Natural Resource Endowment: a Blessing or a Curse ?

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In memory of my late grandparents ..

This thesis is dedicated to my parents, without whose support I would never have been able to chase my dreams. I owe them all my academic and personal achievements.

This thesis is also dedicated to Rym, Mohamed and Karima. They have always been a source of joy, love and reassurance and I am thankful for all their encouragements.

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Declaration

I hereby declare that except where specific reference is made to the work of others, the contents of this dissertation are original and have not been submitted in whole or in part for consideration for any other degree or qualification in this, or any other university. This dissertation is my own work and contains nothing which is the outcome of work done in collaboration with others, except as specified in the text and Acknowledgements. This dissertation contains fewer than 65,000 words including appendices, bibliography, footnotes, tables and equations and has fewer than 150 figures.

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Abstract

This thesis investigates the impact of natural resources on resource-rich countries and assesses natural resources' spillover effect in various directions: national economic growth, the financial sector, and regional growth.

The first paper examines the existence of a financial resource curse in resource-rich countries. It explores the importance of financial development associated with the challenges induced by resource wealth. It also studies whether both resource abundance and reliance have a negative impact on financial development, liberalisation, and reforms in resource-rich countries. It is built on a balanced panel dataset with a cross-sectional dimension of 90 economies that includes both resource-rich and resource-scarce countries and a time dimension of all years from 1970 to 2016. It uses the Two-Stage Least Squares (2-SLS). The 2-SLS instrument built is based on the variation of world prices and their volatility, as well as the specific share of every natural resource for each country. The paper's results show that the existence of resource hinders financial liberalisation and that financial reforms have a lower impact when associated with resource abundance. Theb paper concludes the existence of a resource curse in resource-rich countries. It also shows

The second chapter demonstrates the effectiveness of a sovereign wealth fund against the Dutch Disease. Sovereign Wealth Funds (SWF) are government owned investment funds which are formed usually out of the surplus reserves (e.g., foreign exchange reserves or reserves comprising natural resource export revenues). Three categories

of SWF exist, namely stabilisation, savings, and financing. Funds that aim the stabilisation are defined by a price- or revenue-reliant deposit and/or withdrawal rules (such as Algeria, Russia, Mexico, and Venezuela). Saving funds are funds where a predetermined part of total revenues is accumulated in the fund (such Equatorial Guinea's Fund for Future Generations and Kuwait). Additionally, financing funds are funds for which the accumulation rule is directly linked to the budget's non-oil deficit (Norway). This chapter is based on a novel feature in a paper by Hansen and Gross (2018) that incorporates both exploration and depletion of the natural resource (Iron Ore), a feature that has been disregarded in most DSGE papers but which appropriately depicts the transmission channels of the commodity price changes. The model closely follows Hansen and Gross (2018) and explores the impact of implementing a resource-based SWF in Australia. The results show that, following a commodity price shock, the fund has a significant impact in stabilising the responses of key macroeconomic variables, such as exchange rate and inflation. Regarding the optimal tax regime rules, we also find that an ad-valorem royalty (percentage tax on revenue) is efficient in securing a continual stream of returns from the resources sector compared to a rent and reserves tax.

The last chapter of the thesis adds to the literature through a discussion of income spillovers between resource-rich and resource-scarce Australian Local Government Areas (LGAs). Because the impact of mining expansion on a regional scale might be more complicated to discern compared to the national macroeconomic assessment of the natural resources (Australia is a federation comprising 6 states and 2 self-governing territories), two main estimations are employed: a difference-in-difference and a treatment effect to investigate the impact of mining on the LGA, and spatial regressions to assess the impact on the neighbouring LGAs. The paper is built on an original dataset that combines Australian spatial boundaries data for LGAs, Australian mines data and Australian census data from 2006 to 2016. The difference-in-difference results revealed that LGAs without operating mines have lower income compared to areas that enjoy operating mines. Results showed that, in terms of spatial regression, the mining sector has a positive effect on employment and income in rich LGAs and in neighbouring areas. Mining activities have substantial direct contributions in adjacent regions of Australia that reinforce their economic growth.

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Chapter 1

Introduction

This thesis comprises three main chapters that investigate the impact of natural resources on resource-rich countries. The papers' principal objective is to evaluate the effect of resource abundance and reliance and assess the imoacts of natural resources in various directions: national economic growth, the financial sector, and regional growth.

The importance of this intriguing field of research is mainly due to what is called the "resource curse". The term "resource curse" was first used by the British economist Richard Auty in a 1993 when he examined why resource-rich economies underperformed other developing countries (Mittelman, 2017). The resource curse", also called the paradox of plenty consists of the poor economic growth of resource-rich countries. One of the countries that illustrates this phenomenon is Nigeria. Nigeria is among the countries with the lowest GDP per capita in the World, yet it is one of the wealthiest countries in terms of oil since the sixties (Dwumfour and Ntow-Gyamfi, 2018). In fact, the empirical findings confirm the challenges of being a resource-rich country.
Since the oil shock crises in the 1970s and the global financial crisis (GFC), the lack of consensus on the impact of natural resources on both national and regional economic growth or the financial sector, amongst others, has been at the heart of the research. Literature shows that more than one answer can be true simultaneously due to two main

channels: direct and indirect. The direct channel is related to the resource revenues that can be invested by the government. However, the uncertainty resulting from volatile commodity prices can weaken public finances. For instance, the coronavirus pandemic has sparked an unprecedented economic shock in peacetime. This shock led to high uncertainty and resulted in markets' volatility (GSAM, 2020). Energy demand has experienced the largest drop in 70 years, a fall in usage of 6% (IEA, 2020). This drop is considered to have a magnitude seven times higher than the GFC on energy demand. Following the pandemic, the oil crash generated a fiscal crisis in several resource-rich countries such as Russia and Saudi Arabia. The indirect channel is related to the potential negative institutional impact. The literature has shed light on weakened political and governance, institutional quality, as well as feeble accountability and high corruption.

Importantly, whether the impact of natural resources depends on both these channels is a question this thesis attempts to answer.

The first chapter investigates the indirect effect and assesses the existence of a financial resource curse in resource-rich countries. This chapter explores the importance of financial development associated with the challenges induced by resource wealth. Beck (2010) showed that finance is essential for a country's development and poverty alleviation. Evidence from both time-series and cross-country analysis across industry and firm-level corroborates this relationship. This paper attempts to answer the question of whether the same relationship holds for resource-rich countries. Yet, another question arises related to the difference between resource abundance and how it is differentiated from resource reliance.

A country's economy can be reliant on commodities but can be resource-scarce and *vice-versa*, and little attention has been paid to this difference (Beck, 2011). Resource abundance can be calculated through the adjusted savings of the natural resource (all net forest, energy and mineral) depletion as a share of GNI (World Bank, 2020). By contrast, resource dependence is defined as the reliance of the economy on natural resources. In other words, dependence refers to the consumption level that relies on resource production and exports, and it can be measured by annual resource rents. Rents are calculated by subtracting the average cost of extraction and harvesting from the total revenues of the resource's world price units (Kropf, 2010; Shahbaz et al., 2019). The first chapter contributes to the literature by investigating whether both resource abundance and reliance have a negative impact on financial development, liberalisation, and reforms in resource-rich countries. It is built on a balanced panel dataset with a cross-sectional dimension of 90 economies that includes both resource-rich and resource-scarce countries and a time dimension of all years from 1970 to 2016 and it uses a Two-Stage Least Squares estimation. Another contribution of this paper is the instrumental variable estimator built that is based on the variation of world prices and the specific share of every natural resource for each country. This contrasts with the majority of studies that focus only on oil and gas. (Dwunfour and Ntow-Gyamfi, 2019). The results show that the existence of natural resources hinders financial development and liberalisation. Evidence suggests that financial reforms have a lower impact when natural resources are abundant likely due to indirect effect related to the potential negative institutional impact.

The second chapter deals with the direct effects of the natural resources' impact, namely the Dutch Disease, in Australia. It suggests a cure for dealing with government revenues' volatility: a sovereign wealth fund. The term Dutch Disease was first coined by the Economist (1977) when a link between the Dutch currency's appreciation and the discovery of natural resources in the Dutch territory has been made. This appreciation has rendered Dutch manufacturing less competitive (Krugman, 1987). On the national level, when additional mining revenues come from the mining sector boom, the demand for labour in the non-tradable sector rises, to the detriment of the manufacturing sector that loses its competitiveness as a result of the appreciation of the exchange rate (Bulte, Damania and Deacon; 2004; Collier, 2007). This is the spending effect. Besides, the shift of both capital and labour into the booming mining sector and of non- tradables to satisfy the increasing domestic demand leads to a shrinkage of the lagging tradable sector (Ebrahim-Zadeh, 2003). This represents the resource movement effect. The chapter's main contribution is to assess the importance of a resource-based sovereign wealth fund (SWF) for Australia in a DSGE framework. It uses a novel feature modelled by Hansen and Gross (2018) that incorporates both exploration and depletion of Iron Ore, a feature that has been disregarded in the majority of DSGE papers but which appropriately depicts the transmission channels of the commodity price changes. The model closely follows Hansen and Gross (2018) and explores the impact of implementing a resource-based SWF in Australia. The results show the effectiveness of a sovereign wealth fund against the movement effect and the spending effect of the Dutch Disease in Australia. These findings confirm the conclusions of Steigum (2013) and El-Baz (2018), who argues that a SWF can be an instrument to achieve macroeconomic stabilisation. Through the withdrawal of some of the resource windfall of the SWF, stabilisation and savings funds can lower government expenditure procyclicality in a straightforward fashion. We also contribute to the literature by exploring the different tax regimes that should be adopted for the fund. Different taxes regimes have been considered in natural resources literature (Ycel, 1989; Deacon, 1993 and Boadway and Keen, 2015). For instance, Norway and the United Kingdom have been known for adopting resource rent taxes, whilst Australia, Canada and the United States have opted for a tax per unit of revenue. (Otto et al., 2006). We find that the government should opt for a revenue tax regime instead of a reserve tax or a rent tax. The results are in accordance with Stanford (2012), who suggested re-establishing the tax on corporations' revenues on oil production to increase the Canadian government's income.

The final chapter discusses the mining impact on the regional income patterns in Australian Local Government Areas (LGA). To date, the majority of research papers have focused on aggregate or cross-country experiences, and little attention has been paid to the local and regional effects. Specifically, the mining'role in improving local socio-economic growth has not been sufficiently studied (Solomon et al., 2008). Some researchers have acknowledged issues related to the regional development, namely income inequalities and the local resource movement effect from mining expansion (Lockie et al., 2009; Reeson et al., 2013, Fleming et al., 2015). Several mechanisms of the regional resource curse have been studied in the literature: corruption and management malpractices, wars and conflicts, environmental challenges, migration as well as the shift of the production resources and the distortion of local prices (Fleming and Measham, 2013; Cust and Poelhekke, 2016; Cust and Viale, 2016). Hajime et al. (2013) revealed that more than 10 % of resource-rich Chinese towns are now considered "hopeless" because of their depleted resources and their reduced, even negative economic development. Moreover, Papyrakis and Raveh (2013) found that Canadian provinces with a high level of resources have a very weak or minimal capital flight yet much higher inflation. By contrast, Aragon and Rud (2013) investigated the impact on the neighbourhoods of Newmont's Yanacocha mineral project in Peru and found a positive relationship between real income and the operating mine through the mining demand of local inputs. This chapter contributes to two strands of the literature. It is related to the resource curse literature and its mechanisms but importantly belongs to the strand exploring regional growth and income inequalities. The novelty lies in the dataset used, combining spatial boundaries data, mines data and census data: for a total of 563 LGAs across the continent, all the data of the census were collected from the Australian Bureau of Statistics. Regarding the mines, the data for the number and location (latitude and longitude) of active mines and historic mines and their corresponding LGAs were collected from the Australian Mines Atlas (2019). The dataset also contains the mines' total count and the count of active mines for each census year. This required an extensive collection of mine data: It involved searching every single mine among the 250 mines of the dataset, checking the opening year and the date, and which type of minerals. Different econometric models are employed to deal with the complexity of the regional mining impact : a difference-in-difference estimation, along with a treatment effect analysis to assess the impact of the mining openings on income within the LGA, and a spatial autoregression model to investigate the spillover impact of mining to neighbouring areas. The results of the paper are contrasted with the resource curse literature, such as Cust and Poelhekke (2016) and Papyrakis and Raveh (2013) and support the findings of Aragon and Rud (2013). We show that LGAs without operating mines have lower income compared to areas where mines are operating. Moreover, the opening of a new mine increases the income in the rich local government area. Mining activities are also found to make direct contributions in adjacent regions and enhance their economic growth with positive spillovers effect on income and employment.

Chapter 2

The Resource Curse and the Financial Sector: Development, Liberalisation and Reforms

2.1 Abstract

This paper shows the existence of a financial resource curse in resource-rich countries. It arises from the importance of financial development on economic development that has obtained lately significant consideration (Guru and Yadav, 2019). It is also related to the the resource curse theory and challenges induced by being a resource-rich country.

This research contributes to the literature in two key aspects.
Finance is essential for economic development. However, few papers investigated the impact of financial development in resource-rich countries, and the researchers who have done so have focused only on oil and gas as natural resource indicators and discarded others such as minerals (Askari, 2013; Dosmagambet, et al. 2018, Anser et al., 2021). More importantly, little attention has been paid to the difference between the impact of resource abundance versus resource reliance. Canada and the Republic of Congo are two great examples to emphasise the significance of the distinction between resource abundance and resource reliance. The two nations share roughly equal levels of natural resource endowment, with resource rents per capita in 2013 hovering at $1,200. However, Congo (42.3 percent) had a considerably higher resource contribution to GDP than Canada (2.3 percent). Despite having an abundance of natural resources, only Congo can be considered to be completely dependent on the resources. This paper accounts for this distinction and assesses each impact: the total natural resources rents as a percentage of GDP and the adjusted savings from natural resources depletion as a percentage from GNI.

The paper uses the Two-Stage Least Squares with an instrument that depends on world prices and their volatility, as well as the specific share of every natural resource for each country. It is built on a balanced panel dataset with a cross-sectional dimension of 90 economies that includes both resource-rich and resource-scarce countries and a time dimension of all years from 1970 to 2016.

The results show that the existence of resource hinders financial development and liberalisation. Evidence suggests that financial reforms have a lower impact when resources are abundant.

2.2 Introduction

With the emergence of endogenous growth theories such as Romer (1986), Greenwood and Jovanovic (1990) (cited in Chaiechi, 2014), the importance of financial development on economic development has obtained significant consideration, and the literature can be divided into five aspects. The first strand of models concentrated on the financial sector's role in providing resources to support the economy, such as Bencivenga and Smith (1991) and Wu et al. (2010). The second strand, including Levine (1991), highlighted the role of financial markets in investments' diversification that minimises risk, improves liquidity and boost economic growth. The next category analysed the financial system's role in enhancing different financial intermediation effectiveness (Arestis et al., 2001). In addition, papers such as Greenwood and Smith (1997) investigated the relationship between financial development and entrepreneurship, as well as the impact of new technologies on the system. Lastly, research has focused on the "financial markets' ability to impact economic growth through changes in incentives for corporate control" (Demirguc-Kunt and Levine, 1996; cited in Durusu-Ciftci, Ispir and Yetkiner, 2017).

The financial sector is essential in respect of managing households' savings and providing credit to individuals and firms. Beck (2011) argues it is even more important in resource-rich countries as it is needed to smooth the flow of windfalls from the resource sector and ensure those funds are appropriately allocated and well invested in boosting the economy. For those countries, the banking sector is a decisive driver of a country's development, as it might help reduce the impact of the Dutch disease by lending the funds to the manufacturing sector to acquire raw materials, satisfy working capital needs and limit the latter sector's crowding out. The banking sector is also necessary for trade and international transfers through foreign exchange transactions, for instance, advice and counselling. Moreover, savings are crucial in producing new capital assets; therefore, capital formation. An important factor linked to financial development is financial liberalisation.

Several researchers have argued that financial development is positively related to financial liberalisation. Saidane (2002) argued that financial liberalisation means higher competition, "transfers of know-how," and greater transparency. It has, thus, an impact on the successful implementation of financial reforms. Ultimately, as Beck (2010) highlighted, finance is essential for a country's development and poverty alleviation. Evidence from cross-country analysis, time-series data, and both industry and firm-level evidence indicate a positive correlation.

The first question that arises from those findings is whether the same relationship holds for resource-rich countries because of the resource curse. Yet, another issue arises related to the difference between resource abundance and how different it is to resource reliance. A country's economy can be reliant on commodities but can be resource-scarce, and *vice versa*. This difference has been omitted by several researchers.

Resource abundance is resource wealth, calculated through the adjusted savings of natural resources depletion as a share of GNI (World Bank, 2020). It is the sum of net forest depletion [1], energy depletion[2] , and mineral depletion[3]. By contrast, resource dependence is defined as the reliance of the economy on natural resources. In other words, dependence refers to the consumption level that relies on resource production and exports, and it is measured by annual resource rents. Rents are calculated by subtracting the average cost of extraction and harvesting from the total revenues of the resource's world price units (Kropf, 2010; Shahbaz et al., 2019). This difference represents a motivation to investigate whether both resource abundance and reliance have a negative impact on the financial sector in resource-rich countries.

[1] "The unit resource rents times the excess of roundwood harvest over natural growth" (WB, 2020).
[2] The ratio of the value of the stock of energy resources to the remaining reserve lifetime." (WB, 2020).
[3] "The ratio of the value of the stock of mineral resources to the remaining reserve lifetime." (WB, 2020).

Moving to financial liberalisation, it has been broadly demonstrated that financial liberalisation is a fundamental pillar of financial development (Ang and McKibbin, 2007). However, several papers have found that banks are forced to take higher risks with intense open competition, which made them inclined to instability (Marcus,1984; Chan, Greenbaum and Thakor, 1986; and Keeley, 1990). Arestis (2016) argued that since the implementation of the financial liberalisation theory, banking crises are characterised by higher frequency and severity, an example being "the Southeast Asian crisis and the international financial crisis that led to the Great Recession. Although it was argued that liberalisation could make the banking system more fragile, substantial reforms and a strong institutional quality are found to be limiting the risks of financial crisis and fragility.

Moreover, findings show that it has several long-run benefits. The example of India seems to be the most prominent. According to the World Bank (2005), India has started liberalising its financial sector following the foreign exchange crisis in 1991 through several reforms: Indian authorities opted for strengthening bank regulations and supervision. For the Indian Bond Market, "a system of auctions was introduced in 1992 for Central Government securities which signalled a transition to a market-related interest rate system" (UNCTAD, 2012). They deregulated lending and deposits rates to foster competition, increase the efficient allocation of resources and reinforce the monetary policy's transmission (RBI, 2009). The benefits were a substantial growth of bank deposits from both resident and non-resident citizens. Those reform for liberalisation strengthened all stock, bond and commercial markets who provided almost 25% of domestic corporate funding (World Bank, 2005). It also led to large capital inflows and higher banking sector performance.

However, the benefits of reforms are still a debatable issue. Some papers argued that financial liberalisation is positively correlated with higher instability (Ang and McKibbin, 2007). An older paper of Mankiw (1986) argued that the authorities' interventions through subsidising credit and lending to different institutions can be an important booster to the economy as it makes credit allocation effective. By contrast, McKinnon (1973) and Shaw (1973) theories suggested that restrictions related to interest rates ceiling and direct credit could hamper financial development. King and Levine (1993) found that repressing the financial sector could be the reason for low financial development which makes financial development inefficient in promoting economic growth with a tightened system. Durusu-Ciftci et al. (2017) concluded that liberalising the financial system and reforming it accordingly makes financial mediators highly active and dynamic. This explains the necessity for "institutional and legal improvements that strengthen creditor and investor rights and contract enforcement" (ibid.), reduces the complexity of the markets, and consolidates audit examinations and shareholders rights. Lastly, it seems that the literature lacks investigations on how financial development, its liberalisation and reforms impact a developing country's growth, namely in terms of resource-rich countries, such as sub-Saharan African countries. This could be explained by the lack of reliable databases for those countries.

This paper contributes to the literature in two key aspects. First, fewer papers have tried to investigate the resource curse impact on the financial and banking sector. Finance is essential for a country's development and poverty alleviation (Beck, 2010). Empirical evidence from both country and firm-level indicate a positive correlation. However, few papers investigated whether the same relationship holds for resource-rich countries. Also, among those who explored the latter, most of the papers have focused on oil and gas as natural resource indicators and discarded others. Dwunfour and Ntow-Gyamfi (2019) argued that a more exhaustive analysis with exhaustive measures of resources revenues remains limited, a gap this paper fills. More importantly, little attention has been paid to the difference between the impact of resource abundance versus resource reliance. This paper accounts for this distinction and assesses each impact. This paper's importance arises not only from the importance of financial development on economic development but also from the challenges induced by being a resource-rich country.

The remaining of the paper is as follows: the next section reviews the literature, after which the data and the methodology are explained. This is followed by a section for the analysis of the results and, finally, concluding remarks.

2.3 Literature Review

Despite the theoretical appeal of natural resources in economic development, historical revelations and recent research have shed light on the resource curse or the paradox of plenty consisting of resource-rich countries' poor growth. The empirical findings confirmed the challenges caused by the resource endowment, which represents a motivation for this paper. One of the famous examples is Nigeria, which is among the countries with the lowest GDP per capita in the world, yet it is one of the wealthiest countries in terms of oil since the sixties (Dwumfour and Ntow-Gyamfi, 2018). The majority of papers that has analysed the resource curse have focused on a particular symptom of this curse: the Dutch Disease. They highlighted the impact of the Dutch disease illustrated by the exchange rate appreciation and the crowding out of the manufacturing sector. Fewer papers have tried to investigate the resource curse impact on the financial and banking sector, which is another incentive to investigate natural resources' financial impact.

Figure 1 shows the overall financial development in the world. The map shows that, except for South Africa, all sub-Saharan African (SSA) countries suffer from low financial development. This applies to also to Latin American and MENA countries, even though the most considerable impact is devoted to SSA. Emerging Asia might have fewer resources than SSA, MENA, and Latin America, which might explain why they have higher financial development. Those countries are likely relying more on human capital and technology, representing essential factors for financial development.

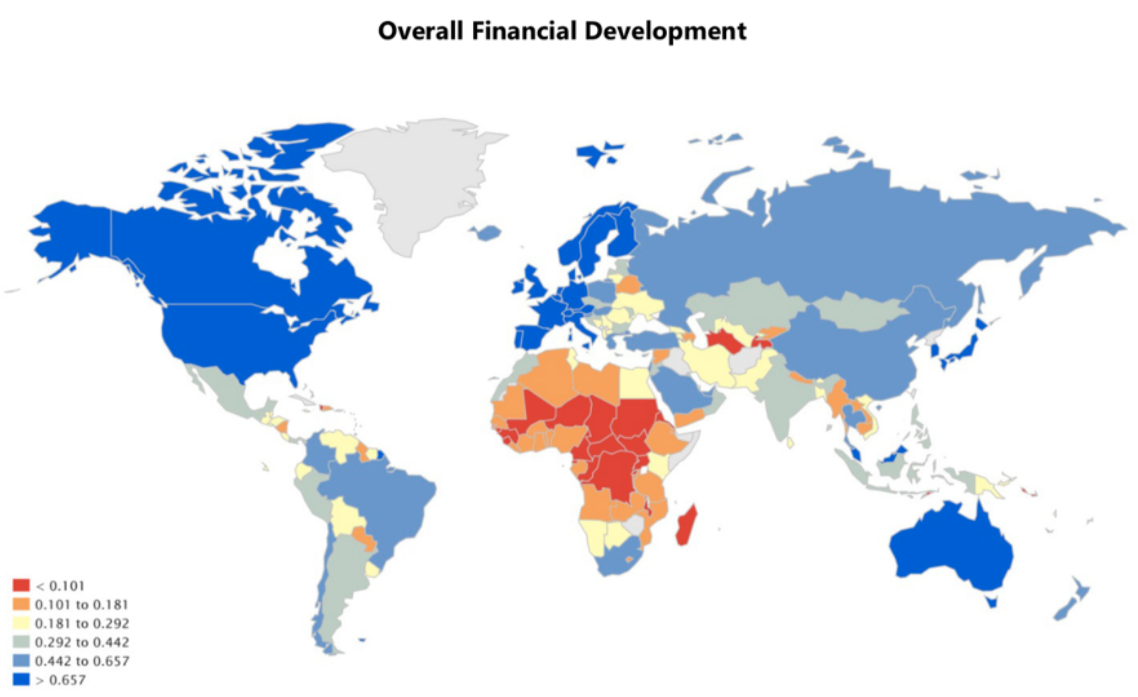

Fig. 2.1 Overall Financial development (Svirydzenka, 2016)

As soon as the theory of endogenous economic growth emerged, researchers revitalised the debate on the role of financial development in economic growth. Previous empirical work has shown what became a stylised fact: the positive correlation and impact of finance on the economy (King and Levine, 1993; Levine and Zervos, 1998; Rajan and Zingakes, 1998). However, the literature investigating how financial development, its liberalisation and reforms impact a developing country's growth, particularly for resource-rich countries, have not been extensively explored.

Among the key papers that attempted to approach the relationship between financial development and natural resources is Beck (2011), one of the pioneers investigating whether the abundance of oil can hinder financial development. Beck (2011) finds that the endowment is a curse and the results have shown that resource-rich countries suffer from under-developed financial systems. Even though their banks have higher liquidity and are highly capitalised, the loans given to firms are limited. Firms are characterised by smaller recourse to external finance while the demand does not differ from other resource-scarce economies. One limitation of Beck (2011)'s paper is using limited natural resources measures. The authors claim it represents a preliminary investigation of natural resources' role in developing the financial system in resource-rich countries. This paper will attempt to explore this limitation through different natural resources measures, namely adjusted savings from natural resources and total natural resources rents as a percentage of GDP. A more recent paper by Beck and Poelhekke (2017) has focused on how the financial system can intermediate and absorb revenues from the resource sector. They found that most papers emphasised the relationship between natural resources and macroeconomic stability. The concluded that little attention has been paid to the domestic financial sector, and only indirect reference to this sector has been made. The paper added to the literature by analysing the impact of exogenous variations of resources revenues on lending and deposits. They have also explored the question of whether capital inflows are expansionary or contractionary. Lastly, they examined the impact of large resource revenues on the banks funding as well as the lending behaviour, but they did not explore the association between large resources windfall, weak political institutions and lower financial development.

This issue has been examined by Dwunfour et al. (2017), who studied how financial development and natural resources impact poverty in Africa through an inclusive dimension of welfare: The Human Development Index. They established that financial development can be efficient in enhancing welfare when the latter profits the underprivileged. Another relevant and recent paper is by Dwunfour and Ntow-Gyamfi (2019), who found that most research papers have focused on oil and gas as natural resource indicators and discarded others. They argued that a more exhaustive analysis with ample measures of resources revenues remains limited. This represents a motive to extend the analysis to different natural resources measurements that take into account each country's' specific resources. Dwunfour and Ntow-Gyamfi (2019)'s paper considers numerous institutional features such as political stability, non-violence and government effectiveness and control of corruption. They also take regional differences and income groups into account. They concluded that there is a resource curse in the financial systems of sub-Saharan countries. As bank deposits depend mainly on the resource sector's revenues, banking institutions experience instability following volatility in the revenues. Regarding the measure they used for financial development, they opted for a transformation of their data into standardised values, i.e., z-scores. However, one can argue that their use of Z values to model the financial development measurement can be reliable as long as a normal distribution of the data is met (Wiesen, 2006). If the data follows a different distribution, results cannot be interpreted, and any conclusion might be misleading.

Those papers, among others such as Sarmidi et al. (2012), have all found that resource wealth negatively impacts financial development and economic progress. They agree that there is a minimum level of financial development to ensure growth, regardless of the abundance of resources in a country (Rajan and Zingales, 2003). An efficient banking system ensures effective resource allocation and accelerates production (Sarmidi et al., 2012).

This role is even more crucial when resources are abundant. This is explained through the shift of the production toward the booming sector at the expense of the lagging sector, which leads to higher demand for labour in the mining sector, disadvantaging not only the manufacturing sector but also the banking sector (Looney, 1991; Kutan and Wyzan, 2005). The resource curse can be even more prominent when the resource windfalls are high, and "the effect of investment to growth is marginal" (Sarmidi et al., 2012). This line of reasoning has been extensively investigated, and little attention has been paid to the interaction of the resource curse and the banking sector. Historical findings show how previous prices increase resulted in expanding the assets held by the resource-rich countries (Aizenman, 2008). Furthermore, uncertainty and instability are serious issues for resource-rich countries due to commodity prices volatility (Van Der Ploeg and Poelhekke, 2010). The problem arises when oil prices collapse later, and the government spending diminishes heavily due to lower revenues and reduced commodity tax income. The difficulty of reducing financial restrictions and diminishing institutional risk explains why countries with low financial development are rarely able to counter exchange rate appreciation due to higher commodity exports, as well as lower non-mining sector competitiveness (Larrain, 2004). Lastly, Nili and Rastad (2007) concluded that the resource curse is emphasised with low financial development and weaker financial institutions.

2.4 Data and methodology

A balanced panel dataset is examined, with a cross-sectional dimension of 90 countries and a time dimension of all years from 1970 to 2016. This remedies the issues introduced about the "lack of time-series based individual country studies" (Athukorala and Sen, 2002, cited in Ang and McKibbin, 2007). The list of countries includes both resource-rich and resource-scarce countries, and the classification is based on the share of total natural resources exports from total exports. It is well documented that some developing countries data suffer from some limitations, which was the case for the used data set. The list of the countries of this paper is presented in Appendix A. The database is collected through the IMF, the World Bank and the UN Comtrad unless stated otherwise.

To measure the resource endowment, two different measures are adopted, which follows a recommendation of Beck (2011) of using specific measures of natural resources richness. Different measures allowed for robustness analysis too. The period covered in this paper is characterised by the high volatility of commodity prices (Beck and

Poelhekke, 2017). As in Cavalcanti, Mohaddes and Raissi (2011), natural resources are measured through the total natural resources rents as a percentage of GDP; and through the adjusted savings from natural resources depletion as a percentage from GNI. The adjusted savings from natural resources depletion (% from GNI) are a measure of resource abundance. The measure comprises the sum of all net forest, energy and mineral depletion. Net forest depletion is defined as unit resource rents multiplied by the additional round wood produced over its natural growth. Energy and Mineral depletion are defined as the stock of energy/mineral resources divided by the outstanding reserves; and it included coal, crude oil and natural gas, and tin, gold, lead, zinc, iron, copper, nickel, silver, bauxite, and phosphate.

The total natural resources rents as a percentage of GDP is used as a measure for resource dependence. It is defined as the difference between the price and the average extraction cost of yielding it. It includes oil, gas, coal, bauxite, copper, lead, nickel, phosphate, tin, zinc, gold, silver, and iron ore. This measurement seems greatly important as it might help avoid endogeneity issues where windfalls might be due to higher production or reduction of the unit costs of production (Beck and Poelhekke, 2017; Bhattacharyya and Holder, 2013). Beck and Poelhekke (2017) argue that "by focusing on the price component in the resource change, we better control for endogeneity, as price changes are all but outside the control of individual countries". Resource revenues are principally subject to the remaining stock of natural resources and exogenous world prices. Whilst this variable can be exogenous, it might still be endogenous as it depends on GDP. It can thus be instrumented for it by using international commodity prices (Ibid.). The use of world prices is explained through the fact that their movements are unlikely to be affected by any country's internal economic conditions on its own in the list. Natural resources prices are a credible exogenous source of variations, as suggested by Ahmed (2012). As price changes are almost entirely outside of the control of particular countries, by concentrating on the price component of the resource change, we are better able to control for endogeneity. A different specification that could alleviate any endogeneity problems brought on by a mechanical effect (Bhattacharyya and Holder, 2014).Specifically, a rise in resource prices could further the GDP share of resources (or the GDP share of resource rents) while lowering the GDP share of private credit as a result of GDP growth. This can have a mechanically detrimental influence on the two variables. Additionally, nations that are financially stable are potentially more democratic (Beck and Poelhekke, 2017). The literature has employed a variety of indicators to gauge how much an economy depends on natural resources, from the proportion of natural resources that are exported to total exports to the significance of subsoil wealth to a nation's overall wealth and the size of enormous oil field discoveries. However, these indicators are based on endogenous factors such as exploration effort, technology, and extraction costs in addition to exogenous factors like exogenous geology (van der Ploeg and Poelhekke, 2010)

It also noted that the two conceptions of abundance and reliance are potentially connected: A country that enjoys abundant resources may profit greatly from their mining while also specialising in the mining primary exports and becoming reliant on them, whether as a result of the Dutch disease or for other reasons. However, some countries with an important resources endowment are not resource-dependent, while others with few resources are. According to Brunnschweiler and Bulte (2006), conventional regression analysis and models use RD as a proxy for RA although they are different: In fact, resource abundance impacts economic performance via three channels: directly as an asset that may be traded, and indirectly via resource dependence or institutional quality. Brunnschweiler Bulte (2006) also add that resource abundance is less prone to the policy endogeneity that impacts export-based metrics, less impacted by technical standards that affect output levels, and just moderately impacted by price changes as well as market conditions. This is a difficulty for any method used to put a "real" monetary value on natural resources wealthiness. Brunnschweiler and Bulte (2006) conclude that abundance echoes how some countries have a comparative advantage in primary industries, which is an important factor regardless of institutions and constitutions, according to the authors' findings. Besides, it is very probable that resource-rich nations have an export structure that is concentrated, which results in a smaller financial system size due to volatility and the high real interest rates that go along with it. Canada and the Republic of Congo are two great examples to emphasise the significance of the distinction between resource abundance and resource reliance. The two nations share roughly equal levels of natural resource endowment, with resource rents per capita in 2013 hovering at $1,200. However, Congo (42.3 %) had a considerably higher resource contribution to GDP than Canada (2.3 %). Despite having an abundance of natural resources, only Congo can be considered to be completely dependent on the resources. We hence use resource abundance even though such a measure may be subject to technology standards which influence production levels, a possible shortcoming of my measure of abundance. We hence use resource abundance even though such a measure may be subject to technology standards which influence production levels, a possible shortcoming of the measure of resource abundance.

To answer the question why do we expect the relationship between financial development and natural resources to be different for resource-abundant and resource-reliant countries, one refers to the example of Canada and Congo above: while both Canada and Congo enjoy a stock of natural resources, only Congo can be said to be actually reliant on on natural resources.

According to research by Lashitew Werker (2020), countries like the Congo have a more evident negative impact on institutions than other nations. This makes theoretical sense since countries with diversified economies are likely to have weaker political-economic channels through which resources obstruct institutional change. Resource rents, on the other hand, strengthen the power of the state in countries with less economic diversification, increasing its potential to exert political control through redistributive policies and substantial spending in security agencies. This finding explains why studies that employ resource abundance and resource dependency as alternative metrics of resources typically present disparate findings.

Given initial income levels, countries that start off with greater resource dependence will end up with relatively lower institutional quality, while this is not necessarily the case for countries that start with high levels of resource abundance. The indirect negative effect through institutions, therefore, is larger and negative for resource dependence. Between the two measures, Lashitew Werker (2020) also find that resource abundance leads to a more consistent direct positive effect on development outcomes. Given the initial income points, countries with higher levels of resource dependence will eventually have institutions of relatively worse quality, whereas those with higher initial levels of resource wealth may not necessarily experience this. Therefore, the adverse indirect effect through institutions is greater and detrimental to resource reliant countries. Lashitew Werker (2020) also discover that the abundance has a more consistent direct favourable impact on development outcomes compared to the reliance.

2.4.1 Financial development data

The paper uses an original, new broad-based dataset from the IMF by Svirydzenka (2016) that contains a financial development index. It is a comparative classification of countries based on yearly data of depth, access and efficiency of both specific financial markets and institutions as seen in Table 2.1. The dataset is recent and has not been extensively used yet. Those measurements are of great importance in the analysis, especially that the traditional measurements widely used such as the domestic credit to private sector (% of GDP) might fail in accounting for the complexity and the multi-dimensionality of the financial development process such aqs the depth and efficiency of the system (Svirydzenka, 2016). Moreover, Čihák et al. (2012) and Aizenman et al. (2015) argue that even it a financial system is large with a wide reach, its impact on economic growth is reduced, if any, when it is wasteful and inefficient. This explains the importance of accounting for access and efficiency as crucial aspects of financial development.

Financial Institutions	Financial Markets
Depth	
Private-sector credit to GDP Pension fund assets to GDP Mutual fund assets to GDP Insurance premium to GDP	Stock market capitalization to GDP Stocks traded to GDP International debt securities of government to GDP Total debt securities of financial corporations to to GDP Total debt securities of nonfinancial corporations to GDP
Access	
Bank branches per 100,000 adults ATMs per 100,000 adults	% of Market Capitalisation outside 10 largest companies Total debt issuers (domestic, external,non-financial and financial corporations)
Efficiency	
Net interest margin Lending-deposits spread Non-interest income to total income Overhead costs to total assets Return on assets Return on equity	Stock market turnover ratio (Stocks traded to capitalisation)

Table 2.1 Financial Development Indices (Svirydzenka, 2016)

As per Table 2.1, the financial development index is a combination of the size and liquidity of the markets representing depth, the ability to access various financial services representing access, and the "ability of institutions to provide financial services at low cost and with sustainable revenues, and the level of activity of capital markets" which represents efficiency (Svirydzenka, 2016). Alongside with Svirydzenka(2016)'s measurements, Appendix A comprises other standard indicators of financial development: the Private Credit to GDP, that measures total lending by financial to local firms and households, and Private credit by deposit money banks to GDP (%) . Other indicators are the Financial system deposits as percentage of GDP, Bank deposits to GDP (%), External loans and deposits, Deposit money banks' assets to GDP (%) and the Money and quasi money (M2) as % of GDP.

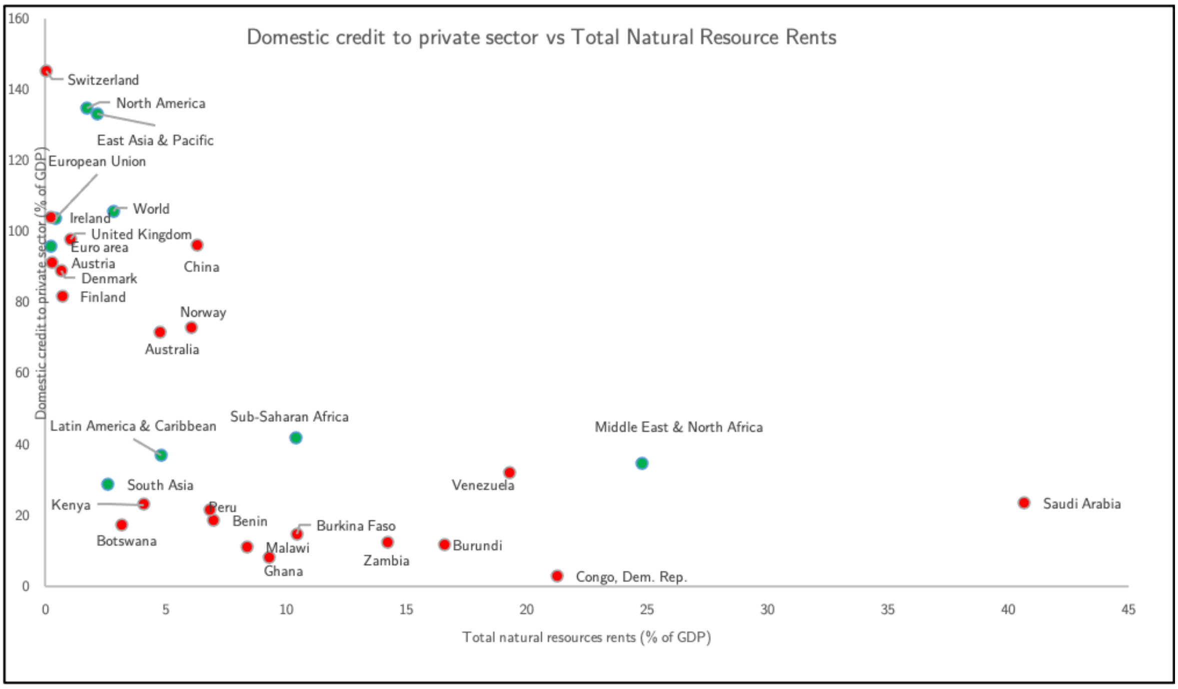

Fig. 2.2 Domestic Credit versus Resources Rent

Figure 2 shows how Domestic Credit provided by the financial sector[4] varies with total natural resources rent: Resource-rich countries such as Kenya, Ghana or Venezuela have low domestic credit, especially when compared with the resource-scarce countries such as Finland or Switzerland. Similarly, Figure 3 displays the relationship between financial development and the share of natural resources from total exports used to build the instrument. The negative relationship is the first remark to be made. The higher the share of natural resources from a country's exports, the less likely it is developed financially. Countries such as Venezuela, where natural resources exceed 80 % of total exports, have the lowest financial growth, where Japan, for instance with only 2.6 %, is one of the most developed countries worldwide

[4]includes all credit to various sectors on a gross basis, with the exception of credit to the central government, which is net. The financial sector includes monetary authorities and deposit money banks, as well as other financial corporations such as finance and leasing companies, money lenders, insurance corporations, pension funds, and foreign exchange companies.

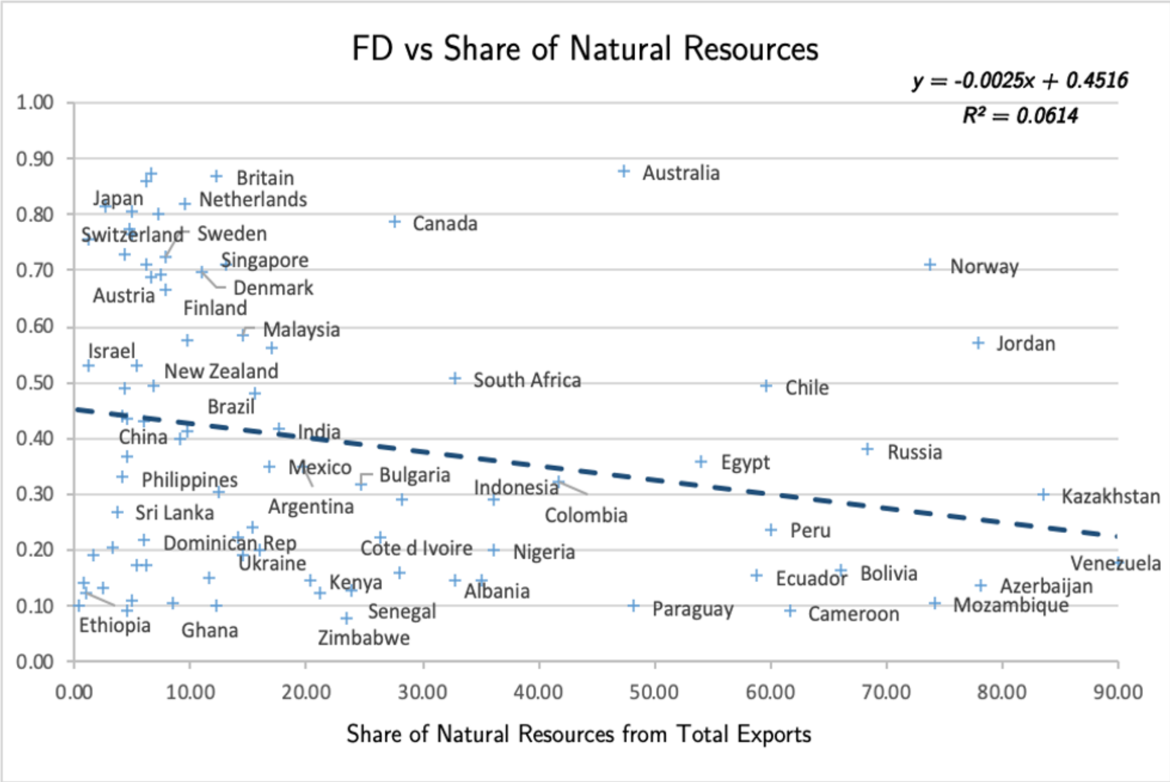

Fig. 2.3 Financial Development and Natural Resources (Share of Total Exports)

2.4.2 Financial liberalisation data

Two standard indicators of financial liberalisation have been extensively used in the literature. The first indicator is the foreign bank assets among total bank assets that shows overseas funds and investment. The second is the consolidated foreign claims of BIS reporting banks to GDP. According to Beck and Poelhekke (2017), historic findings have proved a correlation between resource revenues and deposits in offshore banks. Those indicators can be a proxy for the openness of the financial sector.

However, those indicators fail to account for restrictions on cross-border financial transactions, an issue that matters significantly for financial liberalisation. A paper by Ito and Chinn (2016) provides an index, the Chinn-Ito index, that measure the degree of capital account openness and the "openness in cross-border financial transactions".

Financial liberalisation in this paper is measured by the Chinn-Ito index that accounts for "regulatory controls of current or capital account transactions, the existence of multiple exchange rates and the requirements of surrendering export proceeds, based on the information from the IMF's Annual Report on Exchange Arrangements and Exchange Restrictions (AREAER)." (Chinn and Ito, 2007, 2008). Figure 4 displays the negative relationship between financial openness and the abundance of natural resources. While Hong-Kong and Germany have an index of one, most resource-rich countries have indices between zero and 0,3.

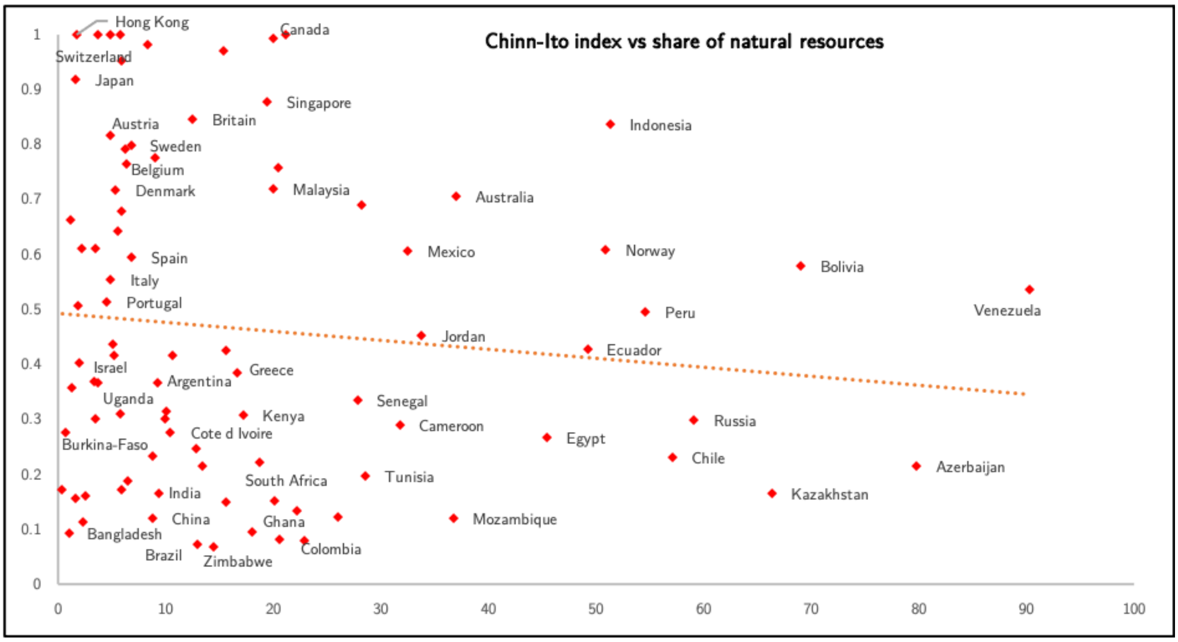

Fig. 2.4 Chinn-Ito Index versus share of natural resources of total exports

Lastly, the regressions reported in Appendix A use various macroeconomic indicators for each country, and consider yearly data of real interest rates, Consumer price indices, exchange rates, GDP per capita, all from the World Bank dataset. The paper also considers two institutional measures: The corruption indices from Transparency International (2018) and the Safety and Rule of Law index from the World Justice Project database (2018).

2.5 Financial Development, Liberalisation and Resource Curse

To assess the role of natural resources in 90 countries across the world, we first estimate the regression by OLS. Based on the discussion of Beck (2011) and following the study of (Shahbaz et al., 2018) and (Khan et al., 2020b) and Ali et al.(2022): FD is the development index, the explanatory variable are adjusted savings (AS) or resources rents (RR), economic growth as GDP per Capita and institutional quality:

	(1)	(2)
	FD	FD
AS	-0.0289	
	(0.0176)	
RR		-0.0159
		(0.0109)
Institutional Quality	0.067**	0.064**
	(0.027)	(0.026)
GDPC	5.7 e -18	5.8 e -18
	(5.03 e-18)	(5.06 e-18)
Cons	0.0019	0.006
	(0.066)	(0.068)
R^2	0.739	0.7377

Table 2.2 OLS Regression

The results show there is no statistical significance for all variables except for the institutional quality.

a Two-Stage linear regression is run with financial development as a function of natural resource endowment as follows:

$$FD = \alpha_2 \, Resources_{i,t} + \delta_i + \mu_t + \epsilon_{i,t} \tag{2.1}$$

The Two-Stage Least Squares use comes following the invalidity of the fixed effect and the OLS results due to the endogeneity issue. Generally, if a variable is endogenous, it is correlated with the disturbance term, therefore violating the OLS assumptions and making the OLS estimates biased.

One contribution of this paper resides in the instrumental variable built as a proxy for $Resources_{i,t}$, that is not correlated with $\epsilon_{i,t}$. This proxy is called $Reso\hat{u}rces_{i,t}$. The instrument is built on extensive data collected from the UN Comtrade: For every country and every year from 1973, the share of resources exports is collected depending on the nature of the resource they are exporting. This percentage of resource exports from total exports is multiplied by the world price of every resource. The instrument used can be seen as having two key characteristics: informative, as such being linked to the explanatory variables, and valid, that is being uncorrelated with the error term.

The instrument used is built as follows:

$$Instrument_{i_t} = \sum_{j=1}^{J} \omega_{i,j} \, P_{j,t} \tag{2.2}$$

where j is the natural resource (oil, gas, minerals), i stands for the i^{th} country and t the year from 1973 to 2015. $\omega_{i,j}$ is time-invariant and represents the $1xK$ vector average share of the natural resource j for each country i ($\sum_{j=1}^{J} \omega_{i,j} = 1$), and P_{jt} is a $Kx1$ vector of the natural resources j prices in period t.

This instrument has the characteristic of being both country and time specific, in the way that it differences between oil-rich, gas-rich countries and minerals-rich countries. It also considers the yearly features a country experiences as it is built based on data collected every year for the country i, and for every potential exported resource j during the period T. Natural resources prices are a credible exogenous source of variations, independent of any country's internal economic conditions on its own, as suggested by Ahmed (2012).

Borusyak, Hull and Jaravel (2020) outline cases where identification through exogenous shocks is appealing such as Autor et al. (2013)'s shift-share instrument, "based on a set of shocks which can itself be thought of as an instrument as per shift-share instrument, it combines industry-specific changes in Chinese import competition (the shocks) with local exposure given by the lagged industrial composition of U.S. regions (the exposure shares). " Borusyak, Hull and Jaravel (2020) present two sufficient conditions for the consistency of the Shift-Share IV. "First, the assumption that shocks are as-good-as-randomly assigned as if arising from a natural experiment. This is enough for the shift-share instrument to be valid: i.e., for the shocks to be uncorrelated with the relevant unobservable in expectation." For this first condition, we argue that resource prices variation is one of the components of the resource endowment change. Commodity prices have a well-defined positive relationship with natural resources rents and abundance as per Hansen and Gross (2018). Furthermore, variations in resource prices occur at the international market. In other words, countries do not have control over the price variations of their resource exports. This means that countries take their exported resource prices as given or exogenous. Beck and Poelhekke (2017) confirm that "by focusing on the price component in the resource change, we better control for endogeneity, as price changes are all but outside the control of individual countries". Secondly, The World Bank (2022) shows that a small number of shocks affect global commodity prices: " Global demand shocks have accounted for 50% of the variance of global commodity price growth, while global supply shocks have accounted for 20% of the variance", and these shocks do have an impact on the treatment, which supports the instrument relevance from Borusyak, Hull and Jaravel (2020)

As such, the instrument used can be considered as being informative and valid.

A common concern with the 2SLS might be that the standard errors are heteroskedastic and autocorrelation consistent. The common observable factors are uncorrelated with the explanatory variables, and the coefficient estimates from the panel are still consistent.

However, standard errors estimates of the covariance matrix estimation techniques will be biased, which means that the statistical inference built on such standard errors is invalid. Dependence might be the reason for such a pattern, notwithstanding the random selection of the cross-sectional units, and presuming no correlation of the residuals between groups of countries requires a spurious and unsuitable restriction on the model (Hoechle, 2007). Fortunately, Driscoll and Kraay (1998) propose a non-parametric covariance matrix estimator that produces heteroscedasticity consistent standard errors that are robust to broad forms of both spatial and temporal dependence. The solution from Driscoll and Kraay (1998) considers the serial correlation between residuals from the same individual in different time periods and the cross-serial correlation between distinct individuals in the various times and the cross-sectional correlation within the same period.

The relevance of the instrument is assessed through the validity of the instrument excluded from the second stage regression (used in the first stage) and is performed through the Sanderson-Windmeijer multivariate F test for the first stage regression, the Kleibergen-Paap rank statistic for weak identification, and the inference robust to weak identification test.[5].

Issues of weak identification appear as the excluded instrument only has a weak correlation with the endogenous variable. Weak identification leads to the estimators' poor performance, although some estimators display some robustness to weak instruments such as the Limited Information Maximum Likelihood compared to the IV (Stock and Yogo, 2005). The detection of the weak instrument is performed through the Sanderson-Windmeijer multivariate F test of excluded instruments.It is built by "partialling out" the linear projections of the outstanding endogenous regressors. The S-W test is built on a Wald test that follows a $\chi^2 (L_1 - K_1 + 1)$, with the tested null hypothesis being the under-identification of the specific endogenous regressor.

[5]See Appendix B

Table 2.3 displays the 2SLS results; a regression of the adjusted savings (columns 1 and 3) and regression of the resource rents (column 2 and 4) on the instrument as built-in (2). The rule of thumb of Staiger and Stock (1997) is 10, which indicates that the maximum bias in the instrument estimators is less than 10 per cent (Staiger and Stock, 1997): a statistic higher than 10 is considered thus reliable. In Table 2, all the F-statistics are significantly larger than this threshold, showing that our instrument is relevant and very strong.

Because Baum (2007) argues that this criterion does not necessarily determine the absence of a weak instruments problem, we further investigate the weak identification. The Cragg-Donald statistic cannot be used. In fact, the violation of the iid assumption for the error terms leads to a larger statistic, which might lead to type I errors (Kleibergen and Paap, 2006; Baum, Schaffer and Stillman, 2007). Instead, The Kleibergen-Paap rank statistic is used to check the instrument's relevance by checking its correlation with the endogenous regressors (i.e $Cov(X, Z) = 0$). Baum, Schaffer and Stillman (2007) argue that this test is a "sensible choice and clearly superior to the use of the Cragg-Donald statistic in the presence of heteroskedasticity, autocorrelation, or clustering". The test's distribution follows a $\chi^2\,(L_1 - K_1 + 1)$ distribution. The rejection of the null hypothesis implies an identified estimation with the full column rank matrix. Our results from Table 2.2 strongly reject the weakness of the instrument.

In addition, we assess the inference robustness through the Anderson-Rubin Wald test (1994) and the Stock-Wright (2000) LM S (GMM distance) test. Both tests whether the coefficients of the endogenous variables in the structural equation are jointly zero, and the overidentifying restrictions are valid. Specifically, the statistic has a $\chi^2(L_1)$ [6] and is comparable to an estimation of a reduced form equation with the whole set of instruments as regressors. The convergence holds regardless of whether the identification is strong or weak (Mikusheva, 2013).

[6] L_1 is the number of excluded instruments

	(1)	(2)	(3)	(4)
2nd Stage	FD $=\beta_1\ \hat{AS}^{*}$ -0.05445*** (0.003) $+\ \sigma_i + \mu_t + \epsilon$	FD$=\beta_2\ \hat{RR}^{**}$ -0.333*** (0.002) $+\ \sigma_i + \mu_t + \epsilon$	FLib$=\beta_3\ \hat{AS}^{*}$ -0.2324*** (0.0416) $+\ \sigma_i + \mu_t + \epsilon$	FLib $=\beta_4\ \hat{RR}^{**}$ -0.3514*** (0.101) $+\ \sigma_i + \mu_t + \epsilon$
F (1,1976)	32.32***	16.06***	32.32***	16.06***
K -P test	χ^2=46.13 ***	χ^2=13.92***	χ^2=46.13***	χ^2=13.92***
A -R Wald test	$\chi^2_1(AR)$=36.84***	$\chi^2_1(AR)$=73.83***	$\chi^2_1(AR)$=36.84***	$\chi^2_1(AR)$=73.83***
S- W statistic	$\chi^2_1(SW)$=29.39***	$\chi^2_1(SW)$=54.68***	$\chi^2_1(SW)$=29.39***	$\chi^2_1(SW)$=54.68***

$^{(*)}AdjustedSavings$
$^{(**)}ResourcesRent$

Table 2.3 2SLS results

The predicted values from the adjusted savings/resource rents become the independent variable in the second stage. The dependent variable is the financial development index for columns 1 and 2; and the Chinn-Ito liberalisation index of liberalisation for columns 3 and 4. The disturbances are clustered at the country and the year level.

The first stage results show a statistically significant positive relationship with the adjusted savings and the instrument, as well as the resource rent and the instrument. The second stage results show that the financial development index decreases with higher resource rents (3.3 %) and higher adjusted savings from natural resources, with a magnitude of 5.44 %. It also shows that the Chinn-Ito index (financial liberalisation) experiences a more significant drop by more than 0.35 (11.6 %) when associated with the resource rent and 0.23 (7.6 %) with the adjusted savings. Notably, the results show that both resource abundance and resource reliance have an adverse impact on financial liberalisation.

In terms of the instrument, we follow Ahmed (2012) in their argument that "an exogenous variation in the price of the natural resource export (a price determined in international markets) can provide a textbook-type exogenous variation". Given that commodity prices are determined in international markets, the results of this paper indicate a strong confirmation of the intuitive idea that commodity prices can provide plausible exogenous variation. The large commodity price volatility in the data (as pointed out by Mendoza (1995)) means that this exogenous variation is quantitatively large and can therefore provide substantial benefits in identifying plausible causal coefficients. Moreover, Hamilton and Clemens (1999) estimated international market prices for "crude oil, natural gas, coal, metals and minerals, and forest" to compute rent in their computation of adjusted net savings. We use their estimated international market prices of these commodities which is a weighted average of the individual prices with country specific production volume index as weights. While resource revenues will, in general, be contingent on many factors, such as transportation costs that is likely particularly high for non-coastal countries, we assume that the time variation in international market prices for commodities is a reasonably good instrument for the time variation in resource revenues (Bhattacharyya and Hodler, 2014).

One robustness check is to run the regression by excluding the countries for which the small economy assumption is less likely to hold. This is to assess the assumption that world prices of commodities are exogenous for countries that produce them. However, the dataset turned out too small to be used for any inference. Hence, we have dropped the countries where the share of oil, gas and mining is higher than 50% from the dataset, and we have rerun the regression

	(1) FD	(2) FD
AS	-0.0567*** (0.0039)	
RR		-0.0347*** (0.0024)
Country Fixed Effect	Yes	Yes
Year Fixed Effect	Yes	Yes
F	305.06***	305.06***

Table 2.4 2SLS - Only small exporters

The results show that the same relationship holds, and we can conclude that the instrument is a sensibly suitable instrument for the financial development index.

To explain this paper's results, one can refer to the transmission channels of commodity prices and revenues. Robust evidence has shown that the volatility of the resource prices has a role in making the financial sector fragile, which hinders its deepening. Kinda et al. (2016) in Mlachila and Ouedraogo (2017) concluded that it might even engender a financial crisis throughout the fall of government income and fiscal deficit and foreign currency debt. Moreover, resource prices volatility has been a reason for cutting banks liquidity and diminishing their profits, especially with the returns on both assets and equity. The rationale behind this reasoning can rely mainly on the uncertainty that characterises commodity prices, which raises the exposure of resource-rich economies

and lowers growth forecasts, impeding the financial sector's growth. This has been confirmed by Kurronen (2012) in Mlachila and Ouedraogo (2017). Older papers such as Bernanke (1983) and Kimball (1990) in Mlachila and Ouedraogo (2017) confirm that this price volatility lowers the domestic economy and leads to less domestic credit and bank deposits. The uncertainty translates into terms of trade vulnerability (Hattern-dorff, 2014). This is likely to result in higher risk premiums by banks, id est greater interest rates. In other words, credit and investments would decelerate. Empirical findings from Hatterndroff (2014) proved that “export concentration tend to weaken private credit to GDP” (Mlachila and Ouedraogo, 2017).
Those findings can also be justified through the way the commodity sector functions. Taking the mining firms as an example, those international enterprises mainly rely on internal finance for the transactions they run and accord less importance to the international financial market. The domestic banking sector loses its weight, which is one of the reasons why Beck (2010) concluded the existence of a resource curse on financial progress.

Lower financial liberalisation can also result from the accessible foreign capital to multinationals (Benigno and Fornato, 2013). Commodity windfalls cause higher consumption, and the production assets shifts to the commodity sector, which reduces productivity. This lessens any need for financial capitals from the domestic sector. Yuxiang and Chen (2001) found that a contracting manufacturing sector can hinder financial liberalisation where "the existence of a small tradable sector in turn also leads to less support for more liberal financial development policies." Another interesting point of view, financial repression can be linked to commodity windfalls management. In fact, countries that enjoy large income from exporting their commodities tend to use them to smooth consumption, a policy that reduces any incentives to strengthen the financial sector that can be a "buffer to smooth consumption over the business cycle" (Mlachila and Ouedraogo, 2017). The incentives to invest in the commodity sector are higher. As the country's growth relies heavily on the latter, the financial sector's resources are shifted to the booming commodity sector, which seems less appealing for investments. One last point, as mining firms are usually owned either by foreign investors or the government or both in joint ownership, it can be argued that high government investments in this sector weaken the private banking as well as the private loaning, and the scarcity of demand for wider financial services dampens the financial development.

Importantly, historical revelations and empirical findings revealed that one major problem in most developing resource-rich countries is their institutions' inadequacy and weakness, mainly for contract enforcement, as highlighted by Mlachila and Ouedraogo (2017). Contract enforcement is defined by the OECD (2019) as the "ability to make and enforce contracts and resolve disputes" for the financial sector to operate appropriately. Notably, contract enforcement's weakness leads to a reduction in the banks' lending (ibid.). The concern lies in the fact that banks do not have any insurance concerning the debt collection and the control of the guaranteed properties as a warranty to lock loans. This, plus the fact that cash is the most important base for financial transactions, induces a limitation of accessible funds needed for corporate growth, slackens trade, investment and economic development. Previous papers such as Bhattacharya and Hodler (2013) indicate that enforcing the national institutions and contract enforcement is crucial in financial development. In the absence of vigorous regulations, borrowers find it easy to escape payments and lenders, and banks have no warranty to get their money back, which prevents them from giving credits even though they have accessible liquidity.

More prominently, in an atmosphere with low regulations, government officials' risk of rent-seeking activities becomes more appealing, and corruption undertakings become easier. The subsequent non-competitive environment decreases any motivating forces for encouraging contract implementation. Yuxiang and Chen (2011) has concluded that the financial system's trustworthiness needs a reliable government, a feature that does not characterise the majority of sub-Saharan African countries. Notably, officials' rent-seeking activities have a negative impact on the economy by dampening the demand for credit by investors, which lowers aggregate domestic credit (Mlachila and Ouedraogo, 2017).

The last concern against financial reform/development is the weak human capital is prevalent in resource-rich African countries. Some might argue that the accessibility of the commodity windfalls prevents the youth from pursuing high education and seeking first-rate instructions. Sarmidi et al. (2012) and Yuxiang and Chen (2011) argued that this is one reason why institutions are weakened in those countries, especially that lower education has been associated with less awareness of the importance of contract enforcement linked to the low level of trust in governments.

2.6 Financial Reforms and Resource Abundance

Up to the 1980s, the financial sector was most likely the sector where the authorities interventions were most evident around the world (Abiad et al., 2010). Several countries were characterised by government control of banks, interest rates ceilings, and allocating credits was subject to numerous regulations and constraints. Moreover, the competition was hampered due to high entry barriers and restraints to foreign capital flow. Later, the financial sector liberalisation has become more prominent, alongside essential reforms (ibid.).

This section aims to assess the impact of reforms, mainly financial reforms when natural resources are abundant across the world, and to assess their interaction. This section uses an original database of financial reforms from the IMF by Abiad et al. (2010). This reforms data offers multi-dimensional indicators of financial reforms with respect to seven policies in the financial sector. For each policy in the Abiad et al. (2010) index, each country is given a graded score from 0 to 3 for each policy, where 0 represents the highest level of repression and 3 for complete liberalisation. This score varies yearly to mirror policy changes in a given year. The database allows to accurately determine the level and timing of different events in the financial liberalisation progression; hence, it can be used to assess those policies' effectiveness.

All traits of the financial reforms produce one index for total reform for each country every year (ibid.) and are defined as below:

-**Credit controls:** These involve control over bank lending to offer low-priced credit to the economy's prioritised sectors, such as the manufacturing and agricultural sectors. This is explained by government policies that use the banking system to direct financing to the investment projects highlighted by their development plans" (Ikhide, 1996) and finance its budget deficit. In Nigeria, for instance, credit control policies were based on individual and aggregate loan ceilings. The tight control of interest rates led to a monetary expansion but hindered capital markets' development (Central Bank of Nigeria, 2002). With high oil windfalls, the fast monetisation of foreign profits fast monetisation in government expenditures and Nigerian monetary instability (ibid.). In the eighties, when oil rents fell and could not meet demand, and due to the high expenditure, the government was obliged to borrow from the Central Bank to finance a massive deficit. Governments can set ceilings on the aggregate credit offered by banks or on loans to certain sectors. Moreover, authorities can require unreasonably elevated reserves, which is what happened in Argentina with the Deposit Nationalisation Law (1973) that obliged to meet a reserves' requirement of 100%. The Argentinian authorities required commercial banks to collect the deposits "only for the account and on behalf of the Central Bank" (Baliño, 1991) and to put all the deposits in the Argentinian Central Bank.

-**Interest rate control:** This is one of the most common practices in financially repressed countries and some developed countries such as the US (Regulation Q until the eighties). The authorities can determine lending and borrowing rates and place tightened ceilings and floors on banks. Thus, liberalised interest rates involve no floors or ceilings or bands exist.

-**Entry barriers:** When the government restricts entry to the banking system, credit allocation is controlled. New financial institutions find it hard to enter the market because of absolute constraints for foreign banks presence, as well as restraints of the activities range of banks and disproportional restricting licensing conditions.

-**Government ownership of banks:** This is the straightest practice of government control over credit allowance. The issue with the state ownership in the financial sector is that they harm the competition, charge lower interest rates than other competitors, higher loan loss provisions, and suffer from lower profitability than the private banks, which might be explained by the mixture of "policy mandates and operational inefficiencies" (Cull et al., 2017). State-owned banks usually favour lagged sectors such as the agricultural and manufacturing sectors.

-**Capital account restraints:** Constraints on global monetary transactions have been frequently enforced to allow the government to not only exert larger control over credit movements domestically but also have higher domination on the exchange rate. This policy aims to bound the movements of foreign capital and includes taxation, volume restrictions and regulation.

-**Prudential regulations and Banking supervisions:** One of the factors that led to the Asian crisis was the inadequate supervision and the lax regulations (Baszkiewicz, 2000), hence the importance of interventions from a supervisor institution to examine the financial functioning and different activities and transactions of the banks and guarantee that they follow the legislation. Importantly, the supervisor institution must be impartial and independent from political pressure and needs to cover all the domestic banks.

-**Security market policy:** related to the authorities' policies to either avert or promote the security market growth. It comprises governmental securities auctions, developing bonds and equities market and support its expansion through tax motivations or settlements systems. It also includes creating incentives for overseas investors and liberalising the security market.

This estimation's first stage represents a fixed effects regression of the adjusted savings from natural resources on the instrument. The second stage illustrates the regression of the reform (Table 2.6) or the reform's traits (Table 2.7) on the adjusted savings' predicted values from the first stage. The hypothesis is as follows: countries that enjoy natural resource abundance are the ones that suffer the most from low reforms effectiveness. This hypothesis can be assessed through the Abid et al. (2020) index that mirrors policy changes and accounts for different events' level and timing in the financial liberalisation progression. As explained in the aforementioned section, reasons vary between bad resource windfalls management, complete reliance on the resource rents activities, weak institutions and rent-seeking.

$$Reforms = \beta_1 \hat{AS} + \delta_i + \mu_t + \epsilon_t \tag{2.3}$$

σ_i represents the country fixed effect and μ_t the time effect.

Using the 2SLS estimation, it is clear that there is a negative relationship between the reforms' effectiveness and the abundance of natural resources. Looking at Table 2.6, one can conclude the existence of a negative relationship between the reforms and the adjusted savings from natural resources, a foreseen relationship, especially as following

Variable
Directed credit = Directed credit (DC) / Reserve Requirements
Credit ceilings = Aggregate Credit Ceilings (CC)
Credit controls = 0.75* DC +0.75* CC when CC is available, and as DC otherwise
Interest rate controls
Entry barriers/pro-competition measures
Banking Supervision
Privatisation
International capital flows
Security Markets
Financial Reform Index, normalized to be between 0 and 1
Resource Dummy for resource-rich countries across the world

Table 2.5 Financial Reform Data (Detragiache, Abiad and Tressel, 2008)

the analysis of the results from the first section. The results of Table 2.6 show that adjusted savings decrease the implementation of the reform[7] by 0.045 .

The postestimation analysis starts with the F statistic. As shown in Table 2.6, F is 16.43, higher than the threshold of 10, which signifies the instrument estimators are unbiased at the 10% level (Staiger ans Stock, 1997). Moreover, the K-P test rejects the under-identification. As the reform index used includes various traits of the financial reforms combined for each country every year, one might find it useful to investigate this negative relationship for each trait separately.

Moving to Table 2.7, Columns 1 to 4 in the table below are for interest rate control, security markets, entry barriers and financial reforms.

The results show that, on a scale from 0 to 3, the interest rates reform was hindered by 0.175 (5.8 %), security markets by 0.11 (3.6 %), entry barriers by 0.18 (6 %) and financial reforms by 0.0712 (2.3 %). All the coefficients estimated are statistically significant at the 90 % conventional level.

[7] Reform is an index between 0 and 3

1st Stage	Adjusted Savings = $\alpha_1\, Inst + \delta_i + \mu_t + \epsilon_t$ α_1 = 0.0833*** (0.0205474)
2nd Stage	Reforms = $\beta_1\, \hat{AS} + \delta_i + \mu_t + \epsilon_t$ -0.0457 ** (0.0211)
S - W F(1,1976)	16.43***
K-P Under id. test: Rank LM statistic	$\chi^2 = 7.73 ***$
Weak instrument robust inference: A-R Wald test S- W statistic	 $\chi^2_1(AR)$= 12.07*** $\chi^2_1(AR)$= 12.46***

Table 2.6 Reform and Resources - Fixed Effect

Among other reforms, all banking supervision, privatisation, and international capital control showed a negative relationship. However, the second stage's coefficients were not statistically significant.

We further examine those results and carry another assessment of the reforms' interaction between financial development and natural resources. The emphasis here is put on the relationship between natural resource abundance, financial development, and financial reforms. As in the previous section, Svirydzenka (2016)'s financial development index is a comparative classification of countries on the depth, access and efficiency of both specific financial markets and institutions. Reforms constitute various policies in the financial sector and acknowledge reversals such as the imposition of capital controls or interest rate controls. This follows:

$$FD = \alpha_1 \, Ref_{i,t} + \alpha_2 \, ResD_{i,t} + \alpha_3 \, Ref_{i,t} \, * \, ResD_{i,t} + \delta_i + \mu_t + \epsilon_{i,t} \tag{2.4}$$

with FD: Financial development index from Svirydzenka (2016);

δ_i being country fixed effect ;

$_t$ the year fixed effect;

$Ref_{i,t}$: The financial reform index, a combination of all 7 policies of Abid et al. (2010);

$ResD_{i,t}$: The Resource dummy that attributes 1 to a resource-rich country, 0 otherwise.

The variable's construction is based on the World Bank, Fragile, Conflict and Violence Group- the Investment Climate team. A resource-rich country is defined as a country with an average total natural resource rent of at least 10% of its GDP in the last three years. The model accounts for the country and the year fixed effect. Also, following Amissah et al. (2016), the standard errors are clustered at both time and country levels to deal with time serial autocorrelation. Table 2.8 shows the negativity and statistically significance of the $Policy{*}Rces$ coefficients. This means that a negative interaction exists between reforms and resource abundance.

As per the previous section, the dataset covers 90 countries and a time dimension of all years from 1970 to 2016. Fixed effects included are both the country fixed effect and the year fixed effect.

Using the coefficients α_2 and α_3 estimated in Table 2.8, Banking supervision reform increases the financial development index by 7.5 %, while it decreases it by 4.6 % when it interacts with the resource dummy, that is, when the country enjoys natural resource abundance. This means an overall increase of 2.9 % only. Likewise, and for credit control, the reform alone increases FD by 4.6 %, but it decreases by 7 %.

The reform for credit ceilings net impact is lower than 1 % when it interacts with the resource abundance compared to 8 % without the resources. Similarly, FD increases with privatisation by 4.6 %, interest rates by 3.5 % and international capital by more than 5 %; but it decreases when the reform interacts with the dummy by 4 %, 3,16 % and 3.6 %, respectively. Those results come in accordance with Amin and Djankov (2009), who found that moving from Swaziland, considered as the richest in their dataset, to Japan, considered as the poorest, is associated with a change in the likelihood of the reform by more than 44% which represents a significant impact especially the likelihood of the reform of the whole sample is around 57%.

	(1)	(2)	(3)	(4)
2nd Stage	InterestCont $=\beta_1 \hat{AS}$ -0.175*** (0.0658) $+ \sigma_i + \mu_t + \epsilon$	SecurityM$=\beta_2 \hat{AS}$ -0.1106*** (0.0483) $+ \sigma_i + \mu_t + \epsilon$	EntryBar$=\beta_3 \hat{AS}$ -0.179** (0.0664) $+ \sigma_i + \mu_t + \epsilon$	FinRef $=\beta_4 \hat{AS}$ -0.0712*** (0.03417) $+ \sigma_i + \mu_t + \epsilon$
S - W F (1,1976)	16.95***	16.95***	16.95***	16.95***
K-P test *	χ^2=7.99***	χ^2=7.99***	χ^2=7.99***	χ^2=7.99***
A-R Wald test** - S-W statistic**	$\chi^2_1(AR)$=3.68* $\chi^2_1(SW)$=3.79*	$\chi^2_1(AR)$=3.68* $\chi^2_1(SW)$=3.79*	$\chi^2_1(AR)$=3.68* $\chi^2_1(SW)$=3.79*	$\chi^2_1(AR)$=3.68* $\chi^2_1(SW)$=3.79*

* Under identification: Rank LM statistic

** Weak instrument-robust inference

Table 2.7 Reforms Traits and Resources

	(1)	(2)	(3)	(4)	(5)	(6)
FD	Banking Supervision	Credit Control	Credit Ceilings	Privatisation	Interest Rates Control	International Capital
Reform	0.0753***	0.0426***	0.0805***	0.0469***	0.0350***	0.051***
Rces Dummy				-		
$Policy * Rces$	-0.046***	-0.07***	-0.078***	-0.0403***	-0.0316***	-0.036***
F	37.57***	10.76***	8.89**	120.43***	10.21***	56.63***
Hansen J test	0.9056	0.8725	0.1669	0.4279	0.9797	0.802

Table 2.8 Interaction of Reforms Traits and Resources

In fact, the verdict from this section is that resource-rich countries generally have no incentive to implement and reinforce reforms in their countries. This follows a claim of Azour, the IMF's director for the department of the Middle East and Central Asia, who confirms that when the commodity world price increases, "the appetite for reform go down."

One conclusion from this set of results is that natural resources hinder financial development even when a country adopts some reforms. Three reasons can explain this claim. Firstly, resource-rich countries' governments do not rely on public taxation to finance their budget. They rather rely on the revenues brought in by the resource sector. This lowers the motivation to reform their fiscal system as they are less liable to the population, as highlighted in Karl (1997) and Moore (2000,2004). As such, Luciani (1987), cited in Amin and Djankov(2009), claimed that "rentier states do not need to formulate anything deserving the appellation of economic policy." Secondly, and as underlined previously, large money inflows from the natural resources represent an encouragement for corruption and rent-seeking activities (Yuxiang and Chen, 2011; Sarmidi et al., 2012; Mlachila and Ouedraogo, 2017). Lastly, it is argued that the considerable accumulation of wealth associated with the resource endowment is a reason for the social capital erosion, which hinders the implementation of reforms (Isham et al., 2002).

To conclude, it is important to highlight how finance is essential to growth, especially when it comes to countering the negative impact of the Dutch disease as well as exchange rate volatility in resource-rich countries. The development of the financial sector can play a crucial role in poverty alleviation and economic growth, especially that Beck (2010) argued that natural resource abundance 'can help over time". This claim is likely to be conditioned on the reinforcement of the Rule of Law and fighting corruption and rent-seeking activities, which will generate a premium on the financial sector in resource-rich countries.

2.7 Conclusion

The financial sector is essential in resource-rich countries as it is needed to smooth the flow of windfalls from the resource sector and ensure the funds are appropriately allocated and well invested in boosting the economy. The literature highlighted the decisive role of the banking sector in reducing the impact of the resource curse. The financial sector plays two key role: it lends the funds to the manufacturing sector to acquire raw materials, satisfy working capital needs; and is necessary for trade and international transfers through foreign exchange transactions.

This paper's importance arises from the importance of financial development on economic development related to the challenges induced by being a resource-rich country.

This paper has shown the existence of a resource curse in resource-rich countries. It follows the literature that found evidence that economic development and financial development are closely related and *vice versa*. It also showed that the existence of the resource hinders financial liberalisation. Moreover, this research found that financial reforms have a lower impact when associated with resource abundance. The reforms lower impact might represent a reason why resource-rich governments have low incentive to implement reforms.

The effective implementation of reforms could play an important role in alleviating the effect of commodity price volatility and decreasing its negative impact not only on financial development but also on macroeconomic stability. This can be achieved by establishing a sovereign wealth fund, for instance, that can act as a fiscal buffer. Lastly, it is important to highlight the role of good governance, democracy and transparency in law enforcement related to the financial sector and the misallocation of resources revenues. Future research can focus on ways to enhance financial development in a resource-rich country and how to make the reforms more effective in those economies.

Chapter 3

Can a Sovereign Wealth Fund cure the Dutch Disease? A model with extraction and depletion of Iron Ore

tablefootnote

3.1 Abstract

This paper investigates the importance of a sovereign wealth fund in an economy with natural resources abundance. It focuses on a developed country, Australia, and its topic is chosen due to the Dutch disease's significant paradox. Although theory supports the role of natural resources in promoting economic development, several studies have shown evidence of the resource curse. A sovereign wealth fund has been adopted as a solution to the latter and proved its efficiency as in the Norwegian case against the movement effect and the spending effect of the resources' endowment. This paper builds on an original Dynamic Stochastic General Equilibrium (DSGE) model with endogenous natural resources, including exploration and depletion, which are uncommon features in most small resource-rich open economies models. It evaluates the impact of implementing such a fund, as achieved in Norway, in enhancing the Australian economy. It also investigates the impact of different tax policies, namely an ad-valorem royalty, a resource rent tax and a reserve tax, to be used with the sovereign fund to limit the Dutch Disease impact. Results show that a resource-based sovereign wealth fund has a significant impact on stabilising key macroeconomic variables' responses following a commodity price shock. Regarding the optimal tax regime rule, findings show that government should adjust taxes according to commodity prices and opt for an ad-valorem royalty (revenue tax) in contrast with a resources tax or a rent tax.

3.2 Introduction

Notwithstanding the theoretical appeal of the importance of natural resources in economic growth, the literature has shed light on what is called the resource curse that consists of the low growth of resource-rich countries. As shown in the literature review, the empirical findings confirmed the challenges of being a resource-rich country. Historical evidence identified several reasons for this curse, with the commodities prices' volatility being the most significant. In fact, high revenues resulting from increasing commodity prices overcome the commodity sector and penalise the other sectors of the economy, whereas a decrease in oil prices leads to a drop in the country's revenues and a shrinkage of the economy. Those symptoms are known as the Dutch Disease.

The term Dutch Disease has first been coined by the Economist (1977) when a link between the Dutch currency's appreciation and the discovery of natural resources in the Dutch territory has been made. This appreciation has rendered the Dutch manufacturing less competitive, and ever since, the term Dutch Disease has been extensively used to refer to the associations between slow growth rates in manufacturing, increased exchange rates and resource specialisation (Beine, Bos, and Coulombe 2009; Krugman 1987). A large body of the literature attempted to analyse potential solutions to cure this disease through monetary policies, fiscal policies and, importantly, the Norwegian cure: the sovereign wealth fund. This paper addresses the question of the effectiveness of a sovereign wealth fund against the Dutch Disease. Cavalcanti et al. (2011)' policy implications showed that a sovereign wealth fund, among others, is an effective solution to offset the negative impact of commodity prices' volatility.

Das et al. (2010) found that the SWF allows the increase of the public financial assets' returns, hence creating room for an increase in government spending, a decrease in taxes and improved sustainability of public finances. Similarly, Steigum (2013) argues that a SWF can be an instrument that assists authorities directly or indirectly in achieving the three targets: economic sustainability, macroeconomic stabilisation and income distribution. The IMF follows by asserting that SWFs can potentially impact the fiscal policy, where it facilitates its stabilisation "and the saving of fiscal resources for long-term purposes" (El-Baz, 2018). The SWF allows the budget expenditure to rely less on the availability of resources revenues, which proved veracious in Kuwait, Alaska State in the USA, and Norway (Fasano, 2000 cited in El-Baz, 2018).

This paper contributes to the three strands of the literature: it adds to the literature of the Dutch Disease, and the negative impact natural resources can have on economic growth (Bulte, Damania and Deacon, 2004; Collier, 2007; Ilmi, 2007; Benkhodja, 2014). It also contributes to the literature that investigates the importance of Sovereign Wealth funds and their management. We contribute to this empirically by exploring the different tax regimes that should be adopted for the fund. Different taxes regimes have been considered in natural resources literature (Yücel, 1989; Deacon, 1993 and Boadway and Keen, 2015). Another strand to which the paper adds uses the framework of estimated DSGE models to investigate the impact of shocks in driving economic fluctuations (Adolfson et al., 2007; Bergholt et al., 2017). The Australian dependence on natural resources revenues is characterised by its extreme uncertainty on one side and the fact that the natural resources are non-renewable. In fact, Australia has Aluminium as the largest share of its exports (18.5 %), but also Natural Gas (6.6 %), Gold (4.6 %) and, with a smaller share, crude petroleum (1.4 %) (Australian Department of Foreign Affairs and Trade, 2019). The 2009's commodity price boom resulted in expanding the assets held by the resource-rich countries, where governments either rule the resource sector or impose taxes on private commodity firms' revenues. Previous prices increase led to the shrinkage of domestic competitiveness and a significant currency appreciation (Aizenman, 2008). This is what happened in 1973 when the sharp surge in oil prices led to a substantial rise in oil-rich governmental spending. The problem emerged when oil prices collapsed few years later, and the government spending heavily diminished with lower revenues and dampened commodity tax income. This uncertainty induced by commodity price volatility can be limited when adopting a SWF and saving a portion of the revenues to ensure sustainable and lasting financial flows. The SWF acts as a stabiliser and functions as an instrument that converts the public exposure to oil price volatility into a diversified and more stable risk. This protects future generations' income (Aizenman, 2008).

The main intuition behind this paper emerges from the fact that fiscal policy in resource-dependent countries tends to be procyclical as per Figure 1 below:

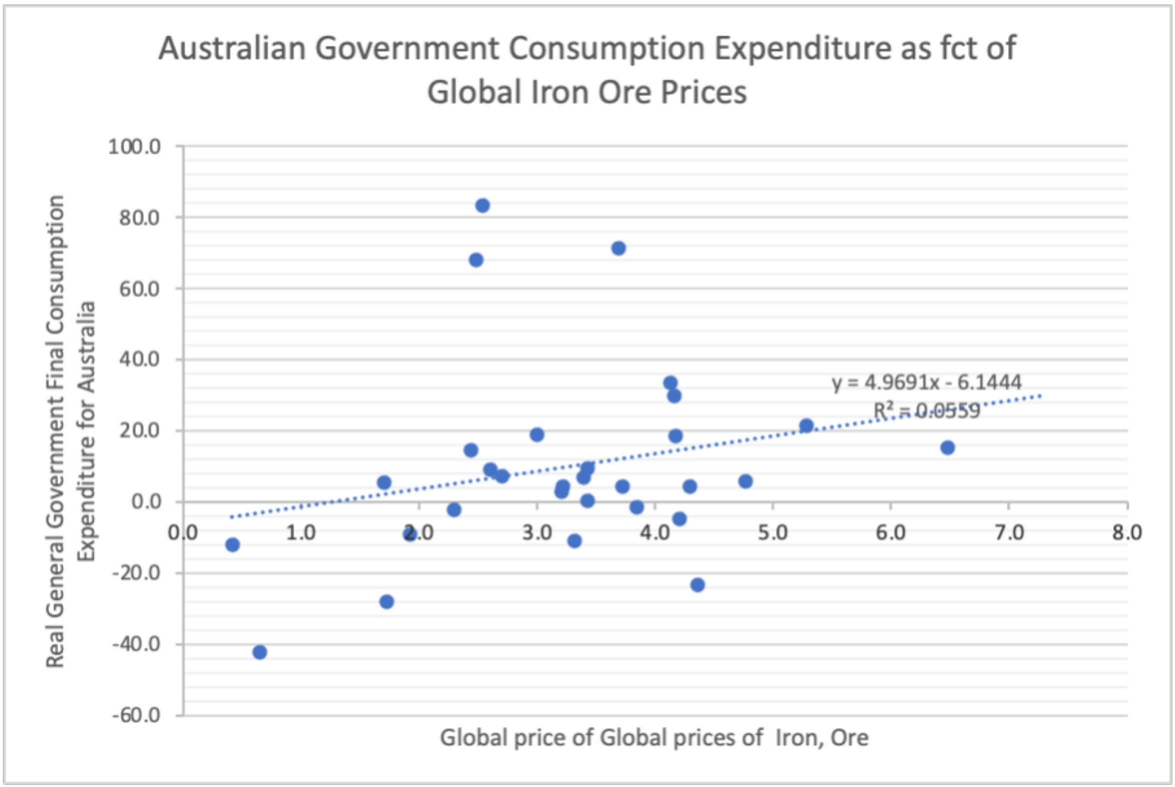

Fig. 3.1 Australian Government Consumption Expenditure vs Global Iron Ore Prices

It shows the positive relationship between the two variables and reveals that real government consumption in Australia tends to significantly rise (fall) in good (bad) times. To be specific, the government magnifies the business cycle by adopting an expansionary fiscal policy at times when the economy is good, and contractionary during recessions or when the economy is facing a downturn. For example, the increase in government consumption in good times tends to exceed the increase in GDP, and conversely the drop in bad times tends to exceed the fall in GDP. Operating a sovereign wealth fund can help limit fiscal policy procyclicality in some instances, while we find no such evidence for fiscal rules. Several research such as Bjornland and Thorsrud (2019) and Mohaddes and Raissi (2017) indicate that fiscal policy rules may not be very effective in limiting fiscal procyclicality. Operating a SWF seems to better achieve this goal as fiscal policy rules might not be as effective in limiting fiscal procyclicality in resource- dependent countries. This is consistent with other studies that find evidence that fiscal rules can be easily circumvented and are not effective in restricting fiscal procyclicality ex-post (Beetsma and Giuliodori, 2010). Through the withdrawal of some of the resource windfall from the budgetary process, stabilisation and savings funds can lower government expenditure procyclicality straightforwardly. Its regulations can also incite larger borrowing from a government that is not credit restricted. The threshold price, or revenue, that initiates accumulation has also changed in several nations, circumventing strict accumulation regulations. According to Ossowski et al. (2008) this has been the case in Norway's SWF, which collects the net central government income from the oil industry and transfers the funds required to finance the non-oil deficit to the budget, with all spending decisions being made within the budgetary process, and the fund run within stringent transparency and accountability provisions.

Importantly, results show that the Australian economy's response without the Sovereign Wealth Fund is highly volatile compared to the one with the fund. The fund has a significant impact on enhancing macroeconomic stability following a commodity price shock.

The remainder of this paper is organised as follows: the next section explores a small open economy model, including exploration and extraction, with a sovereign wealth fund, after which the results of its effectiveness are elaborated. This is followed by an investigation of optimal taxation rule and concluding remarks. Finally, a welfare analysis, as well as a sensitivity analysis, are presented.

3.3 Literature Review

Among the first studies focusing on this issue, Gelb (1988) analysed six rich oil-exporting countries that launched significant investment projects between 1975 and 1978; and found that the non-oil sector witnessed a growth followed by lower performance after 1978. He concluded that there was a temporary impact of these natural resources on the economy. Specifically, Sachs and Warner (1999; 2001) and Larsen (2004) confirmed the negative relationship between natural resources endowment and economic development, as did Van Der Ploeg (2009) and Satti et al. (2014). Similarly, Eifert, Gelb and Borje (2002) claimed that the natural resources revenues management is a serious concern for resource-rich countries. Several papers pointed out reasons for this curse, namely the poor management of public investment and the lack of control of debt level, but importantly the volatility of the commodities prices (Manzano and Rigobon, 2007; Berg et al., 2013; Melina, Yang and Zanna, 2016) as shown in Figure 1. According to Cavalcanti et al. (2011), commodity prices' volatility negatively impacts economic growth by lowering the accumulated physical capital, which offset any positive effect related to the booms and the revenues from the commodity exports. Their paper concluded that the resource richness per se is not the issue but the volatility that drives the "curse".

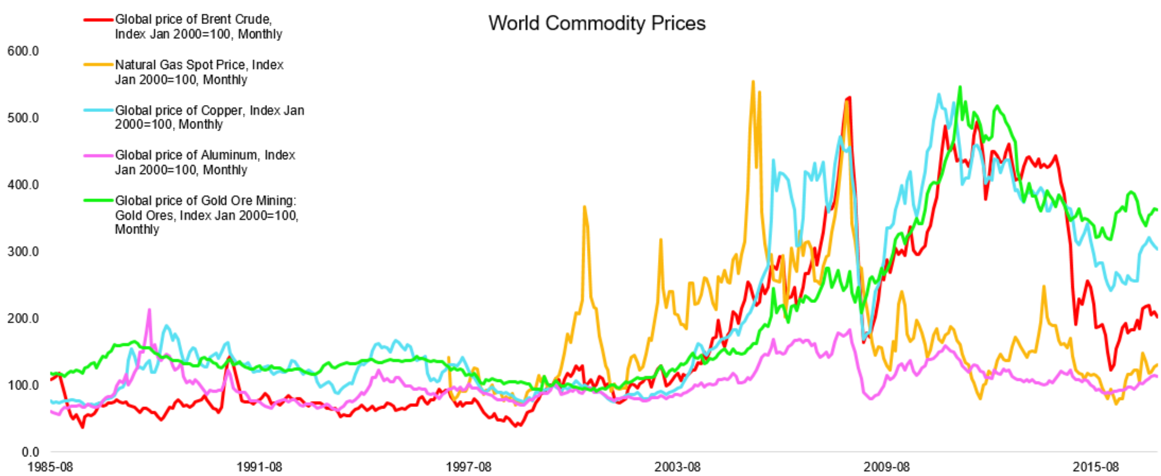

Fig. 3.2 Volatility of World Commodity Prices

Collier (2007a) showed that the resource curse causes the Dutch Disease, consisting of the decline of primary products trade and the deficiency in enhancing the manufacturing area, as defined by Bulte, Damania and Deacon (2004). According to Ilmi (2007), Dutch disease is a major reason why economic growth is weak in resource-rich countries, resulting in limited competitiveness in different sectors. Conformingly, Lartey (2008), Acosta et al. (2009) and Batte et al. (2009) (cited in Benkhodja, 2014) evaluated the "windfall shocks" in small open economies and confirmed the previous outcomes. However, those papers analysed the impact of a windfall shock, that is, a resource increase following the discovery of new reserves, but the boom shock, i.e. an increase in commodity prices, remained unanalysed, as highlighted by Benkhodja (2014). Solomon (2011) studied the Nigerian economy, and Ruiz (2016) the Colombian economy. They highlighted the impact of the Dutch disease illustrated by the decrease in production and employment. Hence, the local small and medium private firms, as well as the public sector, face issues with keeping the jobs due to the contraction of the economy.

One issue with the previous papers is the assumption of exogeneity of the commodity world prices, a gap this paper will try to fill. Van Der Ploeg (2011) considers that macroeconomic models fail in analysing the association of commodity prices and macroeconomic volatility because prices are fixed.This is also supported by empirical findings showing the high correlation between reserves evolution and prices changes (Hansen and Gross, 2018). Moreover, when commodity prices are held fix, that is exogenous to the economy, results show a small correlation with exchange rates, compared to 50 per cent on average when prices are endogenous (ibid.). Hansen and Gross concluded that the exogeneity of commodity price might be the reason why Fornerno et al. (2014) failed to spot Dutch Disease symptoms in their models. The former confirmed that exploration and depletion are decisive in depicting the transmission of commodity price shocks. As such, the incorporation of exploration and depletion improves the depiction of the transmission channels of the commodity price changes. In fact, mining firms have higher incentives to dig for new reserves when there is an increase in commodity prices, and even if the explorations are not fruitful, data shows that, on average, firms could find new reserves.

The sensitivity section of this paper investigates this through a model with fixed resources, and the findings are similar to the conclusion regarding Fornerno et al. (2014) research. This has also been studied in the literature, such as Livernois and Uhler (1987), Cairns (1990), Devarajan and Fisher (1982) and Halvorsen and Layton (2015). They found that because mining firms consider that neither resources nor extraction would last forever, reserves and extraction are significant in adjusting prices when the firms set their best possible decisions for their feasible sets of production. Mining firms explore more as the commodity price goes up, and the new reserves explored lead to a durable development of the feasible production set. This shows how complementary extraction, investment and prices are: a boost of the mining sector with a commodity price rise and a rise in commodity prices increases explorations and investment. This feature can be modelled through the endogenous model that assumes that commodity prices vary with exploration and investment. This complementary cannot be be modelled when commodity prices are held fixed as prices and exploration or prices and reserves are not assumed to be correlated. Those patterns have been confirmed by Anderson et al. (2014), and are highlighted in the sensitivity section of the paper.

Moving to potential solutions to the Dutch disease, Ojeda, Parra-Polania and Vargas (2014) explored the effect of a boom on the major macroeconomic variables such as consumption, exchange rates, but they focused only on the fiscal policy. Hence, it seems clear that governmental policy intervention is a critical tool aiming to stabilise the economy and manage natural resources' revenues. Accordingly, Orrego and Vega (2014) found that the Dutch disease can be offset with a counter-cyclical fiscal rule in addition to an increase in households' welfare when compared to a pro-cyclical fiscal rule. Jointly, Stanford (2012) suggested re-establishing the tax on corporations' revenues on oil production, adopting monetary reforms for the sustainability of the currency's value, and enhancing the government's fiscal involvement in investments to increase the Canadian government income.

Regarding optimal taxation, different taxes regimes have been considered in natural resources literature, such as Yücel (1989), Deacon (1993) and Boadway and Keen (2015). Most of the resource-rich countries have started adjusting reforms change of their resource sector in recent decades. Norway and the United Kingdom have been known for adopting resource rent taxes, whilst Australia, Canada and the United States have opted for a tax per unit of revenue. (Otto et al., 2006). A combination of those two taxes has been used across different jurisdictions. The third tax analysed in this paper is the reserves value tax, which seems uncommon among those developed countries. The majority of resources-rich countries adopted several varieties of royalty on their resource sector(Otto et al., 2006), and some, like Chile, South Africa and Zimbabwe, started the implementation of such tax. The Chilean experience is illustrated through the collection of "Special Mining Income Tax" (Bambac and Pulgar, 2020). The special tax is based on the aggregate operational revenues from the mining activities, with a special rate that depends on the annual sales. South Africa passed a royalty bill in 2003, where the rate is based on profitability, earnings before interests on loans and taxes (Otto et al., 2006). This allows them to take advantages of the high profits mining firms to make with higher prices (ibid.).

On the other hand, according to Aliyev (2012), monetary policy decision plays a crucial role in economic growth. For instance, less vulnerability to shocks was noticed under a fixed exchange rate regime than price level target, which is explained by a smoother consumption and avoidance of Dutch disease. Nevertheless, his model lacks the inclusion of hybrid rules, which might ameliorate the findings from both the fiscal and monetary angles. Those three monetary options were taken into consideration by Batini, Levine and Pearlman (2009, namely the fixed exchange rate regime, the "inflation targets under a fully flexible exchange rate", and the managed float. They showed that adopting an optimal fiscal policy as well as monetary policy would provide better sustainability compared to an optimal monetary policy only, which suggests the indicative role of adopting both optimal policies together. The paper recommended a larger number of countries to analyse.

Notably, it seems that Norway, Indonesia and Canada escaped from the Dutch disease due to the policies implemented. A study by Gurbanov and Merkel (2010) showed that Norway and Indonesia have a favourable economic performance through the control of the resource movement, the spending and the exchange rate. For instance, the Indonesian government froze the short-term market borrowings and relied on the "inter-temporal" distribution of oil revenues, with an aggregated budget surplus (ibid.). Lastly, Collier et al. (2009) suggested that strict fiscal policy and spending policy, as well as encouraging domestic investments, would be useful in avoiding the Dutch Disease. He also suggested that saving a portion of the resource revenue is a solution that seemed appealing to Norway, which opted for a sovereign wealth fund to manage her oil revenues. Cavalcanti et al. (2011)' policy implications showed that sovereign wealth funds, among others, are an effective solution to offset the negative impact of commodity prices' volatility.

Norway could limit the Dutch Disease symptoms thanks to its sovereign wealth fund, the Government Pension Fund Global (GPFC). A sovereign wealth fund is an investment fund owned by the government, usually based on payments or fiscal surpluses or governmental transactions, for instance, but importantly revenues from natural resources exports (SWFI, 2019). Three categories of SWF exist, namely stabilisation, savings, and financing. Funds that aim the stabilisation are defined by a price- or revenue-reliant deposit and/or withdrawal rules (such as Algeria, Russia, Mexico, and Venezuela). Saving funds are funds where a pre-determined part of total revenues is accumulated in the fund (such Equatorial Guinea's Fund for Future Generations and Kuwait). Additionally, financing funds are funds for which the accumulation rule is directly linked to the budget's non-oil deficit (Norway).

The Norwegian strategy is illustrated through a fixed equity share of 60 per cent, a fixed income allocation of 35 per cent and real estate assets representing the remaining 5 per cent of the SWF's worth (Steigum, 2013). This allowed the country to hold a diversified portfolio through international investment in different sectors and gain higher returns compared to the foreign exchange reserves. The fund was, therefore, able to protect and steady the government budget, as well as the domestic economy despite high commodity prices volatility, and therefore revenue volatility. It ensured sustainable long-term capital growth for governmental needed targets. A noteworthy observation, guidelines for fiscal policy in Norway are defined with reference to the government's target spending of their oil revenues. On the contrary, the Swedish fiscal guidelines are set as to the fiscal surplus.

Table 1 shows a list of some of the world's largest sovereign funds by November 2018.

Although a sovereign wealth fund is not a direct macroeconomic policy, it engages in transferring some capital to the government budget and stabilising the domestic economy. Accordingly, Norway considered the oil incomes saving in a sovereign wealth fund to instigate sustained economic development and growth and implement a strict fiscal policy (Larsen, 2004; Holden 2013).

This paper is interested in the funds that built their origin of wealth from the natural resources revenues only. Steigum (2013) argues that the principal goal of the SWF is to prevent disproportionate and unsustainable government spending of the resource revenues, which might destroy the competitiveness of tradables and provoke

Country	Name	Assets in Billion USD	Origins
Norway	Government Pension Fund - Global	1058.05	Natural resources
China	China Investment Corporation	941.4	Non-commodity
UAE	Abu Dhabi Investment Authority	683	Natural resources
Kuwait	Kuwait Investment Authority	532	Natural resources
China	Hong-Kong Monetary Authority Investment Portfolio	522.6	Non-commodity
Saudi Arabia	SAMA Foreign holdings	515.6	Natural resources
China	SAFE and Investment Company	441	Non-commodity
Singapore	Government of Singapore Investment Corporation	390	Non-commodity
Qatar	Qatar Investment Authority	320	Natural resources

Table 3.1 Largest SWFs in the World - SWF Institute (2018)

macroeconomic instability led by oil price volatility. The other rationale of SWFs is to be the "future generations fund". The majority of OECD countries are characterised by increasing government spending as their population is ageing. This represents a justification for the establishment of a national saving fund, as the government spends "less than the permanent income per capita from the total wealth being the sum of the estimated resource wealth and the fund's wealth "(ibid.). Cleary (2011) and Corden (2012) consider the "argument for prudence" where sovereign wealth funds are national savings that allow the government to anticipate the end of the oil boom. In other words, and going back to the Norwegian example, the fund has clear goals: stabilising the oil revenues and save them for the future through international investment to minimise the currency appreciation by reducing large foreign inflows, as well as managing government expenditures (Parkinson, 2011). Hence, the SWF represents a shock buffer that creates little correlation between the resources revenues and their spending over time.

A last comment regarding the effectiveness of SWFs, Das et al. (2010) argued that the fund's operational guidelines need to be coherent with the fiscal policy and allow flexibility to face the economic uncertainty. Evidence shows that various resource-based Funds with inflexible rules had to adjust, neglect or even eliminate them following exogenous shocks or spending pressures. Moreover, they argued that funds should enjoy limited ability, nay no ability at all, to spend the revenues directly. Transparency is crucial to ensure efficiency in resource allocation. This should also hold potential direct interference in the domestic economy, where the government should be the intermediate for any transfers needed. The Norwegian approach proved effective, and this is due to the reinforcement of their assets stock and complement the government budget through the earnings and conserving the principal for the long term. Ultimately, Norway collects oil extraction returns to ensure the resources revenues can adequately support enough earnings for future generations.

3.4 The DSGE Model

The model in this paper introduces a sovereign wealth fund to the model of Hansen and Gross' (2018). The paper's main contribution is to assess the importance of a resource-based sovereign wealth fund for Australia and evaluate the impact of implementing such a Norwegian style fund to enhance the Australian economy.

The model includes a manufacturing sector, a non-tradable sector, imports and mining sector. Mining resources are not renewable and considered inexhaustible with costlier extraction. This means that when a reserve is almost depleted, mining firms needs to increase extraction to find new reserves. The mining sector is perfectly competitive (the standard literature modelling of the resource sector for a SCE typically assumes perfect competition, i.e Basu et al., 2013 ; Langcake and Robinson, 2013 among others), with foreign capital and domestic labour. Those are key features of commodity-exporting economies (Connolly and Orsmond, 2011).

Australia is considered a small open economy based on the assumption that its resource sector does not impact Iron Ore world prices. It participates in international trade but is considered small enough compared to the rest of the world as its trading partner.

As the reserves of Iron Ore are considered endogenous in the model (determined by its interaction with other model variables i.e mining firms decision to extract), firms can access a "costly exploration technology that is a convex function of the level of exploration undertaken and the economy-wide (aggregate) stock of natural resource reserves" (Hansen and Gross, 2018). Mining companies also take depletion into consideration, an issue that does not exist when the reserves are exogenous, thus held constant over time.

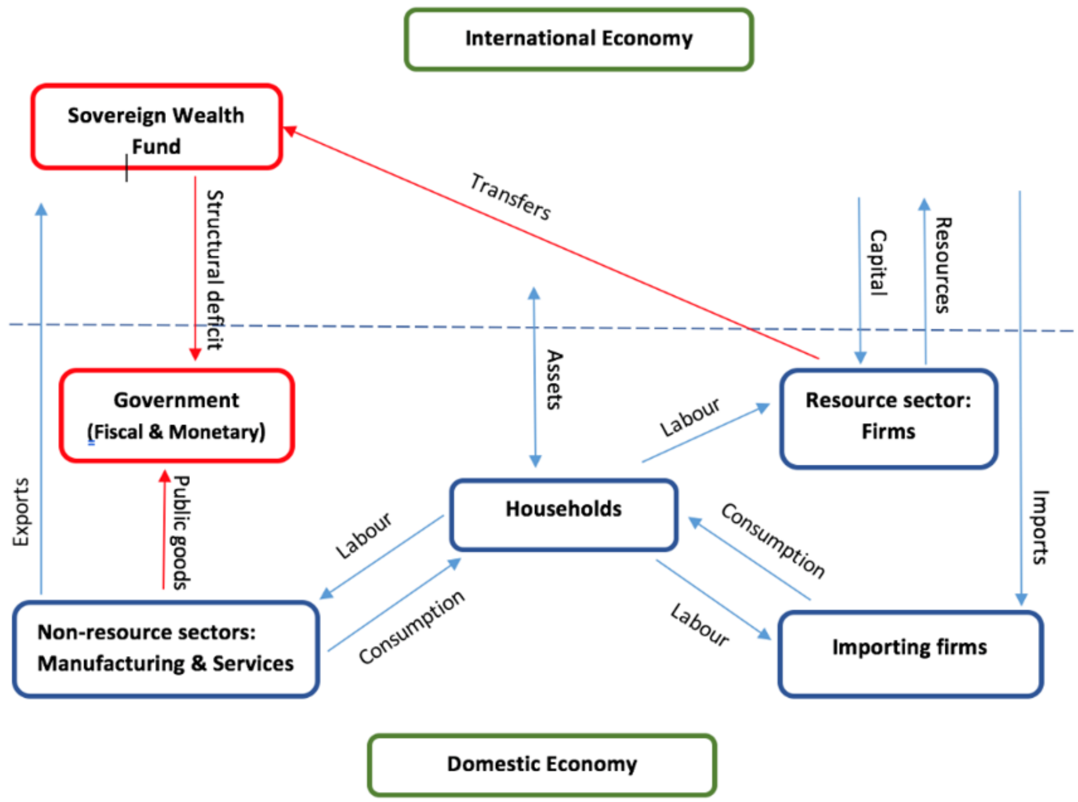

Fig. 3.3 A bird's eye view of the economy's model

The only frictions in the model are price frictions a la Calvo in order to capture the commodity price shock dynamics, following Adolfson et al. (2007). Each period, a fraction (1-Θ_n) of domestic firms can adjust their prices. Other firms are unable to reset prices. Their optimal adjusted price maximises the expected discounted value of their profits, with β being the discount rate.

The other sectors of the economy are characterised by a continuum of firms, monopolistically competitive with Calvo pricing rigidities. Households consume and supply labour optimally, with nominal wage rigidity associated with the optimal wage choice. There is an endogenous risk on foreign borrowing, and financial markets are incomplete.

Variable		Variable	
d_t	New discoveries	$C(d_t \tilde{R}_t)$	Costs of exploration
x_t	Resource extraction	r_t	Level of reserves
$h_{m\,t}$	Resource labour	k_t	Resource capital
I^{nv}	Resource investment	c_t^*	Foreign demand
ω	Foreign ownership of mining firms	ϵ_{M_t}	cost-push cost
ϕ_{mc}	Cost sensitivity - exploration	Ω	Exploration activities fixed costs.
t_t	Households tax	dj	Households external habit
ϕ_t	domestic borrowings' premium	q_{rt}	Marginal value of additional reserves
$c_{x\,t}$	Non-resource exports	y_t	Non-mining production
h_t	Non-traded labour	$c_{o\,t}$	Consumption of imports
$c_{n\,t}$	Consumption of non-traded	$w_{m\,t}$	Real mining wages
$A_{n_t}^a$	Technical labour change	$\tilde{R}_t$	Aggregate level of reserve
w_t	Real wages (non-mining)	$p^*x\,t$	Optimal export price
$\bar{p}_{n\,t}$	Optimal non-traded price	$\bar{p}_{o\,t}$	Optimal import price
$\pi_{n\,t}$	Non-traded inflation	$\pi^*{}_{n\,t}$	foreign inflation
$\pi_{o\,t}$	Import price inflation	$\pi_{c\,t}$	Consumer price inflation
i_t	Domestic interest rate	χ_t	Real exchange rate
$\Pi_{z\,t}$	Real mining profit	$\Pi_{n\,t}$	Real non-traded profits
$\Pi_{x\,t}$	Real export profits	$\Pi_{o\,t}$	Real import profit
Θ_t	Stochastic discount factor	$\mu_{c\,t}$	Household marginal utility
B_t	Real debt	p_{z_t}	Commodity price
G_t	Government spending	FT_t	Transfer from the SWF

Table 3.2 DSGE Model's variables

The government saves the commodity tax revenues in a sovereign wealth fund and draws a fraction every period as transfers, as done in Bergholt et al. (2017). Lastly, an optimal interest rate rule closes the economy.

3.4.1 The mining sector

The model presentation starts with the mining sector as it differs from the majority of papers written on the subject. No price rigidities are set within the mining sector, following Hansen and Gross (2018), who argued that " there is less evidence of such rigidity in sectors subject to a high degree such as resources".

As indicated before, the modelling takes mining exploration and investment, as well as resource scarcity into consideration. This follows the recent paper by Hansen and

Gross (2018) and Halvorsen and Layton (2015), but also less recent articles by Bohn and Deacon (2008) and Sweeney (1993).

Resources firms maximise their future discounted profits V with a stochastic discount factor Θ. They determine their optimal extraction x_t, tangible mining investment I_t^{nv}, labour $h_{m\,t}$, exploration investment d_t:

$$V(k_t, r_t) = \max_{(x_t, I_t^{nv}, h_{mt}, d_t)} (\chi_t\, p_{z_t}\, x_t - w_{m\,t}\, h_{m\,t} - \chi_t\, p_{i\,t}^*\, I_t^{nv} - C(d_t\, \tilde{R_t}) + \beta\, E_t(\Theta_{t+1}\, V(k_{t+1}, r_{t+1})))$$

subject to

$$k_t = (1-\delta)\; k_{t-1} + I_t^{nv} \left(1 - \frac{\phi_k}{2} \left(\frac{I_t^{nv}}{I_{t-1}^{nv}}\right)^2\right) \tag{3.1}$$

$$x_t = k_{t-1}^{\gamma_m} \left(\frac{h_{m_t}}{A_{n_t}^a}\right)^{\eta_m} \tag{3.2}$$

Equations (1) represents the law of motion for capital, and Equation (2) the law of motion of the stock of natural resources [1].

Extraction is a Cobb-Douglas function, with $A_{n_t}^a$ being a technical labour change.

$$r_t = r_{t-1} + \lambda_t\, d_t - x_t \tag{3.3}$$

where k_t is capital and r_t is the reserves' level for a specific firms; $\tilde{R}_t$ is the aggregate level of reserves, h_{m_t} is for the hours worked, $p_{z\,t}$ being the commodity price, $p_{i\,t}^*$ the price of imported goods and χ_t the exchange rate.

This equation follows the assumption that the reserves are depleted through the extraction x_t, its accumulation d_t that represents resources discovery associated with the uncertainty related to exploration λ_t .
λ_t is iid,$E[\lambda_{t+1}] = 1$.

[1] $\gamma_m + \eta_m < 1$

$I_t^{nv}\left(1-\frac{\phi_k}{2}\left(\frac{I_t^{nv}}{I_{t-1}^{nv}}\right)^2\right)$ is the investment adjustment term.

Θ_t is a stochastic discount factor that arises from the consumer's maximisation problem, and that reflects the foreign and domestic ownership ω of mining firms as

$$\Theta_t = 1 - \omega + \frac{\mu_{c_t+1}\,\omega}{\mu_{c_t} r_t} \tag{3.4}$$

With μ_{c_t} the marginal utility of households.

$\Theta$is used by mining firms when they assess their profits over time. Those partial profits updates are a reflection of domestic owners.

For mining exploration, the rationale is explained through the costlier extraction of the reserves: increasing marginal costs shows the increasing rarity of reserves when exploring again after a firm has found a new iron ore deposit.

It is modelled as follows

$$C\left(d_t\,\tilde{R}_t\right) = \frac{p_{n\,t}\,q_r}{\phi_{mc}}\left(e^{\phi_{mc}\left(d_t-\bar{d}\right)}\;-1+\Omega\right)\tilde{R}_t \tag{3.5}$$

where $\tilde{R}$ and $\bar{d}$ being the steady-state levels of reserves and exploration. $p_{n\,t}$ is the non-tradables price, and q_r represents the marginal values of reserves in the steady state (Hansen and Gross, 2018).

ϕ_{mc} stands for the cost sensitivity of exploration activities and Ω relates to the exploration activities fixed costs. In order to model the assumption of the scarcity of resources and take into account the costlier explorations and depletion, Bohn and Deacon (2000) and Hansen and Gross (2018) have assumed the exploration costs function as a convex function that depends on the aggregate reserves level. The function shows that exploration costs increase with the increase of the aggregate level of reserves. The latter assumption captures the idea that larger deposits are often more costly to find and that exploration costs rise as firms drill further underground or in less accessible locations. They have also assumed constant returns to scale for the production function.

The focus put on exploration and depletion is due to the fact that these are essential factors that capture the transmission of commodity price shocks. The opportunity cost of depletion, or the fact that resources extracted today are not available for future extraction, affects resource firms' optimal extraction decisions, and exploration defines the feasible set from which production can occur. These concepts have been highlighted in partial equilibrium models of natural resources (Devarajan and Fisher, 1982; Cairns, 1990; Halvorsen and Layton, 2015). (Pindyck, 1978; Lasserre, 1985; Livernois and Uhler, 1987). Both are crucial for comprehending how resource corporations respond to price fluctuations. Reserves could be significant from a macroeconomic point of view. Standard models have trouble understanding the relationship between commodity prices and macroeconomic volatility in Small Commodity-Exporting economies due to the restricted propagation of commodity price shocks when they are held fixed (SCEs) (Bidarkota and Crucini, 2000; van der Ploeg, 2011; Berka, Crucini and Wang, 2012).

From an empirical standpoint (Hansen and Gross, 2020), there is a positive relationship between increase in prices, exploratory activity and the discovery of new reserves. To expand on this notion, firms have a bigger incentive to look for new reserves when prices are high, and despite the fact that explorations do not always guarantee success, on average, firms do find new materials. Secondly, standard models demonstrate positive relationships and co-movements between price increases and extraction growth. The model of this paper assumes that firms explores reserves to discover new reserves and the further capital necessary to construct new mines are significant margins of adjustment which causes delays in the extraction response. Additionally, the existing literature on the effects of commodity price volatility has highlighted the Dutch Disease effect, which is the crowding out of activity in non-commodity sectors in reaction to increasing commodity prices, particularly in non-commodity exports. Panel studies by Sachs and Warner (2001), Stijns (2003), and van der Ploeg (2011) as well as structural time series models (Jaaskela and Smith (2013), Charnavoki and Dolado (2014), and Bjrnland and Thorsrud (2016) provide evidence for it. The research's key is the exploration that results in the finding of new reserves and permanently raises the production capabilities. To elaborate further, companies frequently increase exploration when commodity prices are high, and any new reserves discovered result in a permanent increase in the viable production set, which emphasises extraction, exploration, investment, and mining labour demand. As a result, the resource sector expands when commodity prices are high and contracts more severely when prices are low.

Three taxes on mining firms are being analysed in this paper and the mining firms profits after the various taxes are:

- a resource rent tax, or a profit tax

$$\Pi_{z\,t,1} = (1 - \tau_{t\,1})\,(\chi_t\, p_{zt}\, x_t - w_{m\,t}\, h_{m\,t} - \chi_t\, p_t^*\, I_t^{nv} - C(d_t\, \tilde{R}_t)) \tag{3.6}$$

- an ad valorem royalty, or a tax per unit of revenue

$$\Pi_{z\,t,2} = (1 - \tau_{t\,2})\,\chi_t\, p_{z\,t}\, x_t - w_{m\,t}\, h_{m\,t} - \chi_t\, p_t^*\, I_t^{nv} - C(d_t\, \tilde{R}_t) \tag{3.7}$$

- a reserve tax, or a tax per value of reserves

$$\Pi_{z\,t,3} = \chi_t\, p_{zt}\, x_t - w_{m\,t}\, h_{m\,t} - \chi_t\, p_t^*\, I_t^{nv} - C(d_t\, \tilde{R}_t) - \tau_{t\,3}\, q_{rt}\, r_t \tag{3.8}$$

where $q_{r\,t}$ is the marginal valuation of an additional unit of reserves [2].

Mining sectors have been following some general taxation trends. Like other countries, Australia has been updating its fiscal policies, especially after the financial crisis where

[2]See Appendix for first-order conditions

the mining industry has been a useful tool to finance governments (Ralbovsky, 2012). Australia authorised the "Mineral Resource Rent Tax" from July 2012. However, The Australian government designed additional fiscal changes for its mining sector to stimulate exploration and mining investment (ibid.). The government adopts now "a profits-based tax levied on all petroleum, oil and gas projects both onshore and offshore" (Australian government, 2019). The royalties' tax regime has been advantageous in terms of the governments' revenues' stability, but also with "administration and compliance costs" (Freebairn, 2015). The results of this paper corroborate what has been argued by Freebairn (2015).

3.4.2 Non-tradables firms

The other sectors of the economy have N producers, with a production function

$$y_t^n(i) = \frac{h_{i\,t} A_t^n}{\epsilon_{M_t}} \tag{3.9}$$

A_t^n being a technology shock, h_t non-mining labour, and ϵ_{M_t} is a cost-push cost. Non-tradables firms are monopolistically competitive. $1-\theta_n$ of those firms set their optimal price with Calvo pricing rigidities and maximise their future discounted profits:

$$\max\ E_{n,t_0} \sum_{t-t_0}^{\infty} (\theta_n\,\beta)^{t-t_0} \frac{p_{t_0}^c\,\Theta_t}{p_t^c\,\Theta_{t_0}} \left(\bar{p}_{i\,t_0}^n\,(i) - \frac{w_{n\,t}\,\epsilon_{M_t}}{A_t^n} \right) \left(\frac{\bar{p}_{i\,t_0}^n}{p_t^n} \right)^{-e_n} y_t^n \tag{3.10}$$

where $\frac{w_{n\,t}\,\epsilon_{M_t}}{A_t^n}$ is the marginal cost of production for a non-tradables firm.

The downward sloping demand function of non-tradables is $(\frac{\bar{p}_{n\,t}(i)}{p_{n\,t}})^{-\theta_n}\,y_t^d$. The price index for an additional bundle of non-tradables is $p_{n_t} = (\int_0^1 \mathrm{p_{n_t}(i)\,d}i)^{\frac{1}{1-\theta_n}}$, and $\bar{p}_{n_t}(i)$ is the optimal price for a firm i. For the firms that are unable to adjust their prices, they keep the previous' period price.

Profits of the domestic non-tradables are modelled as:

$$\Pi_{n_t} = \gamma_{n\,c\,t}\, y_t - (1-\tau_n)\, h_t\, w_{n\,t} \tag{3.11}$$

where

$$\gamma_{n\,c\,t} = \frac{\pi_{n\,t}\,\gamma_{n\,c\,t-1}}{\pi_{c_t}} \tag{3.12}$$

represents the non-tradables relative price dynamics.

Non-tradables consumption represents a portion α of total consumption:

$$c_{n_t} = c_t\ (1-\alpha)\ {\gamma_{n_{ct}}}^{(-\eta_c)} \tag{3.13}$$

3.4.3 Importing firms

Those firms acquire a final output bundle from the rest of the world and use it for the production of a differentiated consumption import good. The world price p_t^* is the price at which there is a perfect elasticity of foreign good supply. Households own importing firms, and the latter maximise their future discounted profits subject to Calvo rigidities, similarly as for the non-tradables:

$$\max\ E_{o,t_0} \sum_{t-t_0}^{\infty} (\theta_o\,\beta)^{t-t_0}\ \frac{p^c_{t_0}}{p^c_t}\ \left(\bar{p}^o_{i\,t_0}\,(i) - \chi_t\,P^*_t\right)\ \left(\frac{\bar{p}^o_{i\,t_0}}{p^o_t}\right)^{-e_o}\ y^o_t \tag{3.14}$$

where χ_t is the exchange rate, and $\chi_t\,P^*_t$ the real marginal cost for all importers in domestic currency terms. θ_o is the probability for an importing firm to retain its previous period's price, as it is unable to optimise it in a given period p.

Importing firms transform the imported good into a differentiated imported good in a monopolistic competitive market to make profits:

$$\Pi_{o_t} = \gamma_{oct}\, c_{o_t} - (1 - \tau_o)\; c_{ot}\, p_t^*\, \chi_t\, \tilde{p}_{o_t}^{-e_o} \tag{3.15}$$

where

$$\gamma_{oct} = \frac{\pi_{ot}\, \gamma_{oct-1}}{\pi_{ct}} \tag{3.16}$$

is the importing relative price dynamics.

$$c_{ot} = c_t\, \alpha\, {\gamma_{oct}}^{-\eta_c} \tag{3.17}$$

To determine the profits of importing firms, the alternative import price index follows:

$$\tilde{p}_{ot} = [(1 - \theta_o)\; {\bar{p}_{ot}}^{-e_o} + \theta_o\; \tilde{p}_{ot-1}^{-e_o})]^{-\frac{1}{e_o}} \tag{3.18}$$

Overall consumption is made of imported and non-tradable goods as follow:

$$c_t = \left((1 - \alpha)^{\frac{1}{\eta_c}}\; {c_{n_t}}^{\frac{\eta_c - 1}{\eta_c}} + \alpha^{\frac{1}{\eta_c}}\; {c_{o_t}}^{\frac{\eta_c - 1}{\eta_c}}\right)^{\frac{\eta_c}{\eta_c - 1}} \tag{3.19}$$

3.4.4 Non-mining exporting firms

The firms acquire a final input bundle from a domestic producer and use it for the production of a differentiated consumption export good. They face the same maximisation of future discounted profits given their production.

An exporter, j, purchases non-traded inputs from a domestic firm g to export a non-mining consumption good following the foreign demand:

$$c_{xt} = c_t^* \left(\frac{p_{xt}}{p_t^*}\right)^{-e_x} \tag{3.20}$$

where e_x represents the within-sector elasticity of the demand for non-mining export, p_t^* is the non-mining exports price. Analogously to the non-tradable sector, firms are monopolistically competitive and subject to Calvo rigidities.

Profits of non-mining exports are:

$$\Pi_{x\,t} = p_{x\,t}\,\chi_t\,c_{x\,t} - (1-\tau_x)\;\gamma_{n\,c\,t}\;c_{x\,t}\;\tilde{p}_{x\,t}^{-e_x} \tag{3.21}$$

3.4.5 Households

There is a continuum of standard households. Their preferences are separable with constant risk aversion, an external habit over consumption and a constant elasticity of substitution between the supply of mining and non-mining labour. They monopolistically supply labour, and maximise their utility function:

$$U_{t_0} = \sum_{t=t_0}^{\infty} \beta^{t-t_0} \left(\frac{(\frac{c_t}{\upsilon_t})^{1-\xi_c}}{1-\xi_c} - \zeta \left(\frac{h_t^{\frac{1}{\upsilon_h}}}{h} + \frac{h_{m\,t}^{\frac{1}{\upsilon_h}}}{h_m} \right)^{\xi_h\,\upsilon_h} \right) \tag{3.22}$$

c_t is the aggregate consumption bundle, and υ_t is their external habit. h and h_m are the households allocation of labour to the non-mining and mining firms respectively. ξ_c relates to the relative risk aversion over consumption relative to the habit, ξ_h is the dis-utility of labour supply and υ_h is the labour substitution elasticity of labour between non-mining and mining sectors. This parameter will be used for a sensitivity check following the results section. Households owe the non-tradables, importing and non-mining exporting firms, and receive dividends from $\Pi_{n\,t}$, $\Pi_{o\,t}$ and $\Pi_{x\,t}$. They also pay a tax on their wages as follows:

$$t_t = \tau\,(w_{n\,t}\,h_t + w_{m\,t}\,h_{m\,t}) \tag{3.23}$$

This paper follows Benigno and Thoenissen (2008) who assumed incomplete financial markets. Households have a choice of trade between two risk-free bonds: a government bond b and a foreign bond b^* and only one of the bonds is traded internationally.

Euler equations arises from the the households' maximisation problem in Equation (19) such as:

$$1 + i_t = \frac{\mu_{c_t}\, \pi_{c\,t+1}}{\beta\, E[\mu_{c_{t+1}}]} \tag{3.24}$$

With i being the domestic interest rate and $i*$ the foreign interest rate:

$$\mu_{c_t} = {c_t}^{-1} \left(\frac{c_t}{c_{t-1}}\right)^{1-\xi_c} \tag{3.25}$$

$$\mu_{c_t} = \frac{\mu_{c_{t+1}}\, \beta\, \left(1 + i_t^*\right)\, \phi_t\, \chi_{t+1}}{\chi_t r_t} \tag{3.26}$$

Households have claims issued in foreign currency with a premium on domestic borrowings, ϕ_t. This premium reflects the ability of the domestic economy to pay its debt and the deviation (%) between the χ_t and mining prices. Mining prices are included to capture the fact that the increase in mining prices and and the real exchange rate's appreciation can indicate an appealing investment opportunity to international investors, which means a smaller risk compensation.

$$log\, \phi_t = \phi_v\, \left(log\left(\chi_{t-1}\right) - log\left(p_{z_{t-1}}\right) + log\left(\bar{p_z}\right)\right) - \phi_b\, \left(r\chi_t\, b_t - \bar{\chi}\, \bar{b}\right) \tag{3.27}$$

As in Hansen and Gross (2018), "the ability to trade in domestic and foreign currency-denominated bonds implies that the return from saving (or cost of borrowing) should be equal to the forgone (additional) consumption enjoyed in the current period."

Only a fraction of households can reset their wage in each period, and this fraction chooses the wage under an optimal contract. The model follows Erceg et al. (2000) who assumes that the trade union negotiates on behalf of households. The union minimises the aggregate labour production cost and takes the household's wage to sell it to the non-tradables firms at the aggregate wage level. Ratto et al. (2008) explain that the wage rule stands from equating a weighted average of the marginal utility of leisure to a weighted average of μ_{c_t} multiplied by the real wage with a wage mark-up adjustment. The union's "demand for each household's labour is equal to the sum of firms' demands" (Erceg et al., 2000).

$$h_{t(l)} = \left(\frac{w_t(l)}{w_t} \right)^{-\theta_w} h_t \tag{3.28}$$

3.4.6 Fiscal authority

On the fiscal side, the government finances expenditures with tax revenues from mining firms, transfers from the sovereign wealth fund, and new public debt.

As in the Norwegian case, government finances public deficit with a share ρ_w of the fund's value every period. Tax collections are deposited in the sovereign wealth fund, which invests exclusively in international markets. The sovereign wealth fund's law of motion is given by:

$$SWF_t = {\pi_{c_t}}^{-1} \frac{\chi_t}{\chi_{t-1}} \left(1 + i_t^*\right)\left(1 - \rho_w\right) SWF_{t-1} + x_t \left(1 - \omega\right) p_{z\,t}\, \chi_t \left(1 - \tau_{t\,1}\right) \tag{3.29}$$

when a resource rent tax is adopted (profit tax);

$$SWF_t = {\pi_{c_t}}^{-1} \frac{\chi_t}{\chi_{t-1}} \left(1 + i_t^*\right)\left(1 - \rho_w\right) SWF_{t-1} + x_t \left(1 - \omega\right) p_{z\,t}\, \chi_t \left(1 - \tau_{t\,2}\right) \tag{3.30}$$

when an ad valorem royalty tax is adopted (tax per unit of revenue);

$$SWF_t = {\pi_{c_t}}^{-1} \frac{\chi_t}{\chi_{t-1}} \left(1 + i_t^*\right)\left(1 - \rho_w\right) SWF_{t-1} + x_t \left(1 - \omega\right) p_{z\,t}\, \chi_t \left(1 - \tau_{t\,3}\right) \tag{3.31}$$

when a reserve tax is adopted (tax per value of reserves).

The transfer from the wealth fund at the beginning of each period is as follow:

$$FT_t = \pi_{c_t}^{-1}\, \rho_w \, \frac{\chi_t}{\chi_{t-1}} \, SWF_t \tag{3.32}$$

The calibration of ρ_w ensures a stationary sovereign wealth fund. ρ_w it is calibrated to 4% of the fund which makes the law of motion of the fund stationary rather than explosive. In the opposite case, the non-stationarity violates the standard assumptions for asymptotic analysis and lead to unreliable and spurious results. Importantly, to match the Norwegian case, the government finances any public deficit with a share of the fund's value in every period. Government expenditures are defined within the budgetary process, determining the non-oil budget deficit. In this process it becomes clear how much of the oil-related income will be used to finance expenditures. The fund then transfers to the government an amount that is benchmarked at 4% of the value of the fund's assets, which is estimated to be approximately the long-term return on the fund's investments. This implies that the fund's capital is saved to help finance increasing pension liabilities and to ensure that future generations can also benefit.
The inter-temporal government budget constraint[3] is

$$B_{t+1} = (1 + i_t)\; B_t \, {\pi_{c_t}}^{-1} - t_t + \bar{p}_{n\,t} \, G_t - FT_t \tag{3.33}$$

with

$$G_t = \kappa_g \, y_t \tag{3.34}$$

[3] In order to ensure the stationarity of B_t, we assume that G_t is dependent on B_t

3.4.7 Monetary policy

The central bank assumes a Taylor rule that shows how the monetary authority should decide or adapt the economy short-term interest rate to respond to inflation, exchange rate and output.

$$log\left(\frac{1+i_t}{1+\bar{i}}\right) = (1-\rho_r)\ \rho_\pi\, log\left(\pi_{c_t}\right) + (1-\rho_r)\ \rho_\chi\, log\left(\chi_t\right) + \rho_r\, log\left(\frac{1+i_{t-1}}{1+\bar{i}}\right)$$
$$+ (1-\rho_r)\ \rho_y\ \left(log\left(y_t\right) - log(\bar{y})\right) + (1-\rho_r)\ \rho_{p_{z_{Taylor}}}\left(log\left(p_{z_t}\right) - log\left(\bar{p_z}\right)\right) \quad (3.35)$$

3.4.8 Market clearing

The market-clearing conditions hold, where supply equals demand for each sector

$$y_t = c_{n_t} + c_{x_t}\,\tilde{p}_{x_t}^{-e_x} + G_t \quad (3.36)$$

3.4.9 Exogenous Processes

the model assumes prices are in line with a reduced-form VAR(1) as per the literature (Rotemberg and Woodford, 1996; Hamilton, 2003)

$$\left(\frac{p_{z_t}}{\bar{p_z}}\right) = \rho_{p_z}\, log\left(\frac{p_{z_{t-1}}}{\bar{p_z}}\right) + \epsilon_{p_{z_t}} \quad (3.37)$$

$$log\left(\frac{c_t^*}{\bar{c^*}}\right) = \epsilon_{c_t^*} + \alpha_c\, log\left(\frac{c_{t-1}^*}{\bar{c^*}}\right) + log\left(\frac{1}{r_t}\right) \quad (3.38)$$

3.4.10 Parametrisation

The calibration has been made to capture an open exporter small economy's characteristics as done in Hansen and Gross (2018). Both calibration and estimation are used to parameterise the models. Parameters that determine the steady state or long-run relationships are calibrated in line with the previous empirical literature. Parameters that govern dynamics and that do not affect the steady state are estimated: $\beta = 0.96$ and α=0.8. The parameters related to the mining sector are reported in Table 3. β, the discount factor, is set according to previous papers, namely Charnavoki (2010) and Garcia and Gonzalez (2010). Regarding the mining capital and labour, the values have been chosen to conform to the 2 % steady state value of the mining extraction (Hansen and Gross, 2018). Mining wages are also selected just as their steady state value being 11 % of the firms' revenues (Topp et al., 2008) Likewise, mining exploration, Ω is chosen in a way that makes mining firms profits nil. The Calvo parameter for the domestic sector equals 0.2 (ibid.).

Parameter	**Calibration**	**Reference**
Fraction drawn from the SWF ρ_w	0.04	Norges Bank
Labour Factor η	0.13	Steady State Labour, (Hansen and Gross, 2018)
Capital Factor γ	0.49	Steady State Extraction
Depreciation rate δ	0.1	Rees et al. (2015)
Exploration cost Ω	0.008	Π_{z_t} to be zero

Table 3.3 Model Calibration

For the remaining of the domestic economy, a parametrisation consistent with Jaaskela and Nimark (2011) and Rees et al. (2015), who modelled medium-scale DSGE models for Australia, has been used. Regarding the elasticities of substitution, their values are the same for all non-mining sectors: non-tradables, imports and exports. The values match 17 % mark-up (Hansen and Gross, 2018). Rees et al. (2015) and Benedict et al. (2016) were a guide for Calvo rigidities and price stickiness values, especially that those papers have drawn attention to the fact that "sectors with a larger share of non-traded costs are likely to have more stable prices than sectors which are exposed to a high degree of international competition" (Hansen and Gross, 2018). On the other hand, non-mining wage stickiness values relied on a paper by Bishop (2016), who found that one fourth of jobs is subject to wage adjustments every quarter, according to Australian data, from 2000 to 2016. The degree of home bias in consumption corresponds to a 20 % import share in the steady state, and the home-imports elasticity of substitution equals 1. 1 is also the value of the elasticity of substitution of labour in the mining and non-mining sectors. The latter sector is characterised by a high within-sector substitution, which implies a wage mark-up of 1 %. Frisch elasticities are equal to 0.35 in the non-traded sector and 0.88 in the resource sector as per Hansen and Gross (2018). The degree of risk aversion is set at just above 1, and consumption preferences are close to logarithmic. Lastly, the foreign ownership share of resource firms is set to 0.35 to match the Australian economy (similar to Conolly and Orsmond, 2011, Reserve Bank of Australia).

3.5 Can a Sovereign Wealth Fund cure the Dutch Disease ?

The first section of the analysis compares the Australian economy's response with a sovereign wealth fund and the economy without it. It would be followed by a comparison of three tax regimes to investigate the most efficient policy when resources are abundant. Finally, the assumption of endogeneity of resources is compared to the same economy when reserves are exogenous. Also, as a sensitivity analysis, the assumption of perfect labour substitution is altered.

This section shows the evaluation of the effectiveness of the implementation of the sovereign wealth fund against the Dutch Disease. Its underlying mechanism is well known and goes as follows: a rise in the mining sector commodities appreciates the domestic currency, which affects the non-mining sector's competitiveness as the exports price keeps increasing. The sovereign wealth fund has seen its popularity rising due to its effectiveness against the Dutch Disease. Figure 3 displays the impulse response function of key macroeconomic variables, where the purple colour represents the model with a SWF and the green represents the model without the fund.

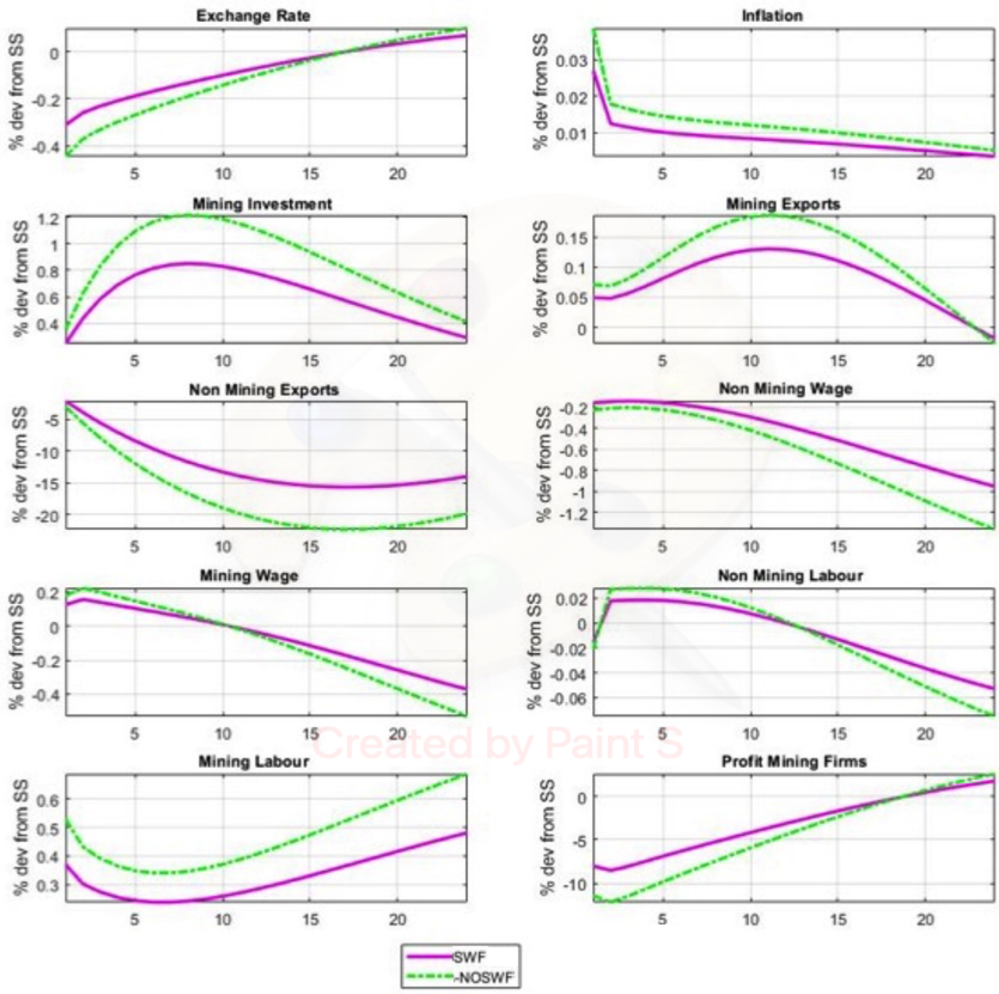

Fig. 3.4 Impulse responses of a Commodity Price Shock

Following a commodity price shock, one can see that the economy's response without the Sovereign Wealth Fund (SWF) is highly volatile compared to the one with the fund.

Following the 1 standard deviation commodity shock, government increases its expenditure which leads to higher prices. The shock is diffused in the domestic activity as a significant decrease in consumption and non-mining exports and a substantial real exchange rate appreciation. The consumption's drop mirrors higher interest rates both domestically and abroad (because it involves higher risk) as commodity- exporting companies borrow to finance increased exploration and investment. Hence, production is shifted from non-mining exports due to rising real exchange rates and high domestic production costs. When the marginal product of labour in the mining sector is greater than that of the non-tradables sector, wages in the former rise and fall in the latter, creating a cross-sectoral labour flow. In terms of production, the impact is positive in general, due to the assumptions that the exploration requires non-tradables inputs. It can alternatively be assumed that resource investment or extraction need the outputs from the non-resource sector. To conclude, the shock generates a positive impact on aggregate demand, "generate a commodity currency and a reallocation of goods and labour" and those are the Dutch Disease symptoms.

As per Figure 3.4, without a SWF, and following a commodity price shock, non-resources exports experience a significant increase. However, after less than ten periods, the shrinkage becomes highly persistent and apparent and does not vanish even three years later. An explanation for this response, as explained in a Bulletin from the RBA (2014), is that manufacturing investments become more significant at the beginning of the boom, which comes to be rapidly counterweighted by the exchange rate appreciation, making this sector non-competitive. This crowding out is supported by the rise in mining wages and the decrease in non-mining wages, a decrease that seems highly persistent. Similarly, opposite movements characterised both non-mining and mining labour, where the latter increases with a response of 0.5 % after one standard deviation commodity price shock, and non-mining wages decreasing by nearly 0.3 %. Those responses illustrate a resource movement, a major symptom of the Dutch Disease.
The resource movement effect translates into the shift of both capital and labour into the booming mining sector and non-tradables to satisfy the increasing domestic demand. Those transfers lead to a shrinkage of the lagging tradables sector (Ebrahim-Zadeh, 2003).

The other symptom, the spending effect, is seen through both manufacturing and services sectors. In other words, when additional revenues come from the mining sector boom, the demand for labour in the non-tradable sector rises to the detriment of the manufacturing sector. This is what is meant by the de-industrialisation of the economy, as there will be a shift from the latter to the non-tradable sector. Subsequently, both demand and prices of non-tradable goods grow, as seen from the response of services firms profits, and because the prices of the lagged sector are internationally determined, they cannot be adjusted. This leads to a shift of labour and capital toward the surging sectors of the economy. The one standard deviation commodity price shock also impacts domestic inflation, which increases by 0.39 %, an increase that translates into higher domestic price levels and higher interest rates as an attempt to limit the inflationary pressures on the economy. The positive response of domestic consumption might rely on the absorption of non-traded inputs by exploration, as explained by Hansen and Gross (2018), or on the need for those inputs by the mining firms to invest and extract more from the reserves.

A noteworthy point is the mining firms profits' response to the shock. Both extraction and investment responses delay behind the commodity price rise. At first, exploration costs rise with exploration activities and the total resource stock increase. Nevertheless, the shortfall in finding new reserves will become more severe over time, as reserves' scarcity contributes to higher exploration costs. If new stocks are discovered during exploration, the stock threshold slightly increases. But revenues and profits in the commodity sector experience higher volatility as companies have borrowed more to finance higher investment and exploration. These hold up the peak level of output. Finally, the new reserves do not depreciate, "the marginal productivity of resource extraction is raised in all periods, or until the full amount of any newly discovered reserves are extracted" (Hansen and Gross, 2018). Any changes in the reserves level, important or small, could lead to a long-term impact on the productivity of commodity companies and yields large and sustained rises in output, investment, and labour demand (ibid.).

The Reserve Bank of Australia has confirmed this reasoning (2010, 2014), a mining boom resulting from an increase in investment prices or commodity prices would lead to higher shares of mining investment as a share of GDP. The terms of trade would increase significantly and reach a peak, as happened after World War I when wool prices increased dramatically. Resources exports experienced growth. This is associated with a strong appreciation of the Australian Dollar, although the RBA found that this appreciation was needed to adjust the economy through the floating exchange rate regime.

The regime made the Australian economy flexible and prevented higher inflation. Tulip (2014) has also confirmed the Dutch Disease impact on the shrinkage of the lagging sector. Initially, tradable goods were backed by higher revenues and expenditure from the mining sector. Specifically, the lagging sector profited from the important demand for equipment and material (Tulip, 2014). Even though manufacturing investments increased originally, the appreciation of the currency offset this effect and made the sector non-competitive. As mining investment diminished and the demand for the tradable sector weakened, the relative price effects dominated. Tradable output kept decreasing as well as its share of total employment.

To cure this disease, Norway has implemented a SWF, and this is why an assessment of its effectiveness in Australia is investigated. With the SWF, the consumption of non-traded goods (services) experiences a remarkable increase, even though the response is still negative. Similarly, non-resource manufacturing exports (i.e. traded goods) see a decrease with a lower magnitude than an economy without the fund. Despite this decline, the fund's efficiency is seen in the longer run, where the recovery is likely sooner than without it. An analogous pattern characterised inflation, where the fund narrows the rise by more than a half (0.26%).

Regarding the mining sector, and by looking at mining profits, the response displays a sizeable decrease, followed by an increasing peak. The decrease in those profits following a mining price shock is explained as follows: as new reserves are discovered, the growth rate of the marginal value of reserves diminishes. As commodity prices and profits of mining firms become volatile, firms need higher borrowings to maintain investment and exploration, which has an impact on delaying the "peak extraction" (Hansen and Gross, 2018). This shows how both prices and production are correlated.

Moving to the Dutch Disease symptoms, the impulse response functions show that the resource movement effect has been slightly countered. The mining labour did increase, but with 0.39 % compared to 0.5 % in the former model without a SWF. Likewise, and although the spending effect exists, its impact has been reduced. Importantly, wages in the mining wages have slightly increased, and non-mining wages have shown a drop. However, compared to the first model, the latter magnitude was significantly lower: -0.028 % without the fund became 0.02 % with the fund following a commodity price shock.

Lastly, the expected result comes in term of the exchange rate, where the appreciation of the currency is higher without the fund, which does corroborate the literature review findings. Those results are consistent with Tulip (2014), when exchange rate appreciation exceeded 0.44 % in 2013, following a mining boom, compared to the rate without the boom. With higher employment rate and increasing commodity prices, inflation increased significantly. The appreciation of the Australian Dollar counteracted this impact, which reduced import prices. Notably, the Sovereign Wealth Fund plays its role in stabilising the domestic currency properly, and this corroborates Bernstein et al. (2013)'s claims, where an effective SWF should be able to deal with macroeconomic issues that are engendered by higher commodity revenues and that lead to inflation as well as exchange rate overvaluation.

To summarise, commodity price shocks lead to Dutch Disease manifestations in the domestic economy and in spite of the symptoms, a SWF seems to have played its main

role to stabilise the economy, as per the question above of what the SWF can do that the fiscal authority in the model cannot.
Authorities usually have three main targets: firstly, economic growth, secondly, economic stability and lastly, "income distribution and social insurance, including intergenerational equity and risk-sharing among generations" (Steigum, 2013). SWFs have a high potential to play a significant role in contributing to all targets, with direct or indirect interventions. Regarding the first role, one might think about the smoothing impact of tax rates on the public assets' accumulation. The idea is that the ageing population associated with unfunded social security could alternatively increase tax rates on future labour income. As Barro (1979) argued, policies targeting stable tax rates over time decreases tax distortions and enhances economic effectiveness. In terms of the second goal being economic stabilisation, SWFs allow the authority to raise the aggregate demand via the expansionary fiscal policy in the aftermath of exogenous commodity price shock. A notable example being the financial crisis and the 2009 recession that drove the economic policy in Norway and Australia. Both countries implemented a flexible inflation targeting and an automatic fiscal stabiliser policy that is, typically, sufficiently effective in stabilising the economy following demand shocks. During the recession following the 2009 financial crisis, this was not effective, and the Norwegian government has to implement expansionary fiscal stimulus policies (IMF, 2010). Regarding Australia, the Global Financial Crisis's effect on households was apparent, mainly after the significant drop of equity prices that shrunk Australian wealth by 10 % in March 2009 (Australian Bureau of Statistics, 2010).

Notwithstanding the decrease of both oil revenues and cyclical tax income, the Scandinavian country continued to enjoy a fiscal surplus and thanks to the SWF's revenues, the Norwegian net foreign assets' maintained their growth. Despite the critical impact of the global recession, this resilience was illustrated through the relative stability of unemployment rates and their domestic financial sector's steady performance. One might argue that those expansionary fiscal policies can be put in place even without the existence of a fund. However, the fund decreases the risk of a weakened government during crises.

The economic theory shows that, when the Ricardian equivalence is held, "government debt or asset accumulation would not affect the size and composition of aggregate national wealth and intergenerational distribution in the absence of distortionary taxation" (Steigum, 2013). This means that, on aggregate, households follow inverse savings that counterbalance the fund's effect on the countries' savings and assets. On the other hand, consumers are unlikely to have enough information on the fiscal policies' impact above their existence to counterbalance the fund in the following way. Thanks to the SWF, fiscal authorities can maintain the labour income taxes provisionally greater than otherwise, which pushes workers to opt for lower private consumption, leading to higher national wealth. This reasoning is confirmed by Persson (1985), who argued that the higher the government financial assets, the more it will crowd in private wealth. In the long-run higher government wealth means higher welfare for future generations, which counterbalance the negative impact of pay-as-you-go strategies and population ageing.

Lastly, Gordon and Varian (1988), Auerbach and Hasset (2007) and Van Der Ploeg (2010) argue that a SWF has a "precautionary savings motive". It plays an essential role in improving generational risk-sharing. When a generation experiences the negative impact of an income shock, the fiscal authorities have the capacity of inter-generational income redistribution.

3.6 The Sovereign Wealth Fund's effectiveness and foreign non-mining demand shocks

The literature has documented the impact of foreign demand shocks, and findings confirm that it stimulates the economy (Lui et al., 2011; Kronborg, 2021); .This section investigates the effectiveness of a SWF following a foreign demand for non-mining domestic goods shock.

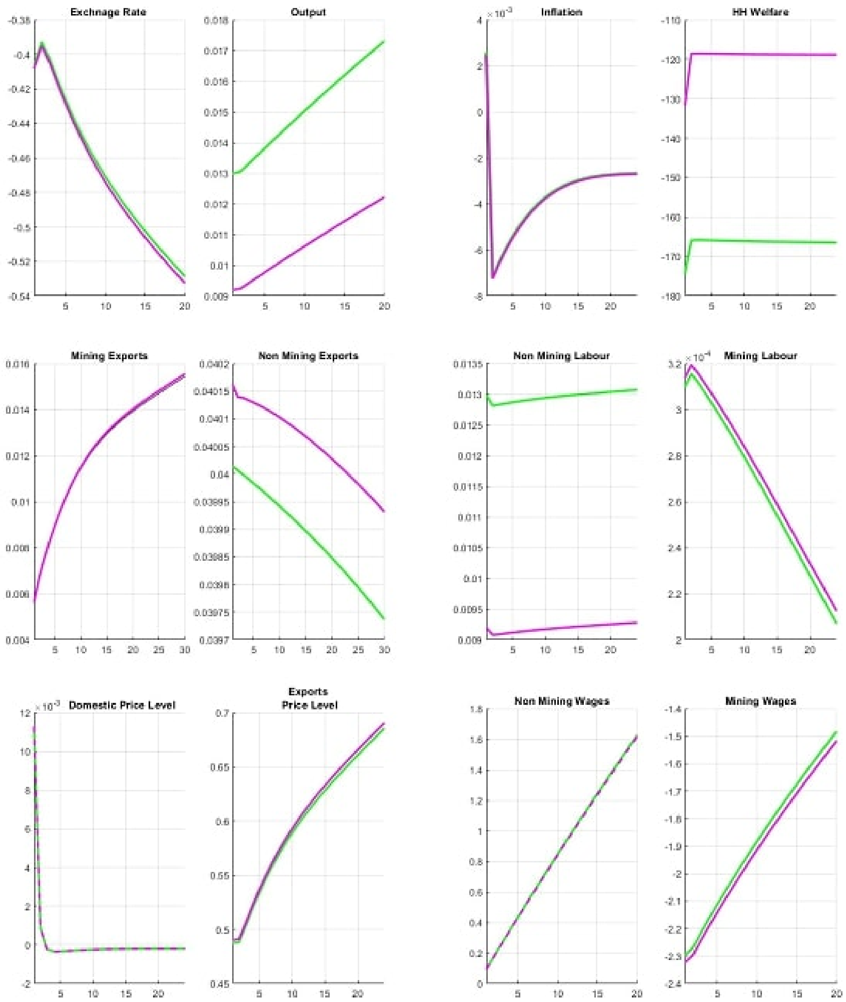

Fig. 3.5 Impulse responses of a Foreign Demand for Domestic Goods shock

As seen in the impulse response functions graph from Figure 4, a foreign demand shock positively impacts the economy. Export prices see a sharp increase, and non-resource exports rise. This increase in exports price is slightly higher than imports price and implies better terms of trade.

This is also explained by the drop in the real exchange rate response. It is noteworthy that the sovereign wealth fund existence led to lower response. Its response is explained as an appreciation of the currency of 0.4 per cent following a 100 % foreign demand shock. This has fed through to lower inflation. Although domestic inflation increased as a first response, it recovered within three periods with the fund and without it, with a marginal lower magnitude when the fund exists. As expected, an increase in foreign demand leads to an increase in domestic output by 0.013 %. The profits of services firms rise as well as the consumption of non-traded goods, and the profits of manufacturing firms increase. The importing firms displayed a drop in their profits due to the increase in domestic output and improved trade balance, making imports cheaper.

Looking at Figure 4, the simulation shows that the fund's presence was not as effective as previously in stabilising the economy following a foreign demand for domestic goods shock. In fact, both mining and non-mining exports increased. Subsequently, both mining and non-mining labour augmented even though non-mining labour displayed a slightly lower response of 0.0038 per cent when the SWF existed. A possible explanation for the increase of mining labour, following a foreign demand for domestic goods shock, is that mining outputs are used in production and consumption, which means a higher demand for the resources sector. Notably, one can see that the fund's existence helped boost mining exports, especially that a fraction of mining revenues are invested in the sector. Thus, and following this shock, households' welfare decreased in both scenarios, but the wealth fund absence produced a significantly higher response with a difference of 40 per cent. Overall, these responses are not different from the results of Dungey and Pagan (2000) through a structural VAR model. This paper's results also corroborate Nimark (2007) results following an export demand shock.

Moreover, one can conclude that the fund's presence was not as effective in stabilising the economy following a foreign demand shock. This can be explained through the modelling of the fund that is alimented through mining revenues only. A shock of

demand for non-mining tradables might explain its modest impact in this case, contrarily to the shock of commodity prices.
This raises some questions about the fund role but also its management. Olawoye (2016) argues that as long as the fund is employed to mainly acquire financial assets in foreign currency, the country would find itself "on a different side of the coin". Without substantial investment (e.g. infrastructure), the country would face a fiscal surplus to the detriment of the private sector, such as manufacturing, which would not mitigate the impact of foreign demand shocks. This would shed light on the investment approaches the government should adopt with the income available. The continual stream of revenues from the resources sector should be oriented toward the non-tradable sector and its productivity, but also toward domestic investment and its infrastructure. Domestic investment should include rural area and target poverty reduction. The question is beyond this paper's scope, but a more in-depth analysis of investment approaches seems fundamental.

3.7 Optimal Taxation

The optimal taxation aims to minimise commodity prices' impact with respect to households' welfare and stabilise the macroeconomic variables' responses. The line of reasoning is illustrated through the commodity shocks' spillovers that induce volatility in the non-mining sector's production and consumption.
Australia, such as other small commodity exporters, adopted new taxes, increased the rates or based them on the commodity price, or enlarged the list of taxed goods (Hansen and Gross, 2018). As described in the previous sections, this paper looks at three different taxes, namely a resources tax, a rent tax and a revenue tax (Ad-valorem royalty).

Following a world commodity price shock, the impulse response functions in Figure 6 shows that the volatility of commodity prices has had its highest impact with a reserves

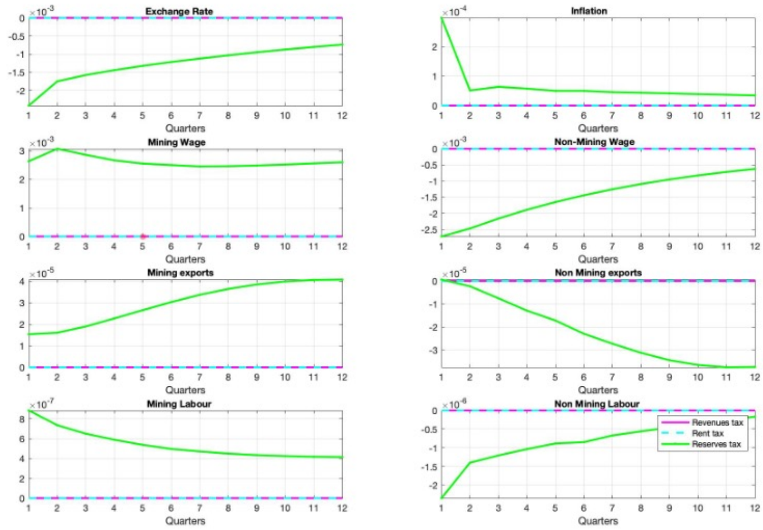

Fig. 3.6 Impulse responses under three tax regimes

tax where it led to the most volatile responses, a lower magnitude with a rent tax and that a revenue tax is optimal in an economy with endogenous natural resources and a sovereign wealth fund.

Reserve taxes and optimal resource rent are less effective in stabilising welfare. Since it is ideal for resource corporations to become more capital intensive in order to lower their tax obligation, rising commodity prices predict higher volatility in the mining sector. An increase in mining investment and output results from a rise in commodity prices, which subsequently has a beneficial knock-on effect on domestic activity, the real exchange rate, and the distribution of commodities and labour among sectors. However, a rent tax and a revenue tax produce comparable welfare effects, and any of them can lessen the negative effects of commodity price volatility on welfare. Therefore, this protects resource corporations from the immediate effects of a commodity price shock by raising taxes on revenue as commodity prices rise. As a result, resource companies are less motivated to alter their ideal extraction, investment, exploration, and labour demand decisions. The best tax laws, tailored to the resource industry and conditional on price, continue to be effective.

Even with a small difference, the revenue tax has proven to be optimal for total output, both mining and non-mining exports, labour and wages in terms of reducing volatility. This tax regime was also optimal regarding the mining sector in terms of investment and reserves extraction. From a government side, a revenue tax is the most efficient for the fund values, government spending as well as government debt. This has, among others, an impact on households' welfare. Although a rent tax regime might seem attractive at first glance, the response under a revenue tax is the most efficient in both the short and long run.

The findings of this paper are similar to Hansen and Gross (2018). One explanation for the revenue tax to be the most efficient among the three regimes is because it isolates resource firms from the direct impact of commodity price volatility. An argument from Hansen and Gross (2018) is based on the high correlation between commodity price volatility and mining revenues (from a firm's point of view), that is every sequence of price shock cancels out with a particular sequence of revenue tax. Ad valorem royalties allow mining firms to keep "their optimal extraction, investment and labour decisions" (ibid.). Accordingly, Boadway and Keen (2013) argue that royalties secure a continual stream of returns from the resources sector once production activities start. Regarding rent taxes, it concerns cash flows, which means lower concerns about the devaluation and reserves depletion expenses. Notwithstanding its theoretical attractiveness, rent taxes should be adopted only when some conditions are met, such as the government's condition in keeping tax rates fixed (ibid.) Hence, and in this model, both resource rent tax and reserve tax, were not effective with regards to households' welfare, even though the impact of commodity price shock was relatively small. The former fiscal options involve significant volatility in the commodity sector, mainly because of a price increase. Hence, and with regards to mining firms, it became advantageous to minimise its tax burden and turn into capital intensive rather than labour intensive to decrease their tax liabilities.

3.8 Welfare analysis

Similarly to the first section of this paper, Figure 6 shows the impact of a commodity price shock as well as a foreign demand for non-mining goods shocks.

The welfare variation is calculated as the percentage consumption where households are indifferent between the original steady state economy or an economy subject to prices volatility.

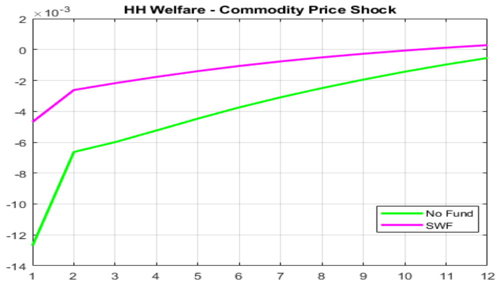

Fig. 3.7 Households' Welfare - Commodity Price Shock

A shock of commodity prices would decrease consumers' welfare over the short run, but they benefit from this shock over the long run, as shown in the figure above. A commodity price shock results in an increase in mining investment and extraction. This leads to spillovers to the domestic sectors and "more reallocation of labour and goods across sectors" (Hansen and Gross, 2018). Moreover, it is notable that the fund's existence was effective in reducing the impact of a commodity price shock on households welfare.

Table 4 shows how welfare varies, with a fund and without, with the three different tax regimes analysed hitherto. The baseline model is an economy without a fund, with the most volatile tax regime, a reserve tax.

This shows that in terms of percentage changes from the baseline scenario, Households' welfare is maximised with a revenue tax with the SWF, and this is explained

	No Fund	Fund
Rent Tax	2.29%	2.28 %
Reserves Tax	Baseline	
Revenue Tax	1.7 %	8.9 %

Table 3.4 Households Welfare - Commodity Price Shock

by the avoidance of additional distortionary impact of commodity prices volatility. In fact, this is explained by the fact that mining firms are less exposed to a commodity price shock under a revenue tax compared to the other tax regimes, which reduces the decision to alter decisions related to their extraction, investment, and labour.

This does corroborate the previous section's findings, which also shows how inefficient a reserves tax regime is in the long run. The remaining results show and confirm the findings of the paper. The fund's existence has had a positive impact on the welfare under a rent tax and the ad-valorem royalty (revenues tax), and the latter has proved to be the most efficient compared to a reserve and a rent tax.

3.9 Sensitivity analysis

3.9.1 Exogenous Resources

With regards to the model with exogenous resources, there is a small impact on the non-resource sector, namely non-resources exports, domestic consumption, non-mining inflation, and mining demand for non-resources output. Regarding the mining sector, and in terms of mining firm's profits, the responses took opposite patterns. The positive response is explained through the assumption of exogenous resources. In fact, there is neither exploration nor mining investment. The realistic assumption of scarce and limited resources is absent. Under the exogenous resource model, the exchange rate response has half of the magnitude of its response with endogenous resources. Also, the recovery comes after two periods only, which shows the failure to capture the impact of

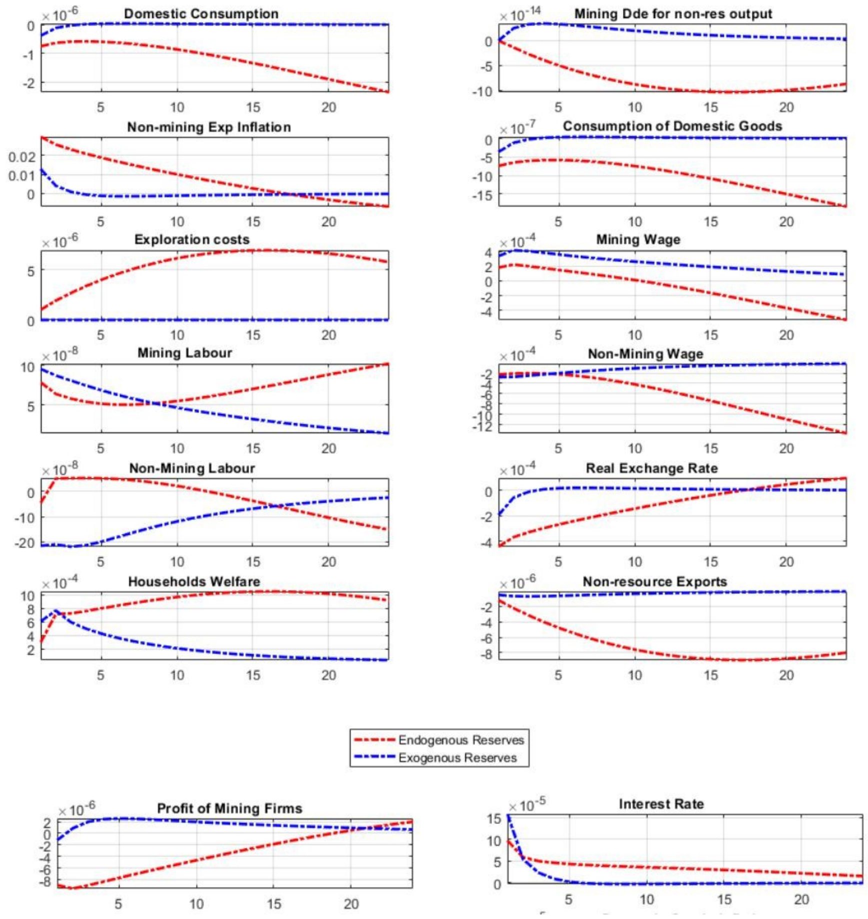

Fig. 3.8 Impulse responses under an exogenous supply of reserves versus an endogenous supply

commodity price volatility. With reference to labour and wages, one could see a limited impact on both mining and non-mining wages and a very persistent response for mining labour. Further, households' welfare displays a high rise compared to the endogenous model, and similarly to the exchange rate, its recovery is faster.

Lastly, it is noteworthy to highlight that the inclusion of exploration and mining investment and exploration allows a more in-depth investigation of the tax regime adopted with regards to reserves tax. Assuming exogenous resources means the reserves are held fix. Hansen and Gross (2018) showed that an endogenous supply of resources has a significant impact on business cycle volatility as well as exchange rate volatility. The results from Figure 8 corroborates Van Der Ploeg (2011) and explains, as stated in the literature review, why papers such as Fornerno et al. (2014) failed to detect Dutch Disease symptoms.

3.9.2 Labour substitution

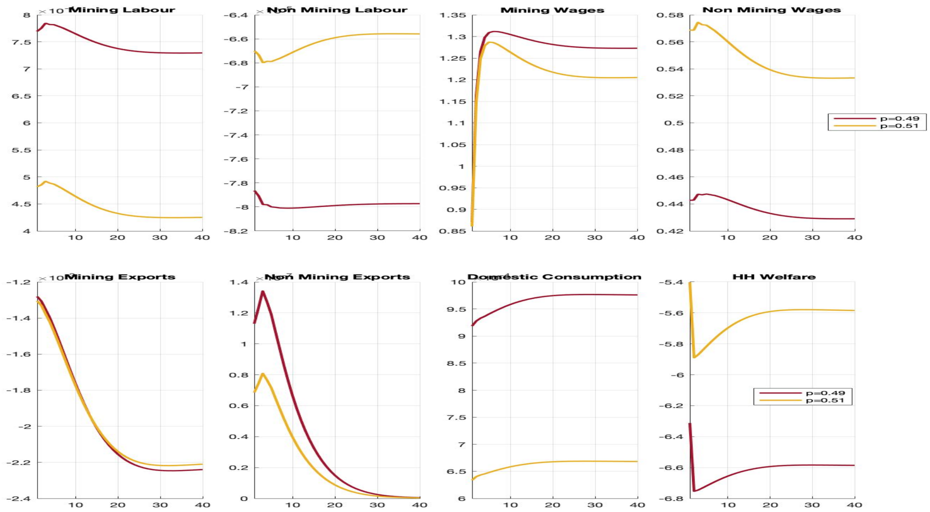

Fig. 3.9 Impulse responses under different labour substitution values

The model assumes a labour substitution of 0.5 to simplify calculations. In order to assess how robust is this model, this value has been lowered and then augmented. Moreover, and regarding the literature, Cantelmo and Melina (2017) stressed the importance of labour reallocation within different sectors and found an opposite association between labour substitution across sectors.

Following a commodity price shock, households, as labour suppliers, would be keen to move to sectors with higher wages, that is, the resource sector. It will explain the higher response of mining and non-mining labour with a higher labour substitution across sectors. In fact, lower labour substitution will encourage households to dedicate more working hours to the mining sector that pays more than the other sectors of the economy. With the expansion of the mining sector, firms need to hire more workers, which leads to lower manufacturing productivity and an increase in manufacturing relative prices, as argued by Cardei and Restout (2014). In a nutshell, higher labour substitution has led to more volatile responses of the economy's non-mining sectors.

3.10 Conclusion

This paper demonstrates the effectiveness of a sovereign wealth fund against the Dutch Disease. One can see that the economy's response without the Sovereign Wealth Fund is highly volatile compared to the one with the fund. The fund seems to have a significant impact on stabilising key macroeconomic variables' responses following a commodity price shock. However, the fund impact was not as important as expected. This shed light on investment approaches where the SWF governments' portfolio should adopt with the mining revenues. Das et al. (2010) suggested that highly risky investment might translate into financial losses and that "higher-risk-tasking may pose higher fiscal risks" The question was beyond the scope of this paper, but a more in-depth analysis of investment approaches would be highly important.

Moreover, the results confirmed that a model with endogenous, explored and depleted reserves better records the impacts of the commodity price shock on the domestic economy with its mining and non-mining sectors. The endogeneity of the reserves allowed a deeper emphasis on the positive correlation between the mining price variations and the exploration, and the commodity shock had largely affected the economy compared to an economy with exogenous reserves. Those findings are in line with the existing literature.

Regarding the optimal tax regime rules that should be adopted, findings showed that government should adjust taxes according to commodity prices, which has been rising in popularity recently. An ad-valorem royalty proved efficient in securing a continual stream of returns from the resources sector in comparison to the rent and reserves tax. It also proved to be better for the mining sector, such as the value of mining firms and their profits. Lastly, the sovereign wealth fund had also a higher value with the revenue tax.

Further research should extend this model to resource-rich developing countries and adapt it to their stylised features. As highlighted by Steigum (2013), better management of natural resources through a sovereign wealth fund, an appropriate exchange rate establishment, and a diversification of exports can help countries escape the Dutch disease. Ultimately, the transmission channels of the volatility of commodity prices need to be thoroughly investigated, as well as ways to mitigate its adverse impact in developing countries weakened by the resource curse. Sovereign wealth funds are well-appointed to manage resources' price volatility more than "private pension funds and university endowment funds" (ibid.). Authorities could take advantage of SWFs to collect and gather volatility risk premia.

Chapter 4

Natural Resources Abundance on a Regional Level: A Blessing or a Curse?

Evidence from Australian Local Government Areas

4.1 Abstract

Although the country-level impact of natural resources has been extensively investigated, little attention has been paid to the local and regional effect. To date, most papers has focused on aggregate or cross-country experiences. This paper discusses the empirical inferences of income inequalities between resource-rich and resource-scarce Australian Local Government (LGA) areas. This has been investigated through a difference in difference estimation and a treatment effect analysis to assess the mining openings' impact on income within the LGA. Second, a spatial autoregression model is estimated to look at the spillover impact of mining on neighbouring areas. A combination of spatial boundaries data, mines data and census data is employed to assess the Australian mining boom and evaluate whether this has been a curse or a blessing on a regional scale with regards to employment and income.

The difference-in-difference outcome revealed that a new mine's opening increases the income in the treated local government area by 6.5%. Moreover, mining activities have substantial direct contributions in adjacent regions of Australia and reinforce their economic growth. The cross-sectional spatial regression shows that a 1 % increase in mining share increases income per capita by 6.61% in neighbouring areas. The results support the strand of literature that found a positive relationship between income and the mining sector. The empirical evidence from the panel spatial regression on a regional level shows that the mining sector has a positive effect on employment and income in rich LGAs but also in the neighbouring areas.

4.2 Introduction

The resource sector plays a key role in the Australian economy, mainly through the contribution of both Queensland and Western Australian resource-rich states. This paper focuses on the impact of mines opening on Australian local government areas in terms of income and employment. It adds to the literature by discussing the empirical inference of income inequalities between resource-rich and resource-scarce Australian local government areas. According to the Australian Department of Foreign Affairs and Trade (2019), Australia has Aluminium as the largest share of its exports (18.5 %), but also Natural Gas (6.6 %), Gold (4.6 %) and, with a smaller share, crude petroleum (1.4 %). Although resource-rich countries might theoretically have an advantage over resource-scarce countries, empirical findings have confirmed the existence of the resource curse. The curse, illustrated by poor economic performance for most resource-rich countries, is due to the poor management of public investment, the lack of control of debt level, and the volatility of the commodities prices (Manzano and Rigobon, 2007; Berg et al., 2013; Melina, Yang and Zanna, 2016). Moreover, the dependence on natural resources revenues is characterised by its high uncertainty on one side and the fact that the natural resources are non-renewable. Moreover, both the resource movement effect and the spending effect lead to the crowding out of the tradables sectors. On the national level, mining extraction leads to the decline of primary products trade and the deficiency in enhancing the manufacturing area and its competitiveness as a result of the appreciation of the exchange rate (Krugman, 1987, Bulte, Damania and Deacon; 2004; Collier, 2007); Together with the fall in employment in the tradable sector, higher salaries for mining workers push the production toward the services and the booming sectors. These represent symptoms of Dutch Disease (Corden and Neary, 1982). On the national level, mining extraction leads to the decline of primary products trade and the deficiency in enhancing the manufacturing area and its competitiveness as a result of the appreciation of the exchange rate (Bulte, Damania and Deacon; 2004; Collier, 2007); This line of reasoning has been extensively studied in the literature.

Across Australia, the mining extractions is characterised by an unequal distribution across LGAs (Hajkowicz et al. 2011; Taylor et al. 2011). This raises the question of whether the symptoms of a resource curse are discernible in local government areas. Although the exchange rate is not a regional concern, the composition of economic activity is. Moreover, resource-rich local government areas in Australia might see higher inflation and salaries, which could harm the non-mining industries. The impact of mining expansion on a regional scale might be more complicated to discern, compared to the national macroeconomic assessment of the natural resources. For instance, Eggert (2001) and Moritz et al. (2017) argue that the effects of mining on employment are difficult to measure regionally because of mining platforms that are becoming more economically disconnected from the communities in which they are located as a result of declining transportation costs and technological advancement. When new deposits are discovered and the extraction begins in a local area, the jobs generated tend to be given to "incomers rather than existing residents because specialist skills are often required" (Reeson et al., 2013). Moreover, the tradable industries might struggle in attracting labour due to wages dispersion.

Why investigate the existence of a resource curse?

Within-countries research on the impact of natural abundance is a helpful tool for policymakers in various ways. Initially, policymakers should consider the importance of natural resources' impact due to its scale. The extraction of resources such as oil, gas or minerals is related to geographically localised production, which has crucial implications for the areas where this occurs. Mining activities could generate greater capital and labour inflows, substantial income and profits, as well as environmental and social challenges. Moreover, natural resources discoveries lead to increased political pressures.

In fact, a boom engenders higher expectations for local inhabitants, hoping for enhanced socio-economic conditions and job creation. Historic revelations showed that, following the Australian gold rush since the 19th century, deep economic changes are associated with higher mining activities in resource-rich areas, and policymakers should answer the question as to whether the positive long-term consequences outweigh the negative impacts. Additionally, careful fiscal policy should be implemented. As Shafiullah et al. (2018) suggested, "Momentum for fiscal federalism is particularly acute in resource-rich countries where political bargaining often focuses on the sharing of government revenues from resources". Authorities should deal with decentralisation's challenges as well as ways to reinvest revenues from the mining sector locally effectively. One of those challenges is the inequalities generated from fiscal autonomy, which might accentuate the regional discrepancies. Policymakers should assess the interaction between the resource revenues and the fiscal policy, promote the economically weaker areas, and reduce the inequalities resulting from the impact of resource abundance.

Lastly, the use of original datasets and methodologies represents an incentive to investigate a resource curse's existence and answer the aforementioned questions, and this paper presents merits in this regard. Cross-countries analysis has been linked to identification concerns, as well as robustness issues (Shafiullah et al., 2018). Regional research can present numerous advantages: the comparison is more robust throughout the "same broad institutional setting and constant variation arising from cross-country difference"; transmission channels of the natural resource abundance are not the same through different countries, making them hard to inspect. The difference in institutional quality and the various monetary and fiscal policies and cultures makes it a challenging task to control for a country's characteristics in empirical research. Within-countries regions tend to have fewer variations, but this has not been studied enough formerly (Papyrakis and Raveh, 2014).

This paper contributes to two strands of the literature: It is related to the resource curse literature and investigates whether the resources represent a blessing or a curse within Australian LGAs. It also belongs to the strand exploring regional growth and income inequalities and discusses the empirical inferences of income inequalities between resource-rich and resource-scarce LGAs. For this purpose, this paper is built on spatial boundaries data are collected from Geoscience Australia for a total of 562 LGAs across the continent. Mines Data covering the number and location of active mines, historic mines and their corresponding LGAs have been collected from the Australian Mines Atlas. This was merged with the census data from the Australian Bureau of Statistics over the years 2001, 2006, 2011 and 2016. First, a difference-in-difference estimation are conducted to investigate mining impact on income within the Local Government Area. This comes to fill the gap of evaluating whether this has been a curse or a blessing on a regional scale with regards to income. Second, a spatial autoregression model is estimated to look at the spillover impact of mining on neighbouring areas. This paper uses spatial and census data to assess the impact of mining on local economies. It investigates the correlation between the direct and indirect income effect and the mining sector's expansion in the smallest scale of local government areas in Australia. The inspiration came from the early investigation of Maxwell et al. (1991), who used three census data, as this paper does. It also came from Fleming et al. (2015), who discussed the encounters of the regional analysis of the resource curse, as well as modelling local growth in the Australian sub-states during the minerals' windfalls. This paper adds to the literature through the dataset that contains the Australian mines' total count and the count of active mines for each census year. It comprises a time-varying operating mines over the years starting from 2001 that involves searching every single mine among the 250 mines of the dataset, checking the opening year and the date, and which type of minerals.

The remaining of the paper is as follows: First, a literature review and a brief history of the mining in Australia are presented. Second, the data collection process and the data transformation are explained, followed by descriptive statistics. Next, an investigation of the impact of mines opening in Australian LGAs is presented trough two estimations: a difference-in-difference and a treatment effect. Ensuingly, cross-sectional and panel spatial regressions are provided to investigate the mining sector's direct and indirect spillover effects. Lastly, an analysis with policy implications is suggested.

4.3 Literature review

The literature around the resource curse has detected several growth issues pertaining to the availability of resources and industries relying on resource extraction. Some literature claim that such a phenomenon, even in best-case scenarios, may lead to manufacturers' loss of local learning by doing spillovers' in periods of resource expansion. The resource curse could thusly be translated into the following: a resource boom entails a crowding out of manufacturing to neighbouring areas, the region itself loses its manufacturing productivity as well as expertise while at the same time maintaining considerably high wages. The term Dutch Disease has been extensively used to refer to the associations between slow growth rates in manufacturing, increased exchange rates and resource specialisation (Beine, Bos, and Coulombe 2009; Krugman 1987). Palatnuk et al. (2019) argue that the strengthening of the ILS is a symptom of the Dutch Disease based on a breakdown analysis of the ILS/USD exchange rate patterns between 2009 and 2019 related to gas discoveries within the same period. The two-decades-long growth in natural gas has already led to an appreciation of the ILS, which complies with the Dutch disease phenomena. Such an increase, in turn, leads to an increase in unemployment and a subsequent weakening of exports. Der Ploeg and Poelhekke (2017) argued that several cross-country research papers suffer from endogeneity issues and confounding dynamics. Moreover, it has been noted that research linked to the Regional Dutch Disease has been extensively narrowed down to the testing for the disease hypothesis. The depiction of the underlying regional mechanisms remains limited, representing a motivation to pay more attention to the local or regional resource curse. Notably, using resource-scarce regions as a control group allows exploring the positive effect on the regional scale despite the decline in growth on the country level.

It is argued that the availability of valuable natural resources within a specific region, among others, leads to an overall increase in the quality of life offered when compared to other regions. However, such a richness in resources, along with all its underlying implications ranging from attracting more companies, markets and necessarily workers, may as well lead to subsequent losses at multiple levels. Research conducted by Papyrakis Raveh (2014) and Rocchi et al. (2015) suggested that grasping the regional discrepancies requires exploring the resource curse's spatial dimension. According to the OECD (2012), such incongruities are due to the changes in exchange rates and energy prices caused primarily by cross-regional productivity spillovers. Besides, price incongruities across nations could prevail over time (Cecchetti et al. 2002, Culver and Papell 2006, Roos 2006) and are similar to those within the same country (McMahon 1991 Slesnick 2002, Walden 1998), all implying that the curse mechanisms can as well occur despite the use of the same currency. Hence, further research is needed to better understand the issues pertaining to this phenomenon, namely the spillover effects, the decomposition dynamics relating to the increase in productivity, and the structural change mechanisms (Oleksandr, 2017).

On the regional level, several mechanisms of the regional resource curse have been considered in the literature: corruption and management malpractices, wars and conflicts, environmental challenges, migration as well as the shift of the production resources and the distortion of the local price (Cust and Viale, 2016). In terms of local prices, an operating mine generates significant revenues from its extraction activities ready to be spent by regional authorities. This leads to an increase in demand for local goods and services and drives the local prices up. This impacts the sectors that are not related to the mining industry, where the wages do not increase with higher prices, thus lowering their workers' welfare. By contrast, the sectors that are linked to the mining industry would gain from the higher economic activity resulting from the extraction activities or the extra revenues generated. On the other hand, the mining boom and its subsequent revenues spent on the local level leads to a shift of employment from the lagging sectors, agricultural or manufacturing, to the mining sector or the new investment projects financed by the mining revenues. This leads to a shortage of labour in the lagging sectors, translated into serious contractions, which worsens if labour mobility is limited. This reasoning has been shown in Peruvian resource-rich regions in a paper by Monge and Viale (2011). Another explored mechanism is the migration of mining workers at the local level. Cust and Viale (2016) found that most mining or mining-related industries' workers who enjoy higher wages tend to commute from neighbouring cities, which implies that their income stays in mines' proximities.

In a study that examines 135 Canadian urban areas over a period that goes from 1971 to 2006, Dube and Polese (2014) address the similarity of reasoning between the Dutch Disease mechanisms where increases in exchange rates could substitute increases in labour costs caused by resource rents as the primary channel through which local economies could be negatively affected. Other studies argue that in such a scenario, we could talk about a disease case when the manufacturing sector does not rebound based on the case of Canada where, between 2002 and 2007, 54 per cent of job losses are caused by an increase in the prices of commodities which in turn fuels an increase in the exchange rate (Beine, Bos, and Coulombe, 2009). The study also centres around the link between productivity and resource usage, where an increase in the latter can give rise to numerous human capital investments, leading to a massive increase in productivity. In India, Asher and Novosad (2013) concluded that, although resource abundance leads to a shrinkage of the manufacturing sector, a resource boom had led to strong economic growth within a radius of 31 miles of the mining site. Similarly, Aragon and Rud (2013) investigated the impact on Newmont's Yanacocha mineral project's neighbourhoods in Peru. They found a positive relationship between real income and the operating mine through local inputs' mining demand. Lastly, Bleakley and Lin (2012) argue that there is usually no crowding out of the manufacturing sector in the absence of productivity spillovers. Hence, in periods following the resources increase, the area not only restores its growth pattern and does not experience any market failures but also cumulates welfare over time.

However, despite its positive impact on income levels, resource abundance rather links negatively to growth rates (Boyce and Emery, 2011). A similar observation has been made by Deller and Schreiber (2012). They based their study on sand frack mining's local impacts during the boom period between 2000 and 2007 in the non-metropolitan US counties. They found that the boom is the major cause of a lack of interest in long term investments, notably in retailing and other industries, and thusly is the major cause behind the overall low growth rates. According to Hajime et al. (2013), the availability of natural resources within a specific area and its use for direct consumption instead of manufacturing investments lead to increased welfare and a rise in the community's salaries. With the decrease in transportation costs, firms would relocate to areas where labour is cheaper, gradually draining those areas with important natural resources with a considerably small number of firms. This is not likely to occur if the resources are used for manufacturing purposes and are either horizontally or vertically involved in related industries. It is therefore essential to note that a resources boom may have one of two outcomes: in cases where the resources are used as a medium input, it may lead to an increase in that region's number of firms; while it may lead to a decrease in the number of firms when the resources are used for direct consumption. (ibid.). Besides, the transportation costs play a significant role in the welfare levels of a given region. Hence, one can conclude that the lower the costs of transport, the more likely it is for the resource-rich region to suffer from the resource curse. Since the movement of goods is not restricted to transportation costs, firms relocate to seek cheaper labour costs. On the contrary, when the transportation costs are high, firms choose to support the labour costs to avoid the important former costs and reduce thusly the risks of the Dutch Disease.

Despite the lack of evidence in confirming the durable link between stunted growth, natural resources and the increase in wages, there is still an apparent relationship between resource specialisation and specific negative impacts. The most apparent effect could be seen between the outmigration joined by a decrease in wages when demand periodically declines. Dyrstad et al. (2017) studied the impact of a resource boom on the increase of wages and the decrease in the workforce's capacity. They show that boom and bust cycles within local economies where resource extraction occurs could be behind the lack of long-term links to different growth characteristics and wages fluctuations. Dube and Polese (2014) also suggest that the considerable wage increase may be explained by the necessity of offering higher salaries as a medium to attract workers to such remote areas and itself justifying a high level of mobility of this workforce and a slow-growing economy. The research concludes that the term curse could only be used when the same resource specialisation is itself at the heart of the declining growth rates and the prevention of other activities from developing. The above results have been countered by a study conducted in the USA over the full of 1969–2014 sample by Allcott and Keniston (2018), showing a link between the increase in local wages during periods of oil and gas booms. However, they found no link between the crowding out of manufacturing and natural resource endowment. They concluded that, within a given area, two major impacts are detected being an increase in the population and an increase in wages. This is joined to a rise in the overall welfare of that same region. At this point, there are two different scenarios; there is the case where no productivity spillovers are recorded, which makes it so that such growth at various levels, may as well lead to a crowding out of tradable activities, which necessarily entails, after the resource boom is over, a restored balance, no market failures and a surprising accumulation of welfare over time. Allcot and Keniston (2018) concluded that the welfare effect is ambiguous. They concluded that, in the presence of spillover effects in productivity, there is a crowding-out impact of the lagging sector, decreasing aggregate welfare. However, higher wages and higher employment increases aggregate welfare over time. If the shrinkage impact is controlled and with substantial agglomeration impact, the accumulated welfare increases more. Bleakley and Lin (2012) highlighted workers' concentration and population growth in depleted regions to the "historical river portage sites" after the areas lost all their productive benefits (Allcot and Keniston,2018). However, Biasi (2015) confirms the link between the effects of displacement on productive factors and the exploitation of resources from the regional industrial sector.

Papyrakis and Raveh (2013) argued that the resource curse mechanisms at a regional scope received almost no attention from researchers. Their cross-provincial panel of data between 1984 and 2007 in Canada shows that resource-rich provinces are found to undergo higher inflation and almost nonexistent capital movement, implying that mineral abundance has a considerably feeble impact on the growth of exports.

Lastly, according to the Chinese Department of Homeland and Resources, 126 towns from 666 were categorised as resource-rich cities in 1996. More than ten per cent of those towns were also considered "hopeless" because of their depleted resources and how polluted those cities were, with a reduced, even negative economic development (Hajime et al., 2013). The same scenario was seen in Japan when Yubari, "the city of coal" (1960) has seen more than ninety per cent of its population leaving after the mines' closure in the nineties. On the other hand, regions such as Tangshan in China has developed thanks to the natural resources. The region has hosted large steel, iron and coal plants, and yet, it is upholding a strong and constant gross regional product until 2018. It also ranks 30 in the world largest 750 cities' report seeing the most significant increase in population and GDP by 2030 (Oxford Economics, n.d.). The successful experiences show that resource-rich regions have used the resources' wealth to build vertical and horizontal associated businesses, as suggested by Hajime et al. (2013). Hence, even when the mines are exhausted, the town can still enjoy expanded industries and technologies crucial to entice workers and businesses.

History of Mining in Australia

The goldrushes of the 1850s put Australia as one of the top mining countries. Gold was initially discovered in New South Wales in 1823, but the deposit was small and scarce. However, different hints of gold were found in the next decades in New South Wales and Victoria. Following updates on the surges, workers started to emigrate to the resource-rich areas, and the developing populace empowered both agricultural and industrial growth. By the mid of the century, Australia provided about 40 per cent of the entire world's gold. During the 1870s, the discovery of minerals in Tasmania has made Australia a significant tin worldwide producer. The nineteenth-century has been characterised by the opening of various large mines such as Copper mines at Mt. Morganin in Queensland; Silver, lead and zinc in New South Wales; Gold at Coolgardie, Kalgoorlie in Western Australia; and Iron Ore in South Australia. However, between 1900 and 1950, the resource sector has experienced a contraction notwithstanding the continuous increase of the minerals value, and only activities associated with lead, zinc and copper carried until the fifties. Until the sixties, Australia was known for lacking sufficient natural reserves of iron metals for local use. Exports of this resource have only flourished after the lift of controls on iron, and the region of Pilbara in Western Australia has seen significant development. This was followed by the discovery of Bauxite for Aluminium, nickel, tungsten, Titanium, Uranium, Oil and gaseous petrol, followed by a renewal of interest in Australia's mineral resources. Productions of different minerals also expanded, and Australia turned into a significant crude materials exporter mainly to Japan and Europe.

Today, Australia is one of the world's leading natural resource nations. It is the world's biggest refiner of bauxite and the fourth biggest maker of essential Aluminium. It is the biggest supplier of jewel and modern precious stones, lead and tantalum, and the mineral sands ilmenite, rutile and zircon. It is in the top 5 countries producers and exporters of black coal, copper and silver, the second-largest producer of metals, the third-largest producer of gold, ore and atomic number 25 ore and the fourth-largest producer of nickel (Minerals Councils of Australia, 2020). Additionally, new deposits are found and advanced as demand for mineral products grows (ibid.). This means that Australia is likely to stay among the world's wealthiest countries in terms of minerals. However, the resource sector needs to explore more and extract additional minerals to fulfil the demand for its product and replace historic non-operating mines. Several ancient mining LGAs have outlasted their natural resources' depletion, a source of population growth. Those "survivors" have grown into local services centres for other sectors such as tourism and education. Several others have been completely abandoned, or have their population regressing, or in the best case, are stagnating without any development. Examples are Mary Kathleen in Queensland or Wittenoom in Western Australia (Australian Bureau of Statistics, 2019).

4.4 Descriptive Statistics

Throughout the last thirty years, Australia experienced strong economic development at around 3 per cent every year. The local government areas growth, however, has not been constant nor identical. Melbourne district, for instance, has seen a development that is four times higher than the Hume Region since 2001, and those counties are both in the same state, Victoria. A move of the economic activities toward resource-rich areas has characterised this stage where substantial investment in the resource sector came following the mining boom. This has led to the fast growth of mining Local Government Areas, even when compared to capital cities. Between 2000 and 2016, the period of interest in this paper, two crucial changes characterised the country's economic geography (Commonwealth of Australia, 2018). The congregation of various economic activities into the business districts of capital cities enhanced their contribution in the nationwide activity to reach 25 %, notwithstanding its total land area of 0.05 % (ibid.). As the country ranks among the most urbanely developed countries in the world, cities generated spillovers, deeper labour markets and economies of scale. The other fundamental change occurred due to the mining boom.

The sixteen years studied in this paper are the years when Australia came across one of the biggest resource booms of its history. The resource sector contribution of the total economy reached 7 per cent in 2016. On a local level, some resource-rich local government areas such as Pilbara, WA Goldfields and Hunter Valley constituted 9 per cent of the Australian economy in 2011, double their contribution in 2000. Moreover, between 2001 and 2014, Mining employment more than tripled. Perth has the highest percentage of mining employees, with Brisbane, Adelaide, Mackay, Melbourne, Newcastle, Sydney and Wollongong, located in Western Australia and Queensland. Those mining towns have higher labour force participation rates and smaller unemployment. Moreover, it seems that the hourly pay is higher for the mining sector than other industries, but that does not necessarily mean higher income. In every local government area characterised by a growing mining sector, with Karratha as an exception, the resource sector employed higher in 2011 than any other sector. Regarding Karratha, 18 per cent of the employment was allocated to the resource sector and 26 per cent to the construction industry. Somewhat, the construction industry is an auxiliary industry to the mining sector. This is explained by the need for required infrastructure that supports all mining operations, extractions, and transportation. Typically, a construction stage would precede the mining operations. Higher demand for housing would also play a role in increasing the construction sector in those LGAs.

In 2006, three industries prevailed in different LGAs. The primary industry was Manufacturing in four states, Victoria, Queensland, South Australia and Tasmania. Western Australia was characterised by the dominance of mining, followed by manufacturing and construction. A leading services industry characterises new South Wales, Northern Territory and Australian Capital Territory. Agriculture, forestry, and fishing contributed 2 % to total income, versus 17 % for manufacturing. In 2018, the mining industry was characterised by the most important capital expenditure with the highest portion of depreciation and amortisation as a percentage of total expenses (13%). With the fall of Metal Ore and Oil prices, a strong contraction was seen through all indicators, and sales and service revenues decreased by 11.4 % in 2016-2017. Notwithstanding this shrinkage, the mining industry has the highest weekly "total cash earnings for full-time non-managerial employees paid at the adult rate". The second highest is for Electricity, gas and water supply (Commonwealth of Australia, 2018), which might be related to the mining activity as well as construction.

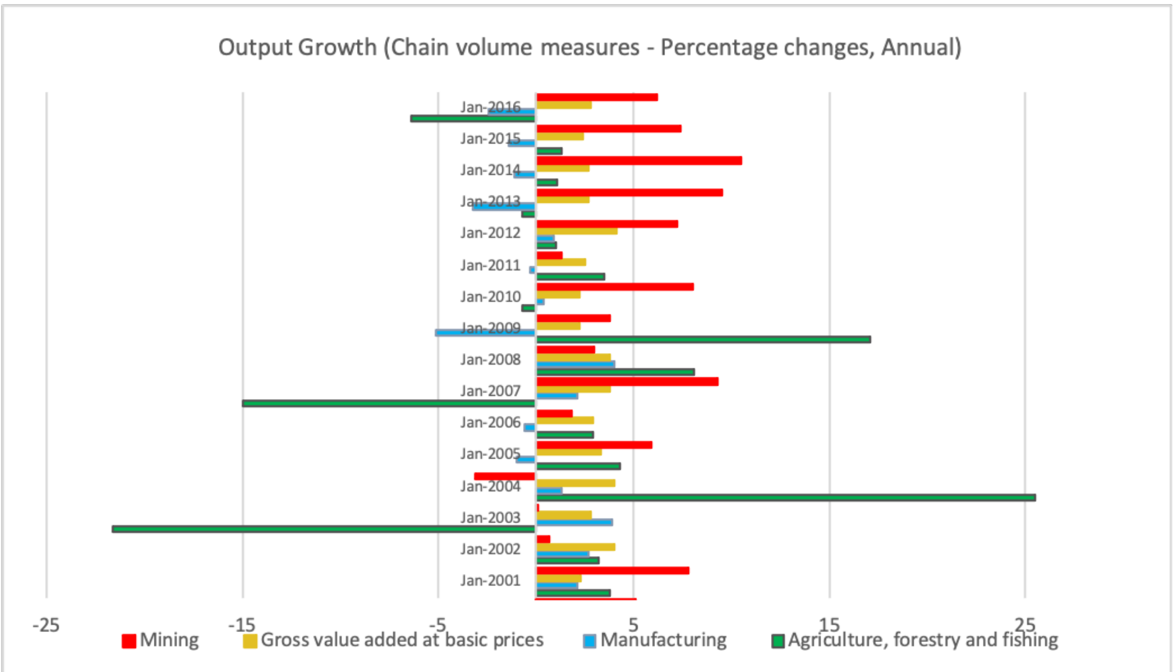

Fig. 4.1 Australian Output Growth (Australian Bureau of Statistics, 2017).

As aforementioned, the Australian economic growth has not been uniform regionally (Bakhtiari, 2016). Resource-rich states have demonstrated specifically solid growth when resource-scarce areas are falling behind. Significant minerals, oil and gas deposits are already known to the Australian authorities, and a boom in exploration activities have characterised the decade of 2003-2013 as shown in Figure 1. Mining output saw an increase by more than 7 % in 2015, the largest contribution to GDP growth. Mining exports grew promptly following the significant investment level over the past decade, translating into further new production capacity (Australian Department of Industry, Innovation and Science, 2015). Australia has benefitted, among others, from the rising demand for minerals and fuel from Asian emerging economies.

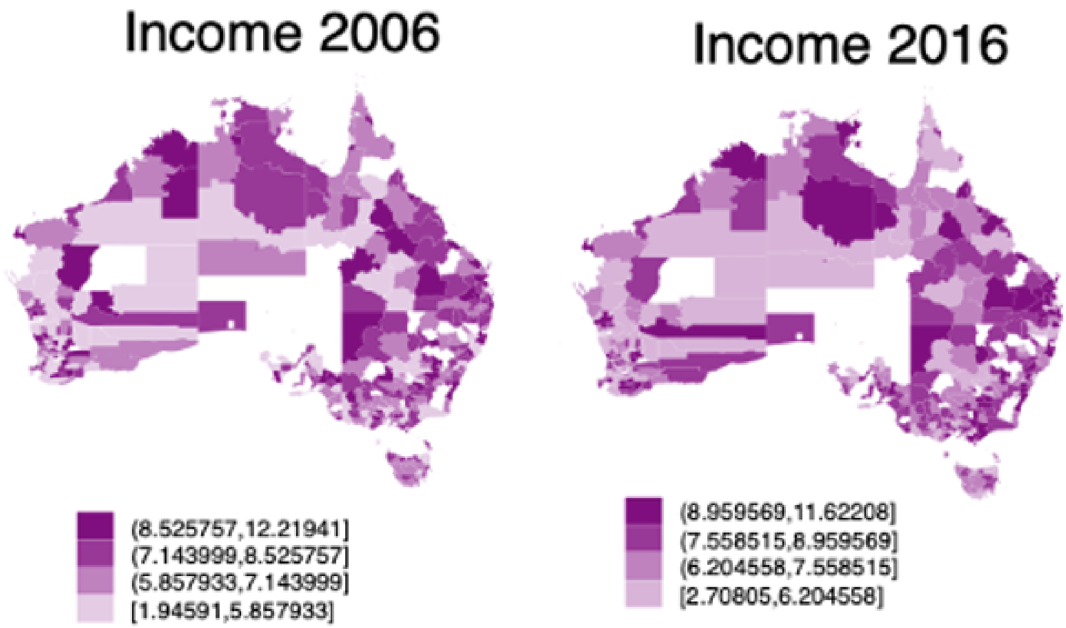

Fig. 4.2 Spatial changes of Total Income – 2006 vs 2016.

As shown in the maps (Figures 2 to 5), resource-rich LGAs have a higher performance in terms of income per capita. Employment has grown quicker in capitals than in other regions, but data also showed that the mining boom shaped it in Western Australia and Queensland. In 2011, around 7 % of the total population over 15 typically received a gross weekly income of more than 2000 Australian Dollars (Australian Bureau of Statistics, 2016). About 22 % receive an income between 1000 and 1999 AUD, where most of the population (72 %) earn less than 1000 AUD weekly. Greater percentages of over 15 in those particular LGAs obtained a weekly income of 2000 AUD or more, with values varying from 17 % in Clermont for instance, to 40 % in Middlemount. A relatively low percentage, compared to resource scare areas, obtained less than 1000 AUD weekly (ibid.). Those results are displayed in the maps above.

According to the Australian Bureau of Industry, Innovations and Sciences (2018), almost 70 % of Australian growth is in capital cities. Their average growth rate of more

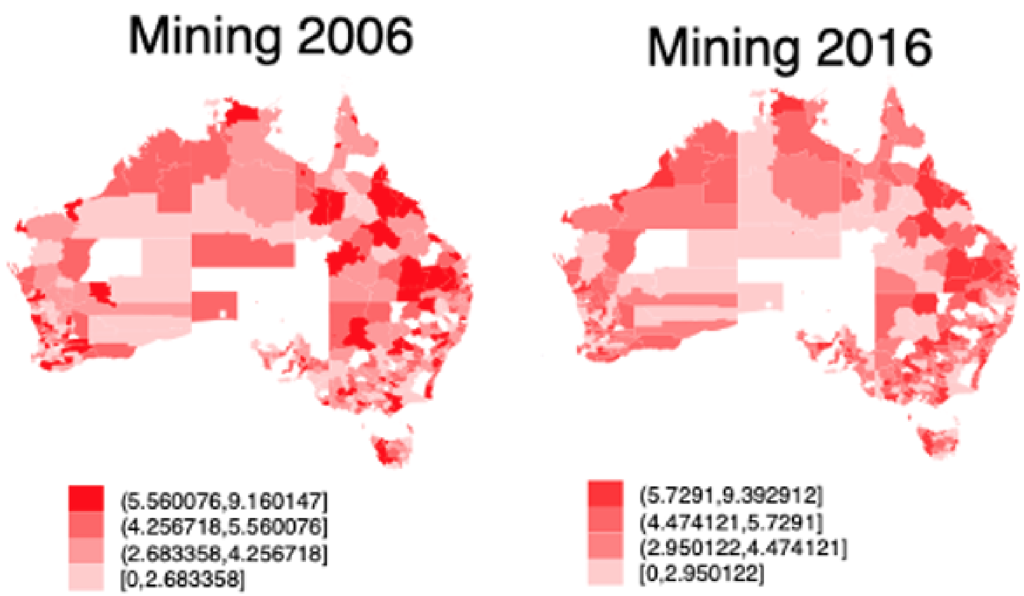

Fig. 4.3 Spatial changes of Mining Employment– 2006 vs 2016.

than 3 % yearly. Another 11 % of national development is created in the resource-rich regions, almost 6 % yearly. The mining boom effect on Queensland and Western Australia is apparent, as those two states are the ones that enjoy a high number of mineral deposits. Both capital cities and neighbouring regional areas saw greater economic development. This sheds light on the resources' income generation that can also be depicted in expanding industries supporting the mining sector. The last 20 % are allocated to resource-scarce areas, with an average growth of 2.5 % yearly. Locally, using the GINI coefficient, it seems that those high living standards are not uniformly spread across regions. For instance, the lowest Gini coefficient was found in resource-scarce local government areas in Tasmania and South Australia (Australian Bureau of Statistics, 2019). On the other side, Western Australia, the state with the highest number of mines, has had three LGAs with the most income inequality: Cottesloe, Peermint Grove and Nedlands.

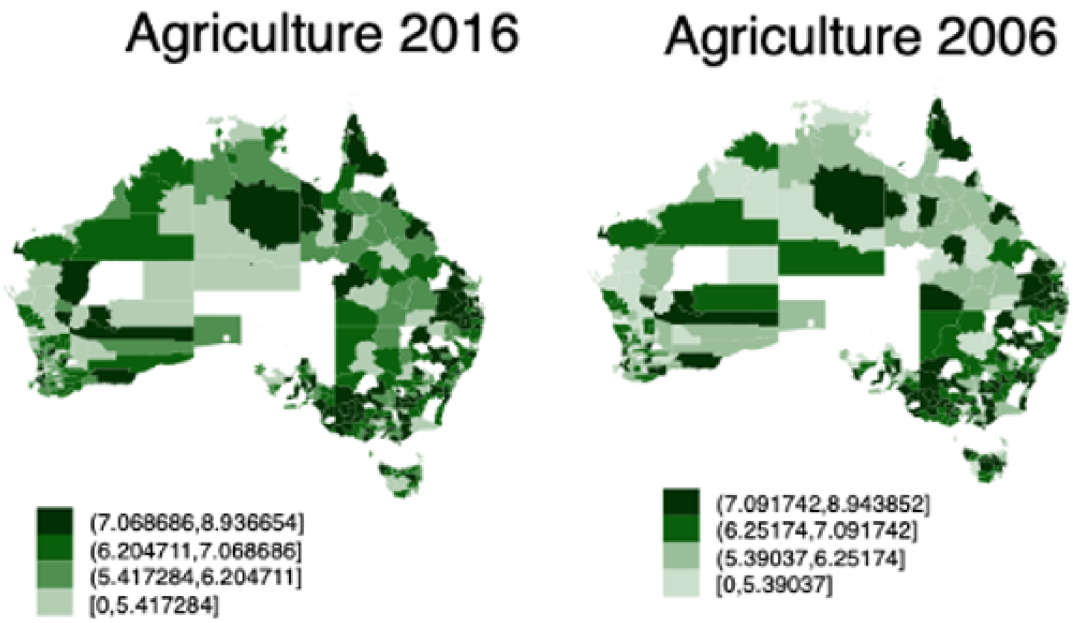

Fig. 4.4 Spatial changes of Agriculture Employment– 2006 vs 2016.

4.5 Data Collection

The data collection process is split into two parts: the collection of spatial data and the collection of the Australian census data.

4.5.1 The collection of Australian data

Local Government Areas are the third tier of the Australian government, subject to the states' jurisdiction or territories. There are seven territorial governments: New South Wales, Queensland, Tasmania, Northern Territory, South Australia, Victoria and Western Australia. There is also the Australian Capital Territory that is considered as what is called unincorporated area; and other territories. There is a total of 563 LGAs across the continent. All the data of the census are collected from the Australian Bureau of Statistics. Regarding the mines, the data for the number and latitude and longitude of active mines and historic mines and their corresponding LGAs were collected from the Australian Mines Atlas (2019). The dataset contains the mines' total count and

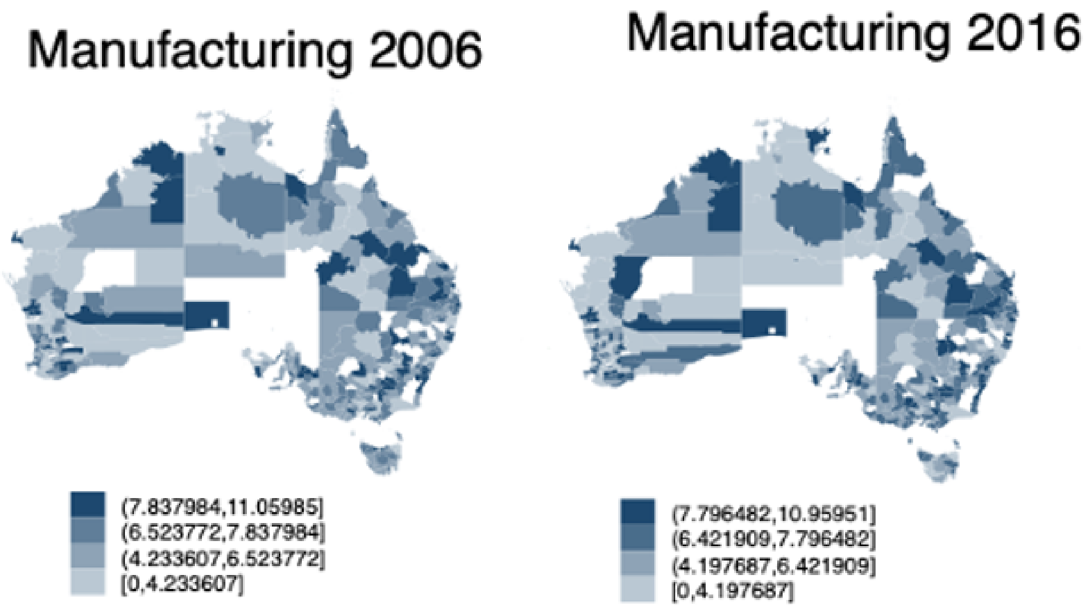

Fig. 4.5 Spatial changes of Manufacturing Employment– 2006 vs 2016.

the count of active mines for each census year. The dummy variables were created depending on the existence of operating mines in the LGA and depending on whether a new mine opened in that year. Two other variables are constructed: The first one specifies the opening year of the mines to assess the opening of one extra mine in the LGA, and the second one identifies the time-varying operating mines over the years starting from 2001. The latter variables required an extensive collection of mine data: It involved searching every single mine among the 250 mines of the dataset, checking the opening year and the date, and which type of minerals. Fortunately, the search was successful for 80% of the mines used hereafter.

The data collected also comprises the number of employees working in different sectors of the Australian economy in each LGA over the years 2001, 2006, 2011 and 2016, but mainly in the mining sector per LGA. The dataset includes the total employment, total population, percentage of labour force participation, unemployment and the total number of persons aged over 15. All the variables are per LGA over the interval 2001-2016.

This yields the data in Table 4.1 below.

Variable	Obs	Mean	Std. Dev.	Min	Max
logIncome [1]	1,482	7.35	1.84	1.95	12.22
LogMin [2]	1,482	4.25	2.16	0	9.39
Unemployment [3]	1,482	6.31	4.69	0	62
Labour force participation [4]	1,482	59.48	7.54	16	82
Total Mines	1,482	4.46	16.88	0	255
Total Operating Mines	1,482	0.76	3	0	44

Table 4.1 Summary of key variables

4.5.2 The collection of spatial data

The boundaries files are collected from the Australian Bureau of Statistics in an ESRI shapefile format. The projections are geographical and comprise latitudes and longitudes. As the spatial units are closed polygons, latitude and longitude points would determine every LGA's centroids, with each polygon's surface.

4.6 Econometric Modelling

This paper looks at the mining impact on regional income patterns. Whether higher mining employment within a local government area is a source of blessing or a curse to the LGA and neighbouring areas is the fundamental empirical matter depending on regional spillovers.

The first section uses a difference-in-difference estimation in order to assess the effect of operating mines and new openings in a local government area. The second section looks at the impact in neighbouring areas and uses spatial regressions based on Australian

[1]Log Income is the natural Logarithm of Income per capita per region

[2]Log Min is the natural Logarithm of number of employees working in the mining sector of the Australian economy in each LGA over the years 2001, 2006, 2011 and 2016

[3]Unemployment: Percentage of people of working age who are without work, are available for work, and have taken specific steps to find work

[4]Labour Force Participation: the percentage of persons in the labour force as a percentage of the working-age population

census data, aggregated to the Local Government Areas (LGAs)' level. The aim is to investigate the total impact, direct and indirect, of the regions' resource-richness, where a number of LGAs have active operating mines, some have historic inoperative mines, and the remaining are resource-scarce with no mines at all. The spatial autoregressive models have been used in a wide range of disciplines, including criminology, demography, political sciences, public health, and economics (Waller and Gotway, 2004; LeSage and Pace, 2009; Fleming et al., 2015, among others).

4.6.1 Impact of opening mines in Australian LGAs: Difference-in-difference with a a Distance Matrix

This section looks at the impact of operating mines and new opening on income at the regional level. Various estimation methods are used in order to discern the effect of mining in a local government area.
Appendix D displays the fixed effect regressions that are not statistically significant. The fixed effect seems to fail to capture the impact of opening the mines on a local government area's income and mining employment. Thus, it could be concluded that there is likely an unobservable component the latter modelling did not account for.

Since the eighties, with Ashenfelter and Card (1985) 's pioneer work, difference-in-difference estimations have become widely used in research, especially that it helps in considering the fixed unobservable characteristics (Imbens and Wooldridge, 2007). A straightforward structure of the estimation is when the outcome, log income, is observable for both resource-rich and resource-scarce LGAs for the time period between 2001 and 2016. However, it is not possible to have a standard textbook difference-in-difference estimation because the untreated group has no time variation. The resource-rich LGAs might have already some mines operating and are treated with the opening of new mines after 2001. Resource-scarce areas have no resources and are not subject to any new opening.

We created a dummy based on a distance matrix that gives zero to areas that more than 100 km away from the centroid of the mining area and 1 if less than 100 km to allow some time variation in the control group. The treated areas are LGAs where a mine opens, and the control group is the resource-scarce neighbouring areas within 100 km with no openings. This allows capturing the impact of opening a mine on a treated area relative to nearby areas that are untreated. Moreover, it can be argued that using nearby areas as controls is worthy, as one can assume that some unobserved characteristics do not vary considerably, if any, between the treated and untreated areas.

The analysis relies then on the difference-in-difference as a way to better control for the unobservable component, following:

$$Y_it = \mu + \beta_1 P_t + \beta_2 T_i + \beta_3 P_t T_i + \alpha_i + \epsilon_i t \tag{4.1}$$

where Y_it is Log income, P_t is a dummy variable or the binary variable that takes zero in the baseline estimation and 1 for the follow-up (2016) and T_i is a dummy variable for the treatment group: dummy based on a distance matrix that gives zero to areas that more than 100 km away from the centroid of the mining area and 1 if less than 100 km to allow some time variation in the control group. The interaction term, P $\times$ T, is equivalent to a dummy variable equals 1 for observations in the treatment group, in the second period. Lastly, α_i: Individual fixed effects that change across LGAs (state-specific characteristics, labour force size and changes in total population)

To better understand this representation, μ is the mean for the control group, $\mu + \beta_1$ is the average outcome of the control group in the follow-up, β_2 represents the difference between the control and the treatment groups in the baseline estimation, $\mu + \beta_2$ is the average outcome of the treated group in the baseline. $\mu + \beta_1 + \beta_2 + \beta_3$ denotes the average outcome of the treated group in the follow-up. The DID outcome would be a result of the interaction of the estimated coefficients β_3 (Villa, 2016).

Difference-in Difference : LogIncome

Baseline			Followup		
	Control	19.95		Control	19.939
	Treated	110.717		Treated	110.658
	Difference (T-C)	130.662**		Difference (T-C)	130.66***
		(0.02)			(0.02)
Diff-in-Diff = 0.065 ** (0.026)					

Table 4.2 Diff-in-difference estimation

The results from Table 4.2 show that the mining dummy has a positive impact on income. The existence of operating mines in a particular LGA and the opening of new mines is likely to a higher income, as shown from the difference-in-difference coefficient. Specifically, the effect of the treatment being an opening of a mine leads to an increase in the income by 6.5 % compared to the average change over time for the control group.

Those findings confirm the findings of Dyrstad et al. (2017), who concluded that a growing mining sector, following the opening of a mine, for instance, would raise the regional consumer prices, namely the housing costs. The latter inflation's nominal wage effects are what they called the "cost of living effect". With the assumptions of the normality of both demand and supply elasticities, it can be argued that the local consumer prices inflation diminishes the labour supply, hence increasing nominal wages but decreasing the real consumers' wages. Moreover, Boyce and Emery (2011) found that, even though natural resources are adversely associated with growth rates, they are positively interrelated with income levels. Importantly, raises the question of the indirect impact of the mining activity on the neighbouring areas. Hence, the following section uses spatial regressions to investigate the mining impact in mines neighbouring areas.

4.6.2 The impact of mining on the neighbouring LGAs

Cross sectional Spatial Regressions

Regarding this section's methodology, it is crucial to highlight that modelling regional growth across the local government areas requires considering the spatial dimension (Fleming et al., 2015). They explained the importance of taking the spatial component into account by the impact of the mining activity on neighbouring areas. In fact, the employment levels, as well as population density and the nature of the leading regional activity, are key elements in the evaluation of mining on regional inequality. This would suggest that, econometrically, the model's errors are spatially correlated and might imply spatial heterogeneity (ibid.). Neelawala et al. (2012) argue that "failing to include this lag price/autocorrelated error variable as an independent predictor has a significant impact on the model specification when spatial dependence/spatial autocorrelation is present (Moran's I is significant)." Those concern are solved in a spatial framework (Anselin1988; Neelawala et al., 2013, cited in Fleming et al., 2015). One challenge associated with this type of model is the need for the data to be strongly balanced, which cannot be possible if the data presents missing values. The only way to deal with this issue was to make the data strongly balanced by retaining 494 out of 562 LGAs. The LGA removed were the ones with densities of less than a 0.1 inhabitant per square kilometre mainly in South Australia.

After running the Moran test to test whether the errors from an OLS estimation are independent and identically distributed or if a correlation with nearby disturbances exists, and after rejecting the null hypothesis of i.i.d, a spatial regression becomes needed.

The first model is a cross-sectional estimation for the census year 2016, that follows:

$$TotalIncome_i = \beta_0 + \beta_1\, MiningEmployment_i + \omega\, W\, TotalIncome_i + \epsilon_i \qquad (4.2)$$

Where Y is total income or income per capita in an LGA i, $MiningEmployment_i$ is a vector that comprises the share of Mining employment from total employment in i. The model includes the term $\omega \, W \, Y_i$, meaning that we assume that the total income spills over from nearby LGAs, that is assuming that the income in a region i is affected by the income of the neighbours' areas.

W is the contiguity weighting matrix, a symmetric matrix that has the same positive weight for adjacent LGAs (sharing the same borders), and 0 for all others.

The solution for Equation (3) as suggested by LeSage and Pace (2009) is:

$y = \beta \, X + \omega \, W \, y + \epsilon$

$y = (I_n - \omega \, W)^{-1} \, X\beta + (I_n - \omega \, W)^{-1} \, \epsilon$

with $\epsilon \sim N(0, \sigma^2 I_n)$.

$(I_n - \omega \, W)$ needs to be non singular, and the product

$(I_n - \omega \, W)^{-1} \, (I_n - \omega \, W)^{-1}$, being the variance covariance matrix, is positive definite.

For this first regression, one might think that the direct effect (similar to the OLS interpretation) resides in the coefficients β_1 and ω; and that the spillover or indirect effect is the coefficient ω. If the regressors increase, income is reduced by β_1 and yields an additional decrease in income of $\omega \, W$. This drop spills over to another reduction in income and this cycle carries on. Thus, to assess the direct versus the indirect impact, one needs the average effect from the latter process (LeSage and Pace, 2009).

In spatial model, the margins are changes in the response for changes in the covariate, reported as derivatives. For this, letting a matrix S_n be S_n= $(I_n - \omega \, W)^-1$. S_d is a matrix with diagonal elements of S_n on its diagonal and with all other non-diagonal elements equal zero. The direct effect would be equal to $S_d \; X_{i,t} \, \omega$: that represents the participation of each element of the regressors on the reduced form mean of y. The indirect effect would be equal to $(I_n - \omega \, W)^{-1} - S_d \, X_{i,t} \, \omega$ that represents the participation of the other elements of the regressors on a unit of the mean.

Starting with the comparison between the spatial model and the OLS regression, both models have mining employment as the explanatory variable. A comparison between an OLS estimation and a spatial regression model shows that the spatial model explains better the data, especially with the result displayed from the Moran Spatial Test. As shown in Table 4.4, the Moran test evaluates the hypothesis of no spatial autocorrelation of the residuals (Lauridsen and Kosfeld, 2004) and assumes errors are i.i.d. When the values of different LGAs follow a random distribution, the Moran statistic tends to zero. If Moran statistic's value is positive and significant, then one can conclude the positive spatial autocorrelation across the LGAs. This holds also for negative Moran's statistic values, that means a negative spatial autocorrelation (Kondo, 2018). The null hypothesis of spacial randomisation is rejected with a 95 % confidence level which justifies use of the spatial regression model.

The spatial model from Table 4.3 shows the coefficient, ω being the estimated value of the spatial autocorrelation parameter. It is associated to the dependent variable y and $\omega = 0.725$ and is statistically significant. ω designates the autocorrelation parameter. It is not a correlation coefficient, even though it shares a number of features with correlation coefficients. It is theoretically bounded by -1 and 1, and $\omega = 0$ means that the autocorrelation is 0. Thus, one can conclude the existence of spatial autocorrelation.

To explain more, the spatial autocorrelation indicates that a spatial variation is present in a mapped structure. If the contiguous observations present similarities, the map displays a positive spatial autocorrelation; if, on the contrary, the contiguous observations present diverging values, a negative spatial autocorrelation exists (Haining, 2001).

	Spatial Regression	OLS
	Income Per Capita	Income Per Capita
Mining Employment Share	5.187***	5.032***
Spatial Lag of IncomePC	0.725***	
R^2	0.1398	0.1306

Table 4.3 Cross-sectional Spatial Regression versus OLS

H_0: Errors are i.i.d H_A: Errors are spatially dependent
$\chi^2(1) = 5.36$**

Table 4.4 Moran test for spatial dependence

The Model from Table 4.5 have mining as an endogenous covariate and assume the disturbance are spatially correlated. All spatial equivalent lagged terms are added because of the uncertainty of how spillover from neighbour areas impact the outcome.

The spatial lag of income, or ω from equation (2) equals 0.78 and is statistically significant. Hence, results show the presence of positive spatial clustering, defined by Pisati (2012) as “the existence of sub-areas of the study area where the attribute of interest takes higher than average values or lower than average values. A valuable post-estimation analysis is margins analysis. This estimates the mean of the regressors' total impact and detangles it into direct and indirect impact on the dependent variable's reduced form, income per capita. The Delta method used in Table 4.6 assumes that the regressors are fixed and estimates the effects' variance. It allows calculating the average marginal impact of the independent variables on the reduced form mean of the income.

	Income Per Capita
Mining Employment Share	5.104***
Spatial Lag of IncomePC	0.78***
Spatial Lag of Mining	4.09
Spatial Lag of Disturbances	-0.88
R^2	0.1226

Table 4.5 Cross-sectional Spatial Regression with Endogenous Covariates

Average impacts	Number of obs=494	
Mining Employment	dy/dx	Std. Err.
Direct	5.20***	.57
Indirect	6.61***	2.15
Total Mining Employment	11.81***	2.22

Table 4.6 Average impacts Delta-Method

For this analysis, all impacts are measured in percentages, which means a 1 % change in the regressor leads to a 1 % change in the dependent variable. The direct effect is the effect inside the LGA without the spillover effect. That is, a 1 % change in the share of Mining employment increases the income by 5,2 %. The indirect effect is the spillover effect, where an increase in mining increases income by about 6.6 %. The total effect of Mining employment is the sum of both effects as displayed in Table 4.6.

Those results can be explained by the fact that the mining industry's labour has a regional income effect due to the rise in salaries and wages following a surge in demand. The regional economic growth might be foreseen to increase in LGAs where mines already exist or where new mines open. This would, in turn, raise both local investments and services' demand that leads to jobs spillovers. Moreover, the increase in total income can result from higher taxes or royalties mining companies pay to the landowners or the local authorities. This explains what Reeson et al., (2012) and Carmignani (2013) (cited in Fleming et al., 2015) concluded that the mining impact is "likely to change the distributional pattern of income in local areas, therefore affecting income inequality across space, which can subsequently also affect economic development".

Panel Spatial Regressions

According to Fleming and Measham (2014), more than 120 mines opened or reopened in all states during 2004-2014. This led mining employment to increase across most LGAs of the continent, as shown in Figure 2. This has driven the analysis to expand to become a panel model. Hence, to further explore mining activity's impact, we now cover data over ten years with census data from 2006 to 2016, with 494 LGAs. Population and the surface of each LGA are controlled for in the following regressions. This model allows the panel-level effects to be associated with the observed covariates.

Mining activity across LGAs emerges as natural experiment resulting from resource endowment and exogenous commodity price shocks; resource-rich LGAs are considered the treatment groups and resource-scarce LGAS controls, creating a natural experimental setting for impact evaluation (Fleming and Measham 2015). The variable of mining employment change is suitable to investigate whether the resource curse impacts local income levels.

$$Y_i = \beta_0 + \beta_1 X_{i,t} + \omega_1 W Y_{i,t} + \omega_2 W X_{i,t} + c_i + \epsilon_i \tag{4.3}$$

Where $Y_{i,t}$ is T*1 vector of the dependent variable; total income by LGAs,
$W Y_{i,t}$is a spatial lag of Y to allow nearby income to impact neighbours' income.
$X_{i,t}$ represents the matrix of time-varying independent variables, being the shares of employment from the mining sector.
$W X_{i,t}$: spatial lags of the regressors to allow nearby employment's share to impact neighbours LGAs.
c_i is the fixed effect
$\epsilon_i = \gamma E \tilde{\epsilon_{i,t}} + \vartheta_{i,t}$: spatially lagged disturbances to allow nearby autoregressive errors to impact income; with $\vartheta_{i,t}$ independent and identically distributed innovations across the LGAs and the years; E an *i*i* weighting matrix.

The panel fixed effect is estimated through the quasi-maximum likelihood (QML), following a methodology suggested by Lee and Yu (2010). As suggested by Lee (2004), the Maximum Likelihood estimation takes into account the robustness of the VCE. The transformation needed to estimate the model yields:

$$\tilde{Y}_i = \beta_0 + \beta_1 \tilde{X}_{i,t} + \omega_1 W \tilde{Y}_i + \omega_2 W \tilde{X}_i + c_i + \tilde{\epsilon}_i \tag{4.4}$$

$$\tilde{\epsilon}_i = \gamma E \tilde{\epsilon}_{i,t} + \tilde{\vartheta}_{i,t} \tag{4.5}$$

Similarly to the solution of Equation (3), the solution for Equation (5) with the fixed effect has an additional individual effect c_i and the conditional mean of $\tilde{Y}_{i,t}$ is equal to

$E(\tilde{Y}_{i,t}|X_{i,t}, W) = (I_n - \omega\, W)^{-1}\, X_{i,t}\beta.$

Dependent Variables	Income PC	Employment
Mining Employment	3.43***	0.65*
Spatial Lag:		
Y	0.75*	0.015
Mining		2.57**
Employment	0.0003**	
Disturbances	-0.85*	0 .071**
Wald test of spatial terms	42.54***	7.86**
R^2	0.0612	0.02

Table 4.7 Panel Spatial Regressions

Table 4.7 displays the panel spatial regressions for both income per capita and employment rate. The results show the statistical significance of the spatial lags. Moreover, the result of the Wald test of spatial terms indicate that we are 99 % confident that the null hypothesis $H_0 : \omega = 0$ (i.e. no spatial relationship) is rejected.

Table 4.8 and 4.9 show that LGAs benefit from higher income and higher employment generated by the mining sector. As the indirect effect is the spillover effect this section focuses on, results show that a 1 % increase in mining share increases income in the same LGA by approximately 3.5 %. The same outcome applies to total employment, where mining increases total employment by 0.66. Importantly, a 1 % increase in mining employment has a positive impact on neighbouring areas by almost 2 % for total income and 1.9 % for total employment.

Those results come in accordance with a paper by Rolfe et al. (2011). Their paper looked at the indirect business and consumption impact due to employment variations, the activities, and the mining industry's supply chains. Their results suggest that income

Number of obs = 1482		
Total income		
Share Mining	dy/dx	Std. Err.
Direct	3.454***	0.41***
Indirect	1.962*	1.11
Total	5.41***	1.23

Table 4.8 Average impacts Delta Method – Total income

Number of obs = 1482		
Total employment		
Share Mining	dy/dx	Std. Err.
Direct	0.66**	0.39
Indirect	1.9**	0.78
Total	2.62***	0.9

Table 4.9 Average impacts Delta Method – Total Employment

generation from mining extraction follows a wide distribution that yields substantial inflows to the regions. Mining activities have solid direct contributions in adjacent regions of Queensland and reinforce their economic growth. Moreover, they revealed that mining expenditures also have spillovers that generate considerable production level in the south-east and centre of Queensland.

4.7 Analysis: a blessing or a curse ?

Several papers have highlighted the labour demand shock resulting from the mining sector's expansion is seen as a resource curse channel operating at the local level. According to Fleming et al. (2015), the mining industry in Australia is capital intensive rather than labour intensive, and the share of mining is lower than the share of manufacturing and agriculture, for instance. This might suggest that the mining sector's direct labour demand has a small impact on economic growth. Regarding the impact on employment, when job spillovers outweigh the crowding-out impact, the medium run of employment's increase can be favourable in mining local government areas. However, the ultimate long run would vary depending on how well the area can maintain its human capital formation and manufacturing and agricultural sectors (Glaeseret al.2015, cited in Fleming et al., 2015). By contrast, some researchers suggest that the direct labour created by the mining activities has a substantial impact on income generation as the salaries rise in relation to the increase in labour demand. Hence, the economic growth is foreseen as greater revenues in resource-rich areas where workers live and work will enhance local investment and demand for non-tradables which generates job spillovers and more development. The resource industry's income effect is also a source of inequalities with the distributional shape of income in different LGAs. Local authorities' income is also foreseen to increase due to returns or royalties remunerated by the mining companies.

This paper's results are in accordance with Hajkowicz et al. (2001), who found that a booming mining sector played a significant role in improving key socio-economic variables, namely the regional income, as in this study. Those results can be explained through various transmission channels of natural-resource abundance at the regional level: investments' spillovers, market linkages and fiscal transfers. The increasing income from the mining industry, positively affects the LGA's economic performance, mainly through linkages with local businesses (Cust and Viale, 2016).

Staple Theory classifies the economic linkages into backward, forward, revenues and demand linkages (Watkins, 1977; Gunton, 2003; Fleming and Measham 2014). The categories aforementioned are backward and forward connections related to the aggregate demand for inputs and outputs created by the mining sector. Linkages are foreknown to enhance the economic development of the local government area. Hence, those linkages' effects seem to dominate over the potential negative impact on manufacturing and agriculture. Furthermore, the life cycle of mining activities should be considered, that is, "investment, construction, transition, maturity and winding down or closure" (Fleming and Measham, 2014). Even the third and fourth stages might require manufacturing outputs for maintenance or expansion. The forward and backward associations suggested in the Staple Theory could be a blessing to the LGA and its neighbouring areas if the LGA can preserve and grow local businesses that specialise and deal with the extractions' inputs and outputs. The enlargement of mines might also promote the creation of new businesses associated with the mining sector. Therefore, the positive spillovers seen in the results are justified by the forward and backward linkages and the impact of agglomerations economies that "tend to affect tradable goods industries positively" (Goetz, 2002; Moretti 2010; Fleming and Measham, 2014). Generally, more mining employment might lead to a crowding-out of the tradables; however, the overall impact depends, among others, on labour supply elasticity (Moretti, 2010). A highly elastic labour supply would reduce the crowding out and diminish labour cost impact, whereas low elasticity translates the opposite.

When a mine opens, the LGA's population and salaries rise, and the regional welfare rises even with the lagging sectors' crowding-out. As Allcott and Keniston (2018) claimed, natural resources' procyclicality characterises all the latter macroeconomic variables and employment rates; they would increase with a boom or a windfall and decrease with busts. In the US's recent resources boom, they found that wages increase by up to 3 % in the resource-rich provinces. They also found that the manufacturing sector did not shrink on a regional level. Instead, it grew thanks to the regionally traded subsectors and industries with "upstream or downstream input-output linkages to oil and gas" (ibid.). On the other hand, highly tradables industries have experienced a serious contraction. Moreover, it is argued that the revenue-based total factor productivity of regional manufacturing factories have procyclical patterns with natural resources due to the procyclicality of regional output prices or the countercyclicality of transport prices. Hence, and in spite of the provisional shrinkage, its total factor productivity does not drop. This process could explain why this paper's results showed a positive spillover effect when the Dutch Disease literature suggests the opposite.

The results of this paper are contrasted with the resource curse literature, such as Cust and Viale (2016) and Papyrakis and Raveh (2013), and support the findings of Aragon and Rud (2013) and Allcott and Keniston (2018). As shown in this paper, the spillover effect has positively impacted income and employment in neighbouring areas, thanks to the boom or windfall revenues.

4.8 Policy implications

The mining industry has impacted Australian LGAs through three channels: mining activities, the generation of revenues to be spent at the LGA level, and regional spillovers. Policymakers should focus on managing and mitigating the negative impacts of the mining industry. The government might pay more attention to ways to offset fiscal policy. Authorities should aim to reduce the regional inequalities and the insufficient financing in resource-scarce regions that suffer from low economic growth. Lastly, reducing the increase in local prices due to the mining sector boom seems essential to prevent the shrinkage of the lagging sectors of the regional economy.

Empirical findings showed that the mining industry's extra revenues' management represents an important challenge to local authorities. This can be alleviated through policies aiming for building assets progressively while improving their capacities to spend. Central authorities could support LGAs to save mining revenues instead of spending them entirely every fiscal year. Those spending patterns, along with prices volatility, could be controlled through stabilisation funds. The USA and Canada have opted for this solution, where the funds act as buffers, hold and manage the revenues such as the Alaska Permanent Fund and The Alberta Heritage Savings Trust Fund. However, it is essential to highlight that that those funds' effectiveness is subject to transparency, and to the enhancement of the accountability of the transfers. In general, Cust and Viale (2016) found that greater transparency encourages "citizen's participation and monitoring of resource revenue spending by government". When run effectively, those funds might reduce the heavy dependence on the mining industry and represent an opportunity for diversification. Careful public investments in infrastructure or spending to develop weakened sectors could be a potential solution to benefit from resource endowment fully.

4.9 Conclusion

Although the country-level impact of natural resources has been extensively investigated, little attention has been paid to the local and regional effect (Rolfe et al., 2011). To date, most research has focused on aggregate or cross-country experiences. Remarkably, the role of mining in enhancing the socio-economic development of local areas has not been sufficiently studied (Solomon et al., 2008) due to the lack of regional data, among others. Some researchers have acknowledged issues related to the regional development, namely income inequalities and the local resource movement effect from mining expansion (Lockie et al.;, 2009; Reeson et al., 2013; Fleming et al., 2015). Those issues suggest an equivalent scenario to the Dutch disease on a regional level. On the national level, mining extraction leads to the decline of primary products trade and the deficiency in enhancing the manufacturing area and its competitiveness due to the exchange rate's appreciation (Bulte, Damania and Deacon; 2004; Collier, 2007). Together with the fall in employment in the tradable sector, higher salaries for mining workers push the production toward the services and the booming sectors (Corden and Neary, 1982).

This paper adds to the literature through a discussion of the impct of mining on income in resource rich and resource-scarce Australian local government areas using various econometric models. In order to investigate the mining openings on income in Australian LGAs, the treatment effect results showed that LGAs without operating mines have lower income than areas that enjoy operating mines. Moreover, the difference-in-difference findings revealed that the opening of a new mine increases the log income in the treated local government area by 6.5 %. Moreover, income generation from mining extraction yields substantial inflows to the regions adjacent to resource-rich LGAs. In terms of spatial regression, results showed that mining activities have solid direct contributions in neighbouring regions and reinforce their economic growth. Results also show that a 1 % increase in mining share increases income per capita by 2 % and employment by 1.9 % in neighbouring LGAs.

As stated by der Ploeg and Poelhekke (2017), natural resources are not definitely a curse. Notwithstanding the large cross-sectional research on the negative relationship between resource endowment and economic growth, the empirical evidence on a regional level shows that the mining sector has a positive effect on employment and income in rich LGAs but also in the neighbouring areas.

Chapter 5

Conclusion

This thesis is a collection of three papers that investigate the impact of natural resources on economic growth. It sheds light on the various spillovers of resource wealth on the country level and the regional level.

The first paper contributes to the literature in two aspects. Firstly, few papers have tried to investigate the resource curse impact on the financial and banking sector. Among those who explored the latter, most of the papers has focused on oil and gas as indicators and discarded other natural resources such as minerals. Second, and more importantly, little attention has been paid to the difference between the impact of resource abundance versus resource reliance. This paper accounts for this distinction. This chapter's importance arises not only from the importance of financial development on economic development but also from the challenges induced by being a resource-rich country. The results show the existence of a resource curse in resource-rich countries and that financial development and financial liberalisation are hindered by the resource abundance and reliance. Empirical findings show that financial reforms have a lower impact when associated with resource abundance presumably due to weak institutions and a high level of corruption. The reforms' lower impact might represent a reason why resource-rich governments have low incentive to implement reforms. In fact, those reforms can play a significant role in alleviating the effect of commodity price volatility and decrease their negative impact not only on financial development but also on macroeconomic stability. This can be achieved by establishing a sovereign wealth fund, for instance, that can act as a fiscal buffer.

This issue is investigated in chapter 2, which demonstrates the effectiveness of a sovereign wealth fund against the Dutch Disease. The fund has a significant impact in stabilising the economy following a commodity price shock. Moreover, this paper confirms that the model that captures the exploration and depletion of natural reserves, as modelled by Hansen and Gross (2018), better captures the impacts of commodity price shock on the domestic economy. Regarding the optimal tax regime rules, the results show that an ad-valorem royalty (percentage tax on revenue) is efficient in securing a continual stream of returns from the resources sector in comparison to a rent and reserves tax.

The last chapter of the thesis adds to the literature through a discussion of the empirical inferences of income spillovers between resource-rich and resource-scarce Australian Local Government Areas (LGAs). This has been investigated through three main estimations: a propensity score matching treatment effect, and a difference-in-difference to investigate the impact of mining on the LGA, and a cross-sectional and a panel spatial regressions to assess the impact on the neighbouring LGAs. Regarding the mining impact on income in Australian LGAs, it is shown that regions without operating mines have lower income than areas that enjoy operating mines. Results showed that income generation from mining extraction follows a wide distribution that yields substantial inflows to the regions. Mining activities have solid direct contributions in adjacent regions of Australia that reinforce their economic growth. The empirical evidence on a regional level level shows that the mining sector positively affects employment and income in rich LGAs and the neighbouring areas.

The three papers of the thesis emphasise that the investigation of the natural resource impact needs an understanding of the complex linkages between the resources and economic performance. Resource richness could be seen as a double-edged sword that has both positive and negative impacts. The balance between these depends on enhancing the role of good governance, democracy and transparency in law enforcement related to the financial sector and the misallocation of resources revenues. Adopting a sovereign wealth fund is also an effective way to offset commodity price volatility's negative impact. Finally, within-countries, research on the impact of natural abundance is a useful tool for policymakers in various ways. Mining activities can generate greater capital and labour inflows, substantial income, profits, and environmental and social challenges for the areas where this takes place. Policymakers should assess the interaction between the resource revenues and the fiscal policy, promote the economically weaker areas, and reduce the inequalities resulting from the impact of resource abundance.

The research undertaken for this thesis has highlighted a number of concerns on which further research could be valuable. Several gaps were highlighted in the literature reviews. Future research can focus on enhancing financial development in a resource-rich country and how to make the reforms more effective in those economies. According to the World Bank (2012), it is ineffective to try and change a country's institutions unless careful consideration is assigned to the primary political forces through which they appeared and persisted. This should allow an understanding of the required interventions to make the reforms successful. The role of good governance, democracy and transparency in law enforcement concerning the financial sector and the misallocation of resource revenues is crucial. As the second chapter of the thesis suggests implementing a sovereign wealth fund as a cure to the Dutch disease, one must highlight the compliance risks associated with rent-seeking activities and corruption.A sovereign wealth fund could be used as a disguise for economic development and growth but is sometimes used to channel hundreds of millions away to corrupt politicians and officials, such as the Malaysian scandal involving Prime Minister Najib Razak.

Moving to the impact of the sovereign wealth fund in Australia, although the results show its effectiveness in stabilising the economy against a commodity price shock, its impact was not as important as expected following a foreign demand shock for domestic goods. This raises some questions about the SWF role but also its management. Olawoye (2016) argues that as long as the fund is employed to acquire financial assets in foreign currency mainly, then the Dutch Disease's symptoms would not be alleviated. Without substantial investment (e.g. infrastructure), the country would face a fiscal surplus to the detriment of the private sector, such as manufacturing, which would not mitigate the impact of foreign demand shocks.

This would shed light on the investment approaches or the portfolio of the SWF. The continual stream of revenues from the resources sector should be oriented toward the non-tradable sector and its productivity, but also towards domestic investment and its infrastructure. Domestic investment should include rural areas and target poverty reduction. Collier et al.(2009) suggested investing in public infrastructure and human capital, aiming to enhance the private sector's competitiveness, an investment that can counteract the Dutch Disease symptoms. Research by Melina et al. (2016) suggested two investment approaches for the SWF: the spend-as-you-go versus the delinked approach to a SWF. The spend-as-you-go approach involves investing all the resource windfalls each period with no savings, and the delinked approach joins investment and savings with a cyclical government spending in terms of resources revenues. Their results show that a sovereign wealth fund with a delinked approach increases macroeconomic stability. This is an area for further development for the research undertaken in the second paper, where those two resource revenue scenarios can be investigated within the endogenous resources DSGE framework. Other scenarios can also consider the proportion of investment against savings.

On a regional level, the role of resource wealth in enhancing the socio-economic growth of local areas has not been sufficiently studied, and further research should grasp the regional discrepancies and further explore the spatial dimension of the resource curse. In fact, the employment levels, as well as population density and the nature of the main regional activity, are crucial elements in the evaluation of mining in the regional counties.

Overall, it can be concluded that resource wealth is a double-edged sword that provides opportunities but also several problems. The prominent policy question for a resource-rich country is to find the most efficient way to take advantage of the opportunities and control the inevitable problems caused by natural resource endowments.

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Appendix A

Chapter 1

A.1 List of countries

Afghanistan
Albania
Algeria
Angola
Argentina
Armenia
Australia
Austria
Azerbaijan
Bahamas
Bahrain
Bangladesh
Belgium
Benin
Bolivia
Botswana
Brazil
Bulgaria
Burkina Faso
Burundi
Cabo Verde
Cambodia
Cameroon
Canada
Central African Rep
Chad
Chile
China
Colombia
Congo, Dem. Rep.
Congo, Rep.
Costa Rica
Cote d'Ivoire
Czech
Denmark
Dominican rep
Ecuador
Egypt
El Salvador
Equatorial Guinea
Ethiopia
Finland
France
Gabon
Gambia, T
Georgia
Georgia
Germany
Ghana
Greece
Guinea
Guinea-Bissau
Hong Kong
Hungary
India
Indonesia
Iran
Ireland
Israel
Italy
Jamaica
Japan
Jordan
Kazakhstan
Kenya
Korea, Rep.
Kuwait
Kyrgyz
Lesotho
Luxembourg
Madagascar
Malawi
Malaysia
Mali
Mauritania
Mexico
Mongolia
Morocco
Mozambique
Nepal
Netherlands
New Zealand
Niger
Nigeria
Norway
Oman
Pakistan
Papua New Guinea
Peru
Philippines
Poland

A.2 Financial indicators - Fixed effect

	Bank deposit/GDP	CB assets	DomesticCredit/PrivateSector	FinancialSystemDeposit/GDP
Y_{t-1}	0.502***	0.583***	0.05***	0.523***
RS	-1.23***	-0.301***	-0.023	-1.189****
Corruption	-0.179	0.0442	0.0432	-0.125**
GDP PC	0.00839*	-0.005***	0.00704***	0.007***
CPI				0.000526***
Exchange rate	7.0182	12.75*	11.0623***	
R^2	0.753	0.0444	0.0827	0.0523

Table A.1 Financial indicators - Fixed effect

	Deposit and loans from the non-banking sector			Credit to government and state-owned enterprises		
yt-1	0.4432****	0.44531***	0.4441***	0.4861***	0.4895***	0.48654***
RR		-8.035				-0.0154
AS	-4.931			0.119*		
Mineral Prices					0.0001082	
Corruption	2.2.3056	0.063	-0.057563	-0.018	-0.0204	-0.0152
GDP PC				0.00214***	0.00234	0.00235***
CPI	-0.00497	-0.00466	-0.004			
Exchange rate		-3.7		8.5722*	7.42	7.458
R^2	0.753	0.0321	0.0444	0.0523	0.0827	0.0931

Table A.2 Other Financial indicators Fixed effect

A.3 Financial indicators - GMM

	Deposit & Loans - BS	Domestic credit to private sector	Financial system deposits to GDP	M2 (Current LCU)
yt-1	0.5087***	0.8***	0.593***	0.847***
RR	0.5363	-0.0603**	-1.532	0.4312***
RRt-1	0.10273	0.38*	-0.8765	1.43e9
RS				
RSt-1				
Safety & Rule of Law	1.8527***	-0.171	-0.834*	6.1e9
CPI	0.67115		-0.1605	2.3e10***
AB for AR(2)	0.412	0.696	0.13	0.27
Hansen Test	0.747	0.934	0.855	0.118

Table A.3 Financial development indicators - GMM

A.4 Financial Development and Reforms

FD	Coef.	Std. Err.	t	Pt
Directed credit	0.049661	0.0108841	4.56	0.000
Credit Ceilings	-0.0853984	0.0264306	-3.23	0.001
Interest Rate Controls	0.0499318	0.025391	1.97	0.049
Entry Barriers	-0.0031148	0.0136219	-0.23	0.819
Banking Supervision	0.0392115	0.0134832	2.91	0.004
Privatization	0.0141091	0.0126794	1.11	0.266
International Capital	-0.0362719	0.0152005	-2.39	0.017
Security Markets	0.0720581	0.0194921	3.7	0.000
MENA	-0.0793677	0.0261297	-3.04	0.002
Transition	-0.2090875	0.0347959	-6.01	0.000
SSA	-0.2339577	0.0381831	-6.13	0.000
Latin_America	-0.1580988	0.0419779	-3.77	0.000
Emerging_Asia	-0.0668867	0.0298299	-2.24	0.025
Credit Controls		(omitted)		
Advanced		(omitted)		
Instrument	-0.0019582	0.0004392	-4.46	0.000
Constant	0.2234339	0.0635702	3.51	0.000

Table A.4 Financial Development and Reforms

Appendix B

Instrumental variable and testing

B.1 Testing for weak identification

The weak-instruments issue results from a small, but not zero, correlations between the endogenous regressors and the excluded. Staiger and Stock (1997) suggested that we can reject the hypothesis of weak instrument in the first stage of the F statistic is higher than 10 (Rule of thumb). This rule of thumb indicates that the maximum bias in the instrument estimators is less than 10 per cent (Staiger and Stock, 1997): a statistic higher than 10 is considered thus reliable.

If $X = Z\omega + \alpha E$ with E being the exogenous regressors, the concentration parameter is $CP = \frac{\omega' Z' \omega}{\sigma^2}$ Letting $CP_{10\%bias}$ be the cutoff value for CP, one needs $CP > CP_{10\%bias}$. The "weakness is expressed in terms of the size of the bias of the IV estimator relative to that of the OLS estimator, or in terms of the magnitude of the size distortion of the Wald test for parameter hypotheses" (Sanderson and Windmeijer, 2015) A Sanderson-Windmeijer (2015) represents a diagnosis for a weak identification of the endogenous variable. It is constructed by "partialling out" the linear projections of the outstanding endogenous regressors. The S-W test is built on a Wald test that follows a $\chi^2(L_1 K_1 + 1)$, with the tested null hypothesis being the under-identification of the specific endogenous regressor. The detection of the weak instrument is performed through the Sanderson-Windmeijer multivariate F test of excluded instruments is based in Stock and Yogo(2005) critical values.

Because Baum (2007) argues that this criterion does not necessarily determine the absence of a weak instruments problem, we further investigate the weak identification.

B.2 Testing for under-identification of the instrument : Kleibergen and Paap

The problem of under-identification arises when the number of instruments is smaller than the number of endogenous regressors. If it is the case, the IV cannot be used. On the other hand, the problem of over-identification occurs when

the number of instruments is higher than the number of endogenous regressors. Identification results hence from the equality of those numbers. The Kleibergen and Paap (KP) statistic hypothesise a weak instrument. In other words, the KP checks the null hypothesis that the instrument used have a deficient explanatory power in predicting the endogenous variable identification, through partialling out the the exogenous covariates. It tests the identification of the instrument in the equation as a whole and the rejection of H_0 concludes the absence of a weak instrument where the instrument matrix ifs a full rank matrix. If $X = Z\omega + \alpha E$ with E being the exogenous regressors, the KP tests the rank of ω with
$H_0 : rank(\omega) = k_{x-1}$
$H_A : rank(\omega) = k_x$ where k_x is the number of explanatory variables.

B.3 Inference robust to weak identification

The Anderson-Rubin Wald test (1994) and the Stock-Wright (2000) LM S (GMM distance) test assess the inference robustness. In other words both tests have the same null hypothesis: the coefficients of the endogenous variables in the structural equation are jointly zero, and the overidentifying restrictions are valid. It is comparable to an estimation of a reduced form equation with the whole set of instruments as regressors. The convergence holds regardless of whether the identification is strong or weak (Mikusheva, 2013). Specifically, the null hypothesis is that the coefficients β in the structural equation are jointly equal zero, from the reduced form for Y:

$Y = X\,\beta + \epsilon$, X X is endogenous and Z is an instrument.
$H_0 : \beta = 0$
After regressing $(Y - X\,\beta)$ on Z:
$AR(\beta) = \frac{(Y-\beta\,X)'\,Z'(Z'Z)^{-1}Z\,/(Y-\beta\,X)/k}{(Y-\beta\,X)'[I-Z'(Z'Z)^{-1}Z]\,/(Y-\beta\,X)}/(N-k)$. The statistic has a $\chi^2(L)$ distribution.

The SW statistic tests the same null hypothesis as the Anderson–Rubin. It tests weak-instrument robust inference, and its H_0 is that the instrument can be excluded from the 1st stage equation. It is based on the value of the GMM continuously updated estimator' objective function with the partialling out of the exogenous regressors. It provides a GMM distance test of the hypothesis of AR.

B.4 Test of over-identification: The Hansen J statistic

After checking for under-identification, Hansen J statistic is used to check for over-identification. Its null hypothesis is that the instrument is not correlated with the error terms, but correlation with the endogenous regressors. In other word, Hansen J statistic is used to test the validity of the instrument.

It is based on the residuals of the IV regression: a cross-product from the residuals and the exogenous variables are constructed under a quadratic form (Sargan, 1988). According to De Blander (2008), the test minimises the optimal GMM criterion : $J = (\epsilon'\,E)(E'E)^{-1}(E'\epsilon)/\sigma^2_\epsilon$ where E is the vector of endogenous and ϵ is the error of the outcome equation.

Appendix C

Chapter 2

This appendix presents all first-order conditions.

C.1 Households

Households are subject to Calvo rigidities in non-mining sectors and their optimal contract follows:

$$\bar{w}_{n\,t} = -\Gamma \frac{Uh_t}{Vhr_t} \tag{C.1}$$

with Γ the non-mining wage markup and

$$Vhr_t = h_t\,\mu_{c\,t} + \pi_{c\,t}\,\beta\,\epsilon_w\,E[Vhr_{t+1}] \tag{C.2}$$

$$Uh_t = \frac{\partial U(c_t, h_t, h_{m\,t})}{\partial h_t} + \beta\,\epsilon_w\,E[Uh_{t+1}] \tag{C.3}$$

$\frac{\partial U(c_t, h_t, h_{m\,t})}{\partial h_t}$ is the marginal dis-utility of non-mining labour, and $1 - \epsilon_w$ represents the fraction of households that can reset their wages in each period p.

Perfect competition in the labour supply is assumed, and is :

$$\mu_{c_t}\,w_{m_t} = \frac{{h_{m_t}}^{\frac{1}{\upsilon_h}-1} \left(\frac{{h_{m_t}}^{\frac{1}{\upsilon_h}}}{\bar{h}_m} + \frac{{h_t}^{\frac{1}{\upsilon_h}}}{(\bar{h})} \right)}{\bar{h}_m \left(\frac{{\bar{h}_m}^{\frac{1}{\bar{\upsilon}_h}}}{\bar{h}_m} + \frac{{\bar{h}}^{\frac{1}{\bar{\upsilon}_h}}}{\bar{h}} \right)} \tag{C.4}$$

C.2 Mining sector

Equation 5 links the marginal cost of capital imported to its return, taking adjustment costs into consideration. Equation 6 shows that mining firms would stop their exploration when their marginal cost equals the expected discounted value of their marginal revenues. Marginal reserves represent the opportunity cost that reserves extracted today cannot be extracted in the future. As in Hansen and Gross (2018), "firms explore to the point where marginal cost is equal to the expected present discounted value of an extra unit of reserves."
Both marginal reserves and capital values are :

$$q_{r_t} = \beta\,\Theta_t\,q_{r\,t+1} + \beta\,\Theta_t\,A^a_{n\,t+1}\,(\mu - \sigma_m)\,k_t^{\,-\mu}\,{x_{t+1}}^{1+\sigma_m}\,(-w_{m\,t+1}) \tag{C.5}$$

Equation (5) represents the present discount value of the marginal value of an extra unit of reserves, and Equation (6) the present discount value of the marginal value of an extra unit of capital.

$$q_{i_t} = \beta\,\Theta_t\;q_{i_{t+1}}\,(1-\delta) + \tau_{t+1}\,\mu\,A^a_{n\,t}\,w_{m\,t+1}\,{x_{t+1}}^{1+\sigma_m}\,k_t^{\,-\mu-1}\Big) \tag{C.6}$$

The firm equates the exploration activity's marginal cost with the expected marginal return of one extra unit of reserves.

$$\chi_t\,p^*_{i_t} = q_{i_t}\left(1 - \frac{\phi_k}{2}\left(\frac{I^{nv}_t}{I^{nv}_{t-1}}\,r_{t-1} - 1\right)^2 - r_{t-1}\,\frac{I^{nv}_t\,\phi_k\left(\frac{I^{nv}_t}{I^{nv}_{t-1}}\,r_{t-1} - 1\right)}{I^{nv}_{t-1}}\right) + \frac{{I^{nv}_{t+1}}^2\,\phi_k\,\beta\,q_{i\,t+1}\,\Theta_t\left(r_t\,\frac{I^{nv}_{t+1}}{I^{nv}_t} - 1\right)}{I^{nv\,2}_t}\,{r_t}^2 \tag{C.7}$$

Equation (8) refers to the extraction marginal revenue that equals its marginal cost. It takes into account the fact that extra costs are incurred with deeper extraction, and that when the mining firms extracts resources today, the mines become depleted in the next period.

$$q_{r\,t} = \frac{\partial C(d_t, \tilde{R}_{t)}}{\partial d_t} \tag{C.8}$$

C.3 Non-tradable sector

The optimal conditions:

$$V_{n\,t} = {\gamma_{n\,c\,t}}^{e_n}\,y_t\,w_{n_t}\,A^a_{n\,t}\,\epsilon_{M_t}\,\mu_{c\,t} + \beta\,\theta_n\,E_t[V_{n_{t+1}}\,{\pi_{c\,t+1}}^{e_n}] \tag{C.9}$$

$$U_{n\,t} = \mu_{c_t}\,y_t\,{\gamma_{n\,c\,t}}^{1+e_n} + \frac{{\pi_{c\,t+1}}^{e_n}}{\pi_{n\,t+1}}\,\beta\,\theta_n\,E_t[U_{n\,t+1}] \tag{C.10}$$

A recursive formulation of the optimal price for the non-tradables firm is:

$$\bar{p}_{n_t} = \frac{V_{n_t}}{U_{n_t}} \tag{C.11}$$

The additional bundle of non-traded goods is

$$1 = (1-\theta_n)\,\bar{p}_{n_t}^{1-e_n} + \theta_n\,\left(\frac{1}{\pi_{n_t}}\right)^{1-e_n} \tag{C.12}$$

and

$$\tilde{p}_{n\,t} = [(1-\theta_n)\;\bar{p}_{n\,t}{}^{-e_n} + \theta_n\;\tilde{p}_{n\,t-1}^{-e_n})]^{-\frac{1}{e_n}} \tag{C.13}$$

C.4 Importing sector

The optimal price for importers is subject to a Calvo pricing:

$$Vo_t = \mu_{c\,t}\,\gamma_{o\,c\,t}{}^{e_o}\,c_{o_t}\,\chi_t\,p_{x\,t}r_t + \beta\,\theta_o\,Vo_{t+1}\,\pi_{c\,t+1}{}^{e_o} \tag{C.14}$$

$$Uo_t = \mu_{c\,t}\,c_{o\,t}\,\gamma_{o\,c\,t}{}^{1+e\_o} + \pi_{c\,t+1}{}^{e\_o}\,\frac{\beta\,\theta_o\,Uo_{t+1}}{\pi_{o\,t+1}} \tag{C.15}$$

$$\bar{p}_{o_t} = \frac{V_{o_t}}{U_{o_t}} \tag{C.16}$$

$$1 = (1-\theta_o)\,\bar{p}_{o_t}^{1-e_o} + \theta_o\,\left(\frac{1}{\pi_{o_t}}\right)^{1-e_o} \tag{C.17}$$

C.5 Exporting sector

As explained previously, the exporters are subject to a Calvo pricing and the optimal reset price is

$$Vx_t = \mu_{c\,t}\,\gamma_{n\,c\,t}\,p_{x\,t}{}^{e_x}\,c_{x\,t} + \beta\,\theta_x\,E_t[Vx_{t+1}] \tag{C.18}$$

$$Ux_t = \mu_{c_t}\,\chi_t\,p_{x_t}{}^{e_x}\,c_{x_t} + \beta\,\theta_x\,E_t[Ux_{t+1}] \tag{C.19}$$

$$\bar{p}_{x_t} = \frac{V_{xt}}{U_{xt}} \tag{C.20}$$

$$p_{x_t} = \left((1-\theta_x)\,\bar{p}_{x_t}^{1-e_x} + \theta_x\,p_{x_{t-1}}{}^{1-e_x}\right)^{\frac{1}{1-e_x}} \tag{C.21}$$

$$\pi_{x_t} = \frac{p_{x_t}}{p_{x_{t-1}}} \tag{C.22}$$

$$\tilde{p}_{x_t} = [(1-\theta_x)\;\bar{p}_{x\,t}^{-e_x} + \theta_x\;\tilde{p}_{x_{t-1}}^{-e_x}]^{-\frac{1}{e_x}} \tag{C.23}$$

Appendix D

Chapter 3

D.1 Fixed Effect

$$Y_{i,t} = \beta_0 + \beta X_{i,t} + \zeta_{i,t}\sigma + c_i + \epsilon_{i,t} \quad (D.1)$$

Where $Y_{i,t}$ is the dependent variable following the table below, X is the explanatory variable being the dummy, ζ is the time varying LGA covariates, c is the separate mean for each LGA and ϵ is the error term. T denotes years from 2001 to 2016, and i is for each LGA.

	Log Income			Mining Employment	
Operating Mines	0.204			0.111	
1.Dummy Opening/ year			0.195		
Total number of mines		0.26			0.024
Constant	7.17***	6.25***	7.29***	4.05***	4.036***
F	2.47	0.88	2.42	0.63	0.03
R^2					
within	0.0017	0.0006	0.0017	0.0005	0.000
between	0.0046	0.0124	0.0026	0.0002	0.0023
overall	0.0096	0.0034	0.0005	0.0002	0.0008

Table D.1 Fixed Effect Regression

D.2 Moran's I test for Spatial Autocorrelation

If N represents the total number of LGAs, α_i the value of the LGA i of the variable α, and $w_{i\,j}$ the ij^{th} element of the spatial weight matrix W, then the Moran's I statistic (Kondo, 2018) is $I = \frac{\alpha'\,W\,\alpha}{\alpha'\,\alpha}$

$z = \frac{I-E[I]}{Var[I]}$ follows a normal distribution.

For a more detailed explanation, see Kondo (2018).