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Background paper

Do Forward Linkages Reduce or Worsen Dependency in the Extractive Sector?

Authors:

Amir Lebdioui
Pavel Bilek

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Correspondence: a.a.lebdioui@lse.ac.uk

Abstract

This paper provides an analysis of the impact of forward linkages on extractive dependence. First, we show that even though there is longstanding debate on the potential for alleviating extractive dependence through forward linkages, there have been few efforts to systematically evaluate the effects of forward linkages on extractive dependence. There have likewise been few efforts to provide a more careful consideration of the broad range of factors that may influence the effects of forward linkages on extractive dependence.

Second, we find that there is no straightforward relationship between forward linkage promotion and extractives dependency. Forward linkages can reduce dependence by: developing productive capacities that spill over into other sectors; reducing the impacts of commodity price volatility (as more processed products can exhibit smaller price fluctuations than raw commodities); or reducing the impacts of resource exhaustibility (via creating durable downstream industries that remain viable once a country's resources run out). However, forward linkages can also at times worsen extractives dependence by drawing more factors of production into the extractive sector making the country more economically dependent on extractives.

Third, we find that whether forward linkages alleviate or worsen extractive dependency depends on a variety of factors, which are either country-specific, commodity-specific or market-specific. We identified and discussed four factors that determine the impact of forward linkages on resource dependence: the absolute size of extractive reserves; the relative size of extractive reserves (monopoly concerns) and monopsony concerns; the depth and strategic orientation of forward linkage development; and the role of policy inputs, which influence the competitiveness of downstream industries.

Contents

1. Introduction

1.1 KEY OBJECTIVES AND THEIR RELEVANCE

Developing countries that depend on the extraction of oil, gas, and minerals for government revenues, foreign exchange and economic activity face critical development challenges, such as heightened exposure to commodity price volatility and the pressure to diversify their economies before extractives reserves run out. For example, in 2014, the collapse of commodity prices plunged several extractives-dependent economies into economic and political crises. In 2020, commodity prices again became volatile as a result of the coronavirus crisis. Notwithstanding the debates over future price trends, it is undeniable that the future trajectory of commodity prices is marked by uncertainties and serious risks of stranded assets (i.e., fossil fuel assets that cease to be commercially viable due to the transition to renewable energy). Against this backdrop, policymakers need to make strategic decisions regarding how to add value to their extractive resources while shielding their economies from the vagaries associated with price volatility and extractive dependence more broadly.

In spite (or perhaps because) of the risks posed by commodity price volatility and exhaustion, governments in resource-rich countries are increasingly seeking to establish or expand forward linkages to their extractive sectors (see e.g., Davis et al, 2021). However, some analysts worry that doubling down on extractives may instead worsen dependency, leading to an even greater share of a country's economic activity being tied to the sector. In that context, this report addresses two central questions that bear high theoretical and policy relevance:

- Do greater forward linkages from the extractive sector to the rest of the economy a) worsen, b) alleviate extractives dependency or c) do neither?
- What determines whether a), b) or c) will occur in a particular country (including policy and non-policy factors)?

In this report, we define forward linkages as the further processing of minerals, oil or gas (which can be referred to, among other things, as beneficiation, value addition or refining) before being exported with a greater value or put to use in the domestic economy.

1.2 METHODOLOGY

This report is a critical literature review. The methodology for identifying relevant literature is based on both background knowledge (particularly information and literature contained in Amir Lebdioui's doctoral thesis (Lebdioui, 2019a) as well as a thorough literature search using keywords pertaining to the three main concepts that constitute our object of enquiry. Those search terms are categorized as follows:

- **LINKAGES:** Linkages OR "Productive Linkages" OR "Economic Linkages" OR "Forward Linkages" OR "downstream linkages" OR Downstream OR "Value addition" OR "Adding Value" OR "Value Chain" OR "Supply Chain" OR Upgrading OR Smelting OR Refining OR Processing OR Beneficiation
- **COMMODITIES:** Minerals OR Metals OR Mining OR Commodities OR "Natural resources" OR resources OR Extractives OR "Extractive Resources" OR Gold OR Iron OR Steel OR Copper OR Diamonds OR Oil OR Gas OR "O&G" OR cobalt OR lithium OR bauxite

- **DEPENDENCE:** Dependency OR Dependence OR Volatility OR Fluctuation OR vulnerability

We have consulted a range of databases such as Google Scholar, SCOPUS, SciEL, JSTOR, Mendeley, as well as search engines to identify potential non-academic sources.

The search strategy that guided this literature review was also refined by targeting specific countries and commodities. The rationale for targeting specific case studies is that suitable case studies need to meet particular conditions for effectively informing our object of enquiry. The countries analyzed generally need to:

- have shown (serious) efforts to develop forward linkages (in order to assess their true impact in terms of extractive dependence)
- have experienced some degrees of extractive dependence before or after value addition efforts (if the country case study is not already dependent on extractives, there is a high risk of selection bias)

There are few countries that fulfill these conditions and for which we ran additional literature searches, on top of the keyword searches outlined above).Those countries include:

- Botswana (diamond sector)
- Chile (copper sector)
- China (rare earth sector)
- Indonesia (bauxite and nickel sectors)
- Malaysia (petroleum sector)

Delving into specific country cases has proved useful because in most instances, as explained below, the literature does not explicitly address our object of enquiry. We therefore needed to make our own assessment and deductions on a case-by-case basis, using existing country studies and data.

1.3 KEY FINDINGS

For more than 100 years, scholars and policymakers have debated the potential for alleviating extractive dependence through developing forward linkages. As this report sets out, existing studies provide conflicting claims on the specific impact of forward linkages on extractive dependence. Researchers have generated little robust cross-country evidence to assess the validity of the different arguments made. Moreover, it appears that the arguments they are making on the different sides of the debate often neglect the broader factors that influence the object of enquiry, and feature observations rather than explanations as to how and when forward linkages alleviate or worsen extractive dependency. This report focuses on contextual factors identified both in the literature and through our own research as influencing the impact of forward linkages on extractive dependence:

- The size of extractive reserves, both in absolute terms and relativeto global supply
- The depth, scale and strategic orientation of forward linkage development
- The role of policy inputs

In this report, we discuss the role of each of these factors in determining the impacts of extractives forward linkages on extractives dependence, as identified in the existing literature. The report is

structured as follows: section 2 provides a general overview of the literature and section 3 explores in detail the respective roles of factors i, ii and iii above in shaping these impacts. Section 4 concludes.

2. Forward linkages' impact on dependency

In this section, we reflect on the adequacy, comprehensiveness, geography and commodity coverage of the existing literature on forward linkages and extractive dependence. We will first review how key concepts such as dependence, and volatility can be/have been defined in the literature and clarify the types of dependencies that we address in this report. We explain why the literature lacks systematic consensus and conceptualization of the impact of linkages on extractive dependence. Later, in Section 3, we explain the contextual factors that contribute the diversity of arguments and experiences in the literature.

2.1 TYPES OF DEPENDENCE

The notion of extractive dependence can be understood in various ways. Economists have tended to measure extractive dependence in terms of the proportion of extractives to a country's overall exports (due to data availability and comparability concerns related to using other measures). However, extractive dependence is multidimensional, as recently emphasized by scholarly work on the Extractive Dependence Index (Hailu & Kipgen, 2017) and the Multidimensional Index of Extractives-based development -MINDEX (Lebdioui 2021). A country can be dependent on extractive resources as a source of gross national income, exports, employment and inputs for other industries. Each of these types of dependence have different implications. Hailu and Kipgen note that the shares of export earnings from the extractive sectors in Zambia and Norway are similar (76 percent and 74 percent respectively), but the two countries have vastly different levels of resource dependence based on economic development, technological capabilities and revenue diversification.[1] The two countries consequently have different levels of exposure to commodity busts (ibid.).[2] This suggests that the share of extractives in total exports is not, in and of itself, sufficient to judge the degree of extractive dependency of an economy. We can also measure dependency in terms of employment, for example. However, employment figures are complex, difficult to compare and can include direct, indirect, and induced employment. Resource dependence and exposure are therefore difficult to measure when analyzing individual aspects of dependence in isolation (Le Billon and Good, 2016).

Extractive dependence can be understood or defined by its different dimensions but also in terms of scale. In terms of the threshold for assessing whether a country is dependent on extractives, the United Nations Conference on Trade and Development (UNCTAD) considers a country to be commodity-dependent when commodities represent more than 60 percent of its total merchandise exports in value terms. According to the International Monetary Fund (IMF, 2012), a country can be considered "resource-rich" (which the paper uses to mean resource-dependent) when it derives more than 20 percent of its government revenues from nonrenewable commodities.[3] The IMF used these thresholds in its guide to resource revenue transparency (IMF, 2008). Another IMF working paper (Thomas and Trevino, 2013) deems countries "fiscally dependent" when resource revenues exceed 20 percent of budgetary revenues in the same period, and "resource-intensive" when resource exports make up more than 25 percent of total merchandise exports.

[3] Various IMF reports and working papers (e.g. IMF 2015; IMF 2012; Thomas and Trevino, 2013) use this threshold to qualify resource-dependent but also 'resource-intensive', and 'resource-exporting' countries, which suggests an interchangeable use of these terms (despite their important nuances).

Extractives resources can also create political dependence, which can be broadly understood as how political outcomes (e.g., electoral outcomes, policies, political finance, etc.) are affected by developments in the extractives sector (e.g., extractives revenues, employment, output, environmental impacts, etc.) (Rossi, 2006, as cited in Brollo et al., 2010).

Although extractives dependence is complex and multifaceted, the literature on forward linkage promotion and extractives dependence has not generally acknowledged such nuances and their potential implications, and has rather tended to pool together different types of economic (and political) dependence.

2.2 TYPES OF VOLATILITY

Vulnerability to commodity price volatility is one of the main negative impacts of extractive dependency, and one that is well-discussed in the literature on forward linkages in the extractive sector. Nevertheless, volatility can take several forms and scholars have understood it in different ways (Le Billon and Good, 2016). Short-term volatility results from rapid market adjustments taking place within hours, which is possible as a result of the financialization of global commodity markets (Arezki et al., 2014). Medium-term volatility partly reflects commodity-specific conditions of production, such as geopolitical, technological or climatic events affecting supplies and changes in demand (Carter et al., 2011). Long-term volatility is the result of deeper and broader political economy trends that stimulate changes in demand or supply (such as major industrialization and urbanization phases experienced in the US in the late 19th century or China since the early 1990s) (Jacks, 2013), or as a result of measures to tackle climate change and decarbonization processes (e.g., since the 2010s).

2.3 OVERARCHING ARGUMENTS IN THE LITERATURE

The debate on downstream value addition's ability to alleviate or worsen extractive dependence is not new, and can be traced back to the "staples theory" of the 1920s, which emphasized the role of "staples" (commodities) as a motor of economic development to explain the history of Canada's industrial development.[4] Nevertheless, advocates of staples theory held divergent views on the extent to which economies can diversify through commodity specialization. Scholars such as Mackintosh (1923; 1939) saw an evolution of commodity production towards a mature staple-based industrialized economy, economic diversification and self-sustaining growth, rather than the risk of a "staples trap," whereby the country becomes overly dependent on commodities. Others, such as Innis had a more pessimistic view of the relationship between staple production and economic development. While he recognized that the country's specialization as a commodity producer did initially contribute to the development of domestic industry and infrastructure in the early years of exploitation, he also noted a tendency for Canada to become permanently locked into dependency as a "resource hinterland" (Watkins, 1982). Indeed, Innis was not confident that a commodity-based economy would be able to diversify and "develop" rather than simply grow. North (1966) echoed this argument and noted that after the initial stage of synergistic linkage development between staple crops and local industry and services, the American south fell into a "staples trap" and linkages were located in other regions of the US.

[4]The staple thesis was presented as an explanation for how the pattern of settlement and economic development of Canada was influenced by the exploitation and export of natural resources (such as fishing, fur, and wheat) but the basic framework of the staple thesis is potentially applicable to any economy whose development is dependent on the export of raw materials.

These two broad types of arguments can still be distinguished in terms of the impact of downstream value addition on an economy's degree of extractive dependence in the more recent studies.

On one side of the argument, several scholars have used theory to argue that production linkages can serve diversification strategies (Hirschman, 1981; Joya 2015; Morris et al. 2012), which are generally considered to be the best way to mitigate the impact of commodity price volatility and dependence (Sachs and Maennling, 2015; Chang and Lebdioui, 2020; Cherif and Hasanov, 2014). Latin American scholars such as Perez (2010) even argued that Latin America should pursue resource-based development through the downstream processing of natural resources to leapfrog into emerging technologies, thereby promoting diversification and reducing extractive dependency. Also in the context of Latin America, though he did not address the role of forward linkages in particular, Prebisch (1950) empirically demonstrated the existence of declining terms of trade for commodity-exporters, which implies that resource-dependent countries need to diversify towards processed and industrialized goods.[5]

Hailu and Kipgen (2017) also argue that even though a country that adds value to its own extractive commodities domestically is, by intuition, dependent on the extractive sector, such dependence is relatively better than dependence on raw extractive commodity exports without domestic value addition. They explain that that value addition allows countries to fetch higher prices for their exports, and that greater forward linkages from the extractive sector also imply higher levels of transferable skills that can increase technology transfer and employment mobility within and between sectors.

Joya (2015) also suggests that for resource-intensive economies to reduce their vulnerability to commodity price fluctuations, an optimal strategy would be to diversify into processed natural resources. This would require developing new industries for processing natural resources, and diversifying away from commodity production towards high value-added goods in resource-based sectors (ibid.).[6] In a similar line of thinking, Morris et al. (2012) sustain that, while resource pessimism led to the wisdom that countries should diversify by expanding their industrial and knowledge-intensive sectors in areas unrelated to their commodities, the paths that successful late-industrializing economies such as East Asian countries followed are difficult to replicate by current resource-rich developing countries. They argue that "Import substitution industrialization" has become more difficult to successfully execute because World Trade Organizations (WTO) agreements, Free Trade Agreements and Bilateral Investment Treaties tend to restrict what policies countries can use to promote their industrial sectors (but countries that industrialized earlier did not face the same level of restrictions). Similarly, they argue that export-led industrial development is more difficult than before because there is more competition from other developing countries – particularly China – that dominate global

[5] The Prebisch-Singer hypothesis suggests that the price of primary goods declines in proportion to manufactured goods over the long run, which calls for the industrialization of resource-dependent countries. This is caused by differences in income elasticity of demand between manufactured goods and commodities, and declining terms of trade (Prebisch, 1950).

[6] Joya (2015) claims that existing studies show that successful resource-rich countries diversify into higher value-added products in resource-based sectors, and they use resource rents to develop other industries in which they have comparative advantage. He also adds that in concentrated economies, as there are a limited number of industries operating, linkages between industries are denser and stronger. Shocks to one sector transmit strongly to another, depending on the share of intermediate goods in output. We could interpret this view as suggesting that forward linkages might help reduce extractive dependency as long as they are accompanied by a broader diversification of the domestic economy.

markets for many manufactured products (ibid.:15). As a result, Morris et al. (2012) argue that resource-rich low-income economies trying to diversify their economies should focus on developing linkages around their commodities rather than attempt to build a competitive advantage in unrelated industries.

Conversely, Lebdioui (2019a) offers a few theoretical counterpoints to this view and questions whether diversifying along the commodity value chain is the best way for resource-dependent countries to diversify, precisely because such diversification may perpetuate their dependence on commodity price fluctuations. In addition, he argues, the desirability of building linkages around a commodity depends on the size of reserves. In that sense, the argument by some of the staple theory advocates that a shift towards non-staple production would slow economic development fails to recognize the need to diversify beyond commodities and develop productive capabilities in other sectors, especially in countries where natural resources are volatile, exhaustible and not labor-intensive enough to cover national employment needs (ibid.).

A similar, yet slightly more clear-cut view is provided by Le Billon and Good, (2016) who argue that backward linkages—that is, the use of local inputs such as labor, goods and services—and forward linkages directly related to a resource sector can all suffer from a bust as profit margins decrease throughout the entire value chain. They explain that backward/forward linkages are generally more exposed than horizontal linkages to (and can even aggravate) commodity busts. By contrast, horizontal linkages diversifying the economy outside the resource sector can improve economic resilience to a commodity bust. The notion of horizontal linkages is defined by Morris et al. (2012) as "a complex set of linkages made up of suppliers and users in the chain, who develop capabilities to feed into other industrial and service chains" (outside of the extractive sector) (2012:24).

Similarly, several works have emphasized the important types of externalities that arise out of extractive activities and that can benefit other sectors of the domestic economy, such as infrastructure and knowledge.[7] For example, recent empirical studies are devoting increasing attention to the capabilities that are embedded in extractive value chains that can also be used in other sectors of the economy (Cosbey & Ramdoo, 2018; Lebdioui, 2019b, 2020). The development of forward or backward linkages to the extractive sector could therefore help to develop skills and knowledge that could boost competitiveness in other sectors of the economy. Nevertheless, it remains unclear whether overall these 'spill-overs' to other sectors are enough to reduce dependency on extractives, or whether adding value to the sector will actually increase dependency, by drawing more capital, land and labor into the extractive sector.

Therefore, there is no consensus nor even a clearly dominant view in the literature as to whether, in general, developing forward linkages in extractives helps to reduce or risks increasing extractives dependence. However, a number of studies look in detail at the experience of different countries with extractives forward linkage development and how this has impacted extractives dependence. In section 3 below, we examine these studies to tease out in what contexts forward linkages in the extractive sector have tended to reduce dependency, and in what contexts they have tended to increase it.

[7] Whether those elements should be considered as linkages or externalities is debatable, but the literature has often labeled those as 'side-stream linkages' (see CCSI, 2016a; IRP, 2019). Lebdioui (2019a) grouped notions of "horizontal" or "side stream linkages" under the concept of transversal capabilities, which include (i) technological and organizational skills; (ii) shared infrastructure; and (iii) 'product linkages' (which are defined as goods with a wide applicability in a range a sectors).

2.4 ADEQUACY AND COVERAGE OF THE LITERATURE

It generally appears that there have been few efforts systematically or empirically evaluate the effects of forward linkages on extractive dependence, as well as to provide a more careful consideration of the broad range of factors that may influence the effects of forward linkages on extractive dependence.

The type of commodities covered in the literature cited in section 2.3 and section 3 is fairly broad and includes various types of mining and energy commodities. Some studies have also highlighted the importance of distinguishing different types of commodities as some commodities do not offer the same opportunities for downstream processing and linkages to the rest of the economy (Le Billon and Good, 2019; Ramdoo 2015).

Box 1. How extractive sector linkages vary by commodity (and why this matters for dependency)

Bocoum (2000) argues that the type of mineral activity affects the level of positive spillovers from extractives to other sectors (depending on the characteristics of the country). Using an input-output analysis based on data on Australia, Chile and the U.S., the author shows that the petroleum and coal transformation sector display the most forward linkages. By contrast, the author notes that forward linkages in the mining sectors were among the least developed across sectors, with the exception of gemstones and diamond mining in the United States as well as the industrial minerals sector. For example, while the metal product manufacturing sector had strong backward linkages in both Australia and Chile, it had weak forward linkages in the same two countries. Ös(„sstensson (2017) and Tordo et al. (2013) also note that forward linkages tend to be less important for mining than for oil and gas.

Bocoum (2000) also finds that mineral processing (such as the processing of iron and steel in Australia and the United States) generates more backward and forward linkages than mining itself, and in so doing fuels industrialization, which confirms earlier research findings by the same author (see Bocoum-Kaberuka, 1999). Franks (2020) criticizes the fact that mining is almost ubiquitously framed as the international trade of metals, energy minerals and precious gemstones, neglecting the industrial minerals and construction materials that are most important for local and domestic development and that dominate global mineral production. He argues that those types of minerals, which he calls development minerals, have closer links with the local economy and are economically important close to the location where the commodity is mined in comparison to minimally processed export-minerals.

Such findings matter for extractive forward linkages' ability to support diversification, since one of the key means through which they can do this is through *developing productive capacities* in downstream activities (which can then be used to branch out into areas unrelated to extractives). Minerals that stimulate domestic industries only to a limited extent overall would seem unlikely to develop local capabilities (and support diversification) when forward linkages are developed. As such, it seems that the impact of developing forward linkages on dependency will likely heavily depend on the specifics of the extractives commodity in question.

The literature cited in this report also features a fairly broad geographic range (especially Africa and North America, with Latin America covered to a lesser extent). However, it should be mentioned that

very few studies that we encountered covered Europe or the Lusophone countries (e.g., Brazil). Europe's general exclusion from this literature may be due to the lack of extractive resources on the continent while the exclusion of Lusophone countries from the analysis is perhaps due to a linguistic blind spot in our search strategy.

While there is literature that addresses the different dimensions of the political dependency on extractives resources (see theoretical contributions such as Ascher, 1999, Karl, 1997 and studies that also provide empirical contributions and case studies such as Mahdavy, 1970; Kohl and Farthing, 2012; and Aldaz, 2020 for instance), the existing literature does not specifically address how forward linkage promotion impacts political dependency on extractives.

More analysis is required to explain the diversity of arguments and experiences that are discussed in the literature. The rest of this report highlights some of the contextual factors that influence the impact of forward linkages, which help in categorizing and making sense of the empirical evidence on the subject.

3. Contextual factors

This section provides an analysis of the contextual factors that influence the impact of forward linkages on extractive dependence. As outlined in section 2 (and shown later in this section) the literature identifies two main ways through which forward linkages can reduce dependence or its effects – they can either provide a springboard to diversification by developing productive capacities that spill over into other (non-extractives) sectors[8]; or they can reduce the negative economic effects of dependence. They can do this by either reducing the impacts of commodity price volatility (as more processed products can exhibit smaller price fluctuations than raw commodities) or by reducing the impacts of resource exhaustibility via creating durable downstream industries that remain viable once a country's resources run out.

However, forward linkages can also, in some cases, worsen extractives dependence. This occurs where forward linkages fail to provide a springboard to diversification, but more factors of production are nonetheless drawn into the extractive sector (into downstream activities that are normally, in such cases, uncompetitive) making the country more economically dependent on extractives.

But what determines whether forward linkages will reduce dependency and/or its effects, or rather worsen them? In this section, we discuss four main factors.

- The absolute size of extractive reserves (exhaustibility concerns)
- The relative size of extractive reserves (monopoly) and monopsony concerns
- The depth and strategic orientation of forward linkage development
- The role of policy inputs

3.1 ABSOLUTE SIZE OF RESOURCE RESERVES

The size of extractive reserves has an important influence in terms of the impact of forward linkages on extractive dependence and may contribute to the variety of outcomes in the literature's empirical case studies. First, the size of extractive reserves can influence the ability of domestic downstream industries to reach economies of scale, which is important for their long-term competitiveness and their impact on economic diversification. Several studies note that the economies of scale of petroleum refineries and refining process units is the key factor for improving economic benefits and enhancing the competitive power of the refiners (see Guosheng, 2007 and many other studies suggesting that petroleum refining is subject to minimum efficient scale). Therefore, relatively small petroleum producers such as Chad may find it far more difficult to establish competitive refineries or petrochemical plants in comparison to countries such as Saudi Arabia, where refineries can far more easily reach economies of scale. There are similar scale economy considerations for mining products (see, for example, Östensson, 2019).

Secondly, the size and exhaustibility of extractive reserves influence the risks associated with the dependence of downstream industries on the availability of the raw material inputs (which is different from the vulnerability to commodity price fluctuation). If a country runs out of a type of extractive resource, it will need to import it to keep operating related industries (Lebdioui, 2019a). Importing raw

[8] E.g. either through knowledge spillovers, through demand for inputs from other sectors, through supplying more cost-effective inputs to other sectors (allowing those sectors to become more competitive), through encouraging greater investment in infrastructure that benefits other sectors, or through generating tax revenues (or firm profits) that can be used to stimulate the non-extractive economy.

material would only be feasible/commercially desirable if downstream industries have reached a certain level of productivity and competitiveness at which they do not rely on raw materials that are subsidized or have low transport costs. Nevertheless, attaining competitiveness may require the gradual accumulation of expertise, technology, knowledge and engineering skills through learning by doing, which may not easily be achievable if domestic resources are expected to run out shortly after the establishment of downstream industries. This is why the size of extractive reserves matters in terms of the short- and long-term impact of forward linkages on increasing or alleviating extractive dependency. This point is somewhat illustrated by the case of the Kyrgyz Republic, where, without large-scale investment, a large part of mineral production is due to cease by 2026 and existing production is too low for processing economies of scale (Manley and Kulova, 2018).

The case of Botswana is also particularly informative in this regard. Grynbertg et al. (2015) estimates that the country's diamond reserves will be depleted by 2027. This puts the domestic economy in a highly vulnerable position because diamond extraction still represents 80 percent of export earnings and 60 percent of government tax revenues (Biedermann, 2018). Estimates from the Botswana Institute for Development Policy Analysis have also shown that, after diamond depletion (between 2025 and 2027), gross domestic product (GDP) will drop over 50 percent compared to a hypothetical scenario in which diamond reserves are not depleted (Grynberg et al., 2015). Chang and Lebdioui (2020) use the example of Botswana to show that an overarching focus on macroeconomic stability and strategies to invest abroad, though they help address short-term fluctuations, can be detrimental to long-term development if they delay the transformation of the domestic economy. In this context, it is clear that the forward linkages that arise from diamond extraction (such as diamond polishing and trading) may not suffice to reduce the country's dependence on the extractive sectors given the short time left before depletion. Instead, higher degrees of horizontal diversification are urgently needed. More cautiously, Fessehaie and Rustomjee note that it is too early to assess whether Botswana's diamond processing industry is sustainable beyond the depletion of the country's own diamonds, given that processing industries in other countries are more cost competitive (India) or more sophisticated (Belgium). They also add that the recent price crisis for cut and polished stones due to a glut of supply in the market has exposed the vulnerability of Botswana's beneficiation strategy.

3.2 RELATIVE SIZE OF RESOURCE RESERVES (MONOPOLY) AND MONOPSONY CONCERNS

This section addresses the relative—rather than absolute—size of extractive reserves (i.e., the country's share in global supply). One aspect that may matter in terms of the effect of forward linkage development is the relative market power that commodity-producing and commodity-importing countries have. Monopolistic and monopsonist situations can explain certain outcomes of forward linkage development on extractive dependence in some countries and for some commodities.

Firstly, countries that control a large share of the supply of a given commodity may find it easier to find leverage to attract large-scale and long-term investments in downstream industries. (See boxes 2 and 3 for the cases of forward linkages in the nickel sector in Indonesia and the rare earth mining sector in China, respectively.) This point is well illustrated in the case of Indonesia. In that country, export bans on ore had different effects in terms of forward linkages and dependency in the nickel and bauxite sectors because of differences in global market shares and substitutability. Exports bans were likely successful in promoting value addition in the nickel sector because Indonesia's endowment of high-grade nickel required by pre-calibrated Chinese nickel pig iron (NPI) smelters provided strong incentives for investments in Indonesia to maintain production and supply. Meanwhile, the worldwide availability of bauxite allowed Chinese firms to easily switch to other providers (such as Australia and Malaysia)

following Indonesia's export ban, resulting in a loss of export revenues and lack of domestic processing capacity in Indonesia. (See box 1 for further information.) Indonesia's trade position has never recovered from the bauxite ban, and lags significantly behind its 2013 export figures to this day. (See table 1.)

Figure 1. Indonesia's nickel exports[9]

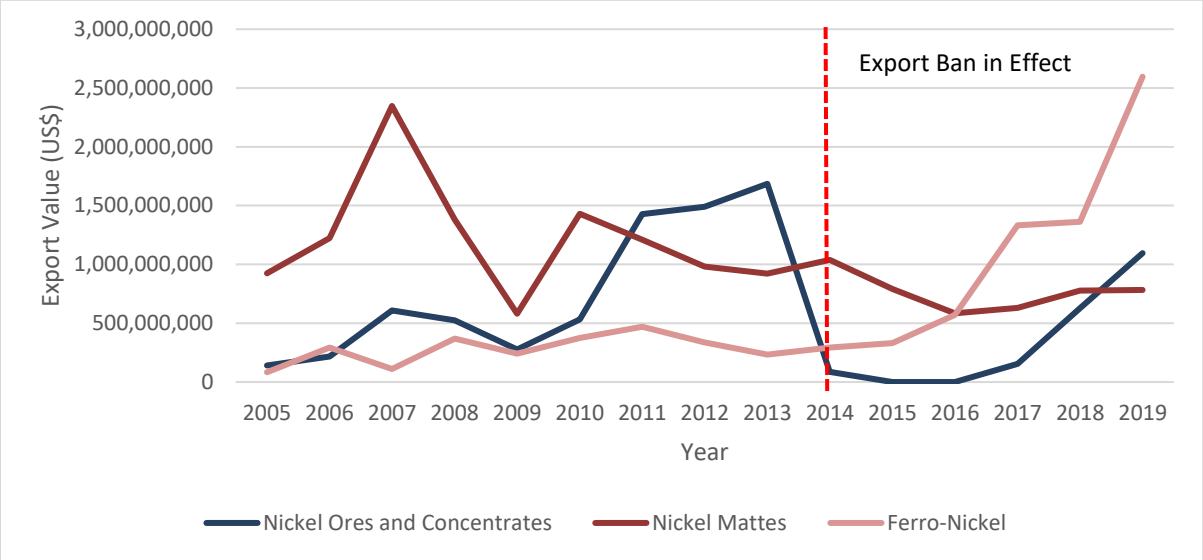


Table 1. Indonesia's bauxite and nickel ores[10]

Category:	Bauxite	Nickel
Share of global reserves	4.00%	23.60%
Global reserves ranking	6th	1st
Share of global production (2013)	18.97%	32.02%
Share of global production (2019) - estimated	4.32%	29.63%
Global production ranking (2013)	2nd	1st
Global production ranking (2019) - estimated	5th	1st

Indonesia's (unsuccessful) experience in bauxite value addition (in contrast to the nickel sector) may hold relevant insights for West African bauxite producers aiming to add value to their commodity (such as Ghana, Guinea, and Sierra Leone). The African continent holds 32 percent of proven world bauxite reserves. Guinea has high-grade ore and is considered the world's richest bauxite-holding country (Jegourel, 2015). However, according to available estimates, as of 2019, Guinea was the world's second-

[9] Indonesia's nickel export ban has been lifted and re-imposed since it was initially introduced in 2014 - see e.g., (Durrant, 2019).

[10] Source: U.S. Geological Survey, 2020a; U.S. Geological Survey, 2020b; Reichl et al. 2017.

largest producer of bauxite, but produced no more than 0.2 percent of the world's alumina (U.S. Geological Survey, 2020b).

In cases in which a given country controls the demand for a commodity (monopsony), countries that export that commodity may find it difficult to stimulate forward linkages while avoiding increasing commodity dependence (or, at least, avoiding worsening their exposure to the economic volatility associated with it).[11] For example, Chile is not only dependent on a commodity (copper), but also on one major client, China. The possibility of China growing more slowly and thus reduced copper demand from China threaten Chile's economic stability. Similarly, if a country produced value-added goods for which demand is restricted to a single client, the resulting forward linkage might exacerbate economic dependency and its negative effects, rather than alleviate them, as the additional value added would also be dependent on the economic fortunes of the client country.

Secondly, countries that control the demand or supply of a given commodity can influence the impact of commodity prices on forward linkages and vice-versa, because commodity price volatility can be explained by changes in demand or supply (or both). For example, given that it holds a very large share of world petroleum reserves, Saudi Arabia can (to a certain extent) adjust its petroleum production to influence world oil prices. Likewise, where countries that control the global supply of a particular commodity decide to process it in-country at scale, this would reduce supply of the raw commodity to the rest of the world (unless the country has sufficient spare production capacity to supply its processing activities and decides to do this while maintaining global supply of the raw commodity). As such, forward linkages in countries that control global supply of a particular commodity will obey different dynamics than in extractives-exporting countries that have little to no control or coordination over prices. As such, countries with more market power (such as Saudi Arabia) may face less economic volatility from petroleum-forward linkages than would other countries with less market power.

Another useful example (though not based on an extractive resource) of the influence of monopolistic dynamics on commodity value addition is provided by the so-called "Cocoa OPEC," established between Côte d'Ivoire and Ghana, the two largest cocoa producers, which together control the global supply of this commodity.[12] With the creation of a cocoa cartel, the two countries have agreed to a price premium on top of futures prices, and hope to further mitigate the volatility and fluctuations brought about by the financialization of commodity markets, which could ultimately help further protect smallholder producers and promote domestic downstream value addition (Wexler, 2020).

The DRC could face similar dynamics in terms of value addition to its cobalt and coltan resources, for which it respectively holds around 50 percent and 64 percent of global reserves (US GAO, 2008).

[11] The more of a country's economic activity is concentrated on exporting a particular commodity, the more volatility of that commodity's prices will affect the country in question. As such, if the exporting country decides to 'double down' on this commodity through developing forward linkages, economic shocks from the commodity's price volatility will have a greater effect on the country's economy, as it will not just be firms/workers involved in extraction that will be affected, but also those involved in downstream activities.

[12] The Ivorian and Ghanaian cocoa sectors are regulated by strong marketing boards (CCC and COCOBOD, respectively), which include minimum price systems, stabilization funds and a variety of services to local smallholders. Both countries are examples of successful functional upgrading, with local grinding sector growth being driven by price and tax incentives, changing sector regulations, and shifting strategies of lead firms towards grinding location (Grumiller et al., 2018).

Box 2. Indonesia's export ban on ore mineral and its divergent effects

In January 2014, Indonesia's 2009 Mining Law came into effect (see below for further explanation of the delay), introducing a prohibition on the export of unprocessed ores, and obligating domestic value-addition by creating forward linkages. The export ban's main targets were raw, unprocessed bauxite and nickel ores, of which Indonesia is a major producer and exporter. Prior to the ban, domestic value-addition in both sectors was low since Indonesia had no alumina refineries and one aluminium smelter (Lederer, 2016), and only three nickel smelters (UNCTAD, 2017), which collectively had the capacity to process only a minor fraction of Indonesia's ore production.

On the eve of the ban, Indonesia was the world's largest nickel ore producer, with the largest proven reserves globally, and second largest bauxite producer after Australia. Indonesia's bauxite and nickel ore production and exports skyrocketed in the decade leading up to 2013, driven primarily by increased Chinese demand, which accounted for over 90% of both ore imports. As China became a major producer of aluminium and stainless steel, demand significantly increased for bauxite and nickel, respectively, with Indonesia becoming China's primary partner for ore imports.
However, although the policies used for the two metals were similar, namely lower duties on imports of capital goods required for processing, key corporate tax breaks and a complete ban on the export of the minerals, there were significant differences between the two metals in terms of the outputs (in terms of the addition of forward linkages and domestic processing and refining outputs). The ban on raw exports of bauxite was seen universally as a failure, while for nickel the ban has often been considered to have been a moderate success. We discuss these differences in outcomes below.

Failure to add value and worsening extractive dependence in the bauxite sector

The global bauxite market provided ready and suitable alternatives, with China ramping up production, and Australia and Malaysia both increasing their domestic bauxite production, compensating for the lost Indonesian ore supply. The lack of existing downstream processing capacity, high costs of developing forward linkages from bauxite, and ready alternate sources of bauxite resulted in a lack of willingness to construct domestic downstream value-addition capacity (Lederer, 2016). Although the 5-year period between the 2009 Mining Law and 2014 implementation was to provide time to create downstream processing capacity, "both foreign and domestic companies failed to invest in mineral smelters, not believing the government would introduce a hard ban and sacrifice export revenues" (Östensson, 2019:210). Indonesia's relatively weak position in the global bauxite market resulted in a significant loss of revenue, the termination of many operations and investor departure due to the ban (Toledano & Maennling, 2018).

Successful value addition and alleviated extractive dependence in the nickel sector

Indonesia greatly benefited from its leading position in the global nickel market, and its high grade of nickel ore. Nickel smelting is an energy-intensive process, but higher graded ores require less

energy, which significantly lowers costs. Indonesia's high nickel grade and high steel content made its nickel ideal for China's stainless-steel production, and throughout the 2000s, nickel pig iron (NPI) smelters in China were calibrated specifically to utilise high grade Indonesian ore. As such, following the 2014 ban, alternatives in the form of lower-grade Philippine nickel did not fulfil Chinese smelter criteria, leaving them with no viable alternatives, and therefore requiring either continued supply of Indonesian nickel ore, or relocating smelting operations to Indonesia to comply with the Mining Law's value-addition stipulations (UNCTAD, 2017). Nine smelters were built by mid-2017, and more have come online since, with Indonesia almost quintupling its refining capacity between 2013-2020 (Sappor, 2020). This has translated positively into exports of primary nickel (ferro-nickel, NPI), which has increased dramatically since 2014, both in terms of weight and export value.

The case study of Indonesia's raw ore bans and the varying outcomes in terms of forward linkage development and extractive dependence between the bauxite and nickel sector therefore demonstrates the importance of substitutability and global market share.

Box 3. Forward linkages from rare earth metal extraction in China

China holds a third of rare earth reserves worldwide. It has taken advantage of the low cost and abundant domestic supply of strategic raw minerals to promote higher value-added manufacturing. From exporting RRE concentrates in the 1970s, there has been a progressive value addition process up until exporting magnets, phosphors and powder by the late 1990s and higher value-added goods such as electric motors, cell phones, computers, and batteries by the 2000s.

Such processing of downstream value addition has been guided by public policies, such as export quotas, export duties, the strategic acquisition of foreign technology and considerable public funding for R&D activities in the rare earth refining and processing since the 1990s, which enabled the reduction of costs and commercial viability. Chinese authorities have also banned foreign investment in rare earth mining, but have allowed foreign investment in downstream activities under joint ventures with domestic firms.

China's success in diversifying its economy through the value addition of rare earth minerals is directly related to its large share of deposits globally and well as its large market size for value added products. Firstly, rather than responding to existing demand for rare earth minerals, China has effectively stimulated demand for rare earth minerals by promoting the downstream and input-requiring industries.

Secondly, almost every major multinational corporation relying on rare earth minerals has moved its manufacturing facilities to China over the past decades despite the infant industry protection measures imposed by the Chinese government because they sought to gain access to these strategic minerals, whose production is dominated by China. The size of the country's reserves therefore play an important role in its attractiveness for investments in value added activities and influence a country's ability to pursue industrial policies.

Source: Medeiros & Trebat (2017).

Market substitutes and demand elasticity

Chile's case showcases some of the factors that increase the impact of forward linkages on commodity dependence.[13] Firms (such as Madeco) that pursued downstream activities in the copper sector (such as copper tubes manufacturing) failed to become competitive because of the increased costs of copper ore and the adoption of substitute products. In fact, rather than benefiting from high copper prices, firms such as Madeco witnessed reduced demand in copper-based products as consumers switch to cheaper alternatives such as plastic and aluminum (Lebdioui, 2019a). The International Copper Association, the marketing arm of the global copper industry, estimates that high prices reduced demand for the metal by as much as 8 percent in the 2000s (Azzopardi, 2011). In such contexts, where the demand for extractives-based products appears to be somewhat elastic, forward linkages can worsen the effects of extractive dependence because their competitiveness is highly dependent on raw commodity prices. The copper price boom in the 2000s has made raw copper exports profitable while discouraging the production of copper-based goods, which became less cost competitive in the market. Such dynamics have important implications for countries that aim to engage in the downstream processing of minerals (e.g., lithium) where there is a potential substitute demand for alternative technologies and goods (e.g., lithium-less batteries).

In summary, the literature we discussed above shows that the effect of forward linkages on extractives dependence can be influenced by a) the absolute size of the country's reserves, b) its share of global supply and c) other features of the market for the commodity in question. In particular:

- Countries with greater absolute reserves are more likely to be able to use forward linkages as a springboard to diversification, to the extent that i) they have more time to develop their productive capacities (which can spill over to other sectors) before their reserves run out and ii) they can benefit from economies of scale, making their downstream sectors more competitive (and more likely to be able to continue using imported raw materials once domestic reserves run out).
  Countries with a greater share of global supply of a given resource are more likely to see efforts to develop forward linkages succeed, as the more difficult it is for importers to source the resource from elsewhere, the more likely they will have to accept higher value-added products from the resource-producing country (rather than substituting for elsewhere). Once downstream industries are successful, they can have positive impacts on other, unrelated sectors (e.g., shared use of infrastructure, knowledge spillovers), which will in turn reduce dependency.
- In addition to the country's share of global supply of the extractive resource, other determinants of a country's market power influence the likelihood that forward linkages can provide a springboard to diversification and reducing dependency. These include the extent to which the market is dominated by a few (or a single) buyers. Few or single buyers would increase the exposure to price volatility from "doubling down" on a certain commodity through

[13] Although some of the literature praises Chile's downstream value addition through the production of goods such as copper cables, tubing and sheet (See Grosse, 2009), other accounts argue that downstream value addition efforts around copper in Chile do not in fact go far beyond primary processing. Lebdioui (2019a) shows that the beneficiation of copper has been rather limited, given that the production of copper cables merely accounted for around USD 300 million in 2015, which represents less than 1 percent of exports of the copper sector.

greater downstream processing, and the extent to which importers can substitute the commodity for another (where the exporting country in question does not also control the supply of that commodity).

More broadly, this seems to suggest that countries are most likely to succeed with forward linkages as a route to diversification when they are competitive producers (or can become so); and when their trading partners are in a relatively weak position (e.g., the exporting country has market power and/or the importing countries do not, and there are no easy substitutes for the resource).

3.3 DEPTH, STRATEGIC ORIENTATION AND SCALE OF VALUE ADDITION

Depth of value addition

It would seem reasonable to assume that the more value is added through downstream processing, the more the prices of the country's output are de-linked from those of the underlying raw commodity.[14] The depth of forward linkages could therefore be a key determinant of their effects of forward linkages on alleviating the economic volatility associated with extractive dependency. The "depth" of linkages refers to the degree of value addition, while the "breadth" of linkages refers to the range of inputs that feed into and emerge from resource extraction (Morris, Kaplan and Kaplinsky, 2012:26).[15] However, the literature on value addition in natural resources and economic development generally does not address what the depth of forward linkages implies for extractives dependency. Nevertheless, there is a literature on price transmissions alongside supply chains that offers useful insights.

On the one hand, some studies show that changes in extractive commodity prices are transmitted to downstream industries, suggesting that the latter remain vulnerable to commodity price fluctuations. Weinhagen (2006) demonstrates that changes in crude petroleum prices are passed on to prices and quantities of organic chemicals and plastics products. The author therefore notes that volatile crude petroleum prices can significantly affect the plastics market. Ederington et al. (2019) also find evidence that the prices of petroleum products are inextricably linked to the price of crude oil by the technology and economics of refining. Zavaleta et al. (2015:206) also note that "econometric evidence supports the hypothesis that the U.S. and European markets for oil and refined products are integrated."

On the other hand, some studies put forward that the price transmission fades out with the degree of forward linkage development. In the case of Malaysia, the World Bank (2013) argues that the great degrees of forward linkage development in the petroleum, rubber and palm oil sectors allowed for more stability in export revenues in all three sectors. Focusing on the same case, Lebdioui (2020) notes that even though value addition did not fully eradicate the vulnerability to the fluctuations of raw material

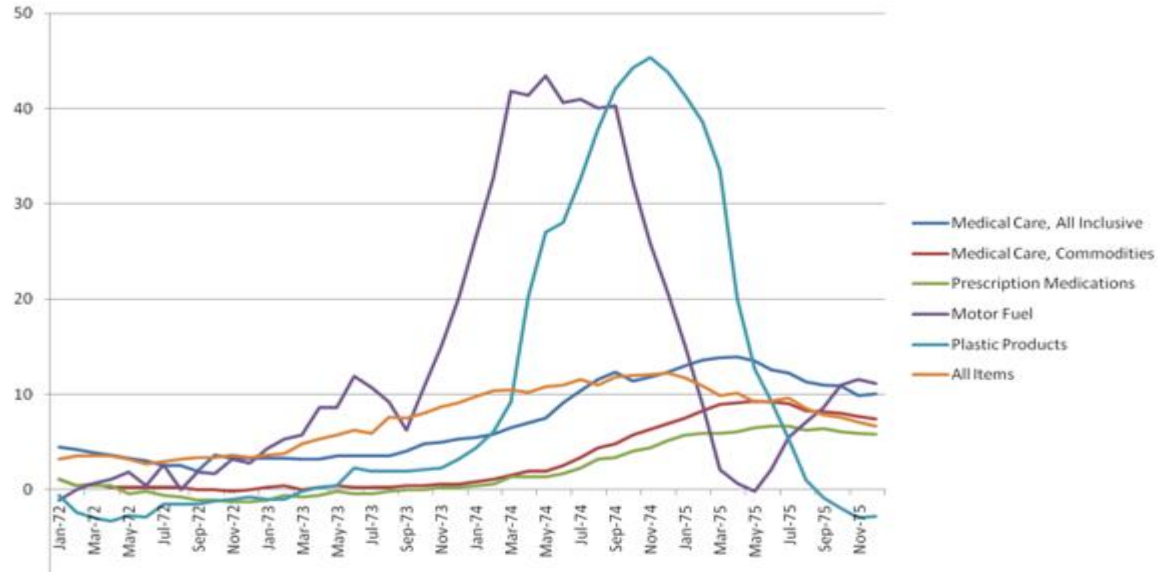
[14] This would not necessarily mean that processed products are shielded from price volatility which could derive from other sources than raw material price fluctuations.

[15] A 'deep' forward linkage is one in which the processed product is much more valuable than the raw extractive commodity used to make it. For example, a country that both cuts and polishes mined diamonds would have deeper forward linkages from the diamond sector than one where the stones are simply cut (as the polishing process adds value on top of the cutting process). A 'broad' forward linkage is one that uses inputs from a wide range of different sectors. To maintain our diamond example, if the country were also to turn the diamonds into jewelry and market them to consumers, this forward linkage would be both deeper (because more value is added) and broader than where stones are only cut and polished, because a much wider range of inputs would now be used domestically – in addition to extraction and industrial processing, the final product sold to the consumer could also make use of gold, jewelry design services, marketing services and retail services.

prices, it resulted in the stabilization of export revenues and the creation of knowledge spillovers that enabled the diversification towards different products and markets. Malaysia's growing petrochemical (and plastics) industry supports other major sectors of the domestic economy by providing a steady supply of feedstock material to automotive, electronics and rubber-based manufacturing (through synthetic rubber production), thereby promoting the diversification of the economy and reducing extractive dependency (ibid.)

Interestingly, while a plethora of studies investigate the price transmissions between crude oil and petrochemical/plastics products, very few studies (e.g. Hess et al. 2011) investigate the link between crude oil and higher value-added products such as pharmaceuticals or plastic industrial parts and components (which itself could be an indication that there is little price transmission between these two sectors). Although Hess et al. (2011) show that there often appears to be an association between decreased petroleum supply (indicated by a rise in inflation in motor fuel prices, which covary closely with petroleum supply), a rise in the price of plastics and, lagging by several months, the prices of healthcare commodities, they also show that the increase in health care inflation is blunted compared with the rise in the price of plastics. In other words, the more downstream is the processing, the less price transmission there is, which suggests a progressive decoupling of prices alongside the extractive value chain. For example, as shown in Figure 2 below, the spike in motor fuel prices in 1974 had an impact on the price of plastic products in the U.S., but virtually no influence on prices of more value-added petroleum-based products such as healthcare commodity prices.

Figure 2. Inflation for U.S. consumer price index variables, 1972–1975[16]

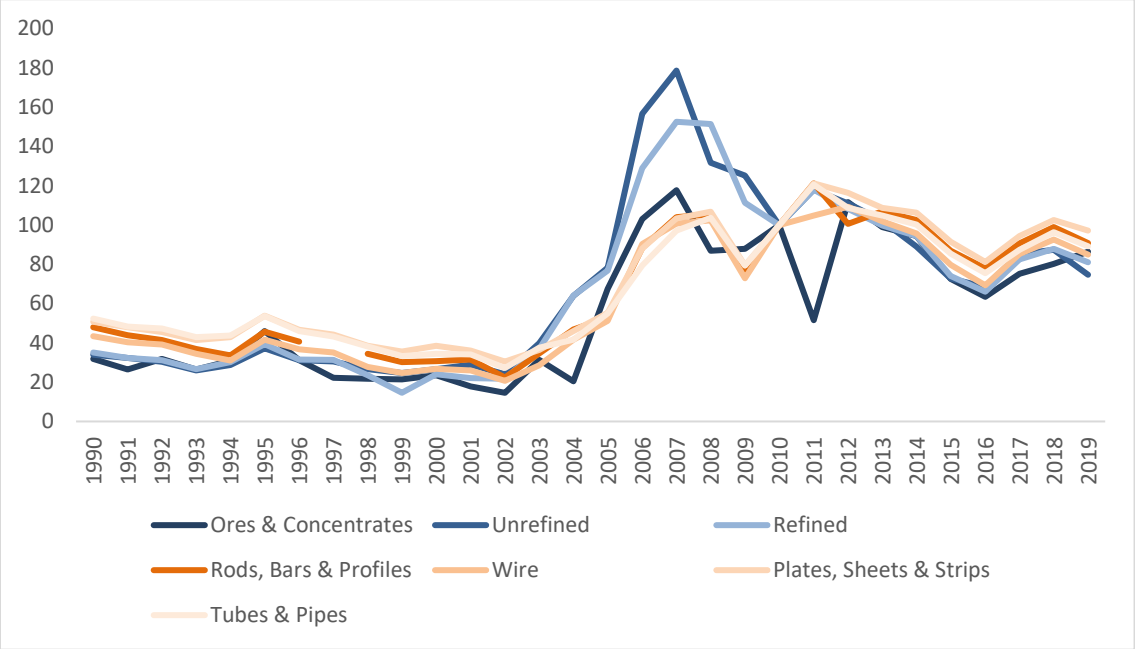


To further test this hypothesis, we have compiled primary quantitative data comparing price fluctuations for different commodity products based on different degrees of processing and value addition. We have used commodity price indices, which serve as a control and generally show less sensitivity than comparisons based on a price-to-weight ratio. The figures below illustrate price trends

[16] Source: Hess (personal communication)

for different commodities using price indices based on a reference year. Each figure (except Figure 6 on phosphates) shows that the prices of the raw commodity in question (represented by darker colors) fluctuated more than the processed counterparts (represented by brighter colors) – moreover, processed products with more value added experienced less volatility than those with less value added. This suggests that deeper forward linkages tend to reduce volatility more than shallower ones. The fact that this relationship did not hold for phosphates also supports the general point that the relationship between linkages and dependency varies by commodity.

Figure 3. Copper products price fluctuations (2010=100)[17]



[17] Source: Authors' calculation based on UN Comtrade data.

Figure 4. Iron and steel products price fluctuations (2010=100)[18]

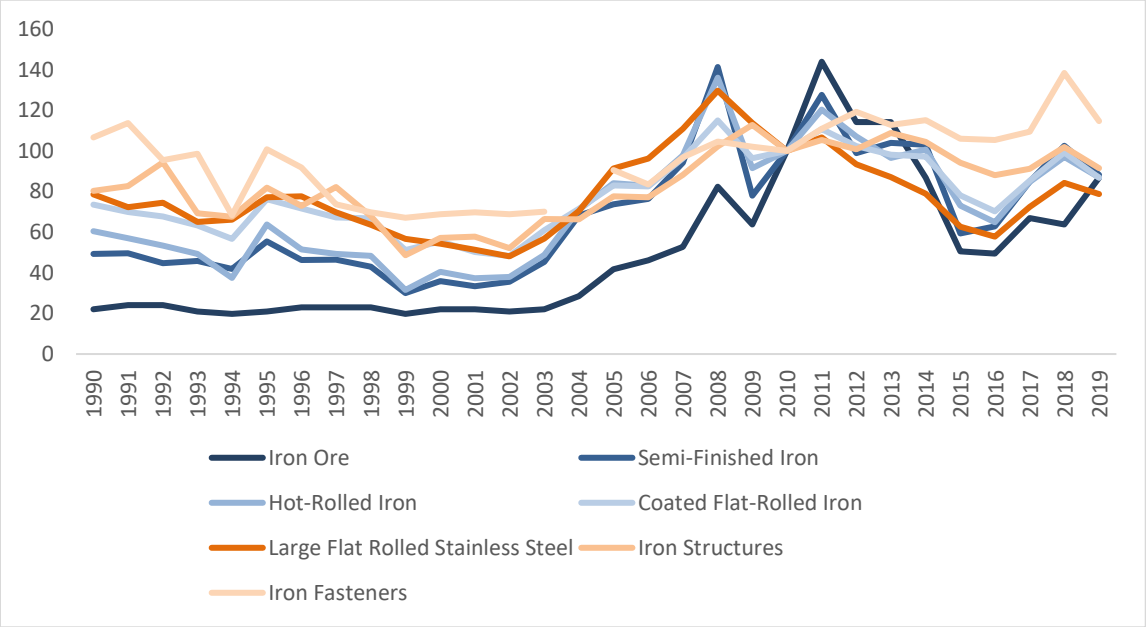
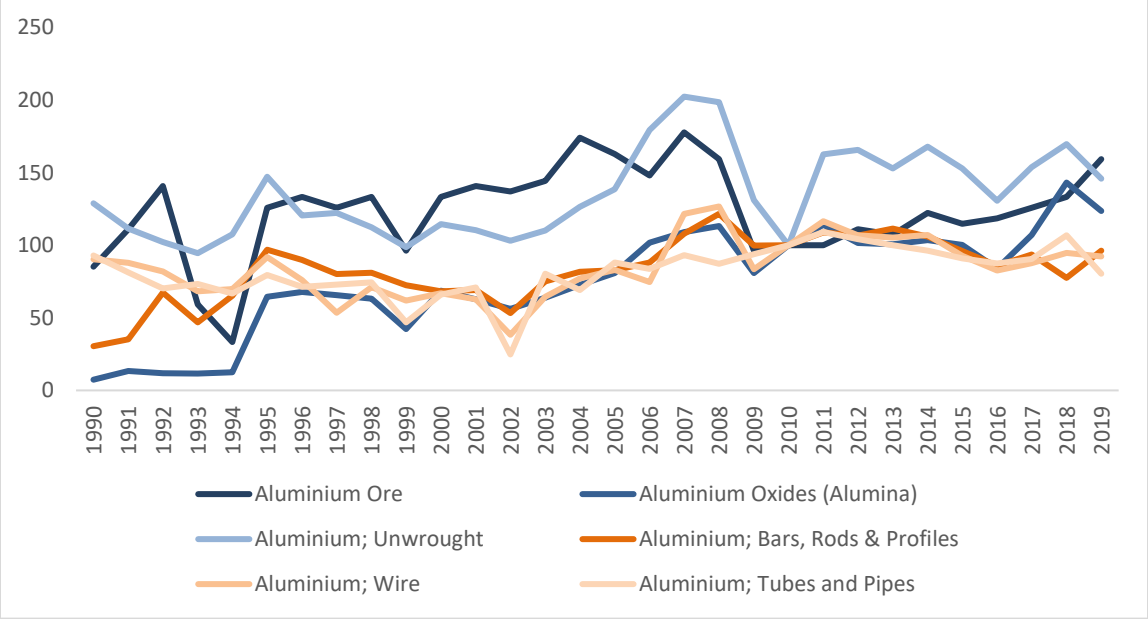


Figure 5. Aluminum products price fluctuations (2010=100)[19]



[18] Source: Authors' calculation based on UN Comtrade data

Figure 6. Phosphate products price fluctuations (2010=100)[20]

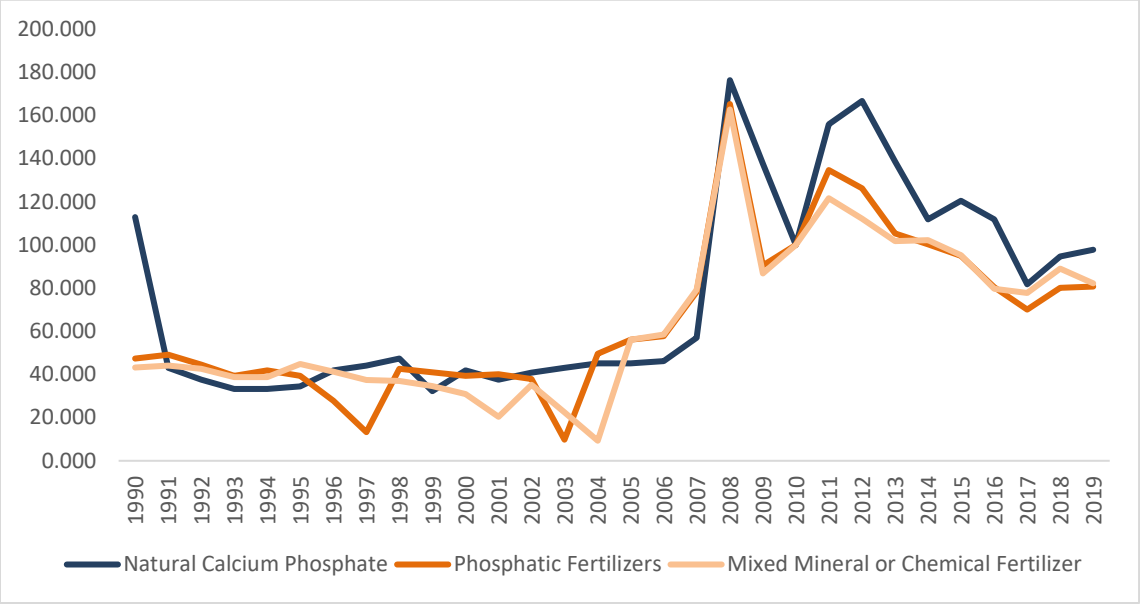
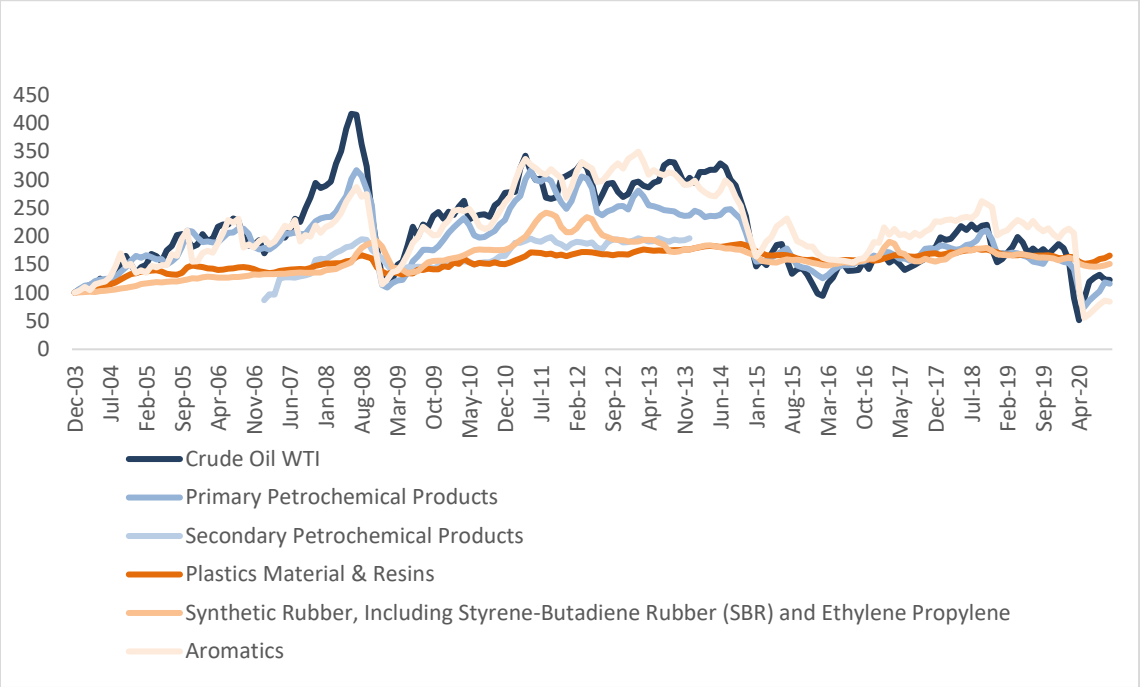


Figure 7. U.S. oil price and products index (Dec 2003 = 100)[21]



Strategic orientation of forward linkages, cost competitiveness and import traps

It is of utmost importance to highlight that some downstream value addition processes require the import (at least initially) of many inputs, while others utilize little in the way of extra inputs or can make

[20] Source: Authors' calculation based on UN Comtrade data
[21] Source: St Louis Federal Reserve

use of inputs that are already locally available. This nuance leads to an important discussion on the effects of the backward linkages that stem from forward linkages, and their implications for the effects of value addition on extractive dependency.

One the one hand, it is important to consider input costs in downstream (and upstream) diversification, which can affect the competitiveness and commercial viability of downstream (and upstream) activities. An example of costly value addition is the transformation of bauxite into aluminum. While aluminum is mainly made of bauxite, the most expensive input is energy. Hence, "value added" considerations should not lead a country to move into the aluminum industry just because it produces a lot of bauxite.

Another example is provided by the oil and gas industry, where both upstream and downstream activities are characterized by high capital investment, specialized input, technological complexity and highly globalized supply chains, which often create barriers to local participation, especially in countries with little existing capacity (Tordo et al. 2013). In that sense, the role that technological factors play in forward linkage development is very important. Hirschman (1981:167) recognized that "perhaps the principal reason why it is difficult to establish backward and forward linkage industries around the staples is not so much that, as argued originally, there are fewer linkage effects in agriculture than in industry, but that they largely point to industries whose technologies are alien to the grower of the staple. Hence, for a very long time these industries are carried on abroad." This argument is in line with the so-called "enclave thesis."[22] As a result of high barriers to value addition and technological complexity, the most easily accessible value addition opportunities may not require high degrees of capabilities. These opportunities in turn reduce prospects of transversal linkages to other sectors and further increase industrial dependence on commodities, and thus continued vulnerability to volatility, as theoretically argued in Lebdioui (2019a).

On the other hand, there is literature and evidence suggesting that the reverse relationship is also true. The existence of considerable backward linkages (from downstream sectors) towards technologically complex goods could lead to the development of transferable skills that enables the domestic economy to become increasingly less dependent on the extraction of raw materials. As discussed earlier, Bocoum (2000) found that mineral processing activities generate more backward and forward linkages than mining itself, and thereby establish a quasi-automatic process of industrialization and diversification. Arguably, the more linkages arise, the more potential avenues for economic diversification away from extractives open up; and the more complex value-added activities are, the more prospects for transversality they offer.

Most "enclave thesis" advocates have indeed underestimated how technological linkages arising out of the mineral sector can spur development. In contrast, several studies have argued that the high technological knowledge embedded in the mining sector spilled over to other sectors, thereby

[22] According to the "enclave thesis," extractive resources are particular because they are capital intensive, concentrate ownership and consequently generate fewer production and consumption linkages in developing countries than more 'diffuse' resources (Auty, 2001; Auty and Gelb 2000; Hirschman, 1981; Singer, 1950). Prebisch (1950) notably referred to FDI in the extractives sectors in Latin America as "enclaves." In Ghana, gold mining is often depicted as having an enclave status, disconnected and isolated from the rest of the economy (e.g., Larsen et al., 2009). Nevertheless, Bloch and Awusu (2012) find that gold mining can no longer be viewed as an enclave activity given deep but understudied linkages into the Ghanaian economy. See Hansen (2014) for a review of the literature on linkages between extractive multinational corporations and local industry in Africa.

promoting the development of today's industrialized economies, such as the U.S., Australia and Scandinavian countries (Blomstrom and Kokko, 2007; Wright and Czelusta, 2004).

In the more recent context of Malaysia, studies such as Nordas et al. (2003), and Lebdioui (2020) also highlight some of the production linkages arising from downstream activities in the petroleum sector and their potential for contributing to diversifying the domestic economy.[23] Nordas et al. (2003) specifically highlight the considerable transversal capabilities that are embedded in the shipyard industry and their linkages to the petroleum sector. They note that value addition in the Malaysian petroleum sector came about via the integration in maritime equipment and services. This in turn enabled the accumulation of capabilities that later went into the production of offshore equipment and platforms. These are mostly made of locally manufactured steel (Nordas et al., 2003), most certainly produced by relying on domestically extracted fossil fuels as a source of energy generation (Chong et al, 2015).

Nordas et al. (2003) also note that in Norway, the reverse trend took place. There were pre-existing shipyards with idle capacity in the 1970s and 1980s, and some of these have restructured and entered the market to build offshore platforms and equipment for petrochemical plants (Nordas, 2003:40).

These examples reveal several interesting points. Firstly, there are linkages between upstream and downstream activities that countries could exploit to maximize value addition in extractive sectors. Secondly, Malaysia and Norway show two different ways in which the development of production linkages towards complex goods and services can help stimulate diversification: one case which leverages pre-existing capabilities (Norway), and another that stimulates the development of new capabilities (Malaysia). This point highlights sequencing considerations: countries could promote the development of "related" industries before pursuing forward linkages, or could promote the development of "related industries" following the establishment of forward linkages. This nuance may have important implications for the success of reducing extractive dependency through forward linkage development. The extent to which forward linkages would enable transversal reach into new and different sectors appears to be a risker strategy, especially in developing countries with little pre-existing productive capabilities and policy planning.

Another key consideration relates to the short term versus long term effect of value addition. As a country moves up the natural resource value chain through downstream processing, most of the required inputs and means of production may be initially imported (seemingly suggesting an import trap and increasing dependence on extractives to keep downstream activities running). However, these can be progressively localized over time. For example, the Malaysian rubber and palm oil sectors' downstream industries initially imported refining technology, but increasingly shifted to domestic production and export.[24] The time horizon of forward linkage development therefore has an important influence in terms of reducing extractive dependency. This is due to the progressive localization of backward linkages that arise from downstream industries and the progressive achievement of productivity gains in downstream industries.

[23] However, in some cases, it may (in theory) be appropriate to develop downstream sectors that rely on imports and not to develop local supply capacity, if both a) the country has limited capacity to develop new sectors, and needs to prioritize (e.g., due to limited bureaucratic capacity or development finance) and b) there are better alternatives available for industrial development (e.g., ones that are not tied to extractives and should therefore help to reduce dependence faster).

Time and sequencing of downstream value addition and the promotion of productive capabilities that provide inputs for downstream activities may be important in determining whether value addition will create an import trap or productive capabilities. However, both of these factors are highly dependent on the nature of the policy environment, which is further addressed below.

In addition to the orientation of downstream linkages, as previously noted, the scale of downstream value addition also deserves attention. The differences between large scale processing capacity versus small scale processing capacity likely has implications for alleviating or worsening extractive dependency. Nevertheless, this aspect has insufficient coverage in existing literature. Östensson (2020) notes that economies of scale are particularly important in the case of oil because a refinery needs to have a large capacity to be profitable, in the order of half a million barrels of crude oil per day.[25] He writes, "Avoiding the problem by building a smaller refinery clearly would not be satisfactory since it would be difficult to achieve competitiveness with supplies from abroad. In Africa, only four out of seventeen oil producing countries (Algeria, Angola, Libya, and Nigeria) have a production higher than half a million barrels of crude oil per day."

While there is an existing literature discussing the refining and smelting capacity required to reach economies of scale, to our knowledge, there is little discussion of the optimal refining capacity in relation to extractive reserves, which has implications for both economies and diseconomies of scale. The context of downstream industries in extractive sectors is particular given the increased risk of diseconomies of scale if processing capacity exceeds the local supply of extractive resources, which are not renewable by definition. Indeed, the development of excess refining capacity compared to the domestic supply of raw materials may increase unit costs or require the import of extractive resources (at a higher cost) to run refineries at full capacity. For example, in recent years, Mexico has been running its refineries at only around half capacity as it has been "unable to compete with more efficient US Gulf coast refiners" (Argus, 2020).

In summary, we find that: a) deeper value addition helps to reduce countries' exposure to commodity price volatility; and b) forward linkages are more likely to reduce dependency where there are greater backward linkages (or transversal linkages, e.g., through the supply of inputs) to non-extractives from the downstream sector, and/or when they are sufficiently large to benefit from economies of scale, in turn becoming competitive and generating spillovers. The latter echoes our earlier conclusion on scale (though here we look at the scale of the processing, whereas in section 3.1 we looked at the effect of the scale of the country's extractive resources).

3.4 POLICY INPUTS AND ENVIRONMENT

The policy environment determines the relationship between forward linkages and extractive dependency in several ways. This section explores two main mechanisms:

- The role of policy tools in determining the *quality* of forward linkages, which determines their spillover effects and broader impact on extractive dependence
- The role of policy tools in dealing with short-term shocks, which influence the competitiveness and viability of downstream industries

[25] Elsewhere, a generally used rule of thumb has been that complex refineries need to process at least 100,000 b/d to be economically viable.

The quality of forward linkages and extractive dependence

It can be reasonably argued that the *quality* of forward linkages is a more important determinant of their impact on extractive dependence than their mere existence. In other words, a key factor that matters in terms of the relationship between forward linkages and extractive dependency is not just whether there are forward linkages as much as how well forward linkages have been established and whether they are truly competitive (or geared towards achieving that objective). Competitiveness in processing activities can allow countries to no longer be dependent on domestic (and potentially cheaper) subsidized extractive raw materials. This implies that they might be able to import them from elsewhere at higher cost and continue operations even if domestic reserves are exhausted, thereby reducing overall dependence on the extractive sector, as discussed earlier. The quality and competitiveness of forward linkages can therefore determine whether those linkages will lead to an import trap in which downstream industries are no longer competitive without subsidies. (This can mean that they do not reduce dependency, to the extent that resource revenues are necessary to finance these subsidies, as discussed earlier.) Conversely, the quality and competitiveness of linkage can enable the long-term generation of spillover effects and transversal linkages to other industries, thereby reducing extractives dependence. The competitiveness of downstream industries will also determine the price of the final processed products and therefore whether forward links generate cheap inputs for other sectors. This would further promote diversification and alleviate extractive dependency.

There are important policy differences in how countries try to develop forward linkages (e.g., subsidies, export bans or tax incentives). These may impact future success and whether processing activities become genuinely competitive. As emphasized by UNCTAD (2019b), moving downstream requires large investment, high-capacity utilization, financing, the right mix of incentives, human capital, and competitive domestic supplier firms. Nevertheless, as noted by Le Billon et al (2016), even when adopted, the implementation of diversification strategies (and downstream diversification by extension) can be marred by poor choices, mismanagement and corruption, as frequently seen in large-scale infrastructure and industrial development.

For instance, even though an overwhelming majority of African governments have put commodity processing promotion at the forefront of their national development plans (UNECA, 2013), several studies such as Morrissey (2012); Morris et al. (2012) and Ramdoo (2015) show that sustainable downstream value chains and production linkages to other sectors of the economy have been very slow to develop in extractive sectors across Africa. Comparing downstream linkage outcomes in sub-Saharan Africa (SSA) *vis-à-vis* countries where this has been more successful (such as Malaysia), Ramdoo (2015) also highlights that downstream linkages require long-term and careful planning, hard and soft infrastructure and conditions that are conducive to business development. Fessehaie (2015) further notes that as regional economic integration gains momentum, it is obvious that linkage development policies in Africa are often designed without considering the potential of regional value chains as markets and the source or destination of investment projects. Schulz (2020) confirms the view that resource-based industrialization still faces bottlenecks in Africa, such as poor energy and road infrastructure, difficult political environments and a lack of adequate technical, financial, and human capital. Processing is therefore often more competitive outside of Africa and foreign processors can outcompete domestic processors in buying domestic raw produce. Therefore, both foreign and domestic investors shy away from processing in the African countries of origin (ibid.).

The governments of developing countries have increasingly reverted to export bans and other export restrictions on un- or semi-processed commodities to encourage downstream commodity processing (ibid.). Indonesia's experience with nickel (see above) shows that these can be successful in the right circumstances. However, in general, several studies have shown that such export bans tend to be ineffective in promoting value addition (see Fliess et al 2017; Fung and Korinek, 2013). Fliess et al. (2017) investigate the impact of export control measures on forward linkages by analyzing the use of export taxes, non-automatic export licensing requirements and outright export bans in Gabon's manganese industry, South Africa's lead industry, Zambia's copper sector and Zimbabwe's chromite sector. They found that export restrictions are inefficient tools to stimulate downstream processing, as there was no improvement in the international competitiveness of the processing activities.[26] Moreover, the measures may have undermined the overall export performance of the mining industries in some of the cases studied.

Even though export prohibitions aim to increase the processing in the country of origin, they offer little guarantee that domestic processing industries can become more competitive in the long term. This is especially the case if countries do not invest, in conjunction with an export ban, in strengthening their productive capacities. Without improvements in production efficiency, countries wanting to develop downstream processing face a costly trade-off between value addition and sectoral competitiveness (Grunstein and Diaz-Wionczek, 2017; Lebdioui, 2019b). The previous example of Indonesia's bauxite sector illustrates this point. Another example is provided by the Kyrgyz Republic's intention to introduce a tax on the final production of gold ore and concentrate to increase in-country processing. Such a measure would only increase domestic value addition by 5 percent, while disproportionately increasing the tax burden on companies and endangering competitiveness of the country's gold sector.

In contrast, investments in targeted human capital, research and development and the gradual accumulation of expertise, technology, knowledge and engineering skills through experiential learning enable local downstream firms to become internationally competitive in a way that may not be achieved if the policy measures only consist of protection without performance requirements (Lebdioui, 2020). The policy environment is therefore essential in guiding how well forward linkages can be established, their degree of competitiveness and the impact they have on alleviating extractive dependence. Differences in the ways and their heterogeneous impact on extractive dependence are further illustrated in box 4 below, which compares value addition processes in the petroleum sector in Malaysia and Nigeria.

Box 4. What explains the different outcomes in terms of forward linkages and dependency in Malaysia and Nigeria?

To a great extent, policy considerations in the design of forward linkage policy strategies can account for the major differences in outcomes between Malaysia and Nigeria in terms of petroleum refining.

In Malaysia, the national oil corporation, Petronas, started to move towards downstream activities in 1983 when it set up its first small-scale refinery. By 2012, the largest share of Petronas' revenues (over 40%) came from downstream activities (World Bank, 2013). Malaysia went from being an importer to becoming an exporter of petrochemical products, which now constitute the second largest contributor to Malaysia's manufactured exports, with an export value of about USD37.2 billion in 2014 (MITI, 2017). Within that sector (which employs about 122,000 people), the plastics industry,

[26] The study's authors assessed this using revealed comparative advantage as an indicator of competitiveness.

which generated USD3.30 billion of exports in 2016 (Malaysian Petrochemicals Association, 2016) and employs around 80,000 workers (MITI, 2017), has become one of the most competitive in Asia. Malaysia's growing petrochemical (and plastics) industry also supports other major sectors of the domestic economy by providing a steady supply of feedstock material to automotive, electronics, and synthetic rubber production.

Successful downstream value addition in Malaysia's petroleum sector relied on the local availability of feedstock, good infrastructure, and its strategic location in the ASEAN market, but also relied on strategic policies adopted by the government. Malaysia pursued downstream value addition in the petroleum sector by accumulating capabilities related to oil refining, oil trading, lubricant production, and the production of petrochemicals that are used to manufacture plastic products and synthetic rubber.

Alongside investments through state-owned Petronas, several policies, including fiscal incentives and skills development programs, contributed to the successful value addition of Malaysia's petroleum resources. An export tax on crude oil of 25% was introduced in 1993 (before being reduced to 20%) to further encourage local refining of crude oil. Petrochemical production has also been on the list of eligible activities for tax breaks under the Promotion of Investment Act of 1986, alongside twenty other activities.

Value addition in Malaysia's petroleum sector has also relied on the human capital accumulated through Petronas' investments in education and training needed for the technology- and knowledge-intensive petrochemical industry. Petronas established the Institut Teknologi Petroleum of Petronas and the Universiti Teknologi PETRONAS (in 1983 and 1997, respectively), which have produced over 140,000 petroleum engineers, technicians, and technical executives. Petronas has also sponsored Malaysian students to pursue tertiary education in the country and overseas. Since 1975, through the Petronas Education Sponsorship Programme, Petronas has invested more than USD 850million in education sponsorship, technical training, and capability building, enabling more than 36,500 students to pursue secondary education and tertiary education at home and abroad (Petronas, 2017).

In Nigeria, a different strategy was pursued, and different outcomes were reached. Ogbuigwe (2018) traces the history of refining in Nigeria and highlights the current poor record of capacity utilization. Shortly after independence, the Shell-BP Petroleum Development Company saw an opportunity to meet the product needs of the country and built the first refinery in the country, which was completed and commissioned in 1965 (20 years earlier than Malaysia's first refinery). It was registered as the Nigeria Petroleum Refining Company (NPRC) in 1972 when the Government of Nigeria increased its shareholding to 60% (from 50%). Nevertheless, as of 2018, the total installed capacity was 445,000 bpsd (which is slightly less than Malaysia, which has a refining capacity of 500,000 bpsd, and a population size 6 times smaller than Nigeria's). These plants in the last 15–20 years had a poor operating record with average capacity utilization hovering between 15 and 25% per annum. As a result, 70–80% of the national petroleum products demand is met through import, which represents a stark contrast with Malaysia, which has managed to consolidate its position as an exporter of value -added petroleum products.

The decline in the performance of Nigeria's refineries started in the early 1990s after the military Government ordered the Nigerian National Petroleum Corporation (NNPC) to close its accounts in commercial banks and transfer them to the Central Bank. NNPC lost its autonomy and became increasingly subjected to interference and directives by politicians Decisions on when to carry out

turnaround maintenance and which contractor to execute it came under the influence of the Government rather than by the professionals within the corporation. The low capacity utilization which developed and still exists today is due to: a poor governance; the lack of major turnaround maintenance (TAM) in any of the refineries since 2008 (which goes against the established best practice worldwide that TAM should be conducted by refineries every two or maximum 3 years; the regular vandalization of pipelines supplying crude oil to the refineries, which leads to massive loss of revenue and worsens the problem of under-recovery of crude cost; and the regulation of the price of Premium Motor Spirit (PMS) by the Government, leading to serious under-recovery of crude cost.

An essential consideration that contributes to explain the stark difference in policy approaches in the two countries is that in Malaysia, policy-makers have viewed the oil and gas sector as a catalyst for industrialization. The petroleum sector was a priority for the government to extract more fiscal revenues that could contribute to the government's treasury to be later reinjected in national development programs. The timing of value addition policy efforts was related to a recession caused by low commodity prices which negatively impacted the ruling coalition's important source of financing (petroleum revenues). Nevertheless, rather than a short-term approach to maximizing petroleum revenues, Malaysian policymakers had favored long-term transformative investments for vertical integration to enhance the productivity and general health of the sector, which now generates more revenues from downstream value addition than from crude oil extraction.

Nevertheless, notwithstanding the considerable degrees of value addition achieved in Malaysia's petroleum sector, it should be noted that extractive dependency has not been fully eradicated. One of the challenges for the Malaysian petrochemical industry remains the volatility of crude oil prices that create uncertainty for investments. The petrochemical industry is characterized by a cyclical nature and needs to overcome sporadic volatilities in feedstock costs (Federation of Malaysian Manufacturers, 2018).

Sources: Lebdioui (2020) for Malaysia; Ogbuigwe (2018) for Nigeria.

Dealing with short-term shocks

A country's ability to deal with the short-term shocks from commodity price fluctuations influences its relationship between forward linkages and extractive dependence. Indeed, as posited by the Dutch disease theory, commodity price volatility can have a strong impact on currency appreciation and therefore on the competitiveness of manufactured goods (which includes value added goods in extractives sectors) (see Neary and Van Wijnbergen, 1986; Corden, 2984; Sachs and Warner, 1991, 2001; Moreno et al., 2014).[27] The ability to cushion short term shocks (through a counter cyclical policy or savings for instance) therefore influence the resilience of downstream activities in extractive value chains. There is a vast theoretical (and empirical) literature on the role of the institutional quality in determining the exposure and vulnerability of countries to the challenges of resource dependence (See Mehlum et al., 2006, Robinson et al., 2006, NRGI, 2013, Kaufmann et al., 2014). Strong institutions can contribute to resilience to external shocks by enabling the reduction of external debt, the accumulation of savings and external reserves. These can be used to finance a counter-cyclical policy and ensure

[27] 'Dutch disease' theory explains how rising value of a country's exports of primary commodities can harm the economy over the longer term. This occurs because the increased demand for primary commodities makes other (more dynamic) sectors less competitive, due to an exchange rate appreciation and/or by drawing scarce inputs into producing the commodities for which demand is booming.

macroeconomic stability (Robinson et al., 2006). This perspective explains Le Billon and Good's (2016) argument on the sharp contrast between wealthier exporting countries like Saudi Arabia that have the capacity to address drops in extractive revenues through disbursements from the saving funds built during the commodity boom; and poorer countries—or those who failed to build-up such funds or reimburse loans– that are more likely to increase expensive borrowing, drastically cut public expenditure, and see their currency value plummet with imports becoming more expensive.

In sum, section 3.4 underscores the importance of business excellence and competitiveness for downstream sectors to be viable, and for them to reduce dependence. Moreover, it finds that there is a two-way (and time dimensional) relationship between forward linkages and extractive dependency and price volatility. Macroeconomic stability is essential to the long-term success of forward linkages and their contribution to economic diversification. However, the success of forward linkages is also dependent on the level of short-term exposure of an economy to commodity price volatility. If a government needs to cut back spending because of a drop in revenue from extractives, or if the local currency appreciates as a result of a commodity boom, extractives-based manufactured exports may become less competitive and therefore increase extractive dependency.

4. Conclusion

In summary, it appears that there is no straightforward relationship between forward linkage promotion and extractives dependency. Whether forward linkage promotion alleviates or worsens different types of extractives dependencies depends on a variety of factors, which are either country-specific, commodity-specific or market-specific. It appears that efforts to develop extractives forward linkages are most likely to reduce dependency where:

- The resulting downstream industries are competitive
- The resulting downstream industries have stronger backward linkages to the rest of the economy
- The producing country has greater market power in global markets for the commodity in question (in such cases, forward linkage efforts are more likely to succeed in developing viable downstream industries, which is an important first step towards such activities providing a springboard for diversification)

Where efforts to provide a springboard to diversification fail, forward linkages may worsen extractives dependency by drawing more factors of production into the extractive sector, weakening the rest of the economy and increasing dependence.

In addition to potentially reducing/increasing dependence, forward linkages can also help to reduce dependency's effects. This is most likely where a) downstream industries are competitive enough to outlast resource exhaustibility, and/or b) the depth of downstream value addition is higher, which reduces the volatility of the country's export prices.[28] Where these conditions do not hold, forward linkages may instead worsen the problem, by drawing more factors of production into a sector that is exposed to exhaustibility and volatility.

The literature directly on the topic of the relationship between forward linkages and extractives dependency remains scarce. This has enabled us to identify areas where further research is needed. For instance, little has been written on the impact of technological innovations on the relationship between forward linkages and extractives dependency. The literature has also generally ignored the impact of value addition in extractive sectors in terms of alleviating or compounding *political* dependence on extractives. It has also overlooked the impact of value addition in extractive sectors through quality upgrading (e.g., producing a higher quality version of the same good rather than processing/refining it) and its implications for extractive dependence/economic development. This agenda is particularly relevant in the context of climate change, given the progressive shift towards bio-mining or bio-refining (e.g., green mining, blue ammonia, and so on), which consists in producing the same raw materials but with less carbon intensive methods, and can be seen as a form of "higher-quality" (i.e., lower environmental impact) mining/refining.

Policies to promote forward linkages in extractive sectors are also often designed at the national level while ignoring the potential for regional supply chains. As evidenced by an increasing number of studies, and as regional economic integration is gaining momentum in regions such as Africa through the African Continental Free Trade Area (AfCFTA), it is timely to discuss regional strategies and trade facilitation to foster synergies and complementarities in extractives supply chains. The COVID-19 crisis also represents

[28] This is because prices of more value-added products are less volatile.

a critical juncture for rethinking the regionalization of supply chains. The disruption of global value chains witnessed in Africa and Latin America as a result of the pandemic is largely related to those regions' dependence on imported manufactured goods and extractives exports. Against this backdrop, there is an urgent need to strengthen productive capacities in developing regions to achieve both resilience and competitiveness.

It is worth ending this report by underlining that forward linkage development in extractive sectors is not necessarily a fit-for-all development strategy. Whether—and which—downstream value addition policies are the best avenue for diversification and reduction of commodity dependence is governed by several country-specific and commodity-specific factors and may not substitute the role of much needed horizontal diversification in some contexts. Forward linkage development therefore needs to be anchored in a broader strategy and long-term vision for value addition in the extractive sectors and economic diversification, rather than being pursued only for its own sake. Where investment capital (and policymakers' capacities to promote certain sectors) are limited, it also needs to be weighed carefully against other available opportunities for diversification and development.

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