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Essays on Economic Diversification in Resource-Rich Developing Countries

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Thèse défendue pour l'obtention du diplôme de docteur en sciences économiques et de gestion

Jury

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Stay hungry, stay foolish.

Steve Jobs

Summary

Economic diversification is a major preoccupation for policymakers in developing countries. Greater levels of economic diversity appear to be associated with higher economic stability and steady growth. However, countries at early stages of development often exhibit high levels of sectoral concentration. This is particularly striking for resource-rich developing countries as they tend to be highly dependent on commodity exports. This thesis aims to analyse economic diversification in the context of resource-rich developing countries with a particular focus on Sub-Saharan Africa.

Chapter 1 assesses the total effect of the lack of economic diversity on long-term growth and the contributions of some indirect transmission channels through which part of this effect is carried. The study uses the levels of exports concentration and resource dependence as measures of activity concentration. The analyses reveal negative effects of sectoral concentration on long-term growth which appear to be more pronounced in countries at early stages of development than in advanced economies. Parts of these effects are found to be indirectly transmitted to long-term growth via human and physical capital deterioration, changes in trade openness and foreign exchange reserves, and higher corruption levels induced by exports concentration and resource dependence. However, the study shows that favourable initial levels of some of the transmission variables may moderate the negative effect of concentration on long-term growth. In the case of advanced economies, high initial levels of international competitiveness and education are even found to result in a positive impact of sectoral concentration on long-term growth. This suggests that, though it might be crucial for developing countries to aim for greater economic diversification, such strategy may not be dominant for advanced economies.

Chapter 2 investigates Dutch disease patterns in two major copper producing developing countries, namely the Democratic Republic of Congo (DRC) and the Republic of Zambia. The analyses show some signs of copper-induced de-agriculturalization in the two countries. These findings indicate that Dutch disease dynamics may undermine diversification initiatives in

resource-rich developing countries by making non-resource traded sectors more vulnerable to foreign competitors.

Chapter 3 analyses the impact of special economic zones (SEZ) adoption on export diversification in Sub-Saharan Africa. Over the past 30 years, SEZ programs have proliferated in the region with the aim to enhance exports and economic diversification. It appears that SEZ adoption may have fostered diversification in the region by balancing more equally export shares amongst traditional industries. However, these policies seem to have been less effective to promote the creation of new activity sectors.

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General introduction

This thesis is devoted to analysing economic diversification in the context of resource-rich developing countries with a particular focus on Sub-Saharan Africa. The work is composed of three chapters which can be articulated around three main questions: (1) *"How is economic diversification linked to growth in developing countries?"*, (2) *"What does hinder economic diversification in resource-rich developing countries?"*, and (3) *"How do current industrial policies contribute to economic diversification in Sub-Saharan Africa?"*. The objective of this general introduction is three-fold. Firstly, it provides the reader with some theoretical concepts related to comprehension and measurement of economic diversification. Secondly, it discusses the choice of export diversification and resource dependence as indicators of economic diversification. Finally, it offers some preliminary analyses which unveil the common thread linking the different chapters of the thesis.

The literature provides us several definitions of economic diversification and various angles through which to consider that topic. Kenen (1969) defines economic diversification as the number of single-product regions contained in a country. The idea is that as each region focuses on its comparative advantage, diversification for a country consists in the sum of multiple regional specialisations. For Hackbart & Anderson (1975) and Attaran (1986), economic diversification refers to an equalisation of the shares of activity sectors in total employment. Through that prism, a country is fully diversified when equal importance of sectors is reached. Imbs & Wacziarg (2003) follow the idea of equal sectoral contribution and argue that a country is diversified when its economic activity is spread equally across sectors. Malizia & Ke (1993) include the notion of uncorrelation amongst sectors in their conception of diversity. They claim that diversity refers to the variety of economic activity which reflects differences in economic structure. For Chen (2016), diversification refers to a transformation of the economy through a widening of sources of income spread over primary, secondary, and tertiary sectors, involving a large section of the population.

Besides the aforementioned various definitions of economic diversification, the metrics to measure it are also numerous. There seems however to be a consensus in the literature on the fact that economic diversification should be linked to levels of employment, exports, or income. Thus, the level of diversity can be measured as the share of sectors in GDP, in exports or in total employment, or as the dependence of a country on the export of a good or commodity (Chen, 2016). Alsharif et al. (2017) argue that for large countries with important internal markets, employment trends are likely to be better indicators of diversification. On the other side, for small and medium sized countries with smaller internal markets and a higher propensity to be outward oriented, export-based measures are better indicators. In this thesis, economic diversification is measured by two indicators, namely the IMF's Theil exports diversification index and the total natural resources rent (% of GDP). It is important to note that for both measures, higher values indicate lower levels of diversification (i.e. higher concentration). The rationale for this choice is two-folded: (1) although resource dependence may show an accurate picture of economic diversification for resource-rich countries, this measure is likely to be less effective for countries with low resource endowment. Exports diversification may perform better in such cases and reflect more accurately the level of diversification than resource dependence. (2) Alsharif et al. (2017) show that export-based measures of diversification do not provide accurate insight on economic diversification for countries with important internal markets as they tend to be less outward-oriented. In such cases, resource dependence may reflect better the sectoral concentration of the country. This is especially the case for resource-endowed countries with strong internal markets such as Australia or Canada. For these reasons, both measures are included in the study as they appear to be complementary.

Greater economic diversification is a desirable feature toward which countries generally intend to lean. The main argument in that sense is that greater levels of diversification may help countries to cushion the adverse effects of business cycles. Indeed, by spreading the activity, and thus employment and income sources, over a wider range of sectors, countries become less sensitive to economic fluctuations. Beyond these nice portfolio properties, the path to greater levels of diversification is also paved with learning by doing enhancement in a growing number of sectors. These elements put together tend to consolidate the bases for steady long-term growth (Attaran, 1986; Agosin, 2008).

However, the literature suggests that fetching higher levels of economic diversification may not necessarily be a dominant strategy for countries. Indeed, Ricardian trade models rather extol comparative advantage-based specialisation. Moreover, the influential work of Imbs & Wacziarg (2003) has shown that countries at low stages of development tend to pursue economic diversification, while more advanced economies appear to follow a trend of re-specialisation. Figure 0.1 illustrates this U-shaped pattern of concentration with a locally weighted scatterplot smoothing (LOWESS) of the relationship between GDP per capita and export concentration for a panel of 211 countries over the period 1960-2019.

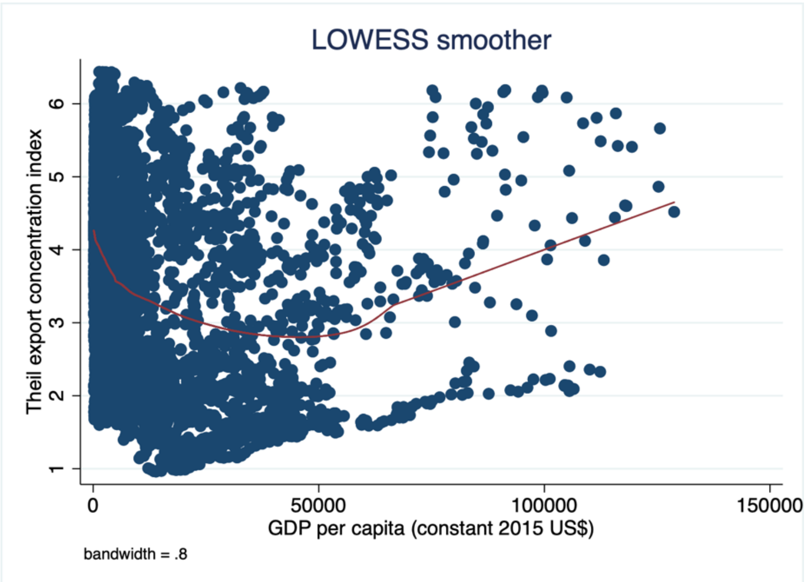


Figure 0.1. Theil export concentration index and GDP per capita with fitted LOWESS smooth curve.

These constatations tend to suggest that the appeal for diversification may differ depending on the development level of a country and exclude the idea of a monotonic relationship between economic diversification and growth. Chapter 1 aims at evaluating the impact of economic the lack of diversity on growth for countries at early stages of development and advanced economies separately. Moreover, the study provides insight on the transmission channels through which diversity may be indirectly linked to growth.

Figure 0.2 depicts the relationship between resource abundance measured by the total natural resources rent per person (as suggested by Lashitew et al. (2020)) and export concentration for a panel of 188 countries over the period 1960-2019. Countries endowed with abundant natural resources tend to exhibit higher levels of sectoral concentration. The resource curse literature provides some insight on the difficulty for resource-rich countries to diversify. The abundance of natural resources and the subsequent resource windfall are found to foster rent seeking behaviours and poor economic management. Indeed, political elites and resource rentiers in resource-rich countries tend to capture large shares of resource benefits. Moreover, government revenues in such countries are mainly gathered from direct access to resource rents rather from disciplined tax collection from all agents. These elements put together are found to results in poor institutional quality, corruption, unsound industrial policies, and weak investments in non-resource sectors, in infrastructures and in human capital; which jeopardize the development of new economic sectors (Sala-i-Martin & Subramanian, 2013; Cockx & Francken, 2016; Badeeb et al., 2017). Additionally, resource-rich countries may be subject to Dutch disease effects which are detrimental to existing non-resource traded sectors and further undermine diversification attempts (Corden & Neary, 1982). Chapter 2 tackles this latter concern by analysing the reaction of the agriculture sector to copper booms in the Democratic Republic of Congo (DRC) and in the Republic of Zambia. Since the early 2000s these two developing countries have adopted some investor-friendly mining codes resulting in tremendous surges in copper extraction which may have come at the expenses of de-agriculturalization and further sectoral concentration.

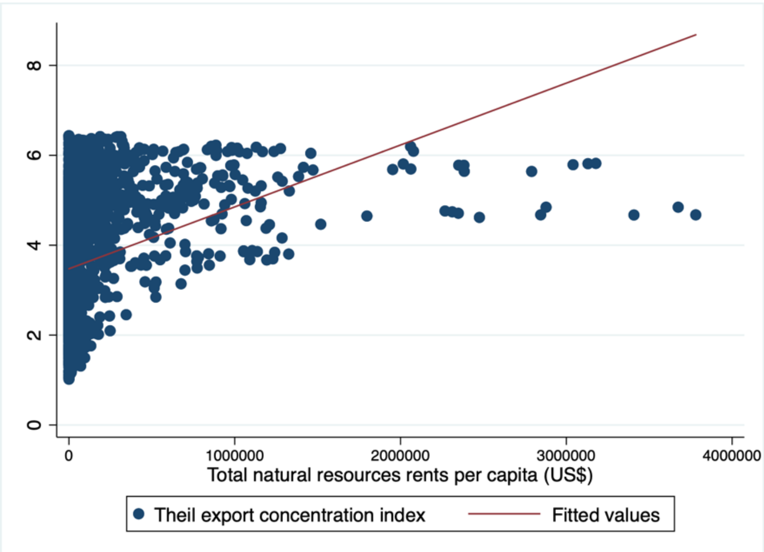
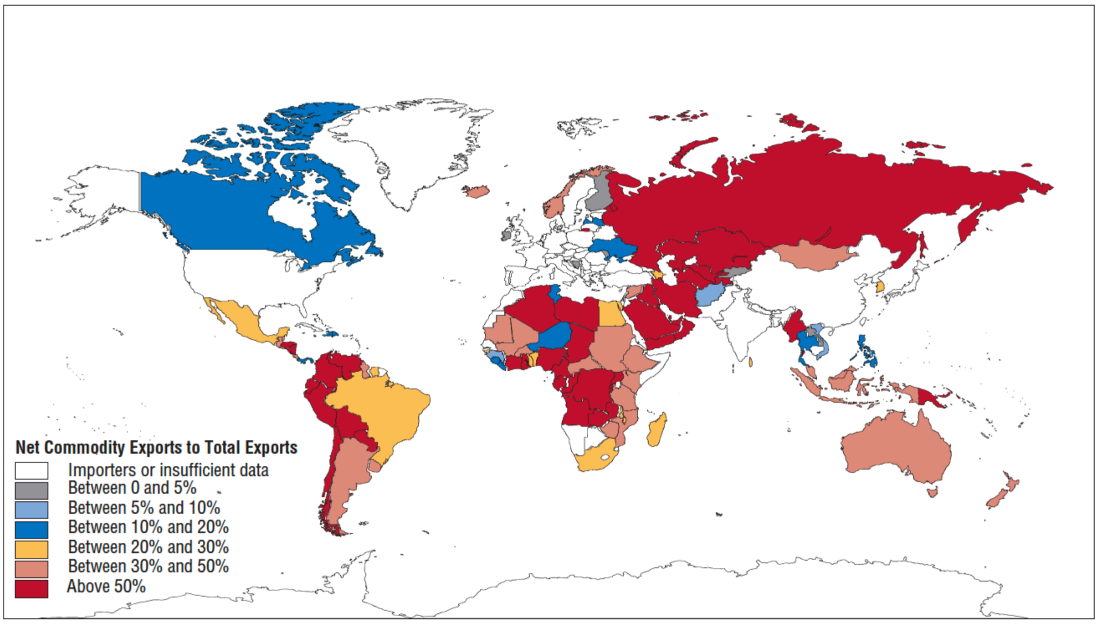


Figure 0.2. Total natural resources rent per capita and Theil export concentration index with fitted values.

High sectoral concentration appears to be a recurrent feature in resource (or commodity)-rich countries, some of which being even considered to be resource-dependent. A country is said to be dependent on resources (e.g., minerals, ores, metals, fuels, forest products, etc.) if these items account for at least 60% of exports (UNCTAD, 2022). Figure 0.3 depicts the levels of shares of commodities in total exports over the globe based on IMF's data averaged for the period 1962-2010.

Figure 0.3. Net commodity exports (% of total exports).



Source: IMF

Based on the aforementioned definition, 83% of countries in Africa are considered as resource-dependent and about 45% of resource-dependent countries in the world are located on the African continent (UNCTAD, 2022). Given that constatation, economic diversification and the reduction of resource dependence have become major concerns for policymakers on the continent. Amongst the policy tools devoted to serving the diversification objectives are those consisting in the adoption of special economic zones (SEZs). Chapter 3 dives into SEZ implementation in Sub-Saharan Africa and provides an evaluation of the impact of SEZ programs on export diversification in the region. The analyses performed in that chapter target overall export diversification along with extensive margins (i.e. diversification by the creation of new sectors) and intensive margins (i.e. diversification by balancing more equally the shares of traditional sectors in exports).

These three chapters are presented in the form of articles that have been submitted for publication in international scientific journals and are currently under review.

Chapter 1 Economic Diversity and Growth: Empirical Investigation of Transmission Channels

This chapter empirically assesses the total effect of the lack economic diversity on long-term growth and the contribution of some indirect transmission channels through which part of this effect is carried. Sectoral specialisation, measured by the level of exports concentration and resource dependence, is found to have negative effects on long-term growth which appear to be more pronounced in developing countries than in advanced economies. Parts of these effects are established to be transmitted indirectly to long-term growth through human and physical capital deterioration, changes in foreign exchange reserve and trade openness levels, and higher corruption induced by economic concentration. Further analyses indicate that favourable initial levels of some of the transmission variables may help alleviating the negative effect of concentration on long-term growth through some moderation effects.

1.1 Introduction

Economic diversity refers to the level of spreading of a country's economic activity across sectors (Imbs & Wacziarg, 2003). Greater levels of diversity are associated with more stability in income and unemployment. Indeed, spreading risks (and opportunities) over a wider range of sectors is intended to allow countries to absorb the adverse effects of economic cycles and external shocks more smoothly (Attaran, 1986; Malizia & Ke, 1993; Wagner & Deller, 1998; Deller & Watson, 2016). Beyond these stabilisation properties, economic diversity is increasingly recognised as an instrument for growth, especially for countries at early stages of development (Herzer & Nowak-Lehnmann, 2006; Papageorgiou & Spatafora, 2012; Mania & Rieber, 2019). This is partly because by fostering economic stability, greater levels of diversity help consolidate the bases of economic growth (Gylfason, 2018). Moreover, developing countries that tend to specialise based on their comparative advantage may remain confined to either highly volatile natural resource sectors or to low-growth traditional manufacturing sectors (e.g., food, textile, apparel, etc.) (Sekkat, 2016).

Although the literature provides support of a linkage between diversity and growth, studies aimed at disentangling the mesh of that nexus remain scarce. Herzer & Nowak-Lehnmann (2006) and Gelb (2010) argue that export diversification comes along with positive externalities of learning-by-doing and learning-by-exporting due to international competition, resulting in accelerated growth. Papyrakis & Gerlagh (2004) analysed the question through the prisms of the "resource curse" hypothesis and natural resource abundance. Indeed, economic concentration around a dominant sector is a common feature in commodity-rich countries. The authors identify dampened investments as the main channel through which a higher dependence on natural resources may undermine growth. The other channels, ranked by relative importance, include lower trade openness, less favourable terms of trade, lower education, and higher corruption levels.

This paper aims to assess the total effect of the lack economic diversity on long-term growth, and to identify the mechanisms through which this effect may be carried. Cross-sectional data for 196 countries over the period 1998-2019 are used for the analyses. The considered channels include some typical growth determinants, such as investment and education levels, along with corruption. As countries diversify, an increasing number of products can be found locally, resulting in a reduced import bill and local currency appreciation (Alley, 2018). To account for these effects, some additional plausible international channels (i.e., openness to trade, foreign exchange reserves, and real effective exchange rate) are also considered. Chen (2016) mentions that economic diversity can be measured either in terms of the sectoral distribution of national income, total employment, or exports or as a country's dependence on a certain commodity. In this paper, economic diversification is measured by two indicators, namely the IMF's Theil exports diversification index and the total natural resources rent (% of GDP). It is important to note that for both measures, higher values indicate lower levels of diversification (i.e. higher concentration). For clarity purposes, these indicators will be referred to as concentration measures in the analyses. Therefore, the effects that will be assessed in this chapter will be related to the lack of diversification.

The choice to use these two measures lies in their complementarity. Figure 1.1 plots observations of mean values of natural resources rent (% GDP) and exports concentration for the period 1998-2019. The fitted LOWESS curve shows that higher levels of natural resource dependence correspond to higher exports concentration. However, at low levels of natural resource rent, we observe a wide dispersion of observations along the vertical axis. The dependence on natural resources thus appears to be a fairly less accurate measure of economic concentration (and diversification) than the Theil exports index for countries with low resource endowment. On the other hand, Alsharif et al. (2017) show that export-based measures of diversification do not provide accurate insight on economic diversification for countries with important internal markets as they tend to be less outward-oriented. In such cases, resource dependence may reflect better the sectoral concentration of the country. This is especially the case for resource-endowed countries with strong internal markets (e.g., Australia, Canada, U.S.A, etc.).

The empirical analyses conducted in this paper allow us to identify both direct and indirect effects of economic diversity on growth via mediation studies. Moreover, as the manifestation of the nexus between diversity and growth may differ at various stages of development, some additional analyses are performed separately on subsamples of developing and developed countries.

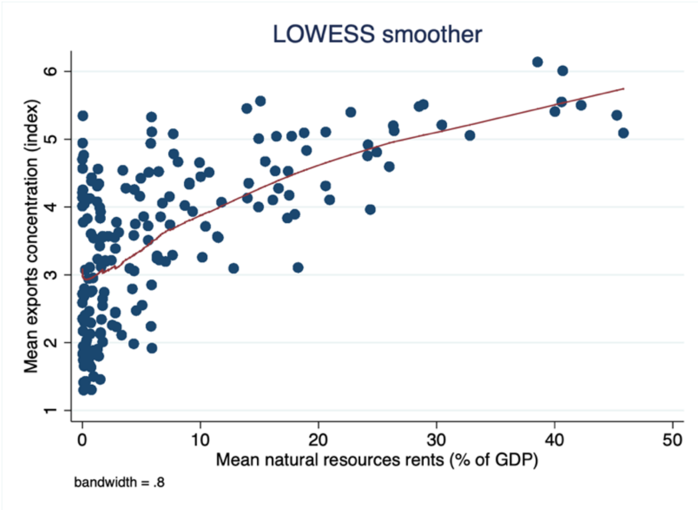


Figure 1.1. Mean natural resource rent (%GDP) and mean Theil export index with fitted LOWESS smooth curve.

Beyond this introductory section, the remainder of this chapter is organised as follows: section 1.2 presents the envisaged transmission channels and the rationale for their selection. The core empirical analyses are performed in section 1.3 while some further moderation studies are performed in section 1.4. The conclusions drawn from the findings are presented in the last section of the chapter.

1.2 Transmission channels

A. Openness to trade

Higher openness to trade comes along with more opportunities for countries, especially small States, to access larger markets and benefit from knowledge and technology transfers. This in turn contributes positively to their capacity for long-run growth (McIntyre et al., 2018). The level of economic diversity that a country exhibits is likely to influence its openness to trade. On the imports side, as more types of products become available locally, domestic consumption is expected to be enhanced. This results in lower import levels and in changes in the type of goods imported. On the other hand, exports are expected to be positively influenced by higher levels of diversification, as greater variety in production offers more opportunities to serve foreign markets. Gylfason (2018) argues that as countries diversify, they tend to be more efficient in their production processes and more open to trade. However, given the expected decrease in the imports bill and increase in exports, no clear-cut hypothesis can be made about the direction into which economic diversity may influence trade openness.

B. Reserves

Krušković & Maričić (2015) show that the build-up of foreign exchange reserves has a stimulating effect on long-term growth in developing and emerging countries. A first argument in that sense is that the accumulation of reserves leads to exchange rate depreciations, which in turn discourage imports while fostering exports and thus enhancing growth. In addition to the export-led growth argument, another motivation for reserve accumulation is that it may help reduce the odds of currency crises and protect against subsequent output losses (Wyplosz, 2007). Indeed, larger reserves may contribute to increasing the trustworthiness of developing and emerging countries and act as a deterrent tool against speculative attacks. For developed countries, however, bearing the costs of excessive stock of reserves appears to be unworthy, as they can easily borrow in the international capital market when required (Krušković & Maričić, 2015). Greater levels of economic diversity are expected to be associated with larger foreign exchange reserves. The idea is that as countries span their activities over a wider range of sectors, they increase their opportunities for trade and reach new trading partners. This is reflected in the amount of foreign currency inflows, as well as in the currency composition of reserves, which depends directly on the currency invoicing of trade (Ito & McCauley, 2020).

C. Investment

Successful diversification efforts tend to be associated with enhanced investment in physical and human capital, which in turn contribute to long-term growth (Mim & Ali, 2020). Rodrik (2005) argues that prosperous economies are characterized by diversified investments into a wide range of activities. Economic concentration on the other hand is linked to lower levels of investment. This negative relationship between concentration and investment may result from the fact that the lack of sectoral diversity bereaves investors from opportunities for portfolio diversification. Consequently, investment in such an environment may appear to be more vulnerable to market fluctuations and shocks, which can be discouraging for investors. This is particularly the case in resource-based economies, as recurrent fluctuations in resource prices tend to increase real exchange rate volatility, resulting in decreased investment in tradable sectors. Moreover, resource abundance also tends to foster rent-seeking behaviours from investors and producers, causing investments to be rechannelled from more socially profitable sectors (i.e., manufacturing and agriculture) to the resource sector (Gylfason & Zoega, 2006). This study considers investment as a channel through which economic diversity may influence growth. Indeed, physical capital accumulation is required both to stimulate new economic sectors and to keep them alive as they face international competition. This in turn is expected to foster growth.

D. Competitiveness

Through the diversification process, efforts to stimulate new activity sectors confront international competition, especially in the case of tradable sectors. Successful diversification strategies are thus accompanied by increased competitiveness. The real effective exchange rate (REER), which measures the real value of a country's currency in relation to the basket of the trading partners of the country, provides a gauge of international competitiveness (Darvas, 2012). REER appreciations appear to affect competitiveness and growth negatively, as they cause investments and resources to be rechannelled to nontradable sectors, while tradable goods become less affordable for consumers and less attractive for investors and thus more vulnerable to foreign competition (Comunale, 2017). Such schemes are common in resource-rich countries subject to Dutch Disease issues, especially those exhibiting high concentration levels around their resource sector (Badeeb et al., 2017). Alley (2018) analyses the relationship between economic diversification (proxied by non-oil exports) and the exchange rate. The author argues that diversification stems currency depreciations in oil-exporting countries by decreasing the sensitivity of the currency to oil prices. Currency depreciations make local products more affordable for foreign consumers and thus stimulate exports. Moreover, as diversification allows more consumption needs to be satisfied by local production, it offers protection against imported inflation associated with currency depreciation.

E. Corruption

The literature remains divided about the effect of corruption on economic growth. On the one hand, some researchers support the hypothesis of a desirable "grease the wheels" effect of corruption (e.g., Acemoglu & Verdier, 1998; Méon & Weill, 2010). The idea is that corruption may increase efficiency in the provision of government services by providing additional pecuniary incentives for bureaucrats to do their jobs. Moreover, bribery may help entrepreneurs avoid the burden of heavy and inefficient regulations (Mo, 2001). Méon & Weill (2010) find significant positive marginal effects of corruption on aggregate efficiency in countries with weak institutional frameworks. On the other hand, several studies (e.g., Mauro, 1995; Mo, 2001; Méon & Sekkat, 2005) show a detrimental "sand the wheels" effect of corruption on growth, as it may favour institutional instability and discourage investors. In this study, we remain theoretically agnostic about the effects of corruption on growth.

The literature shows a negative link between the levels of economic diversity and corruption (e.g., Serra, 2006; Bhattacharyya & Hodler, 2010). The multiplication of activity sectors may help alleviate the strangleholds of autocratic leaders and pressure groups on the economy. Moreover, diversity helps reduce the reliance on resource rents while enhancing the role of tax proceeds as a source of revenue for the nation. These changes come along with increased demand for democratic accountability and institutional efficiency, which are associated with lower levels of corruption (McFerson, 2010; Badeeb et al., 2017).

F. Human capital

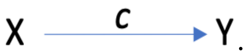
The literature recognizes education as an important driver of economic growth givent that it contributes substantially to human capital accumulation (e.g., Barro & Lee, 1994; Krueger & Lindahl, 2001). Higher levels of economic diversity tend to be linked with enhanced schooling, as the variety of activity sectors translates into a variety in labour-skills needs (Mim & Ali, 2020). Economic concentration around sectors with relatively high-paying and low-skill jobs, which is a common feature in resource-based economies, tends to be detrimental to schooling and thus to human capital. Indeed, such a configuration tends to result in higher opportunity costs and lower returns on education, discouraging human capital accumulation (Cockx & Francken, 2016; Marchand & Weber, 2018). The crucial role of education in long-term growth along with its relationship with economic diversity suffice to envisage it as a plausible transmission channel.

1.3 Empirical analyses

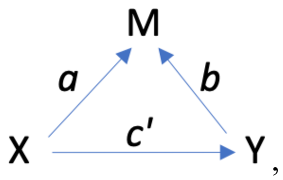
1.3.1 Methodology and data

The aims of this study are to assess the influence of sectoral concentration on long-term growth and to analyse the mechanisms through which that effect is carried. To that end, a mediation analysis is implemented considering the identified transmission channels as potential mediators via which the levels of exports concentration and resource dependence may have causal effects on long-term growth.

Let X, a variable assumed to have a causal effect c on an outcome variable Y. This can be represented by the following diagram:



Assume the total effect c is partially carried through some mediation variable M as depicted in the following diagram:



then the path c' represents the direct effect of X on Y, while ab is the indirect or mediated effect of X on Y through M, and $c = c' + ab$ (VanderWeele, 2015). The purpose of the current study is to measure both the direct and mediated effects of exports concentration and resource dependence on long-term term growth considering the multiple transmission channels identified in the literature as mediation variables.

The study uses cross-sectional data for a sample of 196 countries covering the 1998-2019 period. The causal variables analysed are the levels of exports concentration (measured by the IMF's Theil exports concentration index) and resource dependence (total natural resources rent as percentage of GDP). Both measures are expected to capture the level of sectoral concentration of the economic activity in the observed countries. The vector of transmission channels denoted $\overrightarrow{TC}^i$ contains all the potential mediation variables. The outcome variable is the long-term growth rate of GDP per capita from 1998 (t_0) to 2019 (t_T), denoted by $G^i = (1/T)ln\left(GDP_T^i/GDP_0^i\right)$.

In line with Papyrakis & Gerlagh (2004), the estimations are based on the hypothesis of growth convergence. It is expected that advanced economies exhibit lower growth rates than countries at earlier stages of development. G^i is thus assumed to depend negatively on the control variable $ln(GDP_0^i)$ (i.e., the logarithm of the initial GDP per capita). In addition, potential regional effects are controlled for by including a categorical region variable to the estimations.

Details on the definitions, sources and timeframes of the variables are provided in appendix 1-A, while Table 1.1 displays the descriptive statistics. Note that all causal and mediation variables consist in observations at t_0 except for the corruption measure which is an average over the period 1998-2011. This exception is due to the lack of data on corruption for early periods in the sample for many countries. The choice of an average measure for corruption instead of initial period observations is expected to have little impact on the estimation outcome. Indeed, as institutions tend to evolve slowly, corruption variables appear to exhibit low variability over time (Mo, 2001; Papyrakis & Gerlagh, 2004). Therefore, the computed average for early periods is likely to be close to initial values and allows to make up for missing observations. Note that the corruption measure employed in this study consists in a scale from 0 (highly corrupted countries) to 10 (clean countries).

Table 1.1. Descriptive statistics

Variable	Obs.	Mean	Std. Dev.	Min	Max
Growth	190	0.021	0.018	-0.018	0.085
Exports concentration	181	3.371	1.174	1.342	6.369
Resource dependence	182	4.982	7.758	0.0007	43.559
Trade openness	176	79.970	46.223	1.166	312.079
Reserves	171	20.693	2.546	13.332	26.096
Investment	165	22.886	7.366	2.100	45.495
REER	176	108.606	46.583	13.762	437.486
Corruption	185	4.047	2.044	1.160	9.487
Schooling	166	66.537	32.213	5.291	155.724

The mediation model analysed in this study is estimated using structural equation modelling (SEM) for the following system:

$$\begin{cases} G^i = f(X^i, \overrightarrow{TC}^i, ln(GDP)_0^i, Region^i) \\ TC^i = f(X^i, ln(GDP)_0^i, Region^i) \end{cases} . \quad (1)$$

Note that $\overrightarrow{TC}^i$ refers to the entire vector of transmission channels while TC^i corresponds to the channels taken separately.

The structure imposed to the system is represented by the path diagram displayed in figure 1.2. Following traditional notation for SEM path diagrams, single-headed arrows indicate senses of causality while double arrows indicate that variables may influence each other in both directions. Compared to traditional multiple equation approaches such as that employed by Papyrakis & Gerlagh (2004), SEM allows for the estimations of all effects in a single run via maximum likelihood. Moreover, this estimation technique permits to explicitly test for the significance of the mediation effects via bootstrap (Zhao, et. al, 2010).

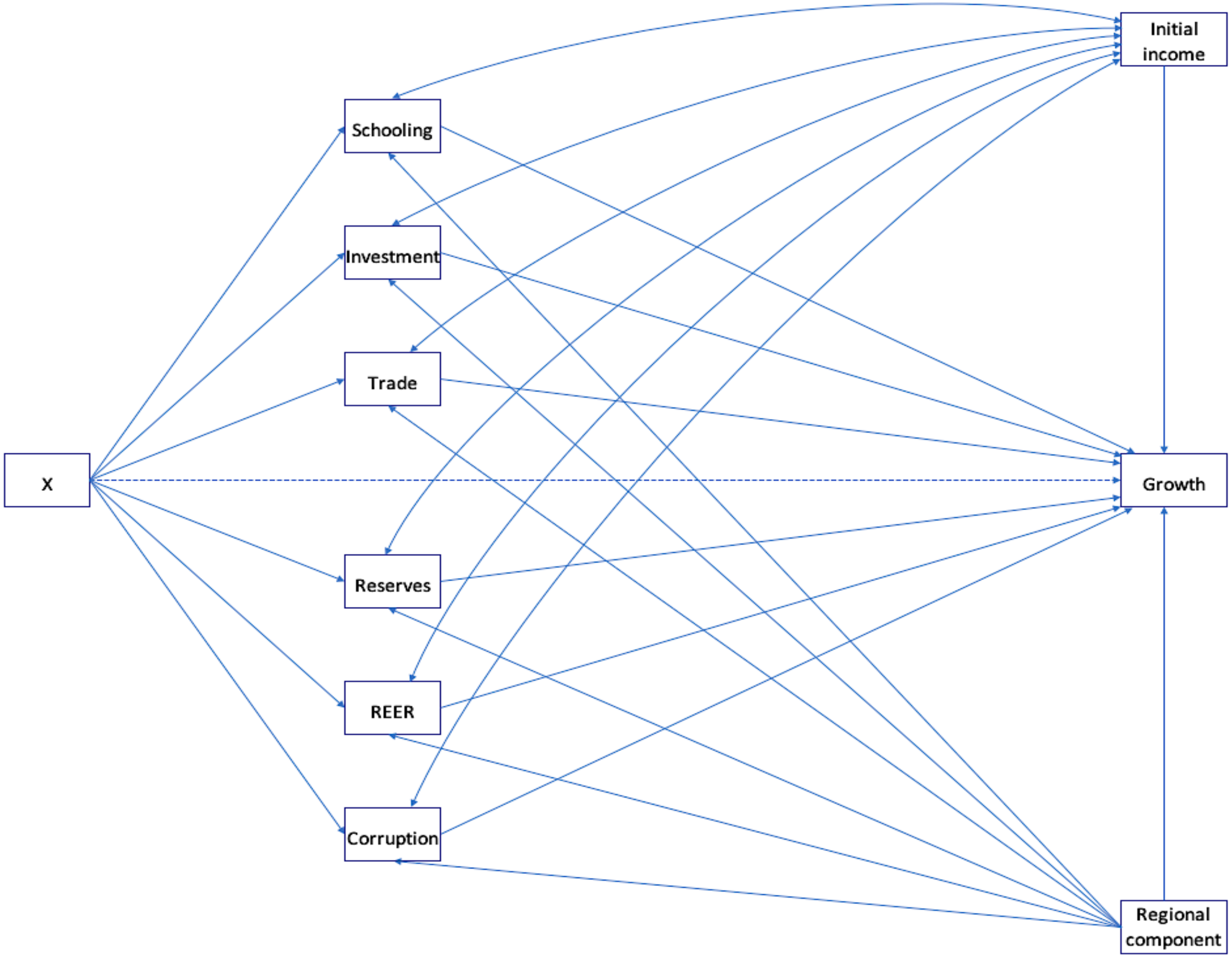


Figure 1.2. Mediation study path diagram.

1.3.2 Results

Figures 1.3 and 1.4 display the results of the maximum likelihood (ML) estimation of the SEM for the entire sample with respectively exports concentration and resource dependence as causal variables. Note that for clarity reasons, only the paths of interest are depicted. Following Baron & Kenny (1986), mediation is established if both paths a and b are significant. In the current analysis, these cases are represented by thicker arrows in the diagrams. Note that while all the coefficients on arrows are unstandardized, the estimated indirect effects (noted inside mediation variable rectangles) and the direct effects (on dashed arrows) are standardized in units of standard deviations of mean to facilitate the comparison and ranking of the channels.

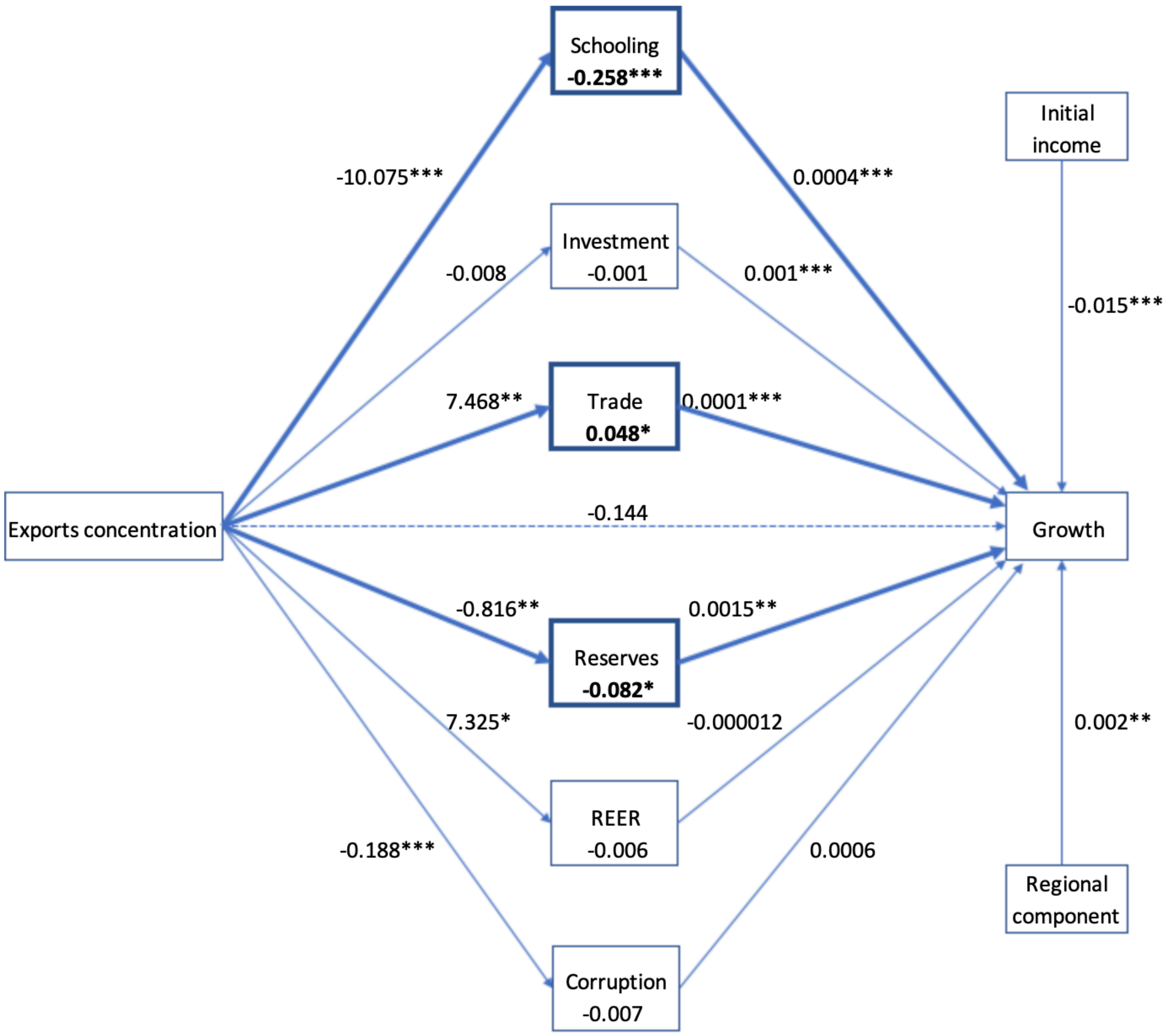


Figure 1.3. Path diagram SEM with exports concentration (full sample).

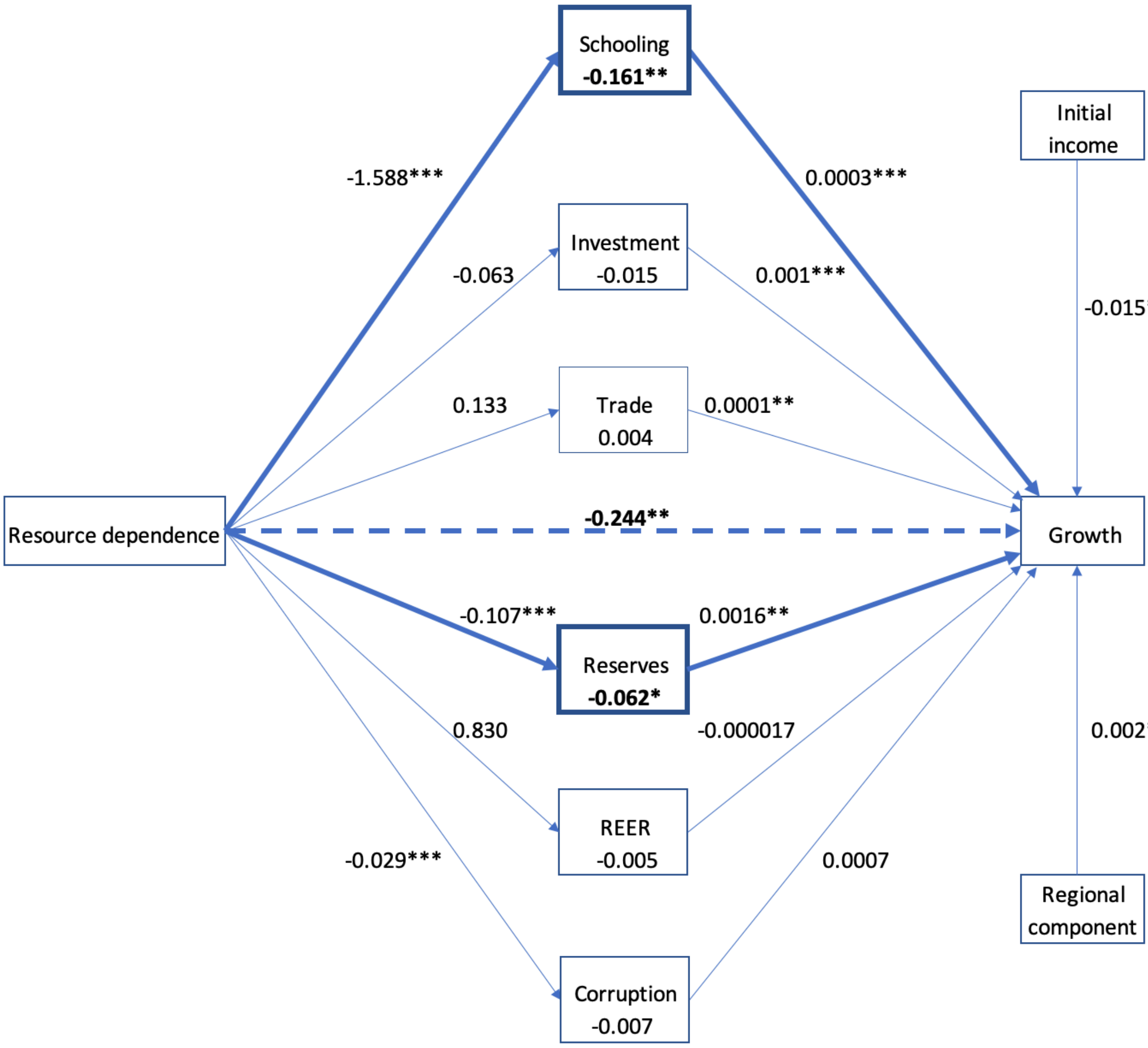


Figure 1.4. Path diagram SEM with resource dependence (full sample).

The results show that both exports concentration and resource dependence have negative direct effects on long-term growth, yet these effects appear to be significant only for the latter causal variable. This tends to suggest that while resource dependence per se may be detrimental to growth, higher levels of exports concentration may undermine growth only indirectly. Among all the channels considered, schooling, trade openness and reserves accumulation appear to be mediators of the causal effect of exports concentration on long-term growth. Higher levels of exports concentration are found to undermine human capital accumulation as suggested by the estimated negative impact on schooling. Given the significant and positive role played by education on long-term growth, a negative mediation through the schooling channel (-0.258) is established by the model. The same is observed with reserves accumulation with an established mediation effect of -0.082. Increases in the exportx concentration index are found to raise trade openness, which in turns appears to have a positive significant impact on the outcome variable. The model therefore establishes a positive mediation of the trade openness channel amounting to 0.048. The standardized indirect effects for this model show that most of the causal effect of exports concentration on long-term growth is carried through human capital deterioration, followed by foreign exchange reserves depletion and trade openness enhancement.

In the case of resource dependence, the SEM estimation indicates that the highest share of the total effect seems to be directly transmitted to the outcome variable as suggested by the significant negative direct path with a size of -0.244. Then follow some indirect effects through human capital deterioration (-0.161) and a negative mediation via the reserves channel (-0.062).

Likewise multiple regression analyses, SEM estimations may be vulnerable to potential endogeneity issues. For instance, there may exist some confounders that cause both the mediator and the outcome, leading to inconsistent and biased estimators. As suggested by Pearl (2014) and Kirby & Bollen (2009), a SEM approach with instrumental variables (SEM-IV) could be a more robust estimation technique in such case. Before proceeding to the alternative estimation, two important points should be raised here. Firstly, the choice has been made to instrument each variable in the model (except the initial income and the region variable considered as exogenous) by its own quadratic transformation. The set of instruments is thus always of the same length as the set of endogenous variables. Secondly, it should be noted that the ML estimation of SEM-IV does not enable testing for the appropriateness of instrumental variables. Following Kirby & Bollen (2009), the corresponding multiple regressions 2SLS estimations are performed with the only purpose to test for the presence of endogeneity and to check for the validity of the instruments. The results of these tests are displayed in Appendix 1-B. The p-values of the endogeneity tests in the growth equations tend to indicate that SEM-IV should be preferred to the initial SEM specification, and the validity of the chosen instruments is confirmed as the values of the Kleibergen-Paap tests for weak identification are all above the threshold of 10.

Figures 1.5 and 1.6 present the results of the mediation analyses based on SEM-IV maximum likelihood estimations. For both causal variables, the model detects significant negative direct effects on long-term growth (-0.274 for exports concentration and -0.281 for resource dependence) accounting for the highest shares of the total effects. As in the initial specification, schooling deterioration remains the most important transmission channel for both causal variables on long-term growth. However, the sizes of these indirect effects (-0.032 and -0.30 for exports concentration and resource dependence respectively) appear to be substantially lower in this more robust specification than in the previous estimations.

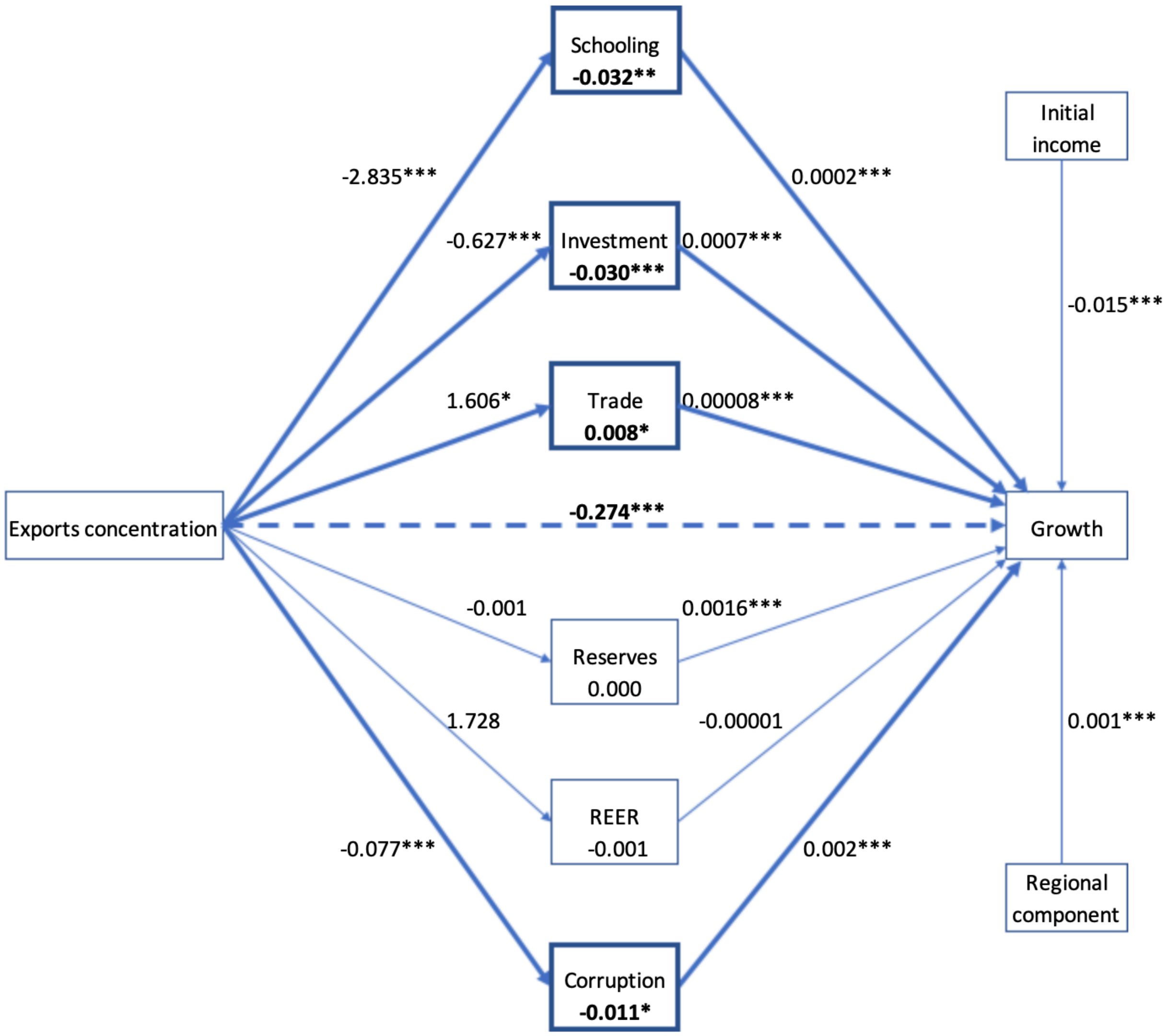


Figure 1.5. Path diagram SEM-IV with exports concentration (full sample).

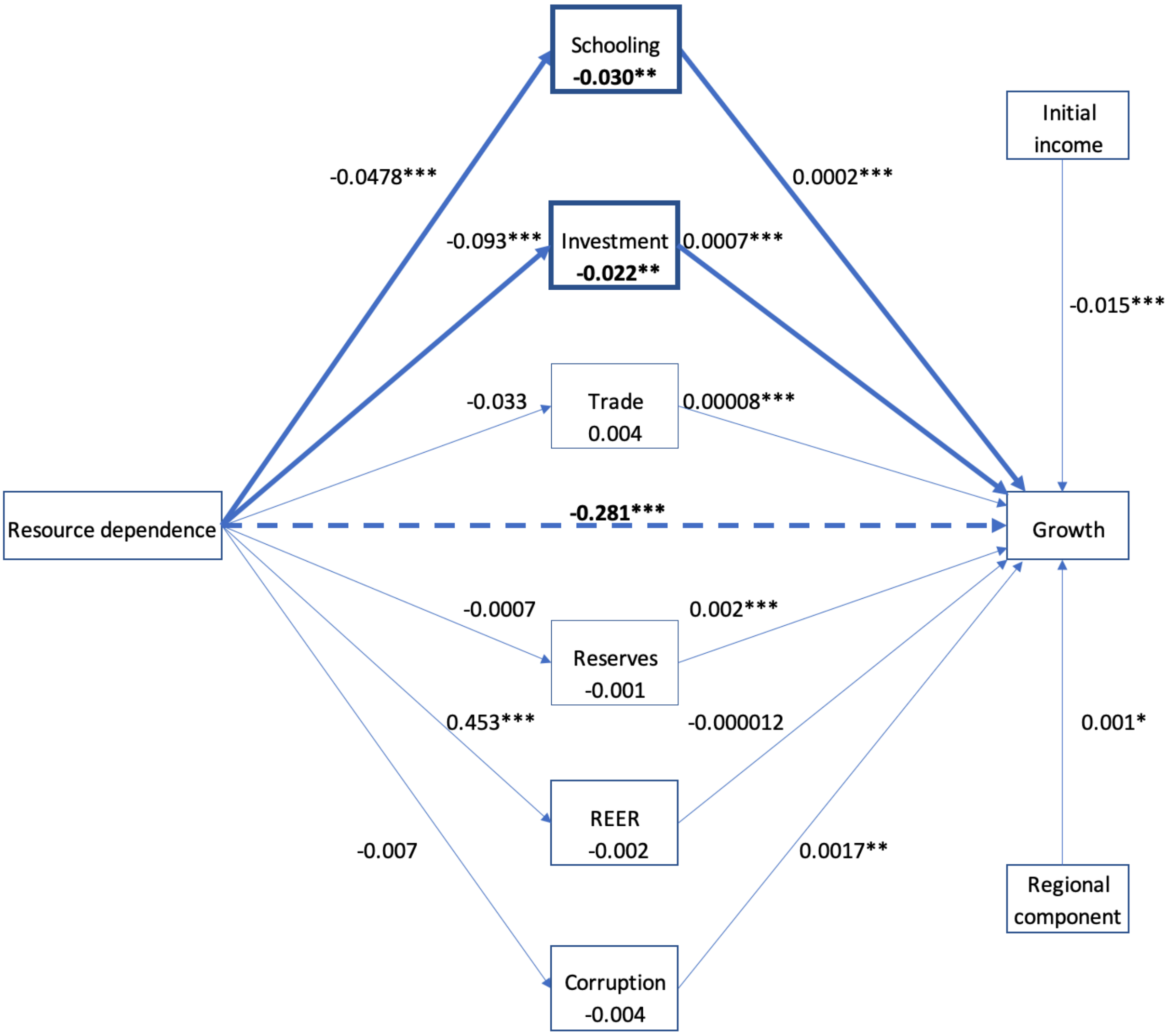


Figure 1.6. Path diagram SEM-IV with resource dependence (full sample).

The results show that exports concentration has some additional indirect effects on the outcome variable through investment, trade openness and corruption. It appears that higher levels of concentration tend to be associated with lower levels of physical capital accumulation, while investments are positively linked to growth. Unlike previous estimations, the SEM-IV establishes no mediation through the reserves channel, while the corruption channel is found to carry some negative indirect effect. Indeed, the model indicates that higher exports concentration tends to deteriorate the perception of a country in terms of corruption, while growth is found to be enhanced as countries are perceived as cleaner. The corruption channel is estimated to be the third most important mediator (-0.011) of exports concentration on long-term growth behind schooling (-0.032) and investment (-0.030), and before trade openness (0.008). Regarding resource dependence, the model establishes mediation through human and physical capital deterioration with indirect effects estimated at -0.30 for schooling and -0.022 for the investment channel. Contrary to the initial specification, the SEM-IV estimation detects no significant mediation through reserves accumulation. Note that for all estimations, the hypothesis of convergence is verified as countries with higher initial income levels are found to experience lower growth than countries at earlier stages of development. Also, the significant and positive signs of the paths between the corruption perception measure (with higher values corresponding to less corruption) and growth tend to go in the sense of a “sand the wheels” effect of corruption.

Sarin et al. (2022) mention that a sharp contrast exists in the influence of economic concentration on growth between developing and developed countries. Potential discrepancies between income groups are assessed here by applying the analyses to subsamples of developing countries and advanced economies. The first group is composed of low- and middle-income countries, while the group of advanced economies consists of high-income countries based on the World Bank classification. The descriptive statistics for the two groups are presented in appendix 1-C.

The results of the SEM-IV estimations for the two subgroups are presented in figures 1.7 and 1.8. It emerges from these models that while investment (-0.035 for exports concentration and -0.034 for resource dependence) and schooling (-0.025 for exports concentration and -0.024 for resource dependence) appear to be the main indirect paths via which the two causal variables may influence long-term growth in developing countries, no mediation can be established for these two channels in the case of advanced economies. This tends to suggest that both human and physical capital accumulations in developing countries are vulnerable to the adverse effects of sectoral contraction while more mature economies do not appear to exhibit such fragility. In addition, while resource dependence is found to reduce trade openness in developing countries, both causal variables appear to significantly enhance trade in advanced economies. Given the significant positive impact of trade openness on growth in both groups, the models establish mediation via that channel. However, the indirect effect through trade openness is found to be negative in the resource dependence and growth nexus in developing countries (-0.013) while positive for both causal variables in the case of advanced economies (0.018 and 0.026 for exports concentration and resource dependence respectively). This outcome for advanced economies is in line with the works of Dornbusch et al. (1977), Imbs (2004) and Di Giovani & Levchenko (2009), who associate openness to trade with sectoral specialisation. Their view is that specialisation leads to a more intensive use of production factors in fewer sectors, which in turn results in a greater necessity to recur to foreign markets to satisfy the demand for goods that can be obtained at lower cost through trade than via local production. This tends to suggest that the import-increasing leg of economic concentration outpaces its export-reducing leg in advanced economies, while the opposite may hold in resource-rich developing countries.

Another striking difference between the two groups is that, against expectations, higher sectoral concentration around resource activities is found to be associated with enhanced foreign exchange reserves accumulation in advanced economies. Given the significant positive impact of reserves on growth, a positive mediation (0.003) is established for the reserves channel in the resource dependence and long-term growth relationship in the case of advanced economies. This indicates that advanced economies may accumulate reserves (partly through exports) at a higher pace than they burn it through imports.

Note that for both causal variables, the total effects appear to be larger for countries at early stages of development (-0.208 and -0.372 for exports concentration and resource dependence respectively) than for developed countries (-0.169 and -0.228 for exports concentration and resource dependence respectively). This tends to suggest that countries at early stages of development may have more incentives to pursue greater economic diversification than advanced economies as the adverse effects of concentration appear to be more pronounced in the first group than in the latter. These findings are consistent with the idea of a U-shaped relationship between economic concentration and development level supported by the works of Imbs & Wacziarg (2003) and Mania & Rieber (2019), among others. The U-shaped hypothesis predicts decreasing incentives along the development path for countries to seek higher levels of economic diversity as re-specialisation appears to become a better rewarding strategy after reaching a certain threshold of development[1].

[1] IMF (2014) locates that threshold at levels of annual GDP per capita around $25,000-$30,000.

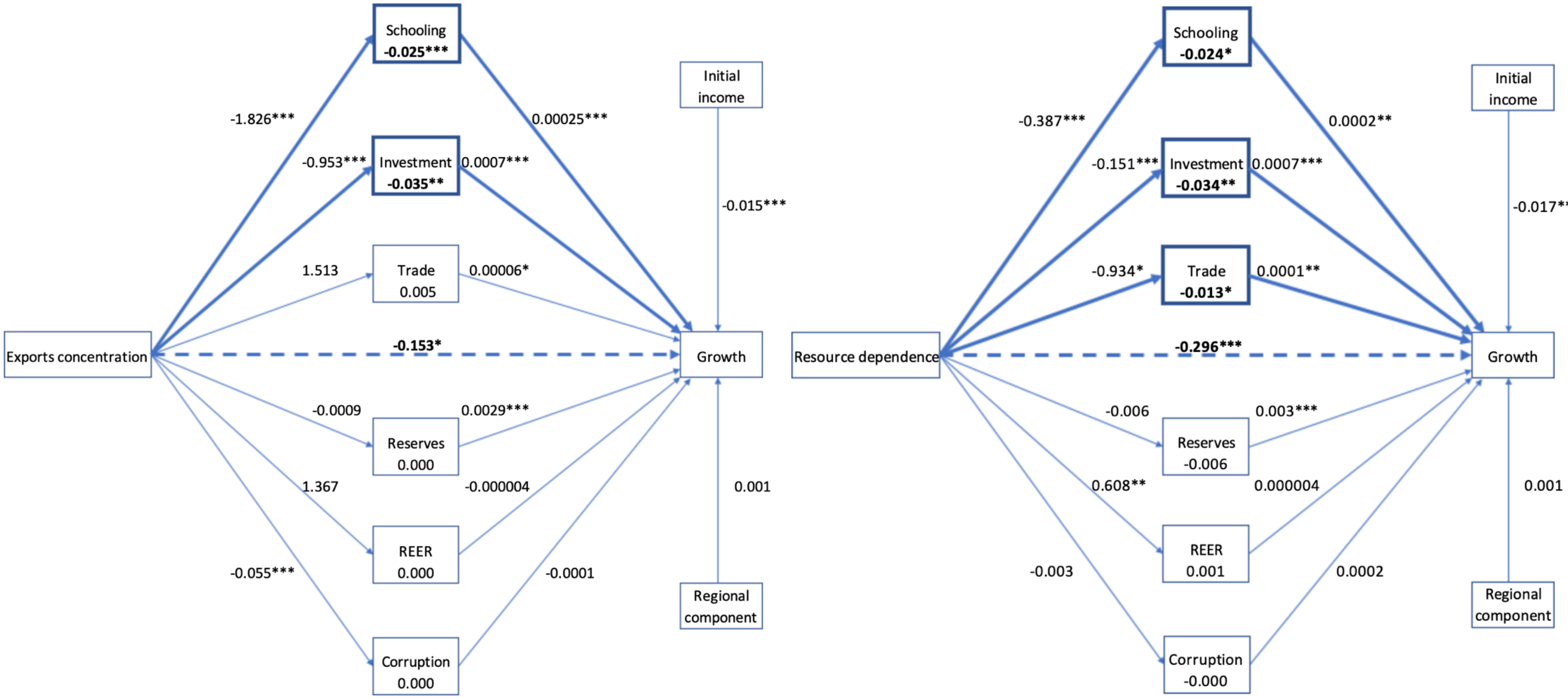


Figure 1.7. Path diagrams SEM-IV with exports concentration and resource dependence (Developing countries).

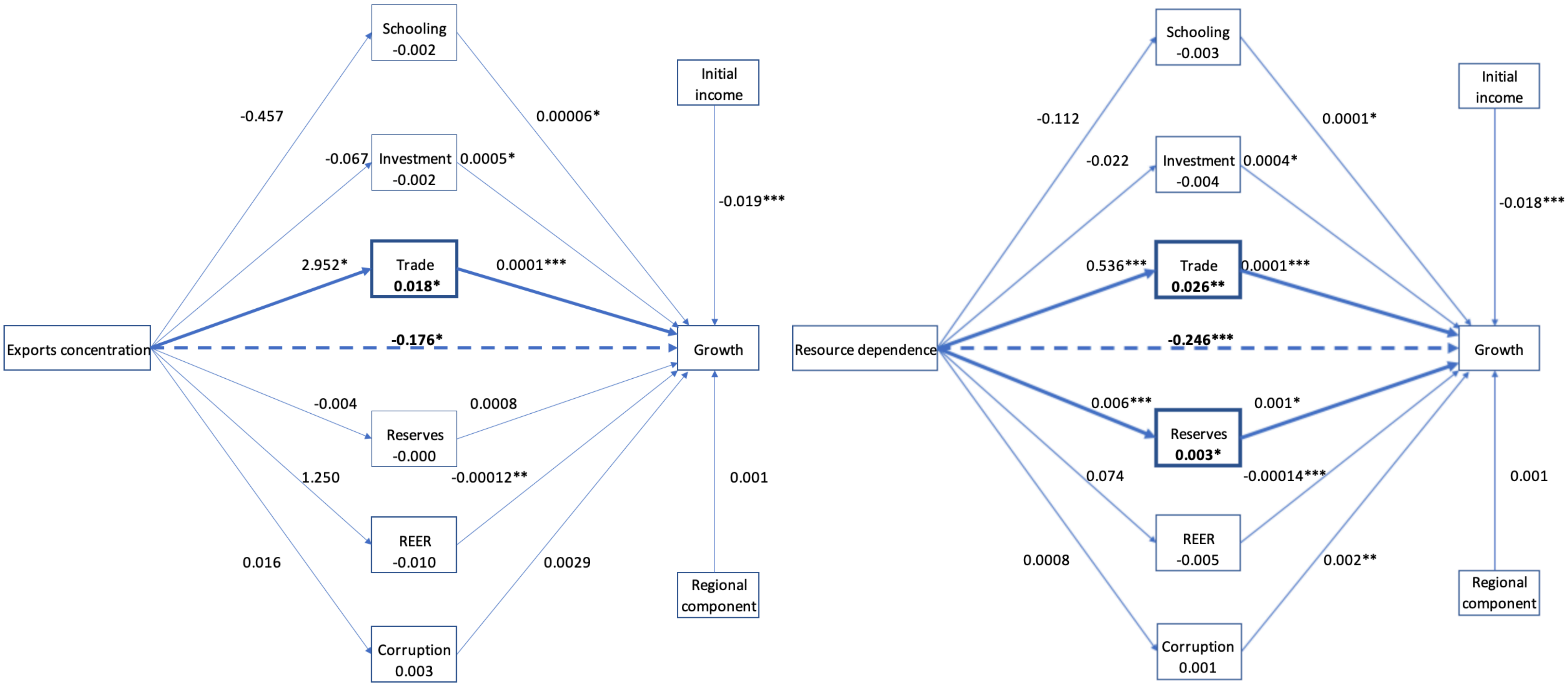


Figure 1.8. Path diagrams SEM-IV with exports concentration and resource dependence (Advanced economies).

1.4 Further analyses: Moderation study

The mediation study has allowed us to identify and measure the mechanisms through which the two causal concentration variables analysed may influence long-term growth. Although the considered channel variables have been envisaged as mediators, it should not be discarded that they might also alter the intensity of the causal effects and, therefore, act as moderators.

To measure the potential moderation effects of the channel variables, a regression approach with interaction terms is employed as suggested in the literature (e.g., Frazier et al., 2004; Memon et al., 2019). The following equation is estimated:

$$G^i = \alpha_0 + \alpha_1 ln\left(GDP_0^i\right) + \alpha_2 X^i + \alpha_3 \overrightarrow{TC}^i + \alpha_4 (X^i \times TC^i) + Region^i + \epsilon^i, \qquad (2)$$

where α_2 corresponds to the simple effect of the causal variable on long-term growth and $(\alpha_2 + \alpha_4 TC^i)$ is the moderated effect. Provided α_4 is significant, it can be concluded that the effect of X^i on G^i depends on the level of the considered $\overrightarrow{TC}$ variable, this confirming the presence of a moderation relationship. Note that $\overrightarrow{TC}^i$ refers to the entire vector of transmission channels while TC^i corresponds to the channels taken separately.

Appendix 1-D presents the tables resulting from the 2SLS estimations of the moderation equation for the entire sample as well as for the two income subgroups. Note that as in the mediation analyses, all dependent variables (except the regional component and initial income considered as exogenous) are instrumented by their quadratic transformations. Following Aiken & West (1991) a spotlight analysis is performed to visualise the moderation effects of the variables for which α_4 is found to be significant. This consists in plotting graphs with the outcome variable on the vertical axis and causal variables on the horizontal axis. Then representing the moderation effects as simple slopes for some representative levels of the moderation variable (i.e., the mean, one standard deviation below the mean, and one standard deviation above the mean level of the moderator). Tables 1.9 to 1.11 display the plots of the spotlight analyses for the established moderators based on the 2SLS estimations of equation (2) for the entire sample and for the two income subgroups.

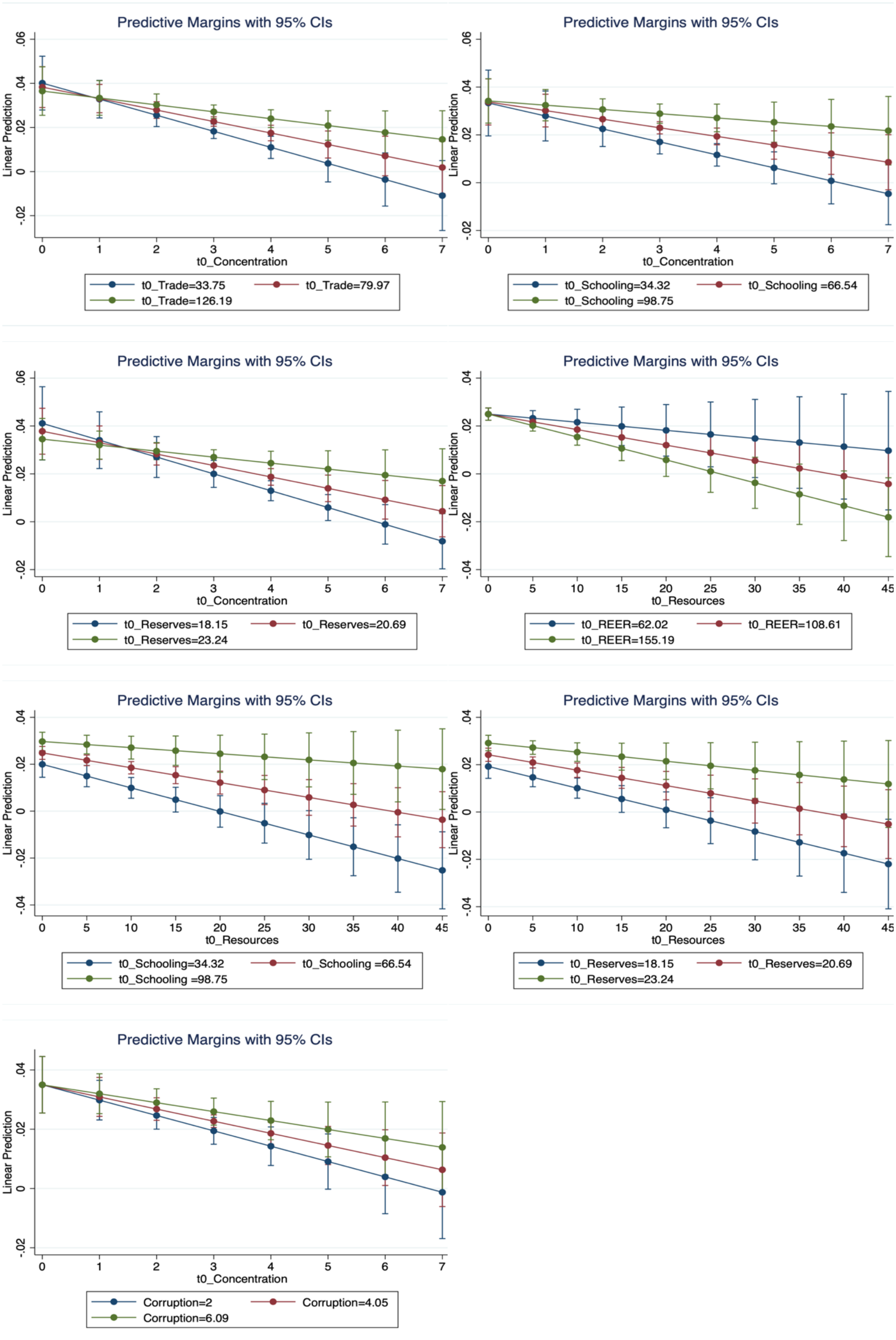


Figure 1.9. Simple slope spotlight analysis of moderation effects (full sample).

The results for the entire sample show that higher initial levels of trade openness, schooling and reserves may help alleviating the negative effect of exports concentration on long-term growth. Indeed, the negative slopes of the relationship between the causal and the outcome variables appear to be steeper at lower levels of these moderation variables, while the lines are flatter for higher levels. Note that a flat line for one of the representative values of the moderation variables would indicate that the moderation would totally neutralise the simple effect of the causal variable.

Higher initial values of schooling and reserves also appear to cushion the adverse effect of resource dependence on the outcome variable. The same is observed with the corruption variable as the model indicates that cleaner countries tend to suffer less from the detrimental impact of resource dependence on long-term growth. The results for the entire sample also indicate that higher levels of real effective exchange rate may worsen the negative effect of resource dependence on the outcome variable. Indeed, the spotlight analysis shows that the relationship between the two variables is flatter for lower initial levels of REER. This indicates that international competitiveness may play a role in the nexus as countries which are less competitive vis-à-vis their trading partners (i.e., exhibiting higher levels of REER) are likely to be more vulnerable to the harmful effect of economic concentration around resource sectors.

Like the mediation study, the moderation analyses detect some discrepancies between income groups. Regarding developing countries, some moderation effects are established for trade openness with both causal variables. The results indicate that higher levels of trade openness may reduce the negative impact of the two concentration measures of long-term growth. In the case of exports concentration, the simple slope appears to be even close to zero for the highest initial values of trade as suggested by the almost flat green line corresponding to levels of trade one standard deviation above the mean. Like with the full sample, the model indicates that lower international competitiveness (i.e., higher levels of REER) tends to exacerbate the negative effect of resource dependence on long-term growth in developing countries.

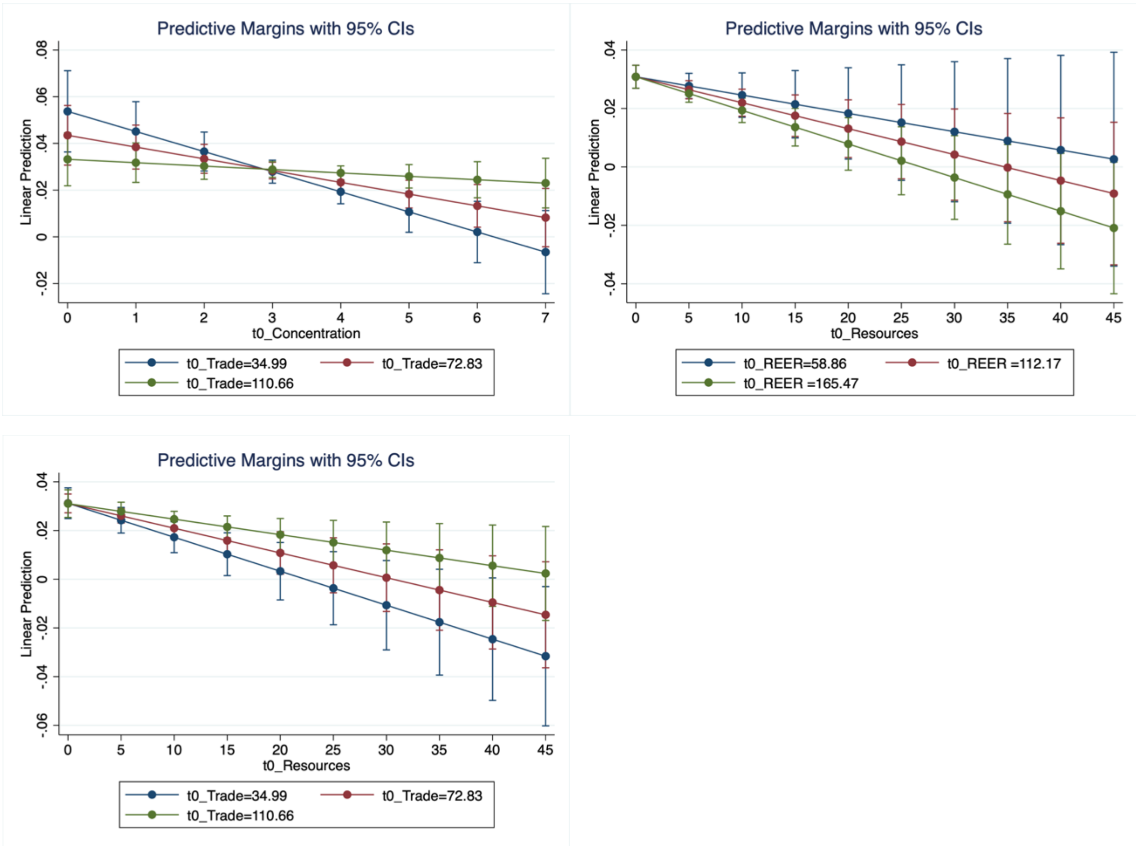


Figure 1.10. Simple slope spotlight analysis of moderation effects (Developing countries).

The analyses show that in certain configurations, sectoral concentration may happen to be profitable for advanced economies. Indeed, the spotlight analyses with both causal variables indicate positive slopes for high-income countries for which initial schooling levels attain the highest representative value. The same applies to the relationship between resource dependence and long-term growth for the lowest representative REER level. This suggesting that high-income countries maintaining high levels of competitiveness vis-à-vis their trade partners are more likely to experience resource-led long-term growth. These findings tend to corroborate the idea of an increasing appeal for re-specialisation for advanced economies as it may become a better rewarding strategy than aiming for higher levels of economic diversification along the development path. Lower levels of REER are also found to reduce the negative impact of exports concentration on the outcome variable in advanced economies. However, the slope remains negative for the three representative values of REER unlike with resource dependence. Finally, the results show that developed countries with the cleanest perception in terms of corruption appear to be protected against the negative impact of exports concentration on growth. This indicates that the quality of institutions may play a crucial role in neutralising the adverse effects of sectoral concentration.

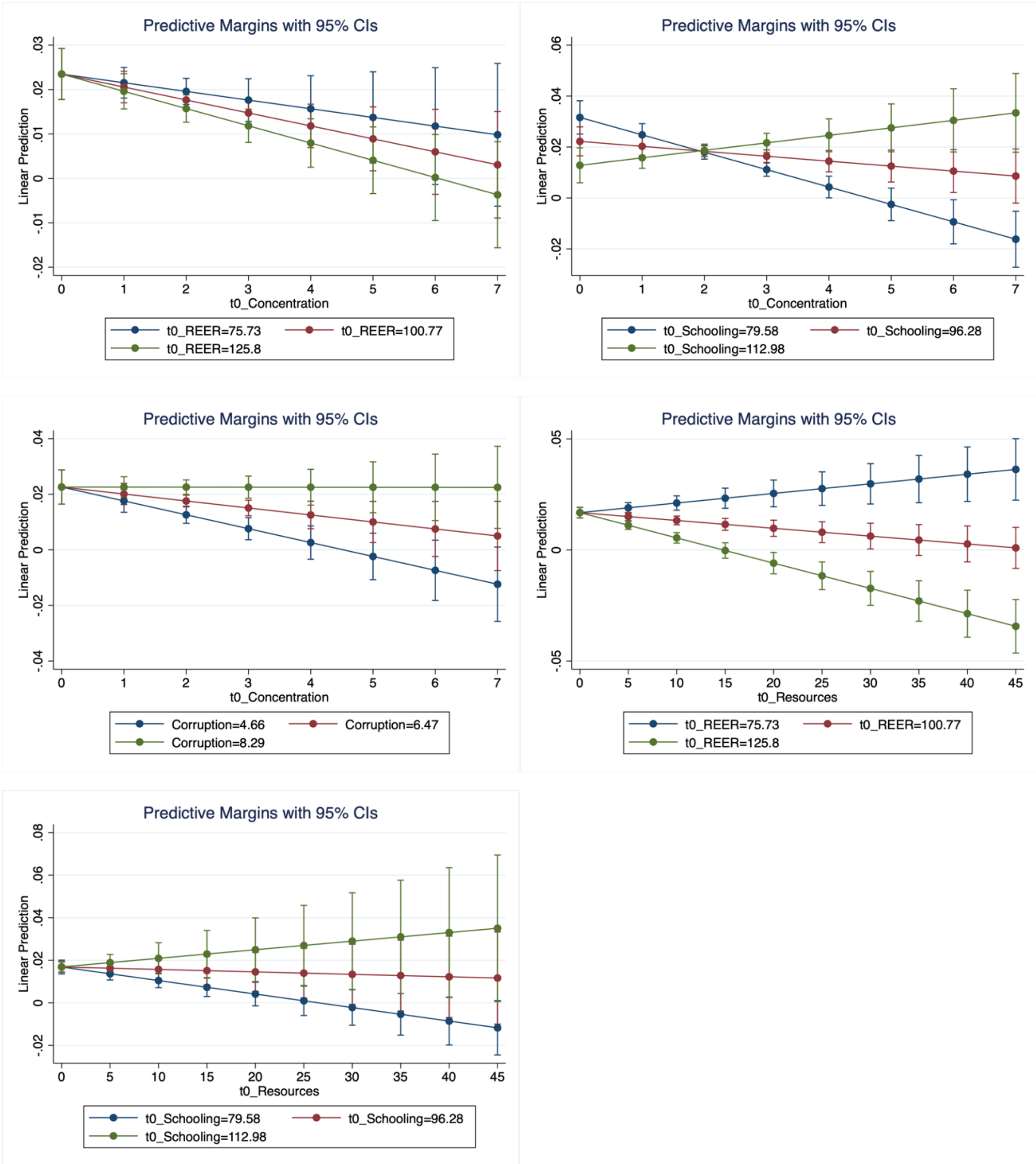


Figure 1.11. Simple slope analysis spotlight of moderation effects (Advanced economies).

1.5 Conclusions

This chapter aimed to evaluate the total effect of (the lack of) economic diversity on long-term GDP per capita growth and to assess the sizes of the indirect transmission channels through which this effect may be carried. To that end, mediation studies have been performed on the entire dataset as well as on two subsamples of developing and developed countries separately envisaging possible income-related discrepancies in the nexus between growth and diversity.

The various models specified indicate that sectoral concentration has negative total effects on long-term growth which are partially transmitted via some indirect mechanisms. The analyses performed on the entire sample indicate that human and physical capital deterioration are the main indirect paths through which the lack of economic diversity may harm long-term growth. Other less important mediation effects are established for the corruption and trade openness channels. In the first case, greater levels of exports concentration are found to undermine long-term growth by fostering corruption. Trade openness on the other hand is the only mediator in the full sample estimation via which exports concentration appears to influence positively the outcome variable. However, this indirect positive effect is estimated to have the lowest magnitude among all the established mediators and does not compensate the direct and indirect negative effects of exports concentration on long-term growth.

The income-level distinction allowed us to identify some important dissimilarities between countries at early stages of development and advanced economies. First, while the mediation effects of schooling and investment observed for the entire sample appear to hold for developing countries, the model detects no indirect effects through these channels in the case of developed countries. This suggests that unlike in countries at earlier stages of development, human and physical capital accumulation in advanced economies appear to be insensitive to the level of economic concentration. Second, the analyses establish some negative mediation through trade openness in developing countries. This is due to an estimated contraction of trade induced by resource dependence in that income group. The opposite is observed for advanced economies for which the effects of both causal variables are found to include some significant positive indirect effects through trade openness. Third, against expectations, a positive moderation of resource dependence via the reserves channel is observed for the high-income group while this channel remains inactive for developing countries. Finally, the total negative effects of both causal variables are found to be more pronounced in developing countries, than in advanced economies. This latter finding combined with the positive mediations through trade and reserves spotted in the high-income group may contribute to justify the U-shaped pattern observed between concentration and income level. Indeed, these elements tend to indicate that specialisation may become less harmful at higher levels of economic development. On the other face of the coin, this shows that pursuing greater sectoral diversification may happen to be an increasingly less advantageous strategy along the development path.

Further analyses on potential moderation effects of the channel variables have allowed to observe that, provided favourable initial levels of moderation variables, the negative effects of sectoral concentration on long-term growth could be alleviated or even fully compensated in some circumstances. Higher initial levels of trade openness, schooling, reserves, as well as better international competitiveness and cleaner perception in terms of corruption are found to be significant moderators that may contribute to cushion the adverse effects of concentration. In the case of developing countries, moderation is established for trade openness and REER. Note that both variables are related to the interaction of the countries with foreign markets. This tends to suggest that the ability of developing countries to absorb the negative effects of acute resource dependence and higher exports concentration on long-term growth is strongly connected to their capacity to operate at the international level.

Higher initial levels of international competitiveness (i.e., lower levels of REER) also appear to be significant moderators that attenuate the negative impact of sectoral concentration on growth for advanced economies. This moderation effect is even found to outpace the negative effect of resource dependence, leading to a positive slope in the relationship for the lowest considered representative value of REER in high-income countries. For advanced countries exhibiting schooling levels one standard deviation above the average of the group, the moderation analyses detect positive slopes for both causal concentration variables, while higher levels of good perception in terms of corruption appear to make up for the negative impact of concentration on long-term growth in that group. These findings indicate that high-income countries may turn out to benefit from exports concentration and resource booms as engines for long-term growth thanks to more favourable internal factors such as high human capital and clean perception, as well as stronger international competitiveness. These latter findings also tend to be in line with the re-specialisation pattern expected for more advanced economies.

This empirical work provides some additional evidence on the mechanisms through which the lack of economic diversity may influence long-term growth both positively and negatively. Additionally, it sheds some light on potential discrepancies that may exist between countries at different stages of development in the manifestation of the total effect of economic diversity on growth. A better understanding of these elements is crucial for the design of sound diversity-based development policies. Future research could include some additional potential channels and investigate more thoroughly the ins and outs of each channel. Moreover, some domestic market-based measures of diversity such as employment distribution could be used, as solely focusing on export diversification and resource dependence may not provide the whole picture.

Appendices

1-A. List of variables

Variable	Definition	Period	Source
G	Average annual growth in GDP per capita (2015 USD), calculated as $G^i = \left[ln\left(Y^i_{2019}/Y^i_{1998}\right)/21\right]$.	1998-2019	World Bank
Exports concentration	Level of concentration of exports measured by the IMF's exports diversification index (EDI), a Theil index with higher values indicating lower levels of diversification.	1998	IMF
Resource dependence	Total natural resources rents measured as the sum of oil rents, natural gas rents, coal rents (hard and soft), mineral rents, and forest rents, expressed as percentage of real GDP.	1998	World Bank
Trade openness	Sum of exports and imports of goods and services measured as percentage of real GDP.	1998	World Bank
Reserves	Logarithm of total reserves minus gold (current USD). The measure includes special drawing rights, reserves of IMF members held by the IMF, and holdings of foreign exchange under the control of monetary authorities.	1998	IMF
REER	Real effective exchange rate. The index measures the development of the real value of a country's currency against a basket of 65 trading partners. Increases of the index correspond to REER appreciations.	1998	Bruegel
Investment	Gross fixed capital formation (including land improvements; plant, machinery, and equipment purchases; and the construction of roads, railways, schools, offices, hospitals, private residential dwellings, and commercial and industrial buildings) as percentage of real GDP.	1998	World Bank
Corruption	Average corruption level calculated as $Corruption^i = \left(1/T \sum_{t=1}^{T} CPI_{i,t}\right)$, where CPI refers to the corruption perception index which is a scale of 0 (highly corrupt) to 10 (very clean).	1998-2011	Transparency International
Schooling	Gross enrolment ratio at secondary school.	1998	UNESCO

1-B. Instruments validity checks

Table B1. 2SLS estimations of mediation equations with exports concentration for the full sample.

Variables	(1) Growth	(2) Schooling *t0*	(3) Investment *t0*	(4) REER *t0*	(5) Reserves *t0*	(6) Trade *t0*	(7) Corruption
Concentration *t0*	-0.00465***	-9.789***	-0.0213*	6.388	-0.872***	6.772**	-0.205*
	(0.00160)	(1.488)	(0.941)	(5.683)	(0.235)	(3.145)	(0.107)
Schooling *t0*	0.000174***						
	(6.61e-05)						
Investment *t0*	0.000671***						
	(0.000201)						
REER *t0*	1.06e-05						
	(2.30e-05)						
Reserves *t0*	0.00166**						
	(0.000714)						
Trade *t0*	9.57e-05***						
	(2.50e-05)						
Corruption	0.000921*						
	(0.000873)						
Ln GDP *t0*	-0.0142***	12.50***	1.604***	-1.856	0.524***	9.588***	1.177***
	(0.00159)	(1.385)	(0.495)	(2.729)	(0.142)	(2.814)	(0.0866)
Regional component	0.00112	1.006	-0.238	-2.533	0.180*	4.124*	0.0697
	(0.000707)	(0.948)	(0.355)	(1.668)	(0.102)	(2.486)	(0.0621)
Constant	0.0770***	-8.042	10.25	110.9***	18.79***	-38.21	-5.218***
	(0.0173)	(14.69)	(6.320)	(36.32)	(1.731)	(29.70)	(0.944)
Underidentification test (Kleibergen-Paap rk LM statistic p-value)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Weak identification test (Kleibergen-Paap rk Wald F statistic)	18.002	786.638	786.638	786.638	786.638	786.638	786.638
Endogeneity test (p-value)	0.011	0.12	0.51	0.74	0.10	0.11	0.82
Observations	122	122	122	122	122	122	122
R-squared	0.533	0.699	0.121	0.064	0.468	0.120	0.739

Robust standard errors in parentheses

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

Table B2. 2SLS estimations of mediation equations with resource dependence for the full sample.

Variables	(1) Growth	(2) Schooling *t0*	(3) Investment *t0*	(4) REER *t0*	(5) Reserves *t0*	(6) Trade *t0*	(7) Corruption
Resources *t0*	-0.000724***	-1.125***	-0.0851*	0.536	-0.0888***	0.236	-0.0316*
	(0.000213)	(0.243)	(0.132)	(0.365)	(0.0229)	(0.538)	(0.0183)
Schooling *t0*	0.000185***						
	(6.02e-05)						
Investment *t0*	0.000634***						
	(0.000200)						
REER *t0*	-4.33e-06						
	(2.41e-05)						
Reserves *t0*	0.00233***						
	(0.000547)						
Trade *t0*	9.20e-05***						
	(2.63e-05)						
Corruption	0.00103						
	(0.000836)						
Ln GDP *t0*	-0.0142***	15.14***	1.484***	-3.709	0.800***	6.822***	1.179***
	(0.00155)	(1.251)	(0.394)	(2.583)	(0.127)	(2.443)	(0.0762)
Regional component	0.00117*	1.800*	-0.134	-2.210	0.214*	3.115	0.0742
	(0.000702)	(0.993)	(0.362)	(1.632)	(0.120)	(2.558)	(0.0642)
Constant	0.0529***	-59.47***	11.43***	144.1***	13.96***	8.081	-5.743***
	(0.0128)	(10.56)	(3.412)	(23.60)	(1.064)	(20.78)	(0.677)
Underidentification test (Kleibergen-Paap rk LM statistic p-value)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Weak identification test (Kleibergen-Paap rk Wald F statistic)	22.039	226.914	226.914	226.914	226.914	226.914	226.914
Endogeneity test (p-value)	0.028	0.00	0.34	0.23	0.85	0.24	0.96
Observations	121	121	121	121	121	121	121
R-squared	0.576	0.678	0.118	0.043	0.371	0.085	0.719

Robust standard errors in parentheses

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

Table B3. 2SLS estimations of mediation equations with exports concentration for developing countries.

Variables	(1) Growth	(2) Schooling *t0*	(3) Investment *t0*	(4) REER *t0*	(5) Reserves *t0*	(6) Trade *t0*	(7) Corruption
Concentration *t0*	-0.00377*	-11.34***	-0.244*	7.197	-0.804**	7.969**	-0.178*
	(0.00200)	(1.848)	(1.315)	(8.218)	(0.332)	(3.671)	(0.0939)
Schooling *t0*	0.000221**						
	(9.89e-05)						
Investment *t0*	0.000543**						
	(0.000255)						
REER *t0*	5.96e-06						
	(2.27e-05)						
Reserves *t0*	0.00262***						
	(0.000821)						
Trade *t0*	5.95e-05*						
	(3.42e-05)						
Corruption	-0.00104						
	(0.00200)						
Ln GDP *t0*	-0.0135***	13.25***	2.832**	-8.924*	0.702**	20.33***	0.489***
	(0.00245)	(2.493)	(1.125)	(4.983)	(0.290)	(4.609)	(0.117)
Regional component	0.00131	1.485	-0.0108	-1.851	0.100	6.446***	0.0106
	(0.000934)	(1.286)	(0.426)	(1.640)	(0.134)	(2.501)	(0.0437)
Constant	0.0580***	-9.828	0.933	157.1**	17.54***	-130.3***	-0.0489
	(0.0217)	(23.89)	(12.17)	(62.37)	(3.183)	(40.85)	(1.077)
Underidentification test (Kleibergen-Paap rk LM statistic p-value)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Weak identification test (Kleibergen-Paap rk Wald F statistic)	36.019	682.206	682.206	682.206	682.206	682.206	682.206
Endogeneity test (p-value)	0.041	0.32	0.90	0.51	0.03	0.35	0.20
Observations	74	74	74	74	74	74	74
R-squared	0.477	0.514	0.128	0.068	0.307	0.256	0.314

Robust standard errors in parentheses

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

Table B4. 2SLS estimations of mediation equations with resource dependence for developing countries.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Variables	Growth	Schooling *t0*	Investment *t0*	REER *t0*	Reserves *t0*	Trade *t0*	Corruption
Resources *t0*	-0.00106***	-1.332***	-0.177*	0.583	-0.105**	1.288*	-0.0209
	(0.000312)	(0.455)	(0.186)	(0.699)	(0.0434)	(1.056)	(0.0130)
Schooling *t0*	0.000185**						
	(9.17e-05)						
Investment *t0*	0.000575**						
	(0.000253)						
REER *t0*	1.86e-06						
	(2.21e-05)						
Reserves *t0*	0.00289***						
	(0.000671)						
Trade *t0*	9.25e-05**						
	(4.04e-05)						
Corruption	0.000132						
	(0.00231)						
Ln GDP *t0*	-0.0161***	14.76***	2.531**	-8.788*	0.721**	19.75***	0.488***
	(0.00232)	(2.754)	(1.047)	(4.668)	(0.305)	(5.887)	(0.122)
Regional component	0.00108	2.365*	0.0298	-1.287	0.123	5.567**	0.00788
	(0.000959)	(1.276)	(0.417)	(1.432)	(0.157)	(2.416)	(0.0494)
Constant	0.0603***	-58.21***	3.414	177.9***	14.92***	-100.6**	-0.504
	(0.0198)	(22.46)	(8.487)	(41.35)	(2.608)	(46.29)	(1.024)
Underidentification test (Kleibergen-Paap rk LM statistic p-value)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Weak identification test (Kleibergen-Paap rk Wald F statistic)	12.818	67.969	67.969	67.969	67.969	67.969	67.969
Endogeneity test (p-value)	0.048	0.02	0.16	0.34	0.34	0.71	0.52
Observations	74	74	74	74	74	74	74
R-squared	0.514	0.478	0.135	0.042	0.189	0.229	0.268

Robust standard errors in parentheses

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

Table B5. 2SLS estimations of mediation equations with exports concentration for advanced economies.

Variables	(1) Growth	(2) Schooling *t0*	(3) Investment *t0*	(4) REER *t0*	(5) Reserves *t0*	(6) Trade *t0*	(7) Corruption
Concentration *t0*	-0.00339**	-5.324**	1.661*	4.057	-1.081***	7.918*	-0.438**
	(0.00134)	(2.357)	(0.885)	(2.580)	(0.231)	(5.987)	(0.178)
Schooling *t0*	3.58e-05*						
	(5.48e-05)						
Investment *t0*	0.000442**						
	(0.000221)						
REER *t0*	-5.90e-05						
	(4.88e-05)						
Reserves *t0*	0.000353						
	(0.000850)						
Trade *t0*	9.09e-05***						
	(2.53e-05)						
Corruption	0.00310***						
	(0.000809)						
Ln GDP *t0*	-0.0191***	9.991***	-2.219**	5.101	0.417	-1.853	1.916***
	(0.00211)	(3.237)	(0.919)	(3.459)	(0.433)	(12.19)	(0.187)
Regional component	0.00145	0.423	0.0415	-6.632*	0.417**	2.913	-0.0551
	(0.00109)	(1.354)	(0.637)	(3.874)	(0.181)	(5.655)	(0.147)
Constant	0.165***	8.713	43.42***	66.19*	19.31***	76.12	-11.36***
	(0.0302)	(27.71)	(9.973)	(40.08)	(3.919)	(106.3)	(1.992)
Underidentification test (Kleibergen-Paap rk LM statistic p-value)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Weak identification test (Kleibergen-Paap rk Wald F statistic)	28.099	848.335	848.335	848.335	848.335	848.335	848.335
Endogeneity test (p-value)	0.044	0.40	0.88	0.40	0.84	0.07	0.06
Observations	48	48	48	48	48	48	48
R-squared	0.721	0.268	0.182	0.146	0.414	0.041	0.565

Robust standard errors in parentheses

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

Table B6. 2SLS estimations of mediation equations with resource dependence for advanced economies.

Variables	(1) Growth	(2) Schooling *t0*	(3) Investment *t0*	(4) REER *t0*	(5) Reserves *t0*	(6) Trade *t0*	(7) Corruption
Resources *t0*	-0.000411*	-0.798***	0.116	0.265	-0.0812***	0.0506*	-0.0858***
	(0.000220)	(0.252)	(0.170)	(0.375)	(0.0231)	(0.497)	(0.0145)
Schooling *t0*	2.88e-05*						
	(6.10e-05)						
Investment *t0*	0.000255*						
	(0.000214)						
REER *t0*	-9.40e-05**						
	(4.49e-05)						
Reserves *t0*	0.00143**						
	(0.000685)						
Trade *t0*	0.000107***						
	(2.84e-05)						
Corruption	0.00260***						
	(0.000886)						
Ln GDP *t0*	-0.0189***	9.964***	-2.245**	5.781	0.440	3.678	1.944***
	(0.00275)	(3.362)	(1.015)	(3.777)	(0.464)	(11.62)	(0.184)
Regional component	0.00105	0.945	0.109	-6.522*	0.446**	0.852	-0.000253
	(0.000953)	(1.469)	(0.691)	(3.884)	(0.194)	(5.487)	(0.146)
Constant	0.144***	-4.136	47.21***	68.87*	16.63***	45.66	-12.73***
	(0.0292)	(30.04)	(10.47)	(40.87)	(4.379)	(109.1)	(1.910)
Underidentification test (Kleibergen-Paap rk LM statistic p-value)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Weak identification test (Kleibergen-Paap rk Wald F statistic)	30.253	300.027	300.027	300.027	300.027	300.027	300.027
Endogeneity test (p-value)	0.040	0.11	0.39	0.42	0.18	0.72	0.80
Observations	47	47	47	47	47	47	47
R-squared	0.748	0.272	0.104	0.115	0.224	0.006	0.608

Robust standard errors in parentheses

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

1-C. Descriptive statistics for developing and developed countries.

Variable	Obs.	Mean	Std. Dev.	Min	Max
A. Developing countries					
Growth	125	0.024	0.019	-0.017	0.084
Exports concentration	124	3.748	1.040	1.755	6.369
Resource dependence	125	6.011	7.987	0.008	43.558
Trade openness	117	72.825	37.831	1.165	209.492
Reserves	113	19.877	2.353	13.332	25.728
Investment	109	21.582	7.965	2.100	45.495
REER	121	112.167	53.306	13.762	437.486
Corruption	130	3.022	1.009	1.160	7.020
Schooling	109	50.983	27.011	5.291	107.126
B. Advanced Economies					
Growth	65	0.016	0.014	-0.018	0.048
Exports concentration	57	2.550	1.028	1.341	4.851
Resource dependence	57	2.726	6.761	0.0007	29.577
Trade openness	59	94.138	57.243	19.003	312.079
Reserves	58	22.281	2.136	16.887	26.096
Investment	56	25.423	5.223	16.005	41.137
REER	55	100.767	25.034	56.999	220.135
Corruption	55	6.471	1.814	2.993	9.486
Schooling	57	96.279	16.703	64.396	155.723

1-D. Moderation study estimations.

Table D1. 2SLS estimations of moderation effects with exports concentration (full sample)

Dependent variable: Growth	(1)	(2)	(3)	(4)	(5)	(6)
Concentration t_0	-0.00420*	-0.00158	-0.00880***	-0.00737***	-0.0232***	-0.00672**
	(0.00238)	(0.00382)	(0.00257)	(0.00249)	(0.00818)	(0.00278)
REER t_0	2.84e-05	1.50e-05	2.34e-05	6.75e-06	4.73e-06	1.40e-05
	(7.22e-05)	(2.05e-05)	(2.08e-05)	(2.00e-05)	(2.39e-05)	(2.33e-05)
Investment t_0	0.000684***	0.00121**	0.000680***	0.000582***	0.000654***	0.000602***
	(0.000220)	(0.000541)	(0.000195)	(0.000195)	(0.000194)	(0.000199)
Openness t_0	9.48e-05***	9.20e-05***	-3.91e-05	9.16e-05***	7.93e-05***	9.65e-05***
	(2.57e-05)	(2.53e-05)	(7.73e-05)	(2.57e-05)	(2.31e-05)	(2.53e-05)
Schooling t_0	0.000175***	0.000183***	0.000161**	1.35e-05	0.000169***	0.000177***
	(6.55e-05)	(6.57e-05)	(6.45e-05)	(0.000106)	(6.46e-05)	(6.54e-05)
Reserves t_0	0.00164**	0.00155**	0.00137**	0.00191***	-0.00129	0.00183**
	(0.000700)	(0.000637)	(0.000684)	(0.000702)	(0.00159)	(0.000715)
Corruption	0.000933	0.000816	0.00145*	0.00158*	0.00119	-0.000443
	(0.000876)	(0.000858)	(0.000879)	(0.000890)	(0.000816)	(0.00126)
REER t_0*Concentration t_0	-4.43e-06					
	(1.61e-05)					
Investment t_0*Concentration t_0		-0.000134				
		(0.000128)				
Openness t_0*Concentration t_0			4.50e-05*			
			(2.30e-05)			
Schooling t_0*Concentration t_0				5.66e-05**		
				(2.68e-05)		
Reserves t_0*Concentration t_0					0.000890**	
					(0.000376)	
Corruption*Concentration t_0						0.000645
						(0.000497)
Ln GDP t_0	-0.0142***	-0.0140***	-0.0148***	-0.0150***	-0.0141***	-0.0146***
	(0.00159)	(0.00154)	(0.00159)	(0.00157)	(0.00160)	(0.00164)
Regional component	0.00114	0.00107	0.00114	0.00109	0.00133*	0.00111
	(0.000727)	(0.000703)	(0.000708)	(0.000715)	(0.000725)	(0.000711)
Constant	0.0755***	0.0651***	0.0983***	0.0876***	0.140***	0.0826***
	(0.0196)	(0.0225)	(0.0179)	(0.0197)	(0.0341)	(0.0200)
Underidentification test (Kleibergen-Paap rk LM statistic p-value)	0.00	0.00	0.00	0.00	0.00	0.00
Weak identification test (Kleibergen-Paap rk Wald F statistic)	11.402	15.679	17.474	21.303	16.956	21.366
Endogeneity test (p-value)	0.18	0.18	0.12	0.21	0.42	0.24
Observations	122	122	122	122	122	122
R-squared	0.532	0.534	0.537	0.544	0.550	0.535

Table D2. 2SLS estimations of moderation effects with resource dependence (full sample)

Dependent variable: Growth	(1)	(2)	(3)	(4)	(5)	(6)
Resources t_0	0.000658	-0.000893*	-0.00101***	-0.00134***	-0.00281**	-0.00163***
	(0.000525)	(0.000482)	(0.000371)	(0.000348)	(0.00126)	(0.000424)
REER t_0	4.54e-05*	-4.82e-06	-1.79e-06	-1.47e-06	-5.63e-06	1.17e-06
	(2.42e-05)	(2.42e-05)	(2.27e-05)	(2.11e-05)	(2.45e-05)	(2.10e-05)
Investment t_0	0.000686***	0.000574**	0.000628***	0.000594***	0.000610***	0.000561***
	(0.000196)	(0.000265)	(0.000201)	(0.000194)	(0.000198)	(0.000198)
Openness t_0	8.16e-05***	9.22e-05***	7.11e-05**	9.15e-05***	8.81e-05***	0.000103***
	(2.96e-05)	(2.64e-05)	(3.25e-05)	(2.74e-05)	(2.60e-05)	(2.96e-05)
Schooling t_0	0.000190***	0.000186***	0.000182***	0.000146**	0.000182***	0.000181***
	(5.95e-05)	(6.05e-05)	(5.98e-05)	(6.24e-05)	(5.93e-05)	(6.07e-05)
Reserves t_0	0.00234***	0.00236***	0.00223***	0.00227***	0.00195***	0.00244***
	(0.000540)	(0.000539)	(0.000548)	(0.000538)	(0.000638)	(0.000544)
Corruption	0.00134	0.00112	0.00125	0.00165*	0.00136	0.00122
	(0.000866)	(0.000827)	(0.000841)	(0.000880)	(0.000833)	(0.000799)
REER t_0* Resources t_0	-1.21e-05***					
	(3.84e-06)					
Investment t_0* Resources t_0		8.14e-06				
		(2.02e-05)				
Openness t_0* Resources t_0			3.54e-06			
			(2.97e-06)			
Schooling t_0* Resources t_0				9.37e-06**		
				(4.77e-06)		
Reserves t_0* Resources t_0					0.000104*	
					(5.95e-05)	
Corruption* Resources t_0						0.000230**
						(8.94e-05)
Ln GDP t_0	-0.0149***	-0.0144***	-0.0144***	-0.0151***	-0.0146***	-0.0154***
	(0.00158)	(0.00150)	(0.00154)	(0.00153)	(0.00151)	(0.00156)
Regional component	0.00117*	0.00114	0.00124*	0.00117*	0.00110	0.00100
	(0.000683)	(0.000698)	(0.000711)	(0.000695)	(0.000707)	(0.000713)
Constant	0.0512***	0.0551***	0.0572***	0.0633***	0.0639***	0.0617***
	(0.0128)	(0.0141)	(0.0131)	(0.0139)	(0.0152)	(0.0131)
Underidentification test (Kleibergen-Paap rk LM statistic p-value)	0.00	0.00	0.00	0.00	0.00	0.00
Weak identification test (Kleibergen-Paap rk Wald F statistic)	20.973	17.671	22.746	24.976	26.149	15.305
Endogeneity test (p-value)	0.15	0.36	0.25	0.24	0.19	0.28
Observations	121	121	121	121	121	121
R-squared	0.577	0.576	0.578	0.581	0.579	0.583

Table D3. 2SLS estimations of moderation effects with exports concentration (Developing countries)

Dependent variable: Growth	(1)	(2)	(3)	(4)	(5)	(6)
Concentration t_0	-0.00155	0.000618	-0.0119***	-0.00564*	-0.0191	-0.00419
	(0.00256)	(0.00491)	(0.00330)	(0.00335)	(0.0129)	(0.00530)
REER t_0	0.000101	1.18e-05	2.86e-05	1.74e-06	2.97e-06	6.24e-06
	(9.25e-05)	(2.02e-05)	(1.86e-05)	(2.08e-05)	(2.41e-05)	(2.29e-05)
Investment t_0	0.000618**	0.00148	0.000488**	0.000498**	0.000540**	0.000536**
	(0.000286)	(0.00105)	(0.000223)	(0.000251)	(0.000250)	(0.000261)
Openness t_0	5.28e-05	5.39e-05	-0.000271***	5.57e-05	5.48e-05*	6.00e-05*
	(3.48e-05)	(3.54e-05)	(9.78e-05)	(3.46e-05)	(3.28e-05)	(3.47e-05)
Schooling t_0	0.000216**	0.000229**	0.000202**	6.73e-05	0.000199**	0.000220**
	(0.000102)	(9.75e-05)	(9.59e-05)	(0.000247)	(0.000101)	(0.000101)
Reserves t_0	0.00259***	0.00235***	0.00233***	0.00275***	-7.53e-05	0.00265***
	(0.000779)	(0.000761)	(0.000718)	(0.000820)	(0.00272)	(0.000866)
Corruption	-0.00118	-0.00129	4.92e-05	-0.00114	-0.000901	-0.00163
	(0.00203)	(0.00199)	(0.00212)	(0.00204)	(0.00200)	(0.00729)
REER t_0*Concentration t_0	-2.27e-05					
	(2.11e-05)					
Investment t_0*Concentration t_0		-0.000207				
		(0.000206)				
Openness t_0*Concentration t_0			9.45e-05***			
			(2.76e-05)			
Schooling t_0*Concentration t_0				4.71e-05		
				(5.97e-05)		
Reserves t_0*Concentration t_0					0.000730	
					(0.000592)	
Corruption*Concentration t_0						0.000157
						(0.00170)
Ln GDP t_0	-0.0136***	-0.0129***	-0.0150***	-0.0138***	-0.0133***	-0.0135***
	(0.00245)	(0.00252)	(0.00241)	(0.00229)	(0.00244)	(0.00252)
Regional component	0.00134	0.00123	0.00146	0.00135	0.00144	0.00131
	(0.000934)	(0.000933)	(0.000903)	(0.000957)	(0.000947)	(0.000936)
Constant	0.0489**	0.0390	0.0994***	0.0657***	0.115**	0.0589**
	(0.0248)	(0.0299)	(0.0215)	(0.0223)	(0.0569)	(0.0250)
Underidentification test (Kleibergen-Paap rk LM statistic p-value)	0.00	0.00	0.00	0.00	0.00	0.00
Weak identification test (Kleibergen-Paap rk Wald F statistic)	20.300	32.270	32.193	30.087	32.346	26.840
Endogeneity test (p-value)	0.49	0.37	0.66	0.53	0.48	0.36
Observations	74	74	74	74	74	74
R-squared	0.479	0.479	0.512	0.483	0.485	0.477

Table D4. 2SLS estimations of moderation effects with resource dependence (Developing countries)

Dependent variable: Growth	(1)	(2)	(3)	(4)	(5)	(6)
Resources t_0	0.000350	-0.00117*	-0.00175***	-0.00113**	-0.000407	-0.00172*
	(0.000745)	(0.000668)	(0.000475)	(0.000475)	(0.00203)	(0.000885)
REER t_0	4.72e-05*	1.25e-06	5.76e-06	2.12e-06	3.13e-06	9.46e-07
	(2.44e-05)	(2.19e-05)	(1.81e-05)	(2.20e-05)	(2.16e-05)	(2.19e-05)
Investment t_0	0.000628***	0.000509	0.000489**	0.000571**	0.000580**	0.000573**
	(0.000241)	(0.000472)	(0.000245)	(0.000258)	(0.000258)	(0.000252)
Openness t_0	6.32e-05	8.81e-05**	-2.06e-06	9.17e-05**	9.83e-05**	8.32e-05*
	(4.26e-05)	(3.85e-05)	(6.21e-05)	(4.29e-05)	(4.23e-05)	(4.33e-05)
Schooling t_0	0.000197**	0.000190**	0.000197**	0.000175*	0.000181*	0.000190**
	(8.76e-05)	(9.35e-05)	(8.58e-05)	(0.000102)	(9.39e-05)	(9.07e-05)
Reserves t_0	0.00288***	0.00291***	0.00269***	0.00289***	0.00309***	0.00289***
	(0.000661)	(0.000674)	(0.000652)	(0.000683)	(0.00113)	(0.000691)
Corruption	0.000520	0.000373	0.00148	0.000129	-3.36e-06	-0.000612
	(0.00228)	(0.00255)	(0.00228)	(0.00230)	(0.00241)	(0.00256)
REER t_0* Resources t_0	-1.09e-05**					
	(4.64e-06)					
Investment t_0* Resources t_0		7.36e-06				
		(3.29e-05)				
Openness t_0* Resources t_0			1.00e-05**			
			(4.29e-06)			
Schooling t_0* Resources t_0				8.68e-07		
				(1.06e-05)		
Reserves t_0* Resources t_0					-3.62e-05	
					(0.000111)	
Corruption* Resources t_0						0.000275
						(0.000316)
Ln GDP t_0	-0.0161***	-0.0163***	-0.0167***	-0.0161***	-0.0162***	-0.0159***
	(0.00229)	(0.00256)	(0.00224)	(0.00231)	(0.00234)	(0.00230)
Regional component	0.00111	0.00108	0.00145	0.00110	0.00109	0.00108
	(0.000940)	(0.000959)	(0.000982)	(0.000981)	(0.000967)	(0.000962)
Constant	0.0543***	0.0621***	0.0711***	0.0611***	0.0569**	0.0615***
	(0.0197)	(0.0230)	(0.0197)	(0.0211)	(0.0260)	(0.0201)
Underidentification test (Kleibergen-Paap rk LM statistic p-value)	0.00	0.00	0.00	0.00	0.00	0.00
Weak identification test (Kleibergen-Paap rk Wald F statistic)	23.265	19.591	24.432	20.297	10.883	40.726
Endogeneity test (p-value)	0.66	0.61	0.53	0.52	0.56	0.61
Observations	74	74	74	74	74	74
R-squared	0.519	0.514	0.533	0.513	0.514	0.517

Table D5. 2SLS estimations of moderation effects with exports concentration (Advanced economies)

Dependent variable: Growth	(1)	(2)	(3)	(4)	(5)	(6)
Concentration t_0	0.0133*	-0.00344	-0.00506*	-0.0301***	0.0107	-0.0128***
	(0.00748)	(0.00551)	(0.00300)	(0.00461)	(0.0106)	(0.00392)
REER t_0	0.000334*	-5.91e-05	-5.70e-05	-6.21e-05	-6.64e-05	-4.43e-05
	(0.000176)	(5.15e-05)	(4.86e-05)	(4.27e-05)	(5.17e-05)	(4.54e-05)
Investment t_0	0.000614***	0.000437	0.000480**	0.000553***	0.000351	0.000447*
	(0.000192)	(0.000632)	(0.000214)	(0.000204)	(0.000235)	(0.000237)
Openness t_0	8.13e-05***	9.10e-05***	4.71e-05	0.000103***	9.99e-05***	9.36e-05***
	(2.34e-05)	(2.66e-05)	(6.28e-05)	(2.20e-05)	(2.88e-05)	(2.51e-05)
Schooling t_0	6.60e-05	3.57e-05	3.91e-05	-0.00056***	7.00e-06	7.18e-05
	(5.62e-05)	(5.73e-05)	(5.18e-05)	(0.000109)	(5.84e-05)	(6.31e-05)
Reserves t_0	-3.98e-05	0.000355	0.000185	0.001000	0.00209	0.000364
	(0.000817)	(0.000971)	(0.000915)	(0.000837)	(0.00185)	(0.000860)
Corruption	0.00297***	0.00310***	0.00313***	0.00275***	0.00322***	-0.000680
	(0.000681)	(0.000812)	(0.000791)	(0.000678)	(0.000807)	(0.00171)
REER t_0*Concentration t_0	-0.000167**					
	(7.85e-05)					
Investment t_0*Concentration t_0		1.94e-06				
		(0.000237)				
Openness t_0*Concentration t_0			1.65e-05			
			(2.12e-05)			
Schooling t_0*Concentration t_0				0.000293***		
				(4.96e-05)		
Reserves t_0*Concentration t_0					-0.000656	
					(0.000494)	
Corruption*Concentration t_0						0.00159***
						(0.000586)
Ln GDP t_0	-0.0202***	-0.0191***	-0.0190***	-0.0182***	-0.0193***	-0.0189***
	(0.00209)	(0.00211)	(0.00213)	(0.00200)	(0.00210)	(0.00214)
Regional component	0.00186*	0.00145	0.00146	0.00100	0.00133	0.00162
	(0.000965)	(0.00110)	(0.00107)	(0.000987)	(0.00111)	(0.00109)
Constant	0.138***	0.165***	0.169***	0.197***	0.133***	0.179***
	(0.0290)	(0.0298)	(0.0311)	(0.0281)	(0.0440)	(0.0293)
Underidentification test (Kleibergen-Paap rk LM statistic p-value)	0.00	0.00	0.00	0.00	0.00	0.00
Weak identification test (Kleibergen-Paap rk Wald F statistic)	24.534	32.213	20.832	27.629	40.230	27.522
Endogeneity test (p-value)	0.38	0.39	0.48	0.89	0.50	0.41
Observations	48	48	48	48	48	48
R-squared	0.755	0.721	0.724	0.780	0.722	0.739

Table D6. 2SLS estimations of moderation effects with resource dependence (Advanced economies)

Dependent variable: Growth	(1)	(2)	(3)	(4)	(5)	(6)
Resources t_0	0.00232***	-0.000391	-0.00169	-0.00316***	0.00631	-0.00169*
	(0.000483)	(0.000485)	(0.00134)	(0.000706)	(0.00478)	(0.000980)
REER t_0	-5.36e-05	-9.39e-05**	-9.02e-05**	-8.33e-05*	-0.000100**	-8.90e-05**
	(4.56e-05)	(4.52e-05)	(4.56e-05)	(4.34e-05)	(4.63e-05)	(4.34e-05)
Investment t_0	0.000291	0.000259	0.000296	0.000378*	0.000123	0.000171
	(0.000192)	(0.000230)	(0.000229)	(0.000216)	(0.000246)	(0.000233)
Openness t_0	0.000104***	0.000106***	9.27e-05***	9.51e-05***	0.000111***	0.000115***
	(3.30e-05)	(2.97e-05)	(3.14e-05)	(2.91e-05)	(3.15e-05)	(3.11e-05)
Schooling t_0	3.19e-05	2.86e-05	1.61e-05	1.67e-06	7.40e-06	4.11e-05
	(6.40e-05)	(6.16e-05)	(5.79e-05)	(5.48e-05)	(5.97e-05)	(6.70e-05)
Reserves t_0	0.00133**	0.00142**	0.00139*	0.00123*	0.00178**	0.00159**
	(0.000672)	(0.000696)	(0.000710)	(0.000664)	(0.000801)	(0.000714)
Corruption	0.00276***	0.00260***	0.00289***	0.00269***	0.00293***	0.00240**
	(0.000886)	(0.000877)	(0.000883)	(0.000824)	(0.000899)	(0.000973)
REER t_0* Resources t_0	-2.66e-05***					
	(4.37e-06)					
Investment t_0* Resources t_0		-7.80e-07				
		(2.49e-05)				
Openness t_0* Resources t_0			1.42e-05			
			(1.49e-05)			
Schooling t_0* Resources t_0				3.13e-05***		
				(9.11e-06)		
Reserves t_0* Resources t_0					-0.000310	
					(0.000219)	
Corruption* Resources t_0						0.000244
						(0.000183)
Ln GDP t_0	-0.0201***	-0.0189***	-0.0193***	-0.0188***	-0.0197***	-0.0195***
	(0.00295)	(0.00275)	(0.00272)	(0.00248)	(0.00262)	(0.00290)
Regional component	0.00142	0.00106	0.00104	0.00131	0.000775	0.000984
	(0.000911)	(0.000979)	(0.000982)	(0.000937)	(0.00105)	(0.000981)
Constant	0.150***	0.144***	0.147***	0.144***	0.148***	0.146***
	(0.0279)	(0.0292)	(0.0290)	(0.0283)	(0.0285)	(0.0296)
Underidentification test (Kleibergen-Paap rk LM statistic p-value)	0.00	0.00	0.00	0.00	0.00	0.00
Weak identification test (Kleibergen-Paap rk Wald F statistic)	24.870	21.543	16.993	31.740	18.909	22.490
Endogeneity test (p-value)	0.56	0.53	0.49	0.63	0.39	0.41
Observations	47	47	47	47	47	47
R-squared	0.773	0.748	0.745	0.769	0.751	0.745

Chapter 2 Dutch Disease and de-Agriculturalization in Developing Countries: The Cases of DR Congo and Zambia

This chapter investigates Dutch disease in two major copper producing developing countries, namely the Democratic Republic of Congo (DRC) and the Republic of Zambia over the period 1991-2019. Using VAR and VEC models, the study evaluates the responses of the value added and the number of employees in agriculture and services sectors to shocks in real copper price and copper production. The analyses provide some evidence of Dutch disease spending effects in both countries resulting from copper price shocks. Some partial signs of resource movement effects are observed in the case of DRC. Indeed, copper price shocks are also found to have a negative impact on the number of employees in the agriculture sector suggesting a direct de-agriculturalization of the country. However, this does not translate into a reduction in the Congolese agricultural production. Moreover, value added in services is found to react negatively to copper production shocks in DRC, yet these reactions are not associated with changes in sectoral employment levels. In the case of Zambia, the analyses find strong evidence of copper induced de-agriculturalization as booms in copper production are found to undermine agricultural production.

2.1 Introduction

The term "Dutch disease" was coined by the journal *The Economist* in 1977 in reference to the contraction of the Dutch manufacturing sector in the 1960's after the discovery of important natural gas fields in Groningen (Badeeb et al., 2017). The expression has since been used to describe the phagocytic effect that resource booms may exert on the other tradable sectors of the economy. This adverse effect manifests through real exchange rate appreciations which tend to undermine the competitiveness of local producers (Apergis et al., 2014).

Meade & Russell (1957) had already identified the potential negative impact of sectoral booms on the rest of the economy in the Australian context. The authors argued that an increasing demand for Australian exports, which back then were mainly the product of land rather than labour (e.g. wool, wheat, meat, etc.), led to competitiveness and balance-of-payments issues. Gregory (1976) provided an early attempt to modelling Dutch disease by analysing the impact of the rapid growth of Australian mineral exports on the manufacturing and rural sectors. However, the model proposed in the seminal work of Corden & Neary (1982) is the one that generated most of the attention and is considered as the core model of Dutch disease theory (Apergis et al., 2014; Mien & Goujon, 2021).

The core model is based on the framework of a small open economy with three sectors: a booming resource sector (B), a lagging non-resource sector (L), and a non-tradable services sector (N). The two former sectors are tradable; therefore, they face international competition, and their prices are set exogenously at world level. Prices in the non-traded sector are set locally and fluctuate to guarantee domestic market equilibrium. The production of each sector requires a sector-specific factor and labour which can move freely from one sector to another. The mobility of labour ensures the equality of wage in all sectors. The core model of Corden & Neary assumes that the prices of all factors are flexible and that all factors are internationally immobile. In this framework, the real exchange rate corresponds to the price of non-tradable items relative to the price of tradable goods. A boom in sector B can occur either due to the discovery of new resources, to an exogenous technical improvement in the sector, or to an exogenous increase in the price of its product on the world market (Corden, 1984). Such booms generate additional income for the factors employed in B. This initial impact may set in motion two potential effects (i.e. the *spending effect* and the *resource movement effect*). The spending effect results from the increase in factors income in sector B following the boom. The additional income is either partly spent directly by the sector B factor owners, or indirectly through government spending after tax collection. Assuming sector N is characterized by income elastic demand, the increased income in sector B will result in higher demand for non-tradable items. Consequently, the price of non-tradable goods relative to tradable goods increases as prices in tradable sectors are set at world level.[2] The resource movement effect results from the increase in marginal productivity of labour in sector B due to the boom. The subsequent increased demand for labour in B and the higher remuneration of factors in that sector lead to a draining of labour from N and L. Note that the resource movement effect is a two-folded mechanism: firstly, part of the labour initially employed in L shifts to B, leading to decreased output in L. This first step is called the *"direct de-industrialisation"* as the nontraded sector N is not involved. Secondly, an *indirect de-industrialisation* occurs when part of the labour from N migrates to B, reducing the production of nontraded items. The resulting excess demand for N adds up to the increased demand in that sector triggered by the spending effect. This in turn leads to an additional real appreciation and induces a movement of labour from L to N. All in all, sector L output shrinks due to production factors withdrawal and real appreciations resulting from the initial boom in the resource sector B. No clear-cut predictions can be made about the impact on sector N. Indeed, the rise in the relative price of N due to the spending effect may eventually dampen the demand for nontraded items. Moreover, the attraction of labour from L to N associated with indirect de-industrialisation may not compensate the migration of workers from N to B (Corden, 1984; Struthers, 1990).

Several theoretical contributions to the Dutch disease topic have emulated since the early 1980's. Neary (1985) and Neary & Purvis (1983) incorporated monetary aspects to the core model. They introduced the *liquidity effect* of Dutch disease which results from the rise in money demand following the income increase due to a resource boom. In case of stickiness in money supply, they predict a fall in prices of nontraded items to restore money market equilibrium. De Macedo (1982) provided the first developing country-specific Dutch disease model by analysing the case of Egypt. The author expended the core model with the case of a double exchange rate

[2] Note that increases in the relative price of non-tradable goods correspond to real appreciations.

as prevailing in Egypt back in the 1970's. In that framework, the booming traded sector (i.e. oil) is submitted to the official exchange rate, while the lagging traded sector (i.e. manufacturing) is ruled by a "grey" unofficial exchange rate with a premium. The grey market was tolerated by Egyptian authorities and the premium was seen by manufacturing producers as a subsidy on manufacturing exports. De Macedo arrived at the conclusion that a system of dual exchange rates allowing manufacturing exports at rates closer to the grey market might work better against Dutch disease than exchange rate unification. Aoki & Edwards (1983) proposed a dynamic model of Dutch disease. The authors argue that if the money market is considered in the model, the loss of competitiveness in the lagging tradable sector following the resource boom is expected to be greater in the short-run than in the long-run.

Van Wijnbergen (1984) developed a learning by doing (LBD) model of Dutch disease. The study presents a two-period model where productivity in the lagging tradable sector in the second period is linked, via an LBD process, to the sectoral output in the first period. The author shows that Dutch disease may delay the necessary learning by doing process required by countries at an early stage of industrial development to improve their comparative advantage (or lessen a comparative disadvantage). Torvik (2001) extended the LBD framework by assuming learning patterns both in the lagging tradable and the non-tradable sector; and learning spillovers between the two sectors. It falls from that analysis that resource-booms tend to shift relative productivity in favour of the non-tradable sector. Bjørnland & Thorsrud (2016) built upon the work of Torvik (2001) and proposed a model which allows for productivity spillovers from the booming resource sector to both the lagging traded sector and the nontraded sector. Taking Australia and Norway as case studies, the authors found significant and positive spillovers of resource booms on the non-resource sectors in both countries. The results suggest a two-speed transmission as a greater stimulation of productivity and production is observed in the nontraded sector compared to the lagging traded sector. However, the authors observed some evidence of Dutch disease with a decline in manufacturing in Australia in case of resource price increases unrelated to global activity. Bjørnland, Thorsrud & Torvik (2019) developed a dynamic three sector model and observe some increasing productivity spillovers of the Norwegian oil and oil related industries on the rest of the economy as the oil sector becomes more important.

Roemer (1985) argues that the predictions of the core model may not apply to developing countries. The main objection relates to the presence of substantial underemployment in these countries. Sector N could absorb labour from the pool of unoccupied workforce to align the production to the increased demand following the boom. This would prevent the relative price of N to increase and avoid the real appreciation coming with the spending effect. The need for additional labour in sector B could also be covered by unemployed workers to avoid the resource movement effect. However, the author notes that countries such as Nigeria and Indonesia experienced the effects predicted by the core model despite important underemployment levels. Another concern raised is the frequent use of protectionism in developing countries seeking to shelter their tradable sectors. Roemer argues that this tends to make the distinction between tradable and non-tradable sectors quite tedious. This is because import restrictions and high tariffs somehow disconnect tradable goods from international competition and world prices, converting them into quasi non-tradable items. Benjamin et al. (1989) and Stijn (2003) add that Dutch disease effects in developing countries are likely to materialize into de-agriculturalization rather than de-industrialization which applies to advanced economies. Indeed, agriculture appears to be the main tradable sector in many countries at early stage of development. Moreover, such countries tend to be barely industrialised even in the absence of a strong resource sector. Stijn (2003) therefore recommends studies on Dutch disease in developing countries to consider agriculture as lagging sector.

Although the Dutch disease has been more thoroughly investigated in advanced economies, some empirical papers have focused on developing countries. An early contribution in that sense is the work of Egg et al. (1985). The authors analysed the increases in oil rents experienced by oil-exporting countries in the 1970's. They argue that these oil windfalls paradoxically failed at waving the two traditional hurdles to the development of agriculture in developing countries, namely the lack of financial inputs and the absence of viable domestic markets. Oil income benefited more to urban areas than rural areas and triggered higher imports to the detriment of domestic production. Benjamin et al. (1989) reached similar conclusions analysing the case of Cameroon. They found oil revenues to be responsible of a widening of income gap between rural and urban areas in the country, and harmful to the export part of the agriculture sector. Fardmanesh (1991) estimated a three-sector model to analyse Dutch disease in five developing oil-exporting countries, namely Algeria, Ecuador, Indonesia, Nigeria, and Venezuela. As suggested by Roemer (1985), Fardmanesh relaxed the assumption of free-trade and accounted for protectionism on the non-resource tradable sectors. This leading to semi-traded/semi-nontraded output in the lagging sectors. The author found evidence of a spending effect resulting in a shrinkage in agricultural output and a boost in nontraded items.

More recently, Apergis et al. (2014) investigated the effect of oil rents on agriculture value added in Middle East and North African (MENA) countries. Using panel cointegration tests and causality tests, the authors found a long run negative relationship between oil rents and agricultural output. The study also shows that following oil booms, the lagging agriculture sector tends to return to equilibrium with a rather slow pace of short run adjustments. This tends to show evidence of a resource movement effect from non-oil sectors to the booming oil sector. Barrows (2018) observed a prevalence of the Dutch disease in Sub-Saharan Africa finding that over a quarter of the countries in that region either exhibit signs of the disease or dynamics consistent with it.

In their extensive literature review on Dutch disease in developing countries, Mien & Goujon (2021) underline that resource booms may result in real exchange rate appreciations without significantly affecting manufacturing and agricultural output. Contrariwise, non-resource tradable sectors can experience output declines without signs of RER appreciations after resource booms. Hodge (2015) for example finds real effective exchange rate appreciations in South Africa following rises in commodity prices. However, the author shows that overall manufacturing production tends to increase rather than decrease after commodity booms. On the other side, Pegg (2010) argues that although Botswana managed to avoid sizable real exchange rate appreciations thanks to a successful crawling-peg exchange rate regime, diamond booms have generated Dutch disease in the country. The study shows that Dutch disease has manifested in Botswana through a resource movement effect not towards the mining sector but rather towards the larger government sector in which generous wages tend to be fuelled by mining windfalls.

The Dutch disease phenomenon has been extensively investigated in the context of oil and natural gas producing countries. Besides being exported, these resources are consumed locally both as end products and as intermediate goods in the production of non-resource items. Apergis et al. (2014) present two ways in which this context may be a peculiar field for the manifestation of the Dutch disease. Firstly, in case of an exogenous rise in resource world prices, the spending effect in oil/gas producing countries might be mitigated as the increase in factor income in the booming sector will be dampened by the increased price in consumption of oil/gas locally. Secondly, the rise in oil/gas prices might result in a resource movement between the lagging non-resource tradable sector and the non-tradable sector from the most oil/gas-intensive sector to the other one. If this movement is favourable to the non-tradable sector, the sectoral output level will increase at prevailing prices. This will lead to a less pronounced real exchange rate appreciation. Note also that oil and gas producing countries often subsidise the domestic prices of these resources. This may attenuate the competitiveness loss of domestic import-competing sectors as foreign competitors endure more severely oil/gas price rises and the subsequent increased production costs. The case of oil/gas producing countries might therefore differ from that of mineral resource producers, especially in the context of developing countries. Indeed, mineral resources-rich developing countries tend to appear exclusively upstream of the global value chain as resource providers. Most of the processes after extraction and early treatment of resources are then operated abroad in more industrialised countries. The booming mineral resource sector in countries at early stage of development is thus (almost) entirely export oriented as assumed in the core model of Dutch disease.

This paper intends to investigate Dutch disease in two copper-rich developing countries, namely the Democratic Republic of Congo (DRC) and the Republic of Zambia. These two countries share a common border around which expand import copper deposits. After various ups and downs, copper extraction in DRC and Zambia has been increasing since the early 2000's, turning the two countries into important copper producers worldwide. This study aims at analysing the potential Dutch disease effects that may have resulted from the recent surges in copper activities in DRC and Zambia. Dutch disease studies dedicated to copper exporting countries similarly to the current paper, include the work of Kayizzi-Mugerwa (1991). The author analysed the case of Zambia and found both copper booms and busts to be associated with declines in manufacturing output and exports. However, the magnitude of these negative effects is found to be twice as large after copper booms than following copper busts. Du Plessis & Du Plessis (2006) found no evidence of an equilibrium relationship between real copper price and Zambia's real exchange rate as expected in a Dutch disease context. However, they argue that the stagnation of agriculture both in terms of export revenues and value added per hectare from the mid-1970s to the mid-1980s, along with the growth of the tertiary sector in the 1960s and 1970s in Zambia are consistent with Dutch disease predictions. Ruehle & Kulkarni (2011) and Marañon & Kumral (2021) investigated the impact of copper price increases on sectoral distribution in Chile. It appears from these studies that the abundance of labour has contributed to limiting the resource movement effects towards the copper sector after copper booms. Moreover, fiscal and monetary discipline seem to have reduced the severity of spending effects in the country. Without focusing on copper solely, Otchia (2015) analysed the impact of mining-based growth on sectoral distribution in DRC. The study shows that mining booms are associated with real exchange rate appreciations and drops in the production of non-mining tradable goods in the country. The author advocates for deliberate and sound industrial policies given the observed persistency of sectoral contraction in the rest of the economy following mining booms.

The contribution of this paper is three-folded: firstly, it adds up to the relatively scant non-oil/gas-based literature on Dutch disease by investigating the case of some copper exporting countries. Secondly, it provides additional material on Dutch disease manifestation in developing countries with prevalent underemployment. As suggested by Stijn (2003), agriculture is considered as the lagging sector in such context. Finally, this paper focuses on DRC and Zambia which are respectively the first and second most important copper producers in Africa, and fourth and seventh at the world level. Despite the important mining orientation of these countries and their high reliance on copper exports which make them natural candidates for Dutch disease, they have caught little attention from Dutch disease researchers.[3] This paper thus sheds some more light on the question of Dutch disease in these two countries.

[3] Empirical studies on Dutch disease in Zambia include the works of Kayizzi-Mugerwa (1991) and Du Plessis & Du Plessis (2006), while Otchia (2015) investigates the distributional effect of mining-based growth in DRC.

Beyond this introductory section, the remainder of the paper is as follows: section 2.2 dwells into the history of copper production in DRC and Zambia and provides some preliminary analyses by glancing at some variables usually mentioned in the Dutch disease discussion. Empirical investigations are performed in section 2.3 and the conclusions drawn from the analyses are then presented in the last section of the paper.

2.2 History and stylized facts

Copper production in DRC and Zambia can be traced back to the early 1900's. The copper industry has been deeply intertwined with the social and political evolutions of these two neighbour countries. Over the period 1906-1967, copper production in DRC was mainly operated by the Belgian-owned private company UMHK (*Union Minière du Haut Katanga*) created in 1906. During the colonial epoque, the company accounted for about half of the country's budget (Young & Turner, 1985). The UMHK maintained its operations after the independence of the country in 1960. Annual copper production by the UMHK reached 300,000 metric tons in 1965. The company was nationalised by the Congolese (back then Zairian) authorities in 1967 and took the denomination "Gecamines" (*Générale des Carrières et des Mines*). Despite promising debuts, the production of the state-owned company started to slow from the mid-1970's due to unfavourable copper prices and higher operating and transportation costs due to high oil prices. Moreover, the growing political instability in the young country undermined the business climate. This context was accompanied with a rise in corruption which contributed further to the deterioration of the company. This turmoil culminated in a drop of production from 465,000 metric tons in 1988 to merely about 50,000 metric tons in 1993. International investors were then invited to form partnerships with Gecamines which still owned most of the mines in the copper-rich region of Katanga. However, the political imbroglio that characterized the country from the mid-1990's to the early 2000's[4] discouraged foreign investors (Rubbers, 2004). In 2002, the country enacted a new investor-friendly mining code elaborated

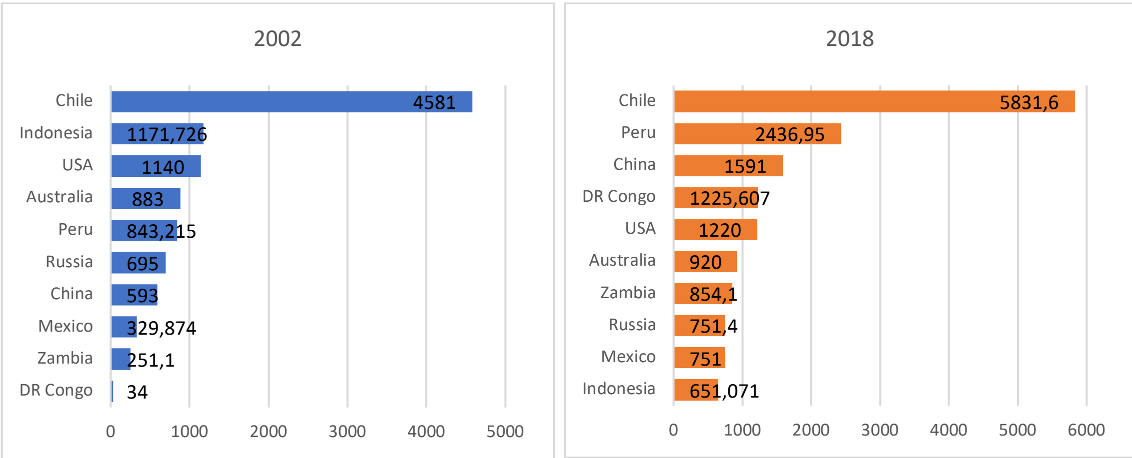
[4] The First War of Congo (1996-1997) ended the 32 years long Zairian regime of President Mobutu Sese Seko who was replaced by Mzee Laurent Desiré Kabila. This conflict was followed by the Second War of Congo (1998-2002) during which several parts of the country were under the control of some local and foreigner (Rwandan and Ugandan) armed groups. The assassination of President Kabila in 2001 added upon to the extremely fragile situation of the country (Huening 2009; Tamm, 2022).

in cooperation with the World Bank. Moreover, the political situation in DRC has been improving over the past two decades. This combination of encouraging factors has contributed to the attraction of foreign investments which enhanced copper production in the country (Lassourd, 2018).

Copper production in Zambia began in 1928 with the opening of the Roan Antelope Mine in the town of Luanshya in the Copperbelt province. From 1900 until the independence of the country in 1964, mining rights in Zambia were detained by the British South African Company (BSA). The company had the authority to grant concessions to foreign mining operators. The sector rapidly grew boosted by the demand for copper, favourable copper prices, and maintained investments in the industry. In 1969, the Zambian copper production peaked at 769,000 metric tons (Lungu, 2008; Sikamo et al., 2016). However, the flow of investments in the sector shrank after the independence of the country as mining rights, and hence the subsequent royalties, were placed in the hands of the government. As in DRC, a process of nationalisation of Zambian mines began in 1969 and became fully effective in 1973. At the same time, the country also adopted a new constitution to become a one-party state. The copper sector then became the backbone of the country's development plan. Massive investments in infrastructure and education, widely neglected under the BSA era, were made. This, however, was realized in detriment of investments in the sector itself. Copper production inevitably decayed progressively, hitting a low point of 250,000 metric tons in 2000. The 1990's saw the return of multipartyism in Zambia and a re-privatisation of the mining sector was decided. The re-privatisation process was completed in 2000, opening the door to new investors (Sikamo et al., 2016).

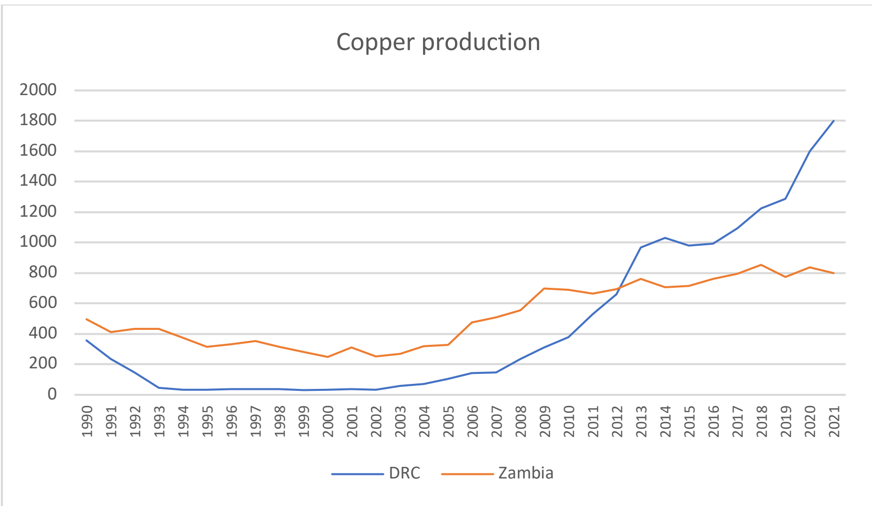
The surges in the production of copper in DRC and Zambia since the early 2000's motivate the investigation of potential Dutch disease patterns. Figure 2.1 depicts the production of copper in the top ten producing countries worldwide in 2002 and 2018. Over that period, copper production in DRC has been multiplied by almost 40, rising from 34,000 metric tons in 2002 to over 1.2 million in 2018. This led the country from the tenth position worldwide to the fourth position behind Chile, Peru, and China in 2018. Copper production in Zambia has more than tripled over the same period, starting from about 251,100 in 2002 to 854,100 metric tons in 2018. The country jumped from the ninth place of top copper producers up to the seventh place between the two periods. As shown in figure 2.2, copper production has been stagnating around 800,000 metric tons in Zambia since 2018, while that of DRC has continued to progress, reaching 1.8 million metric tons in 2021.

Figure 2.1. Copper production in thousands of metric tons in 2002 and 2018.



Source: Natural Resource Governance Institute (NRGI).

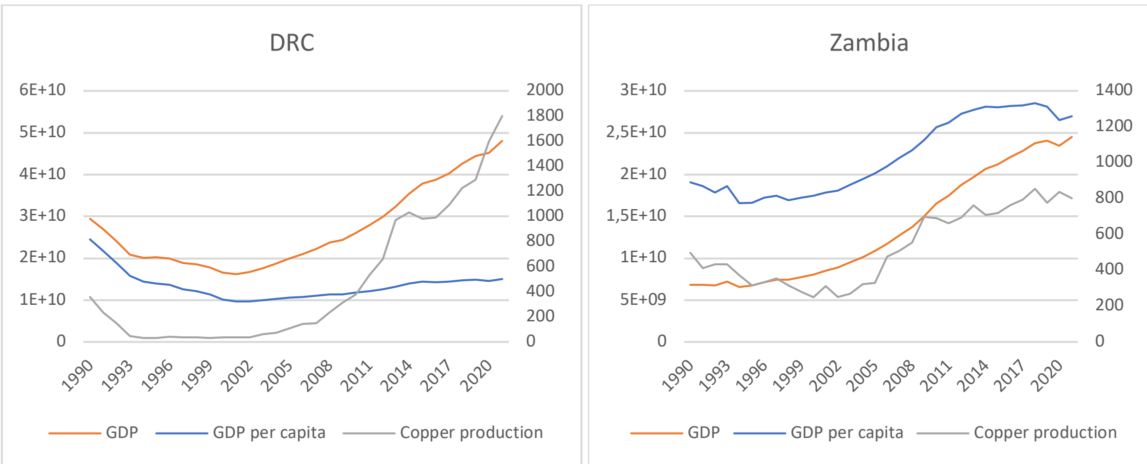
Figure 2.2. DRC and Zambia copper production in thousands of metric tons from 1990 to 2021.



Source: NRGI

Figure 2.3 shows some co-movements in the evolutions of copper production along with real GDP and real GDP per capita in DRC and Zambia. The rebirth of the copper sector in DRC has been associated with economic recovery in the country after the turmoil of the 1990's. Over the period 1990-2000, the average yearly real GDP growth in DRC was about -5.8% while that of real GDP per capita plunged even deeper at -8.8% approximately. Over the period 2001-2021, the country has experienced some progress with an average growth rate of real GDP of about 5.4% per year. This led the country to surpass its real GDP level of 1990 by the year 2012. In terms of real GDP per capita, however, the advances have been shier with an average yearly growth rate of 2.2% over the period 2001-2021. With a real GDP per capita of about 501.24 US$ in 2021, the country had not yet reached back its level of 1990 (817.08 US$) while the peak of 1362.29 US$ registered in 1974 seems to be no more than a memory. In the case of Zambia, economic growth has been accelerated since the completion of the re-privatisation process of the mining sector in the country in the early 2000's. The average yearly real GDP growth rate increased from approximately 1.6% over the period 1990-2000 to around 5.3% over the period 2001-2021. During the 1990's, the country saw its real GDP per capita decay at a yearly rate of -0.8% on average. Over the period 2001-2021, this indicator has known an average increase of about 2.1% per year, outpacing its level of 1990 (889.99 US$) by the year 2004 (907.49 US$). Zambia registered the highest real GDP per capita of its history in 2018 with a level of 1331.45 US$. That year also coincided with the country's all-time peak in copper production (854,100 metric tons).

Figure 2.3. GDP in constant 2015 US$ on the left axes, GDP per capita in constant 2015 US$ and copper production in thousands of metric tons on then right axes.

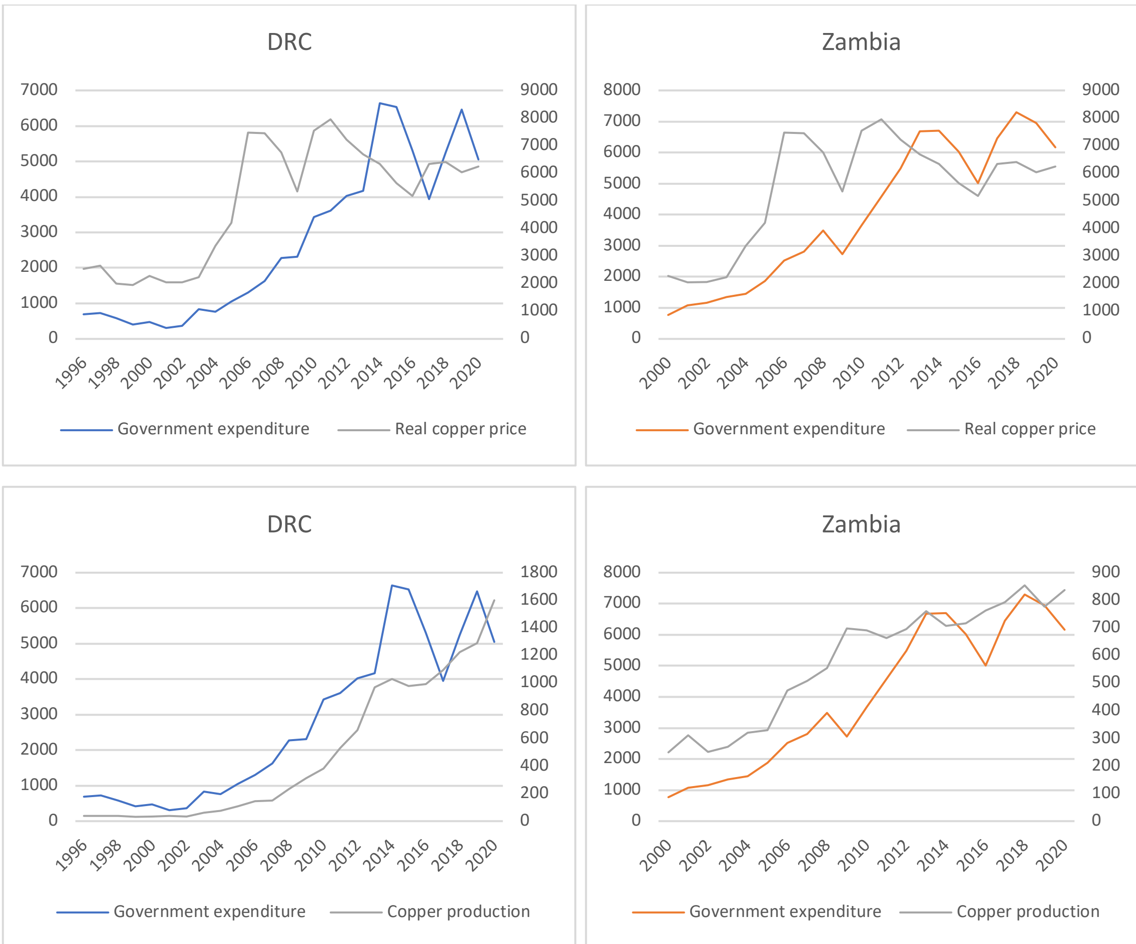


Source: World Bank

Figure 2.4 displays the evolution of copper price and production along with government expenditure over the periods 1996-2020 for DRC and 2000-2020 for Zambia. Public spendings in the two countries appear to be closely pegged to the health of the copper sector. The steady increase in copper production in DRC and Zambia since the early 2000's has been accompanied with enhanced government expenditure. After more than a decade of upturn, the level of public spendings in DRC was reduced by 36.5% from 2014 to 2017. That period was characterized by sluggish progression in copper production in the country and relatively low copper prices.

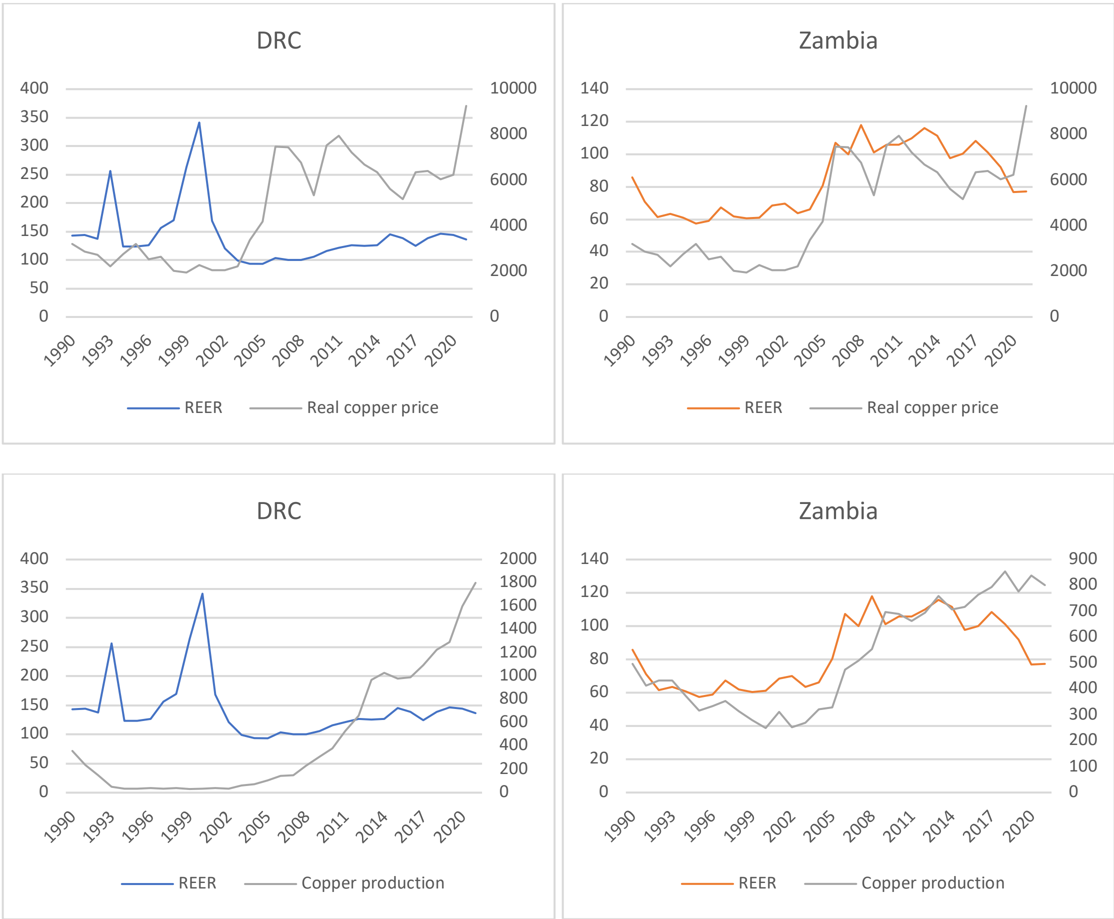
Indeed, after a period of sharp progression (from 148,099 metric tons in 2007 to 970,000 metric tons in 2013), copper production in DRC plateaued before registering a new surge in 2018. On the other hand, after a peak at 7953.63 US$ per metric ton in 2011, the real price of copper started a phase of decline. By 2016, the ore had lost approximately 43% of its value from 2011. This trough in the evolution of copper prices, as well as the drop observed in 2009, also coincide with troughs in the level of government expenditure in Zambia. Moreover, the country further experienced a 5-percent decline in public spendings in 2018-2019, coinciding with a drop in copper production from 854,100 to 776,430 metric tons and a 6-percent decrease in the real price of copper. Note that the drops in government expenditure in both countries in 2020 are likely imputable to the Covid-19 pandemic. The variations in income and government expenditures observed concomitantly with variations in copper price are consistent with the idea of some initial resource-induced additional demand setting in motion the spending effect of Dutch disease.

Figure 2.4. General government expenditure in million US$ on the left axes, and real copper price in US$/metric ton or copper production in thousands of metric tons on the right axes.



Source: World Bank

Figure 2.5. Real effective exchange rate (REER) on the left axes, real copper price in US$/metric ton or copper production in thousands of metric tons on the right axes.



Sources: Bruegel Think Tank and World Bank

Resource booms that result in Dutch disease manifestation may induce competitiveness issues for domestic tradable sectors vis-à-vis trading partners through real exchange rate appreciations. Figure 2.5 depicts the evolution of the real effective exchange rate (REER) for DRC and Zambia from 1990 to 2021, along with copper price and production series. The REER employed here measures the real value of a country's currency against a weighted average of 65 trading partners of the country (Darvas, 2012; 2021). Higher values of the indicator correspond to real appreciations and hence, loss of competitiveness for domestic tradable sectors. After experiencing some important appreciation episodes over the period 1990-2000 which were mainly driven by high inflation[5], DRC has maintained its REER within narrower bands of fluctuation since the early 2000's. The plots do not provide much discernible information about the REER and copper sector nexus for DRC. However, it can be observed that during the 2008-2014 period which was characterized by a take-off of the copper production in the country, the REER in Congo has appreciated by about 45 points. Figure 2.5 is more insightful in the case of Zambia as the curves of REER and copper variables seem to interlock. Although it has been shown in the literature that exchange rate appreciations are not a necessary condition for the manifestation of Dutch disease effects, it appears from this preliminary analysis that Zambia tends to exhibit more expected features of the malady compared to DRC.

The contribution of agriculture to the total production of these two developing countries has been declining over the past two decades. Figure 2.6 shows that while agriculture value added in DRC accounted for about half of the country's GDP in the late 1990's, this share has progressively fallen to stabilise slightly below 20% in recent years. Conversely, the services sector has seen its contribution to DRC's total output increase in the 2000's during which it oscillated between 40% and 45% while it accounted for about 30% of GDP in the second half of the 1990's. Since 2010, the share of services has remained stable around one third of the Congolese GDP. Over the past few decades, the country also saw its industrial sector's contribution grow, mainly due to the expansion of non-manufacturing industrial activities including mining extraction. The higher contribution of services combined with the shrinkage of the share of the agriculture sector observed in DRC following the revival of the country's copper sector are consistent with Dutch disease predictions. Figure 2.6 indicates a tertiarization of the Zambian economy with the country's service sector accounting for less than 30% over the period 1991-1993, then progressing from 38% to 49% in 2008, before stabilising around 50-55%. Contrariwise, the observations show a reduction of the share of the country's agriculture sector to GDP from 18% in 1999 to merely 3% in 2019. That period coincides with an increase in the share of the non-manufacturing industry sector from 12% in 1999 to almost 30% in 2019. These changes in sectoral distributions with higher contributions of services and non-

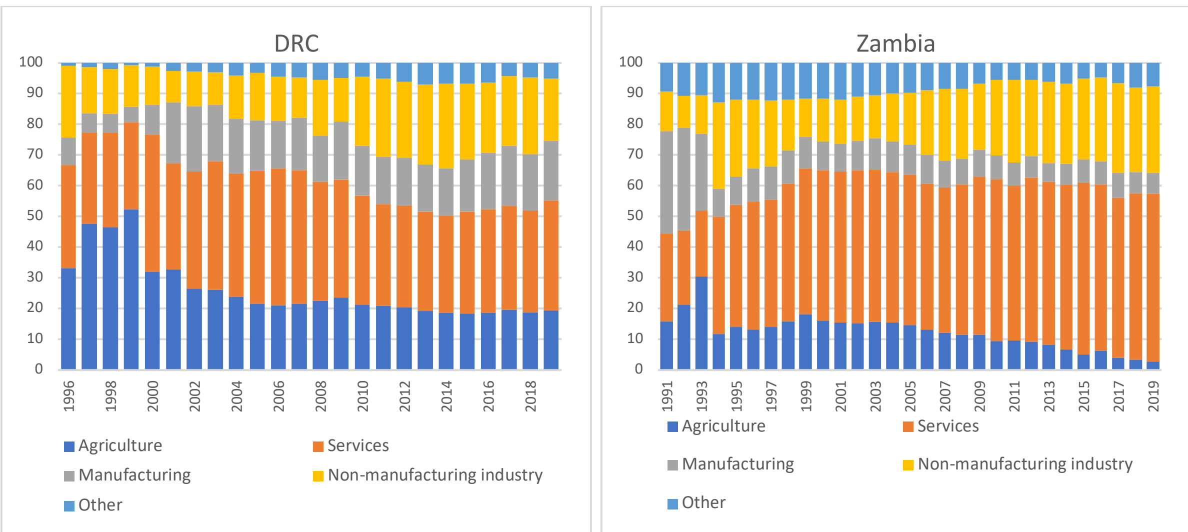
[5] DRC has registered consecutive CPI inflation rates above 1,000% from 1990 to 1994, with a peak at 23,773% in the latter year. During the second half of the 1990's, the country saw a progressive constriction of its inflation reaching a low point of 29.1% in 1998 before rising again up to 513.9% in 2000.

manufacturing industrial activities, and lower shares of agriculture tend to be in line with Dutch disease patterns.

On the employment side, figure 2.7 shows that agriculture and services account for about 90% of jobs in both countries. Despite lower contributions to GDP than the services sector, agriculture appears to provide the essential of jobs in DRC and Zambia. However, the share of total employment occupied in services has been increasing at the expenses of agriculture since the mid-2000’s. This is especially striking in the case of Zambia where the share of employment in agriculture decreased from 72.3% of total employment in 2005 to 49.6% in 2019 while the share of employment in services rose by 19.8 points over the same period and accounted for 39.8% of total employment in 2019. These observations may suggest the presence of some resource movement effects in favour of the non-traded services sector.

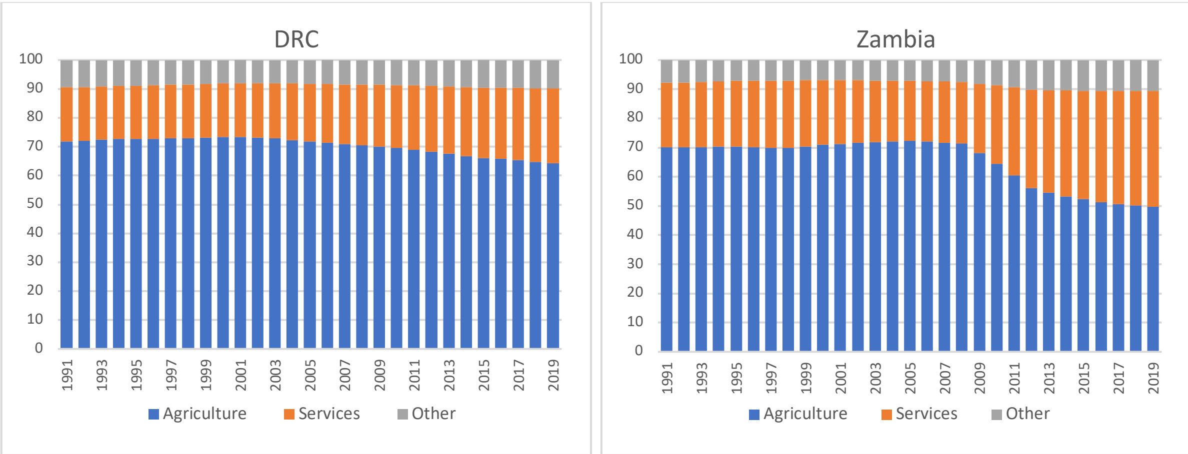
It appears from figures 2.6 and 2.7 that despite contributing to a relatively low share of GDP, the agriculture sector provides most of the jobs in both countries. Indeed, while representing less than 20% of GDP in DRC and about 3% in Zambia in 2019, the agriculture sector accounted for around 65% and 50% of total employment respectively in the two countries. The capacity of agriculture to employ large low-skilled (and rural) workforce adds up to the concerns related to a greater sectoral concentration around less labour-intensive (and urban-based) mining and services sectors as expected in case of Dutch disease.

Figure 2.6. Sectoral value added in % GDP.



Source: World Bank

Figure 2.7. Sectoral employment in % of total employment.



Source: International Labour Organization (ILO)

2.3 Empirical analyses

2.3.1 Model specification

The estimations in this study are based on annual data covering the period 1991-2019 for value added in agriculture (AVA) and services (SVA) both expressed in constant 2015 prices in US$, the number of employees occupied in agriculture (AE) and services (SE), the GDP deflator (P), copper production in thousands of metric tons (Cu) for both countries, and the copper real price (RCP) expressed in 2010 US$ per metric ton. Sectoral value added and employment series are sourced from the World Development Indicators (WDI) database and copper real prices are extracted from the Commodity Price database, both provided by the World Bank. Data on copper production come from the Natural Resource Governance Institute (NRGI) reports. All the series for DRC and Zambia are plotted in appendix.

The vector autoregressive (VAR) framework is employed to examine the impact of copper production and price shocks on the value added and employment in agriculture and services, as well as on price levels in DRC and Zambia. The VAR approach is widely used for multivariate time series analysis including in Dutch disease studies. For instance, Kablan & Loening (2012) followed a similar approach to estimate the impact of oil production and price on inflation in Chad analysing the period 1985-2008. The authors found oil shocks to cause increases in GDP deflator in the country, in line with Dutch disease predictions. Khinsamone (2017) conducted a

VAR model covering the period 1980-2014 to assess the impact of the mining sector on the other activity sectors in Laos finding evidence of Dutch disease.

A K-dimensional VAR model with lag order p takes the following form:

$$y_t = v + A_1 y_{t-1} + \cdots + A_p y_{t-p} + u_t, \tag{2.1}$$

where $y_t = (y_{1t}, \dots, y_{Kt})'$ is a $(K \times 1)$ vector of stationary variables, $v_t = (v_1, \dots, v_K)'$ is a $(K \times 1)$ vector of intercept terms, the A_i are $(K \times K)$ coefficient matrices and $u_t = (u_{1t}, \dots, u_{Kt})'$ is a zero mean white noise error process with non-singular covariance matrix. Note that as u_t is not predictable, it is also referred to as "innovation" or "shock" process (Croux, 2021).

The stationarity condition for VAR estimation requires testing for the presence of unit roots in the series prior to performing any analysis. Table 2.1 displays the results of the augmented Dickey-Fuller (ADF) test with null hypothesis of non-stationarity. Note that all the variables are taken in their natural log form. Beside the log of agriculture value added in Zambia and GDP deflator in both countries, all series appear to be non-stationary in levels. As the null hypothesis of the ADF test could not be rejected for all the non-stationary series in levels when including deterministic trend terms, it can be concluded that working in differences would be the best strategy to reach stationarity. The last two columns of Table 2.1 present the results of ADF tests on series in first difference. All the series that had a unit root in levels appear to be integrated of order 1.

Table 2.1. ADF unit root tests

	Series in levels				Series in first difference	
	DRC		Zambia		DRC	Zambia
Variables	Constant	Constant and trend	Constant	Constant and trend	Constant	Constant
Log(RCP)	-1.0092	-1.4921	-1.0092	-1.4921	-4.1662***	-4.1662***
Log(Cu)	0.2330	-1.9401	-0.3901	-2.5176	-4.1586***	-4.7704***
Log(P)	-5.2212***	-2.8123	-8.4619***	-1.9166	-2.8454*	-1.7260*
Log(AVA)	0.5306	-0.7377	-3.4639**	-6.9302***	-3.9265***	-6.7115***
Log(SVA)	-0.2603	-2.2923	-1.6466	-1.2731	-2.2721**	-5.4268***
Log(AE)	0.3020	-1.9315	-2.2526	-2.2158	-2.1012**	-1.8548*
Log(SE)	2.0947	-1.7057	-0.4433	-2.4483	-1.7825*	-2.4929**

Note: *, ** and *** denote statistical significance at 10%, 5% and 1% thresholds meaning rejection of H0: Non-stationarity

Given that all the series are found to be I(1) or I(0), the Johansen (1991) procedure is implemented to check for potential cointegration in the vector $y_t = (rcp_t, cu_t, p_t, ava_t, sva_t, ae_t, se_t)'$. Note that the variable names in y_t are denoted in lowercase to refer to the log transformations of initial series. Table 2.2 reports the trace and maximum eigenvalue tests for cointegration rank using lag order $p = 2$ for the underlying VARs in level as suggested by the Schwarz Bayesian information criterion (BIC). The results indicate the presence of cointegration. This requires taking the series in first difference and including correction terms in levels to account for cointegration, hence implementing vector error correcting models (VECM) of the form:

$$\Delta y_t = \Pi y_{t-1} + \Gamma_1 \Delta y_{t-1} + \cdots + \Gamma_{p-1} \Delta y_{t-p+1} + u_t, \tag{2.2}$$

where $\Pi = -\left(I_K - A_1 - \cdots - A_p\right)$

and $\Gamma_i = -\left(A_{i+1} + \cdots + A_p\right), \quad i = 1, \ldots, p-1.$

Table 2.2. Johansen cointegration tests

	Trace test				
	Test statistics		Critical values		
H0	DRC	Zambia	10%	5%	1%
r <= 6	0.31	1.97	6.50	8.18	11.65
r <= 5	17.19	11.38	15.66	17.95	23.52
r <= 4	36.80	32.01	28.71	31.52	37.22
r <= 3	58.25	54.41	45.23	48.28	55.43
r <= 2	92.46	81.09	66.49	70.60	78.87
r <= 1	144.46	123.02	85.18	90.39	104.20
r = 0	251.28	225.73	118.99	124.25	136.06
	Maximum eigenvalue test				
	Test statistics		Critical values		
H0	DRC	Zambia	10%	5%	1%
r <= 6	0.31	1.97	6.50	8.18	11.65
r <= 5	16.88	9.41	12.91	14.90	19.19
r <= 4	19.62	20.63	18.90	21.07	25.75
r <= 3	21.45	22.40	24.78	27.14	32.14
r <= 2	34.21	26.68	30.84	33.32	38.78
r <= 1	52.00	41.93	36.25	39.43	44.59
r = 0	106.82	102.71	42.06	44.91	51.30

Although both the trace and maximum eigenvalue tests reject the null hypothesis of $rank(\Pi) = 0$ hence suggesting the presence of cointegration in y_t for DRC and Zambia, the two tests reach different results regarding the rank that should be considered. With a 1% rejection threshold, the trace tests find three cointegrating equations for DRC and two for Zambia, while the maximum eigenvalue tests lead to $rank(\Pi) = 1$ for both countries. As recommended by Lütkepohl et al. (2001), the trace test is preferred as it tends to perform better than the maximum eigenvalue alternative in small samples. Hence, VECM(1) are estimated for both countries with $rank(\Pi) = 3$ for DRC and $rank(\Pi) = 2$ for Zambia. The validity of the specified VECMs is assessed in the next subsection.

2.3.2 Validity tests

Following Kilian & Lütkepohl (2017) a set of tests have been performed to assess the adequacy of the estimated VEC models. A fundamental assumption of VECM analysis is the absence of serial correlation in the innovations u_t. That has been verified using Breusch-Godfrey and Portmanteau tests of which results are displayed in Table 2.3. No signs of autocorrelation in the errors are observed for the employed model specifications as all tests fail to reject the null hypothesis of absence of serial correlation in u_t.

Table 2.3. Tests of autocorrelation in the innovations with p-values entre parentheses.

	Breusch-Godfrey LM test	Portmanteau test
DRC	189	646.33
	(0.99)	(0.89)
Zambia	189	613.46
	(0.99)	(0.98)

Table 2.4 presents the results of some multivariate normality tests applied to the VECM residuals. Indeed, nonnormality of the innovations, hence, nonnormality of the observed variables may indicate that some efficiency gains are possible using alternative estimation procedures (Kilian & Lütkepohl, 2017). Various tests have been performed, namely Mardia (1970), Henze & Zirkler (1990) and Doornik & Hansen (2008).The test statistics and the corresponding p-values suggest that the hypothesis of normal distribution of innovations from the estimated VECM specifications cannot be rejected for both countries.

The validity of the estimations also relies on the assumption of time-invariance of the models. For that assumption to be satisfied, the estimated VECMs must be stationary (i.e. exhibit time-invariant mean, variance, and covariance) and the parameters must remain constant over time (Kilian & Lütkepohl, 2017). The time-invariance of the specified models has been checked using OLS-based and recursive cumulated sum (CUSUM) of residual tests (Brown et al., 1975; Krämer et al., 1988). The results displayed in Table 2.5 indicate no structural change in the VECMs estimated for DRC and Zambia.

Table 2.4. Tests of normality of the innovations with p-values entre parentheses.

	Mardia		Henze-Zirkler	Doornik-Hansen
	Skewness	*Kurtosis*		
DRC	99.11	0.41	0.95	7.75
	(0.12)	(0.68)	(0.08)	(0.90)
Zambia	89.21	-0.12	0.91	23.38
	(0.33)	(0.91)	(0.38)	(0.06)

Table 2.5. Structural change tests with p-values entre parentheses.

	OLS-based CUSUM test	Recursive CUSUM test
DRC	0.2960	0.3639
	(0.999)	(0.905)
Zambia	0.4371	0.3691
	(0.991)	(0.897)

2.3.3 Results

This section presents the impulse response functions (IRFs) and forecast error variance decompositions (FEVDs) obtained from the estimated VECMs after transforming them in their corresponding VARs in level. It falls from the Wold representation theorem that any stationary VAR process can be represented as a multivariate moving average (MA) of infinite order which consist in weighted averages of current and past shocks (Hamilton, 1994). The so-called Wold representation of VAR models takes the following form:

$$y_t = \sum_{i=0}^{\infty} \Phi_i \, u_{t-i}, \tag{2.3}$$

where Φ_i are reduced-form impulse responses (Lütkepohl, 2005). The Wold representation theorem and the derivation of impulse response functions are illustrated in appendix 2-B.

Figures 2.8 and 2.9 report the responses of price levels, and agriculture and services value added and employment to copper price and production unit shocks based on the estimated models for DRC and Zambia respectively. The obtained impulse response functions suggest that the variables of interest may react differently to copper booms depending on whether they are resource price or production shocks. Note that as the impulse and response variables are expressed in logarithm, the estimated responses are interpreted as percentage changes. Moreover, the unit shocks are normalized to one. Therefore, the IRFs can be interpreted as percentage changes in the response variables following a shock of magnitude 1% in the impulse variables.

Price levels on the Congolese market are estimated to decrease by about 3.5% over the year following a unit shock in copper price while no significant reaction of inflation is observed in the sequel of a shock in copper production. These observations depart from Dutch disease expectations of price increases following resource booms. Regarding sectoral output, it appears that the value added in both the agriculture and services sectors tend to be enhanced by copper price increases. Nevertheless, the impact on agriculture value added is not statistically significant and is estimated to be about twice lower than that of services which amounts to +0.39% and +0.55% respectively in the first and second year after the occurrence of the shock. Therefore, copper price shocks are found to increase activity concentration around the services sector in DRC in line with Dutch disease predictions. On the employment side, copper price shocks are found to be responsible of drops in the number of employees occupied in agricultural activities in DRC by 0.021% over the year following the occurrence of the shock with borderline significance (upper bound of confidence interval at -0.0033%). The response of employment in services is estimated to be positive yet non-significant.

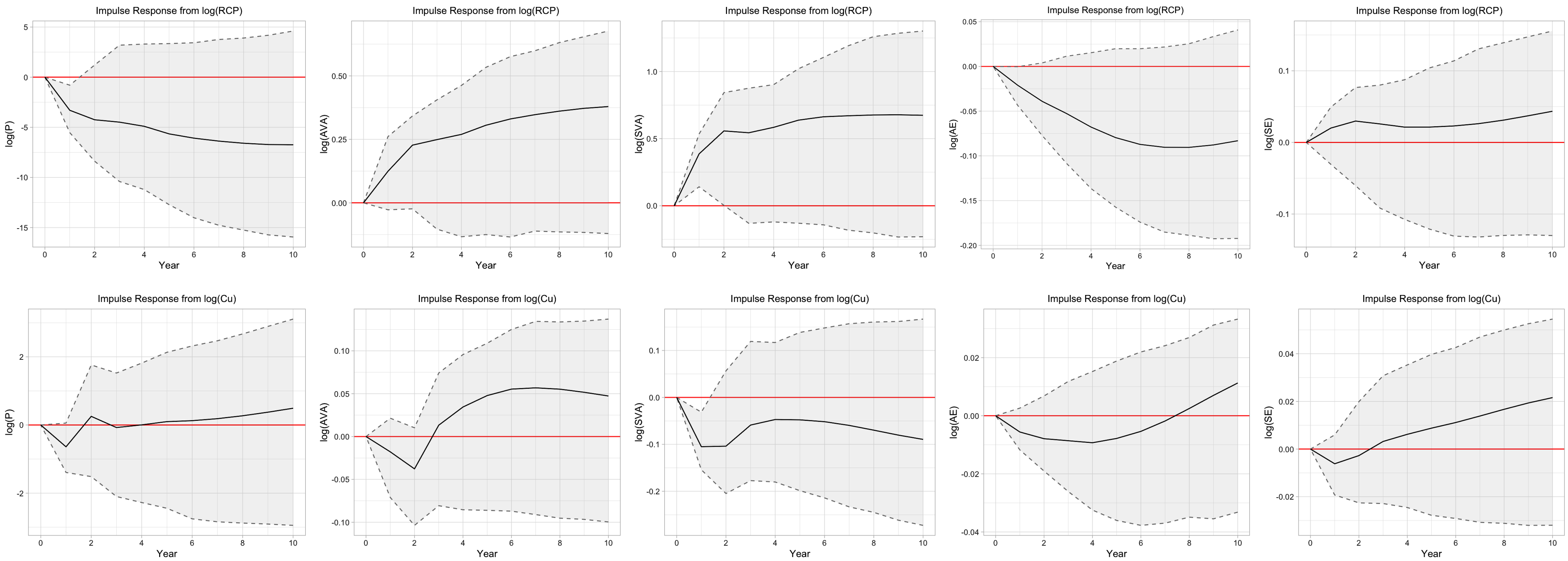
The observed negative impact of copper price shocks on employment in agriculture is consistent with the manifestation of a resource movement at the expenses of the agriculture sector in DRC. The model also detects a significant negative reaction of services value added to shocks in copper production in DRC amounting to -0.1%. This indicates that the Congolese services sector may be confronted with excess demand during copper production booms in the country.

Copper price shocks are found to be associated with transitory inflation estimated at +0.23% in Zambia while booms in copper production tend to decrease prices durably on the Zambian market by up to -3% after 5 years following the shock. Consistently with Dutch disease expectations, the value added in agriculture in Zambia tends to react negatively (-0.63%) after a unit shock in copper production with upper bound of confidence interval at -0.0043%, while that of services is estimated to respond positively to the same impulse yet non-significantly. On the other side, value added in the Zambian services sector appears to react positively to surges in copper price in line with Dutch disease predictions with estimated response of +0.26% following a unit shock, while agriculture value added shows no significant response in the same case. These findings indicate a copper induced de-agriculturalization of Zambia and a greater tertiarization of the country's activity. It is worth noting that the estimated responses of the number of employees occupied in services to both types of copper shocks, as well as that of employment in agriculture following a copper production shock in Zambia tend to go in the direction of Dutch disease predictions. Nevertheless, none of these responses are found to be significant at the 90% confidence interval.

An important remaining question after analysing the IRFs is how much these copper shocks really account for the changes in the variables of interest. Stationary VECMs can provide such information by measuring how much of the forecast error variance based on the estimated model at horizon $h = 0, 1, \dots, H$ is attributable to each impulse variable. Indeed, in stationary models, as $h \to \infty$, the forecast error variance decomposition (FEVD) converges to the variance decomposition of y_t (Kilian & Lütkepohl, 2017). Table 2.6 presents the results of the FEVD for the two countries focusing on horizons 5, 10 and ∞. The infinite horizon is approximated by a large number for h beyond which further increments do not change the results with an accuracy degree to 3 decimal places. The results indicate that shocks in the copper sector account for about 14% of the variance of agriculture value added in DRC, with 6.38% attributable to copper price shocks and 7.11% to copper production shocks. The variance decomposition shows that copper price and production shocks account for respectively 12.90% and 5.70% of the variance of employment in the Congolese lagging agriculture sector. The contribution of copper shocks in DRC to the non-traded services sector appears to be more modest. In total both shocks account for about 6.5% of the variance of service value added (5.21% and 1.24% respectively for copper price and production shocks) and less than 3% for that of service employment in the country.

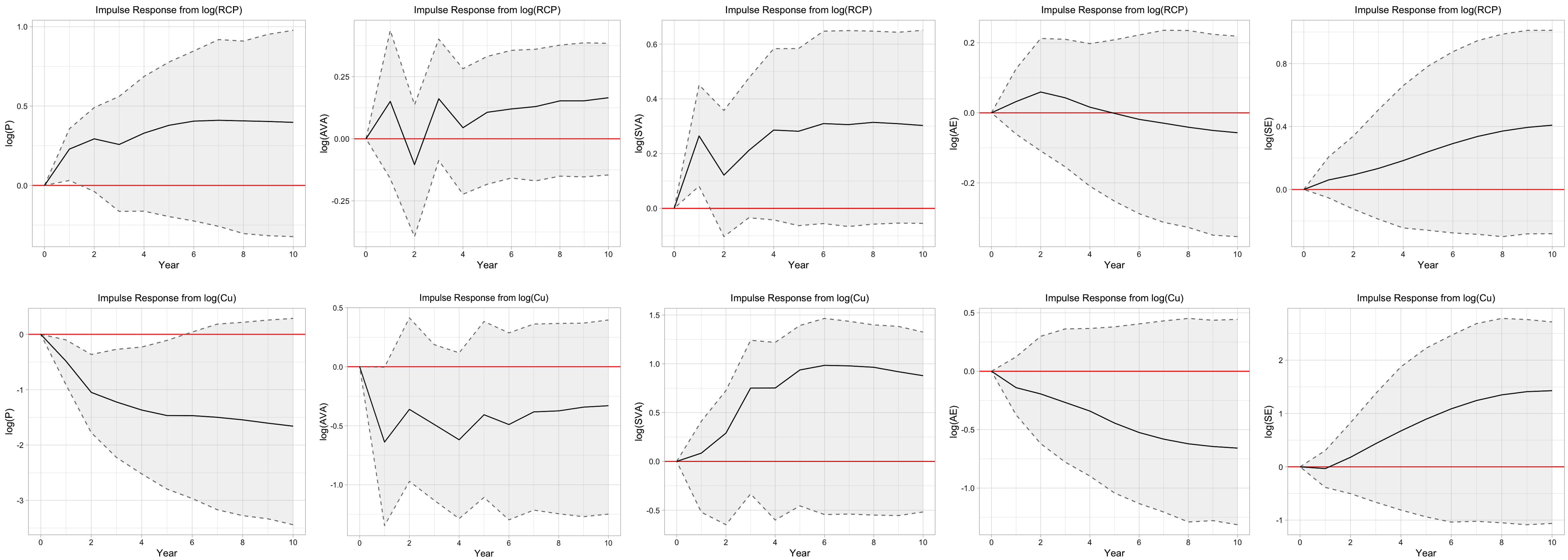
Finally, inflation in DRC appears to be more sensitive to copper production (3.10% of the variance) than to copper price shocks (1.13%). In the case of Zambia, it appears that the influence of copper price shocks on the variables of interest is notably low. Indeed, except for service value added (1.93%) and service employment (1.52%), the contributions of copper price shocks to the variances of the series lie below 1%. Copper production on the other hand is found to be an important determinant of sectoral distribution in the country. The results indicate about 5.56% and 13.34% of the variances of agriculture value added and employment respectively are imputable to copper production shocks. The figures are even higher for the services sector where such shocks are responsible of approximately 20% of the variances of both value added and employment, while they account for about 11% of the variance of the Zambian inflation .

Figure 2.8. Impulse Response Functions from unit shocks in logs of real copper price and copper production in DRC.



(90% bootstrap confidence interval – 1000 runs)

Figure 2.9. Impulse Response Functions from unit shocks in logs of real copper price and copper production in Zambia.



(90% bootstrap confidence interval – 1000 runs)

Table 2.6. Forecast error variance decomposition for DRC and Zambia.

Horizon	Inflation	Agriculture Value Added	Service Value Added	Agriculture Employment	Service Employment
	A. Percent of h-Step Ahead Forecast Error Variance Explained by Real Copper Price				
			DRC		
5	1.93	5.27	5.84	5.83	0.39
10	1.89	5.65	5.71	13.38	0.31
∞	1.13	6.38	5.21	12.90	0.74
			Zambia		
5	0.88	0.44	3.05	0.07	0.24
10	0.81	0.58	2.33	0.05	0.75
∞	0.61	0.84	1.93	0.08	1.52
	B. Percent of h-Step Ahead Forecast Error Variance Explained by Copper Production				
			DRC		
5	2.37	4.35	1.55	8.78	0.37
10	2.97	7.36	1.94	12.21	0.92
∞	3.10	7.11	1.24	5.70	1.96
			Zambia		
5	10.99	7.60	23.02	2.34	3.19
10	9.65	6.50	25.61	7.58	12.07
∞	11.00	5.56	19.90	13.34	20.58

2.4 Discussions and conclusion

This paper aimed at investigating potential copper induced Dutch disease patterns in DRC and Zambia as the two developing countries have evolved to become major copper producers over the past few decades. A preliminary analysis has permitted to observe in both countries some co-movements between the copper activity and a set of variables commonly involved in Dutch disease debates. The revival and expansion of copper production experienced by DRC and Zambia since the early 2000's have been associated with enhanced GDP and GDP per capita levels. Moreover, the increases in copper prices and the expansion of copper production in the two developing countries have been accompanied with rises in public expenditures. These observed surges in national income and spendings alongside copper sector expansion are consistent with the initial condition of enhanced domestic demand that may trigger Dutch disease manifestation.

The stylised facts indicated some strong co-movements between the copper activity and the REER in Zambia. Such features were less blatant in the case of DRC, suggesting that the country may be less subject than Zambia to the copper induced drops in traded sector competitiveness associated with Dutch disease. A glance at sectoral distribution allowed to see a progressive decrease in the contribution of agriculture and a rise in the share of services to the GDP since the early 2000's in both countries, yet more strikingly in Zambia compared to DRC. The same applies to the composition of total employment with increasingly higher shares of the workforce occupied in services at the detriment of the agriculture sector. Similar with what was observed with REER and sectoral distribution of value added, the preliminary analyses indicate that the switches in employment shares from agriculture toward services have been more important in Zambia than in DRC over the past decades.

Following the preliminary analyses, the VAR framework was employed to formally measure the potential Dutch disease effects of shocks in copper price and production over the period 1991-2019. After correcting the initial VAR models to account for cointegration, hence estimating VECMs, the impacts of shocks in copper price and production on GDP deflator, value added at constant price and number of employees in the supposedly lagging agriculture sector and in the nontraded services sector were computed. The analyses provide evidence of some Dutch disease spending effects in DRC as the value added in the nontraded services sector is found to increase following copper price shocks. Moreover, the results indicate some partial manifestation of resource movements in the country. Indeed, the decrease in the number of employees occupied in agricultural activities after the occurrence of a copper price shock tends to suggest a direct de-agriculturalization of DRC. Yet, the expected reduction in agriculture value added does not occur. Moreover, despite no significant reaction of employment in services, value added in that sector is found to decrease after copper production shocks, hence generating excess demand for nontraded items as expected with resource movement effects. In the case of Zambia, the IRFs show that copper price shocks tend to trigger transitory inflation, while copper production shocks have persistent negative effects on domestic price levels. The positive impact of copper price on services value added observed for the country is consistent with the manifestation of Dutch disease spending effects. Despite the non-significance of the estimated negative responses of the number of employees in agriculture to impulses from copper production, the significant negative reaction of agriculture value added to such impulses indicate the manifestation of resource movement effects in Zambia. These results provide evidence of a copper induced de-agriculturalization of the Zambian economy.

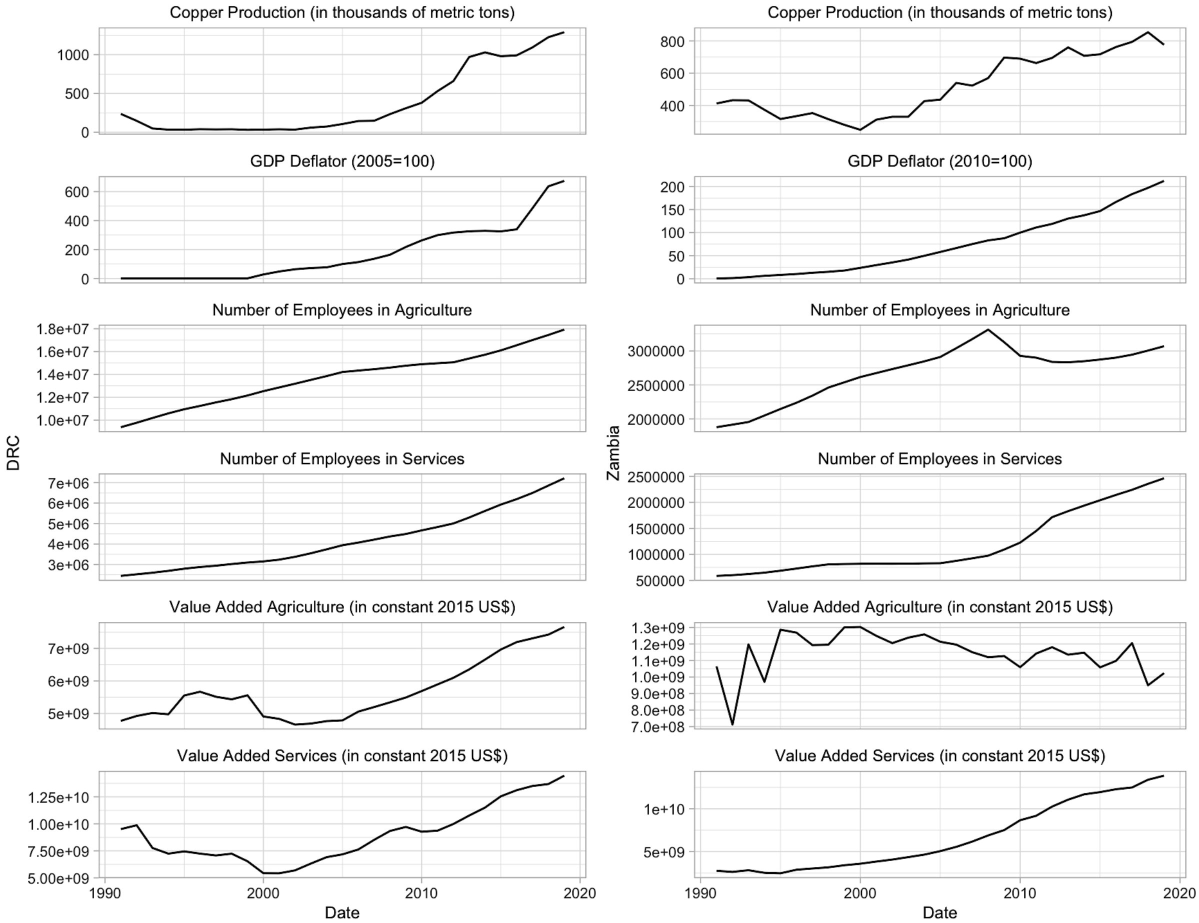
The analysis of FEVDs has allowed to assess the relevance of the impact of copper price and production on the lagging and non-traded sectors in the two countries. The copper sector has been found to be an important driver of fluctuations in agriculture value added and employment in DRC while its contribution to the variances of service indicators was found to be more modest. This tends to corroborate the idea of a more vulnerable lagging agriculture sector in DRC. In the Zambian case, very low contribution of copper price was detected while copper production on the other hand has been found to account for important shares of fluctuations of value added and employment in both sectors, even reaching about a fifth of the variances in the case of services.

The findings of this paper have direct implications for development policies in these two developing countries with important copper sectors. Besides providing most of the jobs in DRC and Zambia, the agriculture sector is also crucial for food security matters. A good understanding of the impact of the copper industry on the rest of the economy and especially on the key agriculture sector is thus critical. Indeed, in the presence of Dutch disease, efforts aiming at enhancing agricultural production may be undermined in times of copper booms. Repeated episodes of copper price increases may cripple the learning-by-doing process in agriculture leading to competitiveness issues and increased dependence on foreign products.

Beside the common point of being copper exporters, the two countries are also neighbours and important trading partners to each other. Further research could investigate how copper booms may influence the trading of agricultural products between the two economies. Indeed, as Dutch disease theory predicts lower competitiveness in the lagging sector in both countries following copper booms, bilateral trade may alleviate the decline in agriculture output in the most competitive one of the two countries.

Appendices

2-A. Time series plots for DRC and Zambia



2-B. Illustration of Wold decomposition and impulse response function.

Let y_t a univariate VAR(1) process of the form:

$$y_t = a + \phi y_{t-1} + u_t.$$

If y_t is stationary, then it can be developed as follows:

$$\begin{aligned} y_t &= a + \phi(a + \phi y_{t-2} + u_{t-1}) + u_t \\ &= a(1+\phi) + u_t + \phi u_{t-1} + \phi^2 y_{t-2} \\ &= a(1+\phi+\phi^2+\cdots) + u_t + \phi u_{t-1} + \phi^2 u_{t-2} + \cdots \\ &= c + u_t + \sum_{i=1}^{\infty} \theta_i u_{t-i}, \qquad \forall t. \end{aligned}$$

This latter expression, corresponding the Wold representation of the initial process, is an MA(∞) process with $\theta_i = \phi^i$ $(\forall i)$ and the constant $c = \frac{a}{(1-\phi)}$ (Hamilton, 1994; Croux, 2021). Based on the Wold representation, the impulse response function states that following an initial unit shock (i.e., an increase of the unpredicted u_t by one), then y_t increases by 1, y_{t+1} increases by ϕ, y_{t+2} increases by ϕ^2, etc. More generally, if u_t increases by 1, then y_{t+i} increases by ϕ^i for all i. Given the stationarity of the y_t process, $|\phi| < 1$. Therefore, the effect of an initial shock on the outcome variable decays over time.

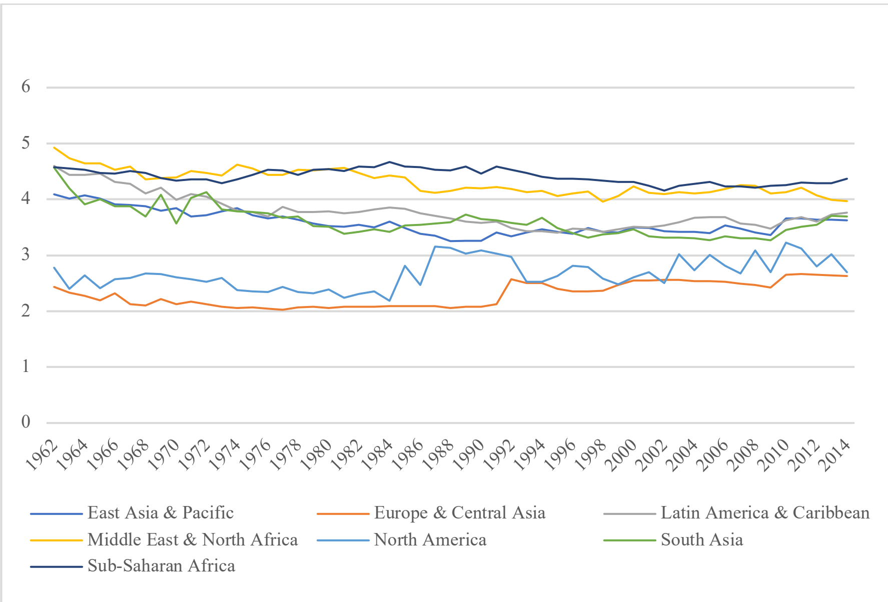
Chapter 3 Impact of Special Economic Zones on Export Diversification in Sub-Saharan Africa

Export diversification is a major concern for policymakers in Sub-Saharan Africa (SSA). Over the past 30 years, many countries of the region have adopted special economic zone (SEZ) programs with the aim to foster industrial development and export-led growth. By offering various pro-investment incentives, SEZs are expected to contribute to the improvement of the business climate and attract firms from traditional and new sectors. This study analyses the impact of SEZ adoption on overall export diversification, and on extensive and intensive margins in the SSA region. For that purpose, a difference-in-differences approach has been implemented on a panel of 32 SSA countries covering the period 1970-2014. The analyses indicate that SEZ adoption may have contributed to balancing more equally export shares amongst traditional sectors, this resulting in greater export diversification in these countries. However, it appears that this policy tool has been less effective for the creation of new activity sectors.

3.1 Introduction

Export diversification is recurrent preoccupation and objective for policymakers in developing countries, especially those endowed with abundant natural resources (Cadot et al., 2011). This is because greater levels of export diversification tend to be associated with enhanced growth. Indeed, as export earnings are gathered from a wider range of sectors, countries protect themselves from volatility in GDP growth, employment rate and real exchange rate which can be detrimental for social welfare and domestic productivity in traded sectors. Beyond these nice portfolio features, the path to greater degrees of diversification is also linked with enhanced learning by doing in a growing number of sectors. This is found to foster steady long-run growth (Agosin, 2008).

Figure 3.1. Theil index of exports concentration per region.



Source: IMF

Figure 3.1 displays the evolution of the Theil index measuring export concentration developed by Cadot et al. (2011), averaged by region over the period 1962-2014. The lowest levels of export concentration are observed in the Europe & Central Asia region with a mean of 2.37 for the period observed, followed by North America with a mean of 2.67. However, these two regions have experienced trends of re-specialisation in the 1990s and in the 1980s respectively. This is consistent with the U-shaped pattern in specialisation observed by Imbs & Wacziarg (2003) which predicts a progressive re-specialisation of more advanced economies. East Asia & Pacific (3.57), South Asia (3.59) and Latin America & Caribbean (3.75) then follow with mean levels of the Theil index below 4. The least diversified regions are Middle East & North Africa and Sub-Saharan Africa with mean levels of export concentration of respectively 4.31 and 4.41. Despite exhibiting the highest levels of concentration, Sub-Saharan Africa (SSA) is also the region which has experienced the smallest evolution of the Theil index towards greater diversification (-0.21) over the period observed. Moreover, a trend of re-specialisation has been observed in SSA since the 2000s. Indeed, Table 3.1 shows that the Theil index has increased for the region by +0.21 over the period 2002-2014 after hitting its lowest level (4.16) in 2002. This step back in export diversification in SSA is attributable to various causes including the tightening in trade and investments in the region during the global financial crisis, and the industrial boom in Asian countries which resulted in a higher demand for African natural resources and a concentration of exports of SSA countries in commodity sectors (Whitfield & Zalk, 2020 and UNCTAD, 2021). Note that concentration in resources sectors is found to be responsible for further sectoral concentration of the economic activity due to Dutch disease dynamics and the subsequent competitiveness issues for non-resource traded sectors (Corden & Neary, 1982). Additional structural challenges have crippled diversification efforts in SSA. Pitagala & Lopez-Cadix (2020) identify the prevalence of political instability and violent conflicts in the region as a key hurdle to diversification. Indeed, the subsequent negative effects on infrastructure and attractiveness for investors are utterly detrimental to the development of new industries. Other barriers to diversification in SSA include low human capital, low access to power, and multiple infrastructure and logistics gaps resulting in difficult access to foreign markets and high exporting costs.

To overcome these barriers and to foster export-led growth and export diversification, many countries in SSA have proceeded to the creation of special economic zones (SEZs) (Newman & Page, 2017). SEZs are instruments of industrialisation policies which consist in geographically delimited areas that are ruled by some specific administrative, regulatory and fiscal regimes which are more liberal than those prevailing in the rest of the country. Special treatments for firms inside SEZs include the alleviation of customs duties, tax, and regulatory requirements, privileged access to scarce inputs and to infrastructures and social services of high-quality (Farole, 2011; Bost, 2019).

Table 3.1. Theil export concentration index per region.

Region	Mean	Std. Dev.	Min. *(Year)*	Max. *(Year)*	2014	Frequency
East Asia & Pacific	3.5706	1.0921	3.2541 *(1988)*	4.0915 *(1962)*	3.6297	1,385
Europe & Central Asia	2.3656	1.0168	2.0264 *(1977)*	2.6660 *(2011)*	2.6315	1,801
Latin America & Caribbean	3.7543	0.8660	3.4041 *(1995)*	4.5993 *(1962)*	3.7603	1,820
Middle East & North Africa	4.3082	1.3196	3.9604 *(1998)*	4.9266 *(1962)*	3.9706	1,058
North America	2.6692	1.3648	2.1867 *(1984)*	3.2272 *(2010)*	2.6996	159
South Asia	3.5938	0.9483	3.2694 *(2009)*	4.5681 *(1962)*	3.6905	360
Sub-Saharan Africa	4.4094	0.8989	4.1581 *(2002)*	4.6696 *(1984)*	4.3652	2,217

By influencing agents' location choices toward some attractive areas, SEZs are breading grounds for the formation of industrial clusters with interconnected firms and agglomeration economies (Combes & Gobillon, 2015; Newman & Page, 2017). These zones are thus expected to provide favourable environments for the development of new industries and to contribute positively to exports. The aim of this study is to evaluate the impact of embarking in SEZ programs on export diversification in the SSA countries. To do so, a difference-in-differences impact evaluation approach is applied to a sample of 32 SSA countries over the period 1970-2014.

The next section of the paper provides some theoretical complements about the notion of SEZ and presents a portrait of SEZ adoption in the African context. The empirical analyses are performed in section 3.3, and conclusions from the findings are drawn in section 3.4.

3.2 Background

3.2.1 Types of SEZs

The broad definition of SEZ provided in the previous section encompasses various specifications which may vary based on the attributes of each SEZ. Five types of SEZs are commonly identified in the literature, namely free trade zones, export processing zones, freeports, special economic zones (in a narrower sense then the broad concept) and industrial parks (Zeng, 2016; Lavissière & Rodrigue, 2017; Bost, 2019; UNCTAD, 2021):

- Free trade zones (FTZs) consist in delimited duty-free areas usually located near international transport nodes (e.g., ports and airports) or land borders, offering warehousing, storage and distribution facilities for the logistic support of trade.

- Export processing zones (EPZs) are fenced-in areas with industrial activities aimed at foreign markets. These zones provide incentives such as free-trade conditions and alleviated regulation constraints for export-oriented firms.

- Freeports are very similar to FTZs as they are developed at proximity of ports and major trade routes. However, they occupy larger areas than FTZs and are not limited to logistic and warehousing activities as they provide incentives to firms operating in wider ranges of industrial activities.

- Special economic zones are large zones which can encompass an entire city or region. Beyond providing incentives and facilities to enhance exports and attract investments, these zones serve broader objectives such as regional industrial development.

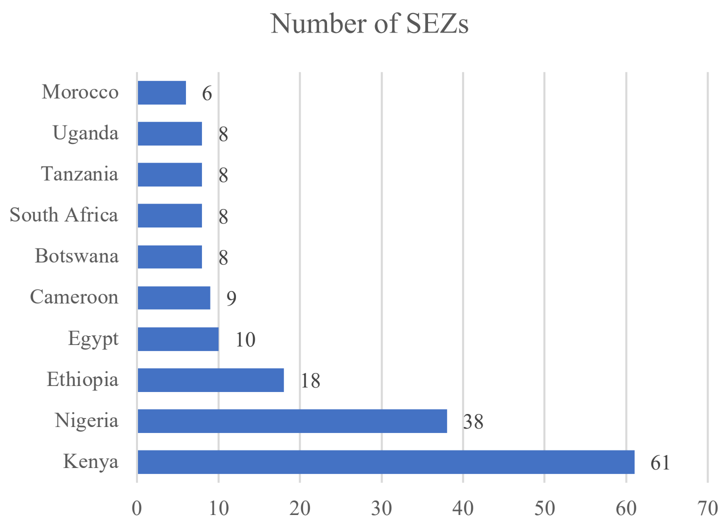
- Industrial parks (or industrial zones) are small scale areas with a concentration of firms usually operating in manufacturing activities. These smaller zones also provide incentives and benefits to firms.

Note that the term special economic zone is employed both as a generic term which covers all the different types of zones, as well as in a narrower sense to refer to the specific type of zone presented in this point (UNCTAD, 2021). The potential denomination imbroglio resulting from this double usage is avoided in this study as "SEZ" will be used only as generic term throughout the analyses.

3.2.2 SEZ adoption in Africa

Special economic zone programs have proliferated in Africa over the past 30 years. The number of SEZs on the continent has increased from 20 in 1990 to 238 in 2020. As of 2020, 31 out of 54 countries in Africa had embarked in SEZ deployment and 7 additional countries were planning to do so. About half of the zones on the continent are concentrated in East Africa with Kenya itself hosting 61 SEZs. The subregion is followed by West Africa accounting for approximately 24% of African SEZs boosted by Nigeria and its 38 zones. Other major SEZ hosts on the continent include Ethiopia (38 SEZs), Egypt (10 SEZs), and Cameroon (9 SEZs) based on 2020 figures (UNCTAD, 2021).

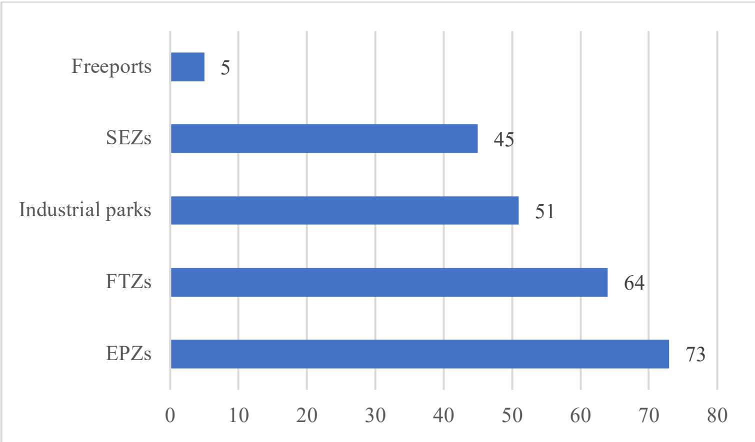
Figure 3.2. African countries with the most SEZs.



Source: UNCTAD

The most common type of SEZ on the African continent is EPZ (31%), followed by FTZ (27%), industrial parks (21%) and "narrow sense" SEZ (19%). Freeports are the least widespread types of SEZs in Africa accounting for only 5 zones in 2020, namely the Mauritius freeport, the Mtware freeport in Tanzania, the freeport of Monrovia in Liberia, and the Assab and Massaura freeports in Eritrea (Newman & Page; 2017; AEZO, 2019; UNCTAD, 2021).

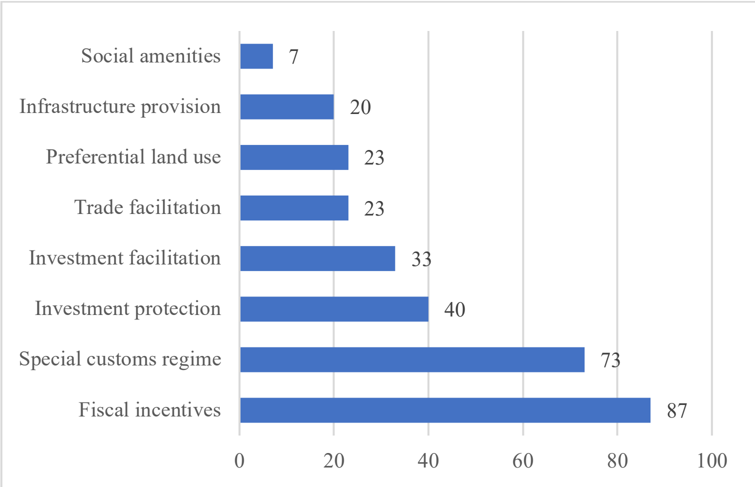
Figure 3.3. Number of SEZs by type.



Source: UNCTAD

As depicted in Figure 3.4, fiscal incentives are the most common instruments used in African SEZ programs to attract firms and investments. As of 2020, such incentives were provided by 87% of SEZs on the continent. Typical fiscal incentives include the exemption of tax for up to 10 years, reduced tax rates, and tax deduction for skill improvement programs destined to local workers employed in SEZs. The second most employed instrument in African SEZ policies (73%) is the application of special custom regimes which usually consist in duty-free import of raw material, machinery, equipment and furniture for companies operating in SEZs. The third and fourth most common instruments are investment protection and facilitation measures. These are directly linked to the high level of risk taken by investors in the context of political instability and institutional weakness in African countries compared to other regions of the world. Protection measures typically include protection against expropriation and guarantees of equal treatment of foreign and domestic investors. Facilitation measures on the other side often consist in the simplification of establishment procedures and in the provision of technical assistance to firms in SEZs. Other investment facilitation actions include the waiving of constraints on the employment of foreign workers in SEZs and on the repatriation of profits for foreign-owned firms. Then follow the trade facilitation measures which aim at soothing trade flows by reducing and clarifying import and export formalities. Examples of actions include the removal of import licence requirements or the development of online platforms for import and export tax procedures aiming at reducing bureaucratic heaviness. To further influence firms' location decisions, some SEZ programs offer preferential land use to firms hosted in SEZs. These can take the form of reduced lease and rent payments which can be temporary or permanent. About 20% of African SEZs intend to attract firms by providing access to some infrastructures. This can go from guaranteed provision of water, electricity and telecommunication services, to preferred access to ports and airports. The least employed attraction tool in African SEZ programs (7%) is the provision of social amenities such as hospitals, educational institutions, recreational areas, banks, praying centres, shopping malls, etc. (UNCTAD, 2021; Newman & Page, 2017).

Figure 3.4. Incentives and services offered by SEZs (in percent).



Source: UNCTAD

3.2.3 Performances of African SEZs

Special economic zones aim to enhance trade and economic growth by serving several intermediary goals such as attracting firms and foreign direct investments (FDI) in a more efficient way than in the absence of these instruments. Farole (2011) provides evidence on the propensity of African SEZ to be catalyst for FDI. The author shows that African SEZs tend to be outperformed by SEZ programs outside of the continent in terms of FDI inflows generated. However, Farole (2011) finds that African SEZs tend to account for relatively high shares of national inflows of FDI. This suggests that the failure of African SEZs to attract FDI compared to non-African SEZs may not be imputable to malfunctions of the SEZs on the continent per se, but rather to poor overall business environments. This also tends to indicate that African SEZs may fail to fully make up for the negative impacts of deficient national investment climates.

Based on a sample of 63 African SEZs, the UNCTAD (2021) provided some evidence on the capacity of SEZs on the continent to attract firms. The analyses show a median of 50 firms and a mean of 60 firms per SEZ. The largest SEZs in Africa based on 2020 figures include the Tanger Free Zone in Morocco (750 firms) and the Alexandria Free Zone in Egypt (405 firms), while some SEZs on the continent host less than 10 firms (e.g., Maluku SEZ in the Democratic Republic of Congo, Vipingo EPZ in Kenya and Sandiare SEZ in Senegal). The study highlights the cases of some SEZs in relatively small economies which have been able to attract large numbers of firms. These include the Nkok SEZ in Gabon and the Kigali SEZ in Rwanda with more than 80 firms, the Chambishi Multi-Facility Economic Zone in Zambia with 45 firms and the Luba Freeport in Equatorial Guinea with over 30 firms.

Regarding employment, about half of African SEZs have brought between 1,001 and 10,000 jobs. Beside the incentives provided by the SEZs, an important determinant of job creation is the focus of the zone. The concentration of SEZs in firms operating in highly labour-intensive industries (e.g., garments and textiles) tends to be correlated with job creation. For instance, by 2020, the Hawasse IP and the Bole Lemi IP SEZs in Ethiopia had created respectively more than 30,000 and 20,000 jobs in garments, textiles and leather industries, while high-tech SEZs such as the green tech ASEZ in South Africa had created less than 500 jobs (AEZO, 2019; UNCTAD, 2021). Note however that the outlook on African SEZs provided by the African Economic Zones Organization (AEZO, 2019) states that SEZs have supported the creation of jobs in skilled and highly skilled industries on the continent. This is illustrated with the case of the Tanger Med Zone in Morocco of which top-notch port facilities and dynamic labour market have contributed to attract firms in high value and export-oriented industries such as automotive, aeronautics and electronics.

Another important point to be raised here is that African SEZs tend to be also outperformed by non-African SEZs in terms of contribution to national industrial employment. Indeed, the UNCTAD (2021) finds that beside the notable exception of Djibouti where SEZs accounted for 48% of national employment in 2020, typical figures for African countries lied between 1% and 5%. This indicator was substantially higher for many countries outsides of the continent such as China (14%), Philippines (16%), Vietnam (19%), Malaysia (23%), Honduras (30%) and Dominican Republic (36%) based on 2020 figures.

3.3 Empirical analyses

The expansion of SEZs is expected to result in the attraction of firms from a wider range of sectors, and in the generation of technology spill overs and agglomeration economies that may contribute to enhance export diversification. In this section, a difference-in-differences approach is employed to evaluate the impact of SEZ programs on export diversification in SSA countries. Beside the main model specification, several alternative estimation techniques are employed to check for the robustness of the results.

3.3.1 Econometric model

The approach followed in this study consists in comparing periods pre and post embarking in SEZ programs to assess the impact of these policy instruments on export diversification in the SSA region. For that purpose, a difference-in-differences (DiD) research design is implemented as commonly done to evaluate causal effects of implemented policies (Angrist & Pischke, 2009).

The original configuration of DiD is that of a model with two periods (i.e., pre and post treatment or policy implementation) and two groups (i.e., a treated group and a control group which is not exposed to the treatment). Such format allows to estimate the average treatment effect on the treated group (ATT) under the assumption that if the treatment were not provided, both groups would have followed parallel trends. The current analysis departs from this canonical DiD format in several manners. First, the study includes multiple periods both before and after treatment. Second, the time of treatment varies amongst treated units as countries' SEZ adoption periods can differ. Finally, the parallel trends assumption may hold only after controlling for some covariates. Following Angrist & Pischke (2009), such DiD setup with staggered treatment can be apprehended by the estimation of a two-way fixed effect (TWFE) model. The corresponding econometric model takes the following form:

$$Y_{i,t} = \alpha_i + \tau_t + \beta D_{i,t} + X'_{i,t}\Gamma + \varepsilon_{i,t} \tag{3.1}$$

The dependent variable $Y_{i,t}$ is the level of export diversification. It is measured by the Theil index of concentration proposed by Cadot et al. (2011). This index includes two components, namely an extensive margin index (EMI) and an intensive margin index (IMI). The EMI measures the part of diversification resulting from the export of new products while the IMI measures the balance of the mix of already exported products (IMF, 2014). The computation of the index is discussed in appendix 3-A. Note that in the estimations, the three indicators (i.e., overall Theil index, EMI and IMI) will be multiplied by -1 so that higher values correspond to higher degrees of diversification. Data on export diversification are obtained from the IMF's Export Diversification and Quality database. α_i and $\tau_t$are respectively country and time fixed effects. $D_{i,t}$ is a treatment dummy which switches on when a country creates its first SEZ and stays on for all periods onward. Note that $D_{i,t} = 0$ for all observation in the control group. Information on SEZ creation periods is obtained from the work of Newman & Page (2017) while the control group is identified based on the list of SSA countries without SEZ by 2020 provided by the UNCTAD (2021). Details on the treated and control groups are provided in appendix 3-B. X' is a vector of time varying control covariates. It includes the logarithm of real GDP per capita, grossed fixed capital formation (in % of GDP), trade openness (i.e., the sum of exports and imports as % of GDP), real effective exchange rate (REER) and domestic credit to private sector (in % of GDP). Some descriptive statistics for the variables are provided in appendix 3-C.

The choice of control variables falls from previous empirical studies on the determinants of export diversification. Many studies (e.g., Imbs & Wacziarg, 2003; Cadot et al., 2011) show that countries at early stages of development tend to diversify as their income level increases and then start to re-specialise after reaching a certain threshold. IMF (2014) evaluates this inflection point at levels of GDP per capita around \$25,000-\$30,000. In the case of SSA countries, the logarithm of GDP per capita is expected to have a positive sign in the estimation. No clear-cut expectation can be made about the sign of trade openness. As underlined by Espoir (2020), on one hand, Ricardian trade models suggest that openness to trade should lead countries to specialise in their comparative advantage. On the other hand, greater openness to trade may also be associated with less protectionism, which tends to foster the expansion of tradable sectors. Espoir (2020) finds a positive impact of trade openness on export diversification in the SADC[6], while, based on a large panel of countries, Agosin et al. (2012) provide strong evidence that trade openness induces specialisation rather than export diversification. Gross fixed capital formation includes investments in production capacities and infrastructures. This indicator is expected to have a positive influence on export diversification. Increases in credits to the private sector contributes to the reduction of liquidity constraints for firms and shows the improvements in the health of the financial sector (Agosin et al., 2012). It should thus exhibit a positive sign in the estimation. REER appreciations are associated with competitiveness issues for domestic traded sectors vis a vis foreign firms due to Dutch disease effects (Corden & Neary, 1982). This covariate is thus expected to come with a negative sign in the estimation. Other potential determinants of export diversification include the level of endowment in human capital or the prevalence of corruption. However, these indicators were discarded due to lack of data for the SSA region. The study spans over the period 1970-2014 and covers 32 SSA countries.

3.3.2 Parallel pre-treatment trends test

Consider the observations $\{(Y_{i,1}, \dots, Y_{i,T}, D_{i,1}, \dots, D_{i,T}, X_{i,t})\}_{i=1}^{N}$ are independent and identically distributed. Following Callaway & Sant'Anna (2021), let $G_{i,g}$ be a cohort dummy variable taking value 1 if country i is first treated in period g, and zero otherwise; and let C be a dummy variable taking value 1 for the "never treated" countries (i.e., the control group). Recall that once a country receives the treatment (i.e., starts a SEZ program), it remains treated for all periods onward.

DiD implementation aims at estimating the average treatment effect on the treated units given by

$$ATT(g,t) = \mathbb{E}\left[\, Y_{i,t}(g) - Y_{i,t}(0) \mid X, G_g = 1 \,\right], \forall\, t \geq g \qquad (3.2)$$

[6] Southern African Development Community (Angola, Botswana, Comoros, Democratic Republic of Congo, Eswatini, Lesotho, Madagascar, Malawi, Mauritius, Mozambique, Namibia, Seychelles, South Africa, Tanzania, Zambia and Zimbabwe.)

The identification of $ATT(g,t)$ requires pre-treatment parallel trends between the treated and the control group conditional on observed covariates. This implies that

$$\mathbb{E}\left[\, Y_{i,t}(0) - Y_{i,t-1}(0) \mid X, G_g = 1\,\right] = \mathbb{E}\left[\, Y_{i,t}(0) - Y_{i,t-1}(0) \mid X, C = 1\,\right], \tag{3.3}$$

$\forall\, g \in G$ and $t \geq 2$.

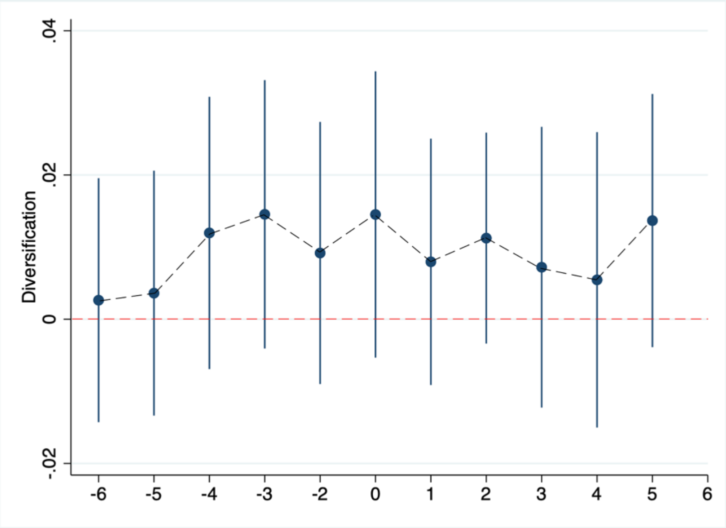
Following Jacobson et al. (1993) and He & Wang (2017), the conditional parallel pre-treatment trends is tested by estimating the following equation:

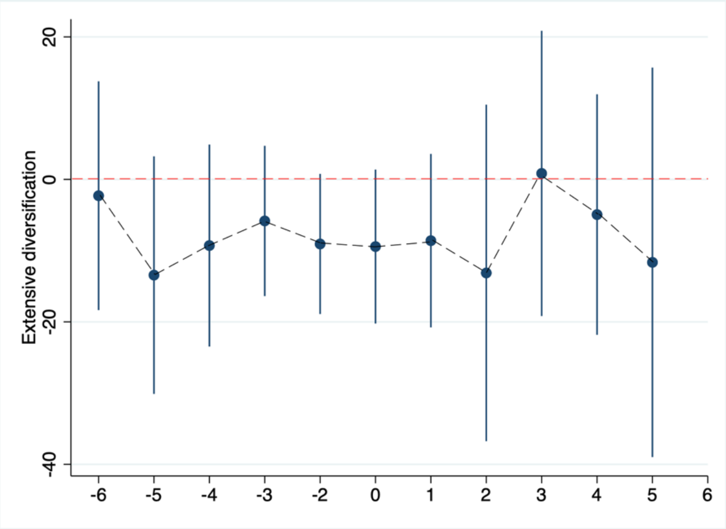
$$Y_{i,t} = \alpha_i + \tau_t + \sum\nolimits_{k\geq -6, k\neq -1}^{5} \gamma_k\, D_{i,t}^{k} + X_{i,t}'\Gamma + \varepsilon_{i,t}, \tag{3.4}$$

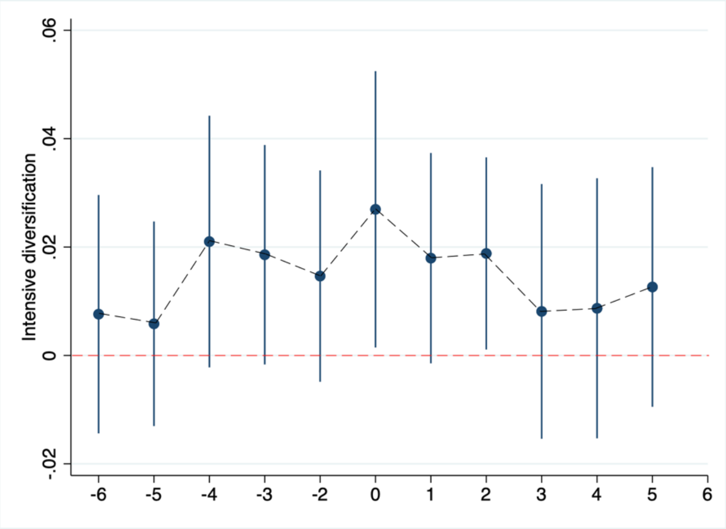
with dummies $D_{i,t}^{k} = 1\{t - G_i = k\}$ indicating that country i is k periods away from the initial treatment time G_i. Five periods prior and after the treatment are considered here. Note that $k = -1$ is omitted so that the post-treatment effects are relative to the last period before the start of the SEZ program. The parallel treatment assumption is said to hold if $\gamma_k = 0$ for all $k \leq -2$, meaning that the leads of treatment have no significant impact on $Y_{i,t}$ (He & Wang, 2017).

Figure 3.5 plots the coefficients from the estimation of Equation 3.4 with 95% confidence interval as vertical lines. It appears that all pre-treatment coefficients are non-significant for the three dependent variables. This tends to suggest that the conditional parallel trends assumption holds. Note that over the five years following the implementation of the treatment, no significant effects of SEZ adoption appears to be detected on the overall diversification index and on the intensive diversification index. On the other hand, SEZ programs seem to contribute significantly to balancing more evenly the mix of already exported products. Indeed, some significant coefficients are observed for the intensive component of diversification already at the year of adoption and two years later. This preliminary analysis tends to suggest that SEZ adoption may have contributed to fostering export diversification in SSA countries more through the enhancement already existing export lines rather than via the development of new sectors.

Figure 3.5. Time passage relative to year of SEZ adoption







Note: Vertical bands represent 95% confidence interval

3.3.3 Results

Table 3.2 presents the results obtained from TWFE estimations for the three diversification indices. The analyses show some positive effects of SEZ adoption on the overall export diversification measure (0.178), while the ATTs associated with the extensive and intensive margins appear to be non-significant. Surprisingly, increases in the income level are found to induce further sectoral concentration of exports. The significant negative coefficient of GDP per capita in the intensive diversification equation tends to indicate that SSA countries appear to exhibit a less balanced mix of export shares amongst the already traded sectors as their development level increase. These rather odd findings seem to go against the negative relationship observed between specialisation and growth in chapter 1. However, the short-run and long-run distinction of the effects of diversification of growth operated by Wagner & Deller (1998) may help reconciling these conflicting outcomes. The authors argue that while on the short-term specialisation based on comparative advantage may foster growth, greater diversification tends to enhance stability and thus pave the way for long-term growth as observed in chapter 1. Appendix 3-D presents the outcomes of 2SLS estimations of growth computed over 1 year, 5, 10, 15 and 20 years. The coefficients of diversity are found to be negative for lower horizon growth measures (i.e., 1 year and 5 years) and positive for higher horizons. This is consistent with the short- and long-run argument of Wagner & Deller (1998).

Trade openness is found to be a significant determinant of the overall and intensive diversification measures. It appears that as countries in the region become more open to foreign markets, they tend to re-centre around a fewer number of existing sectors as suggested by Ricardian trade models. As expected, increases in gross fixed capital formation are associated with greater degrees of export diversification. Also, in line with expectations, REER appreciations appear to have a negative significant impact on the global index of diversification. Moreover, the TWFE estimation suggests that the subsequent competitiveness issues of domestic traded sectors vis-à-vis foreign producers may induce a greater concentration of traditional exports. This tends to indicate the presence of some Dutch disease dynamics in the region. Finally, the model indicates that increases in domestic credits to the private sector tend to enhance export diversification as anticipated. Moreover, this indicator is found to contribute to equalising the shares of already traded goods in the mix of exports.

Table 3.2. TWFE estimations.

Variables	Diversification (1)	Extensive diversification (2)	Intensive diversification (3)
Constant	-1.214	-2.370	1.015
	(1.472)	(1.721)	(2.259)
ATT	0.178*	0.0124	0.180
	(0.108)	(0.116)	(0.148)
Log (GDP per capita)	-0.441*	0.182	-0.596*
	(0.224)	(0.246)	(0.332)
Trade openness	-0.00484***	-0.000469	-0.00431**
	(0.00143)	(0.00149)	(0.00205)
Investment	0.00986**	0.00181	0.00772
	(0.00416)	(0.00189)	(0.00461)
REER	-0.000664**	0.000461	-0.00106***
	(0.000306)	(0.000294)	(0.000370)
Domestic credit	0.0103*	0.000602	0.00954*
	(0.00602)	(0.00343)	(0.00526)
Observations	1,015	1,015	1,015
Adj. R-squared	0.202	0.161	0.161

Robust standard errors in parentheses

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

3.3.4 Robustness checks

A recent literature on DiD has shown that although the TWFE estimator performs well in the canonical two groups/two periods configuration, it has several flaws in cases of staggered treatment and heterogenous treatment effects (see Borusyak et al., 2021; Sun & Abraham, 2021; De Chaisemartin & D'Haultfoeuille, 2020; Goodman-Bacon, 2021; Callaway & Sant'Anna, 2021).

One of the main pitfalls of TWFE outside of the canonical context is the "negative weight problem" associated with the ATT. Theorem 1 in Goodman-Bacon (2021) states that the ATT from TWFE estimation is a weighted average of all possible two-by-two DiD estimators. De

Chaisemartin & D'Haultfoeuille (2020) argue that some of these weights can be negative despite summing up to one. It is thus possible to obtain negative ATT from TWFE estimation while the effect of participating in the treatment is in fact positive for all units in all periods (Callaway & Sant'Anna, 2021). Beyond this, theorem 1 in Goodman-Bacon (2021) also implies that TWFE estimation is sensitive to the time length of the panel, to the size of each group and to the moment at which the treatment is administered.

To overcome these flaws, the ATT is estimated using some alternative robust approaches proposed by Gardner (2021) and Callaway & Sant'Anna (2021). The first one consists in a two-stage DiD estimation procedure for the multiple group/multiple treatment period case which separates the estimation of group and time effects from the estimation of the ATT. The first stage of the procedure consists in estimating the following equation:

$$Y_{g,i,t} = \lambda_g + \gamma_t + X'_{i,t}\Gamma + \varepsilon_{i,t}, \quad (3.5)$$

using only non-treated and not-yet-treated observations and retaining the adjusted outcomes $\hat{Y}_{g,i,t} = Y_{g,i,t} - \hat{\lambda}_i - \hat{\gamma}_t - \hat{X}'_{i,t}$. The second stage then consists in regressing $\hat{Y}_{g,i,t}$ on $D_{g,i,t}$.

Callaway & Sant'Anna (2021) propose a doubly robust estimation of ATT which, instead of averaging all possible 2x2 DiD estimates, only focuses on a subset of comparisons that matter. For each cohort g, the only baseline period considered is the period $g - 1$. Also, for each cohort's average effect estimation, the data which do not belong to the concerned cohort or to the control group are dropped. In the case where no covariates are included[7], Callaway & Sant'Anna (2021) identify the ATTs as follow:

$$ATT(g,t) = \mathbb{E}\left[Y_t - Y_{g-1} \middle| G_g = 1\right] - \mathbb{E}\left[Y_t - Y_{g-1} \middle| C = 1\right]. \quad (3.6)$$

The authors also provide an alternative estimation of the treatment effects using the not-yet-treated units as control group:

[7] See Callaway & Sant'Anna (2021) for identification of ATTs with covariates included.

$$ATT(g,t) = \mathbb{E}\left[Y_t - Y_{g-1} \middle| G_g = 1\right] - \mathbb{E}\left[Y_t - Y_{g-1} \middle| D_t = 0\right]. \tag{3.7}$$

Tables 3 and 4 present the results of estimations based on two-stage difference-in-differences and on the Callaway & Sant'Anna (2021) approach respectively.[8] Likewise in the TWFE estimation, significant positive treatment effects of SEZ adoption on export diversification are found with the two-stage DiD approach. Moreover, this alternative estimation design detects some significant effects of SEZ on intensive diversification, while the extensive component of export diversification shows no reaction to SEZ deployment in SSA countries. Similar results are found with the Callaway & Sant'Anna DiD estimation approach. Note however that significant effects are detected only in the specification using not-yet-treated units as comparison group. It should also be noted that the results from these alternative approaches tend to suggest that the TWFE estimation may have underestimated the size of the ATTs.

Table 3.3. ATTs based on Gardner (2021) two-stage DiD approach.

	Diversification	Extensive diversification	Intensive diversification
Variables	(4)	(5)	(6)
ATT	0.3639**	0.024	0.3947*
	(0.178)	(0.176)	(0.229)
Observations	1,015	1,015	1,015
Adj. R-squared	0.100	0.002	0.090

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

[8] Two-stage DiD estimations are performed using the "did2s" R package (Butts & Gardner, 2021) and the Callaway & Sant'Anna estimators are obtained via the Stata module "csdid" (Callaway & Sant'Anna, 2021; Sant'Anna & Zhao, 2020; Rios-Avila et al., 2021). Note that all equations account for control covariates. However, the corresponding coefficients are not provided after the use of "did2s" and "csdid" which only display the ATTs.

Table 3.4. **ATTs based on Callaway & Sant'Anna (2021) with non-treated and not-yet-treated as control groups.**

	CS (Non-treated)			CS (Not-yet-treated)		
	Diversification	Extensive diversification	Intensive diversification	Diversification	Extensive diversification	Intensive diversification
Variables	(7)	(8)	(9)	(10)	(11)	(12)
ATT	0.0194	-0.152	0.200	0.525*	0.0024	0.520*
	(0.274)	(0.323)	(0.398)	(0.310)	(0.172)	(0.304)
Observations	645	645	645	931	931	931

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

3.4 Conclusion

This study aimed to measure the impact of SEZ adoption on export diversification in SSA countries. For that purpose, a difference-in-differences design was set up to estimate the causal effect of SEZ policies on the export diversification index proposed by Cadot et al. (2011) and on the two components of the index, namely the extensive and intensive diversification indicators. The analyses were performed on a sample of 32 SSA countries organised into a treated group of 20 SEZ-active countries and a control group of 12 countries devoid of SEZ programs, over the period 1970-2014. TWFE estimations along with some recently developed more robust estimation techniques for difference-in-differences with staggered treatment, namely Gardner's two-stage DiD and Callaway and Sant'Anna's DiD estimator, were employed to measure the average treatment effect of SEZ adoption on the group of treated countries. The results indicate that SEZ policies may have fostered export diversification in SSA countries. Moreover, estimations for the extensive and intensive components of export diversification show that the impact of SEZ on export diversification likely manifests through the balancing of shares of already existing sectors in total exports rather than through the creation of new sectors.

The analyses performed in this paper provide SSA policymakers with information on the efficiency of SEZs in attaining the goal of enhancing export diversification. By contributing to the creation of oases of favourable trade environments, SEZ programs appear to foster export diversification at the national level in weakly diversified African economies. The results tend to indicate that the multiplication of these zones may help compensating for the negative impact of poor national investment climates prevailing in many SSA countries.

To the best of the researcher's knowledge, no panel study analysing the impact of SEZs on economic diversification for the SSA region has been conducted and published so far. This gap in the literature, that the current study intends to fill in though imperfectly, may be imputable to the lack of systematic and comparable data related to SEZs in the region. Although the investigations performed in this chapter provide some new insight based on the limited available data which have been analysed, the study suffers some flaws that should be addressed in future empirical works. In the researcher's view, the main shortcoming of this analysis lies in the fact that the adoption of SEZs has been integrated to the estimations only as a binary event. There is little doubt that the study would have gained in accuracy if some weights had been attributed to the presence of SEZs in each country. This could have been possible with additional country and SEZ level data for each period (e.g., number of SEZ per country, number of companies in SEZs and per SEZ, number of employees in SEZs and per SEZ, share of SEZs in total exports, etc.). These limitations partially bereave the study from some elements of nuance. SEZ authorities and policymakers in SSA countries should contribute to improve the availability of data to foster the emulation of new papers on that topic in the wake of this pioneering study.

Appendices

3-A. Computation of the export diversification index

Following Cadot et al. (2011), let N be the total number of potential export lines and μ the export value in USD for each line. Note that N will depend on the export categorization system and on the level of aggregation of items.[9] Consider K subgroups within the entire set of potential export lines. The first subgroup includes the products traditionally exported by country i. This corresponds to products that were exported in the first period observed. The second subgroup includes non-traded products. These are items for which no exports are observed for all periods observed for country i. The last subgroup is composed of new export lines. These corresponds, at time t, to products that have been non-traded in at least the two previous years, then exported in the two following years by country i. Note that while the "New" subgroup may vary overtime for country i, the "Traditional" and "Non-traded" subgroups remain unchanged.

Let N_k be the total number of products in each subgroup and μ_k the average export value per subgroup. The intensive and extensive margin indices are country i in year t as follows:

$$EMI_{i,t} = \sum_k \left(\frac{N_{k,i,t}}{N}\right)\left(\frac{\mu_{k,i,t}}{\mu_{i,t}}\right) ln\left(\frac{\mu_{k,i,t}}{\mu_{i,t}}\right)$$

and

$$IMI_{i,t} = \sum_k \left(\frac{N_{k,i,t}}{N}\right)\left(\frac{\mu_{k,i,t}}{\mu_{i,t}}\right)\left[\frac{1}{N_k}\sum_{j\in k}\left(\frac{x_j}{\mu_k}\right) ln\left(\frac{x_j}{\mu_k}\right)\right],$$

where x_j represents the export value of product j. The Theil index of exports is the sum of the two margins.

[9] The IMF Export Diversification and Quality database from which data for diversification indices are extracted for this study, uses trade flows at the 4-digit STIC (Revision 1) level. This corresponds to 625 potential export lines.

3-B. Treatment and control groups

Country	Treatment	SZE adoption
Togo	1	1989
Cameroon	1	1990
Kenya	1	1990
Mauritius	1	1990
Nigeria	1	1992
Ghana	1	1995
Zimbabwe	1	1996
Mozambique	1	1998
South Africa	1	1999
Tanzania	1	2002
Gambia	1	2005
Senegal	1	2007
Zambia	1	2007
Cote d'Ivoire	1	2008
Madagascar	1	2008
Angola	1	2009
Gabon	1	2010
Rwanda	1	2011
Congo, Dem. Rep.	1	2012
Sierra Leone	1	2012
Benin	0	-
Burundi	0	-
Central African Republic	0	-
Chad	0	-
Comoros	0	-
Guinea-Bissau	0	-
Malawi	0	-
Mali	0	-
Niger	0	-
Sao Tome and Principe	0	-
Seychelles	0	-
Somalia	0	-

3-C. Descriptive statistics

Variable	Mean	Std. Dev.	Min	Max	Observations
A. Full sample					
Diversification	-4.308818	.9316272	-6.330621	-1.784281	1,440
Extensive diversification	-.6590604	.7020673	-3.233945	.061267	1,438
Intensive diversification	-3.596383	.998329	-5.960357	-1.568666	1,440
log (GDP per capita)	6.907431	.9341371	5.119464	9.628238	1,312
Trade openness	59.13072	28.65666	6.320343	225.0231	1,182
Investment	20.02317	9.948408	-2.424358	89.38105	1,131
REER	144.4329	104.4214	24.75845	1954.183	1,320
Domestic credit	16.77035	18.89965	.0077258	142.422	1,205
B. Treated group					
Diversification	-4.087293	1.009597	-6.330621	-1.784281	900
Extensive diversification	-.5589058	.5750672	-3.233945	.0584639	898
Intensive diversification	-3.529629	.9735089	-5.846324	-1.659763	900
log (GDP per capita)	7.085316	.8928171	5.119464	9.628238	856
Trade openness	62.13393	26.72338	6.320343	152.5471	770
Investment	20.99109	10.46818	-2.424358	89.38105	731
REER	144.9682	121.7379	24.75845	1954.183	845
Domestic credit	19.77815	22.77803	.0077258	142.422	751
C. Control group					
Diversification	-4.678025	.6313343	-6.115582	-2.120005	540
Extensive diversification	-.8256139	.8480774	-2.86956	.061267	540
Intensive diversification	-3.707639	1.029708	-5.960357	-1.568666	540
log (GDP per capita)	6.573507	.9192948	5.392851	9.572786	456
Trade openness	53.51792	31.22576	20.0568	225.0231	412
Investment	18.25427	8.657378	2.732897	60.15617	400
REER	143.4807	62.86607	71.15722	418.1472	475
Domestic credit	11.79489	7.110437	.4025806	38.88238	454
D. Not-yet-treated group					
Diversification	-4.211717	.97382	-6.330621	-1.784281	630
Extensive diversification	-.6437058	.6060974	-3.233945	.0584639	629
Intensive diversification	-3.569033	.9926765	-5.846324	-1.659763	630
log (GDP per capita)	7.034461	.9107771	5.119464	9.628238	586
Trade openness	58.45415	26.83092	6.320343	152.5471	500

Investment	20.20998	11.49288	-2.424358	89.38105	464
REER	161.7345	141.0526	24.75845	1954.183	594
Domestic credit	16.0997	16.48749	.0077258	105.5439	494

3-D. 2SLS estimations for short-term and long-term growth

Dependent variable: Growth over	1 year	5 years	10 years	15 years	20 years
Diversity $_{t0}$	-0.00242	-0.00124	0.00153	0.00349***	0.00293***
	(0.00233)	(0.00129)	(0.00107)	(0.000976)	(0.000904)
Investment $_{t0}$	4.20e-05	9.48e-05	0.000254**	0.000136	0.000185**
	(0.000467)	(0.000190)	(0.000103)	(9.16e-05)	(7.77e-05)
Schooling $_{t0}$	0.000495**	0.000502***	0.000469***	0.000450***	0.000433***
	(0.000215)	(0.000103)	(7.64e-05)	(5.68e-05)	(4.59e-05)
Trade openness $_{t0}$	0.000174*	0.000178***	0.000174***	0.000141***	0.000112***
	(9.30e-05)	(4.93e-05)	(4.09e-05)	(4.39e-05)	(3.93e-05)
REER $_{t0}$	2.12e-05	1.05e-05	1.88e-05***	1.44e-05***	1.71e-05***
	(2.63e-05)	(1.04e-05)	(6.69e-06)	(4.84e-06)	(3.61e-06)
Log (GDP per capita) $_{t0}$	-0.00971	-0.0103***	-0.0113***	-0.00918***	-0.00746***
	(0.00606)	(0.00297)	(0.00209)	(0.00193)	(0.00153)
Constant	0.200***	0.0986***	0.0945***	0.0752***	0.0616***
	(0.0359)	(0.0174)	(0.0121)	(0.0106)	(0.00868)
Underidentification test (Kleibergen-Paap rk LM statistic p-value)	0.0389	0.0562	0.0880	0.1011	0.0681
Weak identification test (Kleibergen-Paap rk Wald F statistic)	36.800	32.714	28.859	31.927	43.033
Observations	655	588	504	419	363
R-squared	0.130	0.225	0.294	0.293	0.308

Robust standard errors in parentheses

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

General conclusion

This thesis analyses economic diversification in the context of resource-rich developing countries. Relying on data covering 196 countries over the period 1998-2019, the first chapter of this work provides some insight on the channels through which the lack of economic diversity may influence growth. The analyses indicate a negative impact of sectoral on long-term growth and establish some mediation effects via human and physical capital deterioration, changes in trade openness and foreign exchange reserves, and increased corruption perception. Additionally, the study sheds some light on potential income-based discrepancies in the manifestation of the total effect of sectoral concentration on growth which appear to be more pronounced in developing countries than in advanced economies. While the mediation effects of schooling and investment observed for the entire sample appear to hold for developing countries, the model detects no indirect effects through these channels in the case of developed countries. Moreover, the trade openness and reserves channels are found to carry positive mediation effects to long-term growth in advanced countries while these effects are observed to be negative for trade openness and non-significant for foreign exchange reserves in developing countries. Further moderation analyses in chapter 1 show that, provided favourable initial levels of human capital, trade openness, reserves, competitiveness, and corruption perception, the negative effects of sectoral concentration on long-term growth could be alleviated or even fully compensated in some cases. Indeed, moderation effects of high levels of education and international competitiveness in high-income countries are found to result in a positive impact of concentration on long-term growth. This is consistent with the U-shaped pattern in the relationship between diversification and economic development.

Countries endowed with abundant natural resources tend to exhibit lower degrees of economic diversification than comparable countries with lower levels of commodities. This is in part explained by the Dutch disease effects that may results from resource booms. Chapter 2 investigates Dutch disease in two major copper-rich developing countries, namely the Democratic Republic of Congo (DRC) and the Republic of Zambia over the period 1991-2019. Since the early 2000s, both countries have implemented a series of investor-friendly measures aiming at fostering mining sector-led growth. The analyses show that the expansion of copper extraction in DRC and Zambia has been accompanied with Dutch disease induced de-agriculturalization trends. These findings suggest that resource abundance may undermine diversification efforts by exerting a negative pressure on non-resource traded sectors.

Economic diversification is a major concern for policymakers in developing economies, especially in countries highly reliant on commodity sectors. Most countries in Sub-Saharan Africa appear to exhibit low degrees of economic diversification and excessive resource-dependency. Over the past 30 years, special economic zone programs have mushroomed in that region with the aim to foster export-led growth and economic diversification. Chapter 3 assesses the impact of SEZ adoption on export diversification in SSA countries. The analyses rely on a panel of 32 SSA countries over the period 1970-2014. It appears that SEZ programs have supported export diversification in the region by equalising the shares of existing sectors in total exports. However, these policies are found to be ineffective to impulse the creation of new tradable sectors in the region.

The findings of this thesis have direct implications for policymakers in resource-rich developing countries and provide additional material to the diversification debate. Although most development programs in such countries include both growth and diversification goals, these two objectives may be conflicting. The cases of DRC and Zambia are interesting illustrations of this opposition. In order to foster growth and employment, both countries have implemented investor-friendly mining codes over the past few decades which have resulted in mining sector expansion. As seen in chapter 2, while the resulting copper booms have served the growth objective, it has come at the detriment of the labour-intensive agriculture sector. This example suggests that beside considering diversification as a goal, policymakers in resource-rich developing countries should integrate the fact that the actual lack of diversification may result from market failures induced by growth policies.

Moreover, developing countries, especially in Sub-Saharan Africa, are often characterised by unattractive business climates which can also be endogenous to resource abundance. Indeed, beside Dutch disease effects, resource abundance also tends to be associated with rent seeking behaviours, corruption and poor institutional quality which may discourage domestic and foreign investors and cripple diversification attempts. Development plans should thus include policies aiming at tackling these issues. Special economic zones are interesting tools in that sense. By creating small oases disconnected from the overall national business climates, SEZs provide favourable environments for investors and firms thanks to various incentives including quality public services and clearer regulations. Moreover, the small areas of SEZs make them relatively less dauting to manage than larger scale industrial programs. The positive impact of SEZs on intensive diversification observed in chapter 3 shows that these policies may help alleviating the negative impact of resource abundance on the other traded sectors and contribute to overall diversification. Such policies should thus be encouraged in developing resource-rich countries.

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