigeria and the Western African Economic and Monetary Union, Carton et al. (2010) estimate the impact of Nigerian oil revenues both on Nigeria and on other WAEMU countries under the hypothesis of a regional currency union. They observe that Nigeria would benefit more from a flexible exchange rate with fixed money supply whereas other WAEMU countries would benefit more from a fixed exchange rate. However, they also conclude that a Stabilization Fund in Nigeria could contribute to reduce the divergence between the countries' benefits from different monetary regimes. These results help to understand the regional impacts of DD, and the specific issue it causes in a monetary union, and then confirm the importance to implement both fiscal and monetary policies when facing DD.

Overall, theoretical as well as empirical studies reveal that there is room for public (fiscal or monetary) policies to avoid or at least to mitigate DD. Yet, there is very little evidence and

mixed conclusions related to what these policies should be. It is from now still unclear whether it is better to avoid the DD (for instance by controlling the level of public spending and by accumulating foreign assets during the booms) or to compensate for it (by redistributive policies to the tradable non-resource sector or by efficient public investment aimed at increasing productivity or competitiveness). This difficulty to infer clear conclusions from the literature comes partly from the large variety of issues that governments are facing when experiencing a resource boom (corruption, volatility of revenues, social or environmental consequences). The question of the optimal management of resource revenues is therefore rarely restricted to the fight against DD alone.

6 Continuing Exploring Dutch Disease

There is overall large empirical evidence that DD exists and should be considered seriously by developing resource-rich countries. However, further analyses remained necessary regarding the determinants that explain the probability of such a disease and then the best strategies to implement against such as threat.

It also appears that, even though the seminal models remain at the theoretical core of DD analyses, they are often not suited to study developing countries, characterized by tradable agriculture, high level of unemployment or informal labor, imperfect tradability of “tradable” goods, and difference between importable and exportable goods... Yet, some studies, either theoretical or empirical, have emerged in the recent decades to discuss these assumptions and finally led to the existence of a large literature related to DD in a developing setting.

There is surprisingly very little discussion regarding the most suited empirical strategies and the variables to choose when investigating the presence of DD: most of the knowledge about the issue related to the explanatory variable (resource rent, revenues, prices or reserves) come from the Resource Curse literature whereas there is little debate on the outcome.

Finally, one can highlight the importance to distinguish the DD and the RC, and notice that the DD is not a “curse” per se since the existence of a declining sector does not necessarily imply a declining economic growth, and since DD can be avoided though adequate, while still debated, policies.

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