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Abstract

Several case studies have analysed the potential of natural resource (NR) based industrialisation, a process based on diversification towards high value-added products, in the Latin American region. However, there is limited evidence on how the development of productive linkages – a key aspect of this strategy – behave at the country level. Based on input-output analysis, this paper provides a clearer picture of the extent and evolution of productive linkages of NR sectors across a sample of middle- and high-income countries in Latin America as well as in other developing and developed regions. The paper focuses on the degree to which extractive industries, i.e. oil, gas, and mining, are connected to the rest of the economy by studying both backward and forward linkages using OECD IO data. It also makes a distinction between local and foreign inputs to account for the level of integration that these sectors have into global value chains and/or import dependence. Furthermore, it tries to identify whether the importance of the extractive sectors in exports and total economic output is related to the level of intersectoral linkages. We find that in most countries intersectoral linkages have become smaller despite the expansion of the extractive sector suggesting a higher level of enclaveness as predicted by the resource curse literature.

JEL Classification: O13, O14, 054, O57, L71, D57

Keywords: natural resources, Latin America, mining, extractive, resource boom, industrial linkages

1. Introduction

The commodity bonanza that many emerging economies experienced during the last decade renewed the interest of many scholars in the potential of natural resources as a platform for structural change – especially in resource-rich middle-income countries. This strategy has been especially appealing for the Latin America region whose revealed international competitive advantage lies mainly on natural resources but also includes scientific knowledge and skilled labour (Lin & Treichel, 2012). Furthermore, the experience of Norway and Australia[1], in successfully moving from natural resources to knowledge-based economies has also strengthened the idea that the so-called *resource curse* is not necessarily a curse but potentially a blessing.

These factors, along with changes in the technological paradigm (Perez, 2010), have supported the case for a natural-resource based industrialisation strategy – mainly characterised by the adoption of state-of-the-art technologies along extractive processes and, most importantly, diversification toward high added-value products. According to this view, structural change is not the result of the extraction of commodities itself but rather of the development of productive linkages (Kaplinsky, 2011) – especially with medium and high knowledge intensity sectors. The development of spin-off industries that are suppliers of services and inputs as well as commodity processing industries is essential for diversification, employment generation, improvement of social capabilities, and the overall resilience of the economy. In other words, it is paramount for avoiding the resource curse – which predicts a high degree of 'enclaveness' for natural resource sectors and the weakening of manufacturing industries, among other adverse economic conditions. Therefore, strong inter-industrial connectivity is at the core of this strategy.

Several case studies in Latin America and other developing regions have shown the potential of natural resources to catalyse broad-based growth[2] and, while some of these highlight the importance of inter-industrial linkages, there are few that have studied this matter from a quantitative perspective[3]. The objective of this paper, thus, is to provide an outline of the topology of the inter-industrial relations of the mining sector, i.e. oil, gas, and mining commodities, across a sample of middle- and high-income countries in Latin America and other regions.

For this purpose, we utilise an input-output framework (i.e. backward and forward linkages), which allows for a country-level assessment of inter-industrial linkages, and ultimately, for a better understanding, of how the productive structure is affected by changes in the demand and supply of the mining sector. In particular, this paper provides a more detailed account of how inter-industrial linkages have evolved from the mid-1990s to the end of the commodities boom in 2011. Likewise, our analysis identifies the industries that the mining sector connects to more strongly as well as the degree to which inputs demanded by this sector are satisfied by foreign industries. Overall, this descriptive analysis sheds further light on the differences between and the evolution of the extractive related industries in resource-rich countries during a key period – not only because of changes in commodity prices but also because of a high level of integration into global value chains.

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[1] For instance, see Ville & Wicken (2012).

[2] Some of the case studies on Latin America include: Salmon (Katz, 2006; Maggi, 2003), wine (Benavente, 2006; Giuliani, 2011), coffee (Giovannucci et al., 2002), cassava and flowers (Mytelka & Bortagaray, 2006) and mining (McMahon & Remy, 2002).

[3] Nchor & Konderla (2016) analyse economic multipliers, sectoral inter-dependence and trade concentration before and after the production of oil in commercial quantities in Ghana.

The paper is structured as follows: Section 2 describes the methodology, sample and data utilised. Section 3 presents the evolution of the mining sector and section 4 presents the empirical results. Section 5 concludes.

2. Methodology

In the paper, we utilise an Input-Output framework that measures the interdependencies in the structure of production by calculating backward and forward linkages. The former is based on the Leontief inverse matrix and captures the demand relationship between sectors. A backward linkage coefficient measures by how much supplier industries will increase their demand when sector *i* increases its output. The latter is based on the Ghosh coefficient matrix and it captures the supply relation between sectors: when output in sector *i* increases there is a higher availability of product *i* to be used as an input in other industries[4].

Both provide an insight into the different levels of inter-industrial connectivity: While backward linkages indicate how much other sectors' demand will grow as sector *i* expands, forward linkages describe how much other sectors depend on the output of sector *i* for their own productive activities[5].

Using the framework analysis of Reis & Rua (2006) as a reference, a third measure is also considered to make a distinction between the demand for domestic and foreign products by measuring *backward leakages*. This captures the extent to which non-domestic sectors are stimulated when sector *i* increases its demand. So, if sector *i* has a high level of backward leakages, as it expands, it will generate additional imports to support it. This distinction between domestic and imported inputs is made in order to avoid the overestimation of multiplier effects (Dietzenbacher, Albino, & Kuehtz, 2005) as well as to see where the demand is generated, i.e. domestically or abroad.

Finally, we introduce a fourth measure, *forward leakages*, to estimate the supply relation between a domestic sector and non-domestic sectors. Namely, it measures changes in the availability of primary inputs from sector *i* in all non-domestic sectors when sector *i* increases its output. Our measure is different to the forward leakage measure by Dietzenbacher, Albino, & Kuehtz (2005) which describes the impact of imports on the availability of primary inputs for a domestic sector. Our measure allows us to compare how much of the output of a given sector is absorbed as primary input domestically in relation to the rest of the world.

2.1 Backward linkages

Say we have *n* sectors in an economy and the equilibrium between total supply and total demand for each product i is:

$$x_i + m_i = z_{i1} + z_{i2} + \ldots + z_{in} + y_i \tag{1}$$

[4][4] The Ghosh model is considered a more appropriate one for obtaining the forward linkage measure (Miller & Blair, 2009). However, Dietzenbacher (1997) suggested that the Ghosh model should be interpreted as a Leontief price model, instead of a quantity model. However, this interpretation is also debatable: De Mesnard (2001) and Davar (2005) have proven that this interpretation is erroneous as it would only be valid under strong, unrealistic assumptions (e.g. dichotomy).

[5] For a detailed explanation of the input-output framework, namely of the Leontief and Gosh coefficients, see Miller & Blair, 2009.

where x_i is the output of sector *i*, m_i represents the imports of product i , z_{ij} is sector *i*´s product absorbed by sector *j*, and y_i is the total final demand of sector *i*. Because m_i is defined as:

$$m_i = \sum z_{ij}^m + y_i^m \tag{2}$$

where z_{ij}^m is sector *i*´s imported inputs absorbed by sector *j* and y_i^m is sector *i*´s total final demand of imports.

Then (1) can be rewritten as

$$x_i = z_{i1}^d + z_{i2}^d + \ldots + z_{in}^d + y_i^d \tag{3}$$

We obtain of a set of n equations for each of the n sectors

$$\begin{aligned} x_1 &= Z_{11}^d + Z_{12}^d + \ldots + Z_{1n}^d + y_1^d \\ x_2 &= Z_{21}^d + Z_{22}^d + \ldots + Z_{2n}^d + y_2^d \\ &\vdots \\ xn &= Z_{n1}^d + Z_{n2}^d + \ldots + Z_{nn}^d + y_1^d \end{aligned} \tag{4}$$

The domestic direct input coefficient is defined as:

$$a_{ij}^d = \frac{z_{ij}^d}{x_j} \tag{5}$$

The domestic direct input coefficient (5) is then substituted into the system of equations (4)

$$\begin{aligned} x_1 &= a_{11}^d x_1 + a_{12}^d x_1 + \ldots + a_{1n}^d x_1 + y_1^d \\ x_2 &= a_{21}^d x_2 + a_{22}^d x_2 + \ldots + a_{2n}^d x_2 + y_2^d \\ &\vdots \\ x_n &= a_{n1}^d x_n + a_{n2}^d x_n + \ldots + a_{nn}^d x_n + y_n^d \end{aligned} \tag{6}$$

In matrix terms, one can write (6) as

$$X = A^d X + Y^d$$

With

$$A^d = \begin{bmatrix} a_{11}^d & a_{12}^d & \cdots & a_{1n}^d \\ a_{21}^d & a_{22}^d & \cdots & a_{2n}^d \\ \vdots & \vdots & \ddots & \vdots \\ a_{n1}^d & a_{n2}^d & \cdots & a_{nn}^d \end{bmatrix} \qquad X = \begin{bmatrix} x_1 \\ x_2 \\ \vdots \\ x_n \end{bmatrix} \qquad Y^d = \begin{bmatrix} y_1^d \\ y_2^d \\ \vdots \\ y_n^d \end{bmatrix}$$

(7)

Where A^d is the domestic intermediate input coefficient matrix, X is a vector matrix of the output and Y^d is a vector matrix for the final demand of each of the *n* sectors in the economy. Solving (7) for X

$$X = \left(I - A^d\right)^{-1} Y^d$$

(8)

The Leontief inverse matrix would be $B = \left(I - A^d\right)^{-1}$ where a typical cell gives the ratio of sector *i*'s input absorbed by *j* to sector *j*'s output.

The *total backward linkage* is the sum of the elements in the *j*th column of the Leontief inverse matrix, which measures the total output from all sectors generated from a one-unit change in the final demand of sector *j* (Rasmussen, 1956) that is:

$$b \bullet j = \sum_{i=1}^{n} b_{ij}$$

(9)

Considering that we are primarily interested in the degree of backward dependence to the rest of the economy, it is appropriate that we omit the on-diagonal elements in the column sum of sector j, $b \bullet j$, to consider the output multiplier effect that is created beyond our sector of interest (Blair & Miller, 2009).

We will refer to the total backward linkage as the direct backward linkage (DBL) and to the latter measure, where on-diagonal elements are netted out of the summation, as the indirect backward linkage (IBL).

2.2 Forward linkages

To obtain the forward linkage indicator, let us consider the matrix form for sectoral output:

$$X' = W'\left(I - A^{*d}\right)^{-1}$$

(10)

Where *W'* is the vector of imports and added-value items used by sectors, A^{*d} is the matrix of domestic direct output coefficients and $\left(I - A^{*d}\right)^{-1}$ the Leontief inverse. A cell in the A^{*d} matrix gives the ratio of sector *i*'s domestic production absorbed by *j* to sector *i*'s output:

$$a_{ij}^{*d} = \frac{z_{ij}^{d}}{x_i}$$

(11)

The total forward linkage is the sum of the elements in the *i*th row of the output inverse matrix which gives the effect on total output throughout all sectors of a unit change in primary inputs for sector *i*, that is:

$$b_i^* \bullet = \sum_{i=1}^{n} b^*{}_{ij}$$

(12)

Similarly, in order to consider the forward dependency to the rest the economy we will omit the on-diagonal elements in the row sum of sector j, $b_i^* \bullet$, and refer to this measure as the indirect forward linkage (IFL). The total forward measure, with all on-diagonal elements included, will be referred to as the direct forward linkage (DFL).

2.3 Backward leakages

Defining A^m as the matrix of imported input coefficients, with a typical cell giving the ratio of imports of product *i* absorbed by sector *j* per unit of output of sector *j*, allows us to construct the backward leakage matrix:

$$A^m(I - A^d)^{-1}$$

(13)

Where the sum of the elements in the *j*th column provides the total leakage, i.e. value of all imports, due to a one-unit increase in the final demand for sector *j* (Dietzenbacher et al., 2005).

2.4 Forward leakages

We define A^{IC} as the matrix of inter-country output coefficients with *n* products and *k* countries. The technical coefficients, $a_{ij}^{*d} = \frac{z_{ij}^{d}}{x_i}$ for domestic production and $a_{ij}^{*m} = \frac{z_{ij}^{m}}{x_i}$ for imports, are known. The A^{IC} matrix is a composition of several matrices, with the domestic matrices of direct output coefficients A_k^{*d} of *k* countries along the diagonal and the matrices of imported output coefficients A_k^{*m} above and below:

$$A^{IC} = \begin{bmatrix} A_{AA}^{*d} & \cdots & A_{AK}^{*m} \\ A_{BA}^{*m} & \cdots & A_{BK}^{*m} \\ \vdots & \ddots & \vdots \\ A_{KA}^{*m} & \cdots & A_{KK}^{*d} \end{bmatrix}$$

(14)

Akin to the forward linkage, the total forward leakage is the sum of the elements in the *i*th row of the of the inter-country output inverse matrix, however, we exclude the columns which correspond to the domestic matrix of direct input coefficient A_k^{*d}. Thus, the forward leakage[6] gives the effect on total output throughout all sectors outside of country A of a unit change in primary inputs for sector *i* of country A.

2.5 Data and sample countries

To obtain the previous measures, we utilise a sample of middle and high-income countries using OECD Input-Output data from 1995 to 2011. This period allows us to capture some of the changes in inter-industrial relations that took place as trade liberalisation, stronger integration into global value chains and the emergence of China and other Asian economies materialised. More importantly, it coincides with the commodity boom of the 2000s, in which energy and metal prices in some cases tripled from historical low levels after 2003 (Adler & Sosa, 2011). The boom came to an end in mid-2011 when prices peaked.

National Input-Output Tables (NIOTs) describe supply and demand relationships between producers and consumers within a country. They can either show flows of final and intermediate goods and services defined according to industry outputs (industry × industry tables) or according to product outputs (product × product tables).

The OECD database of harmonised NIOTs takes the industry × industry approach. This reflects the collection mechanisms for data sources according to industrial activity such as R&D expenditure, employment, foreign direct investment, and energy consumption. The utilised version of NIOTs consists of matrices of inter-industrial flows of goods and services (produced domestically and imported) in current prices (USD million) (OECD, n.d.)

The Inter-Country Input-Output (ICIO) tables also cover inter-industrial relationships across countries. In an ICIO table, the diagonal blocks represent domestic transaction flows of intermediate goods and services across industries (NIOTs), while the off-diagonal blocks represent the inter-country flows of intermediates via exports and imports.

OECD Input-Output datasets are based on an ample array of sources, such as National Accounts (SNA 1993 format) statistics from the OECD and UNS, and merchandise trade statistics from UN Comtrade. It employs a 34-sector classification based on the *UN International Standard Industrial Classification of All Economic Activities, Revision 3* (ISIC Rev.3).

[6] Our measure of forward leakages differs to the one put forward by (Dietzenbacher et al., 2005), in which the forward leakage resulting from one unit change in the primary inputs for sector *i* is given by the sum of the elements in the *i*th row of the leakage matrix $(I - A^d)^{-1}A^{*m}$. Such measure describes how imports affect the availability of primary inputs for a domestic sector. Our definition, in contrast, measures how the output of a domestic sector affects the availability of primary inputs in all sectors outside that country.

Table 1. OECD, Inter-Country Input-Output (ICIO) Tables, 2016 edition

	Intermediates use	Final Demand (FD)							Output (X)
	ctry 1 x indy 1 […] ctry 71 x indy 71	Households Final Consumption Expenditure	Non-Profit Institutions Serving Households	General Government Final Consumption	Gross Fixed Capital Formation	Change in Inventories and Valuables	Direct purchases by non-residents	Discrepancy	
country 1 x industry 1									
country 1 x industry 2									
[…]									
[…]									
country 71 x industry 1 […]	(Z)	(FD)							(X)
country 71 x industry 34									
Value added + taxes - subsidies on intermediate products (VA)	(VA)	*Note*: FD = Total final expenditures + *discrepancy* (i.e. exports to unspecified partners)							
Output (X)	(X)								

Z	Intermediate transactions	(2414 rows/sectors x 2414 columns/countries)
VA	Value added at basic prices + taxes less subsidies on intermediate products	(1 row x 2414 columns/countries)
X	Output at basic prices	(1 row x 2414 columns/countries)

Note: 2414 = 34 industry sectors x 71 countries (i.e. 63 countries + Rest of the World + split tables for China and Mexico)
Source: OECD

According to the sector classification, the mining sector ("Mining and quarrying") includes the extraction of minerals occurring naturally as solids (coal and ores), liquids (petroleum) or gases (natural gas). It also includes supplementary activities aimed at preparing the crude materials for marketing, for example, crushing, grinding, cleaning, drying, sorting, concentrating ores, liquefaction of natural gas and agglomeration of solid fuels (UNSD, n.d.).

For the comparative purpose of this analysis, the sample countries were grouped as follows:

- **Latin America** (LCN): Argentina, Brazil, Chile, Colombia, Mexico, and Peru.
- **Middle-income countries** (NON-LCN MIC): *Excludes LCN*. Indonesia, Philippines, Malaysia, Thailand, Russian Federation, South Africa.
- **High-income countries** (HIC): *Excludes LCN*. Australia, Netherlands, Norway, United Kingdom, Canada, and the United States.
- **High-income, oil-specialised countries** (OS HIC): Brunei Darussalam and Saudi Arabia.

Table 2. Classification of sample countries according to region and income group

Country	*Code*	*Region*	*Income group*
Brunei Darussalam	BRN	East Asia & Pacific	High income
Saudi Arabia	SAU	Middle East & North Africa	High income
Australia	AUS	East Asia & Pacific	High income
Netherlands	NLD	Europe & Central Asia	High income
Norway	NOR	Europe & Central Asia	High income
United Kingdom	GBR	Europe & Central Asia	High income
Canada	CAN	North America	High income
United States	USA	North America	High income
Chile	CHL	Latin America & Caribbean	High income
Argentina	ARG	Latin America & Caribbean	Upper middle income
Brazil	BRA	Latin America & Caribbean	Upper middle income
Colombia	COL	Latin America & Caribbean	Upper middle income
Mexico	MEX	Latin America & Caribbean	Upper middle income
Peru	PER	Latin America & Caribbean	Upper middle income
Indonesia	IDN	East Asia & Pacific	Lower middle income
Philippines	PHL	East Asia & Pacific	Lower middle income
Malaysia	MYS	East Asia & Pacific	Upper middle income
Thailand	THA	East Asia & Pacific	Upper middle income
Russian Federation	RUS	Europe & Central Asia	Upper middle income
South Africa	ZAF	Sub-Saharan Africa	Upper middle income

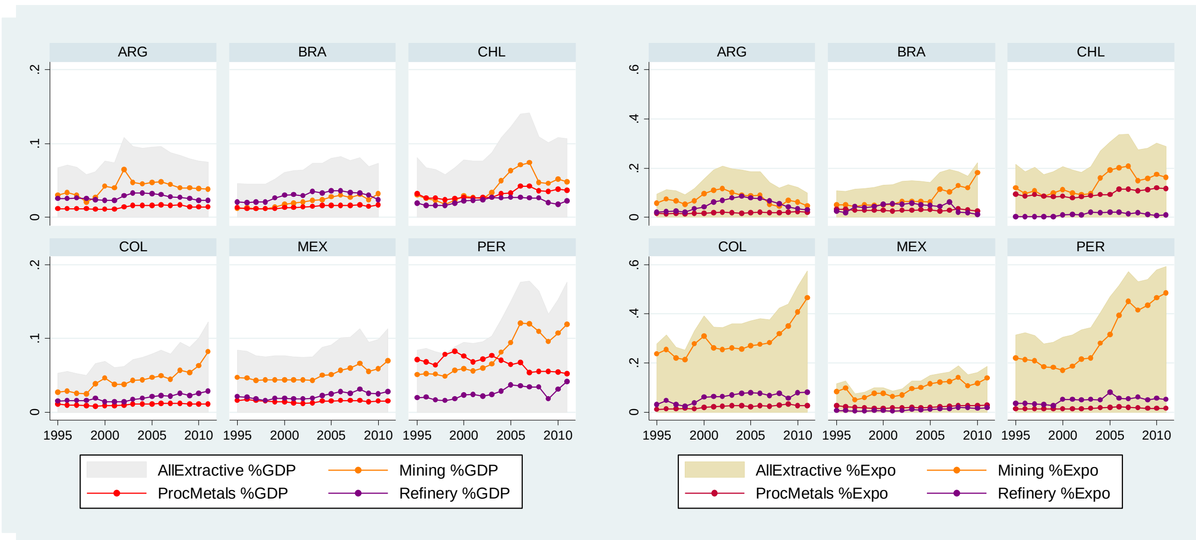
Note: The World Bank classification divides countries among income groups according to 2016 gross national income (GNI) per capita, calculated using the World Bank Atlas method. The groups are: low income, $1,005 or less; lower middle income, $1,006–3,955; upper middle income, $3,956–12,235; and high income, $12,236 or more.
Source: World Bank

3. Mining's Importance

In the period covered, 1995 to 2011, most countries in the sample experienced growth in the mining sector – unsurprisingly so, considering the 2000s commodities boom[7]. Only in Argentina, the Netherlands, Great Britain, and the US did the economic contribution of mining have little to no growth[8]. Furthermore, mining constitutes the most important part of the extractive industries' contribution to GDP and exports[9].

A closer look at Latin America shows that the mining sector has grown substantially in terms of its economic contribution (i.e. share of GDP and exports) with Peru being the most dependent on mining. As a share in GDP, the mining sector grew from 1% to 4% in Brazil, 3% to 8% in Colombia, 5% to 12% in Peru, 5% to 7% in Mexico, 3% to 5% in Chile and 3% to 4% in Argentina. The share of mining in total exports in Mexico went from 8% to 14%, in Colombia from 24% to 46%, in Peru from 22% to 49%, in Brazil from 5% to 20%, and in Chile from 12% to 16%. Only Argentina had a decline from 6% to 5%.

Other extractive industries, have grown as well – namely refinery activities – but marginally if compared to mining. Only in Chile, is the importance of the processing of metals comparable to mining. For instance, in 2011 processed metals represented 4% of GDP and 12% of exports.



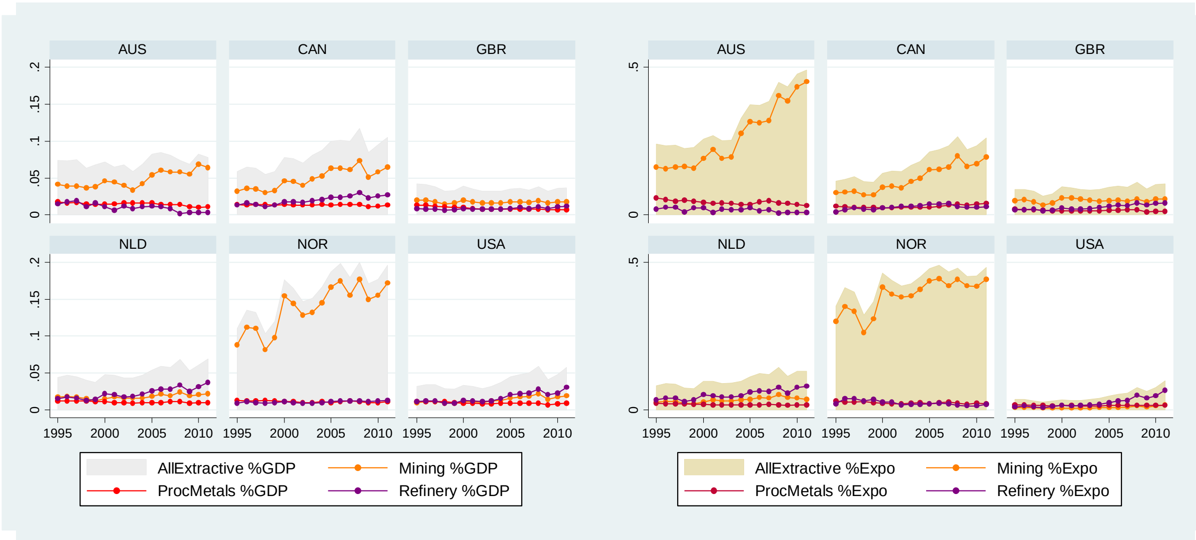
Source: Own elaboration with OECD data

Figure 1: Extractive sectors contribution to GDP and exports in Latin America (LCN)

On average, the importance of mining in high-income countries is comparable to that of Latin America - with the notorious exception of Norway where it is much higher. The share of mining in GDP moved from 9% to 17% in Norway, 4% to 6% in Australia, and 3% to 7% in Canada. There were no significant changes in the US, the Netherlands, or Great Britain. Mining exports went from 30 to 44% in Norway, 16% to 45% in

[7] Although higher production contributed to this growth, it was largely fuelled by higher commodity prices (Sinnott, Nash, & Torre, 2010).
[8] For country-level details see Table 3 in Annex.
[9] This contribution would comprise the output of the extractive commodity sector, i.e. mining (C10 to C14 according to ISIC Rev. 3), and that of the extractive manufacturing industries, i.e. refinery and processing of mineral and metals (C23, C26, C27, C28 according to ISIC Rev. 3).

Australia, and 7% to 20% in Canada. It remained virtually the same in the US (1% to 2%), the Netherlands (3% to 4%) and Great Britain (5%). It is noteworthy that in the US and the Netherlands, the refinery sector became much more important than mining: the share of refinery in GDP grew from 1% to 3% in the US and from 1% to 4% in the Netherlands while refined products exports went from 1% to 7% and from 3% to 8% respectively.

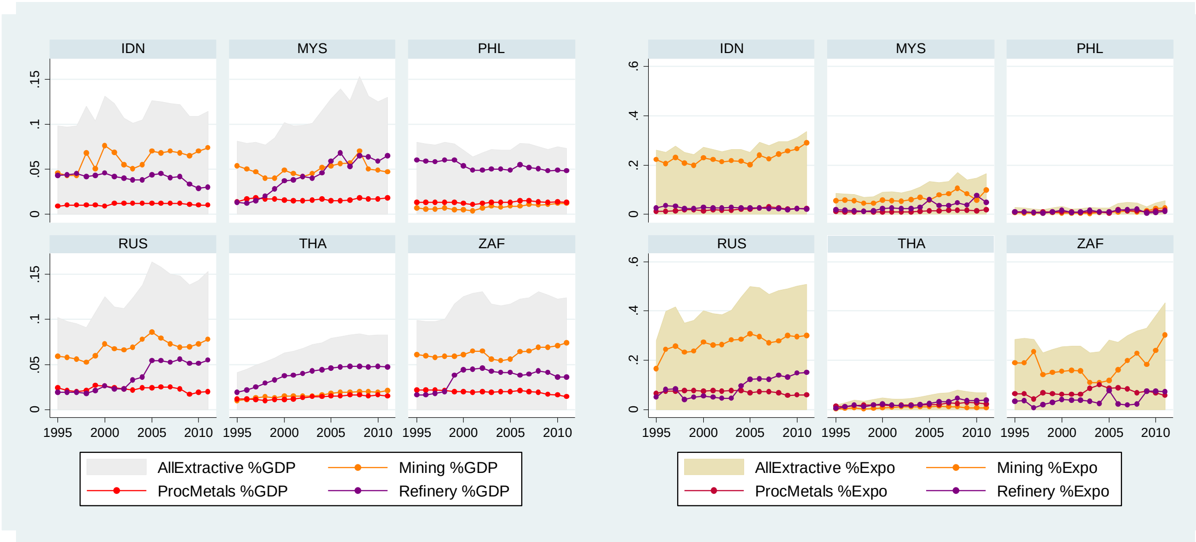


Source: Own elaboration with OECD data

Figure 2: Extractive sectors contribution to GDP and exports in high-income countries (HIC)

The share of mining in GDP in middle-income countries is also similar to that of Latin America: The mining sector expanded from 6% to 7% in South Africa, from 6% to 8% in Russia, and 6% to 7% in Indonesia and remained at 5% in Malaysia. In Philippines and Thailand, the share of mining remained quite low. Overall, mining exports grew substantially more in this group than in Latin America. The expansion of mining was particularly high for South Africa, Russia, and Indonesia where mining exports expanded from 19% to 30%, 16% to 30% and 22% to 29% respectively. Malaysia also expanded its mining sector from 5% to 10%.

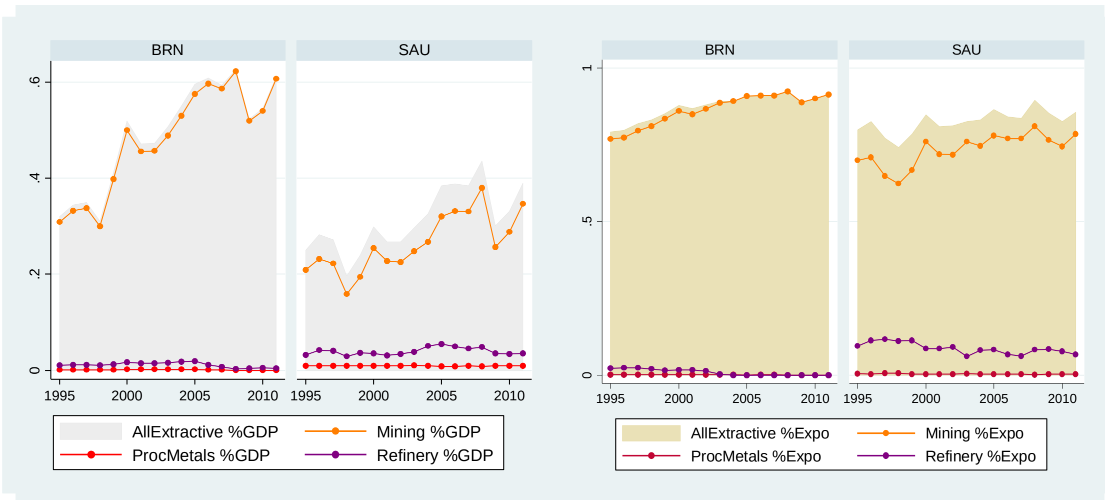
It is worth mentioning that the refinery sector grew substantially in this group, except for Indonesia. The refinery sector stood as the most important type of extractive industry in the Philippines, Malaysia, and Thailand in 2011. Finally, an important difference within this group is that those that have specialised more toward the extractive manufacturing industries, have a much lower proportion of these products in their basket of exports. For instance, Malaysia's refinery sector contributes to 6% to the GDP but only 5% to the exports.



Source: Own elaboration with OECD data

Figure 3: Extractive sectors contribution to GDP and exports in middle-income countries (NON-LCN MIC)

Lastly, Saudi Arabia and Brunei became even more specialised in this sector: Mining's contribution to GDP went from 21% to 35% in Saudi Arabia and from 31% to 61% in Brunei. Exports increased from 70 to 78% in Saudi Arabia and from 77% to 91% in Brunei. Only Saudi Arabia, has a relatively important refinery sector, and yet it declined slightly between 1995 and 2011.



Source: Own elaboration with OECD data

Figure 4: Extractive sectors contribution to GDP and exports in high-income oil-specialised countries (OS HIC)

4. Empirical Results

4.1 Backward Linkages in Mining

Despite the share of the mining sector expanding in every region, mining backward linkage coefficients for domestic industries have consistently declined across the sample of countries. Direct backward linkages (DBLs) were reduced by 18% whereas indirect backward linkages (IBLs) were reduced by 26% between 1995 and 2011[10]. In order to have a better understanding of the level of the inter-industrial interactions of mining, the main proxy measure to be analysed are the IBL coefficients – where most reductions took place[11].

While Brazil has the highest levels of DBLs and IBLs across the sample, these were reduced by 18% and 25% respectively. DBLs and IBLs dropped substantially for other countries in the region: 39% and 43% in Chile, 36% and 36% in Mexico, 18% and 56% in Colombia and 50% and 61% Argentina respectively. The smallest reductions were observed in Peru (4% and 16% respectively). All in all, Latin America is the group in the sample with the biggest drop in DBL and IBL values (on average, 28% and 40% respectively).

In 1995, mining IBL values were slightly lower than the average sector IBL values in most countries. Over the period, the average backward linkages (both DBLs and IBLs) remained quite stable. By 2011 the difference between these and mining DBLs and IBLs grew substantially indicating that mining has a higher tendency toward enclaveness – at least from this perspective.

The changes of mining IBLs in relation to average IBLs became quite obvious in Latin America: In 1995, Argentina, Chile, and Brazil (along with Russia) were the only countries in the sample in which mining IBLs were above average IBLs. By 2011, this was no longer the case. Yet mining IBL coefficients in Chile and Brazil remain rather close to the average: For instance, the average IBL coefficient in Brazil was 0.83 whereas for mining it was 0.71. Contrariwise, Argentina and Colombia are far from their own average values. For instance, in 2011 the average value for IBLs in Colombia was 0.54 whereas in mining it was 0.12.

Furthermore, if compared to the IBL values in extractive manufacturing industries, i.e. refinery and processing of minerals and metals, mining IBLs values are much lower – with the exception of Chile, where IBL values are much more similar across all extractive sectors.

[10] For country-level details see table 4 in Annex.

[11] A more detailed account of where IBL coefficients declined will be explained in the following section.

Source: Own elaboration with OECD data

Figure 5: IBLs in extractive industries and fitted values for average IBLs

In contrast to Latin America, high-income countries experienced the smallest reductions in the sample, with DBLs falling by 10% and IBLs by 13%. The largest reduction was in Great Britain where DBL and IBL values dropped by 29% and 33% respectively. The second steepest reduction in DBL and IBL was Canada with 17% and 20%, and Australia with 20% and 14% respectively. The Netherlands is the only country in the sample that experienced an increase in the DBL and IBL coefficients (9% and 3% respectively). IBL values in the USA and Norway were reduced by less than one tenth. It is also worth noticing that, after Brazil and Russia, the USA and Australia have the highest backward linkage values (both IBLs and DBLs).

Similar to the rest of the sample, IBL coefficients in this group are below the average. However, there are significant differences between these countries. While the gap is quite small for the US and Canada (e.g. in the USA, the average IBL coefficient was 0.64 and mining was 0.53), in Norway these values diverge quite a lot (e.g. the average IBL coefficient was 0.61 and mining was 0.20 in 2011). It is interesting to point out that the average IBL value for Norway increased by 15% in the period covered.

The average drop in DBL and IBL values in middle-income countries was 23% and 22% respectively. South Africa and Russia are among the countries with the highest DBL and IBL values. DBLs and IBLs in Russia were reduced by 30% and 19% respectively, and in South Africa by 13% (both cases). Similar to the case of Brazil, mining IBL coefficients were initially above the average, but by the end of the period this was no longer the case. However, this is also because the average IBLs increased by 19% (Russia) and 10% (South Africa).

Despite mining's expansion and importance, mining IBL values in Indonesia dropped 57% - the second steepest fall after Argentina. Contrariwise, backward linkage values in Thailand and Malaysia remained virtually unchanged. It is particularly noteworthy that average IBLs in Malaysia increased by 37% during the period. The Philippines did not see increases but fared much better than the average Latin American country, with DBLs and IBLs falling by 25% and 29% respectively, while mining IBLs remained relatively close to the average.

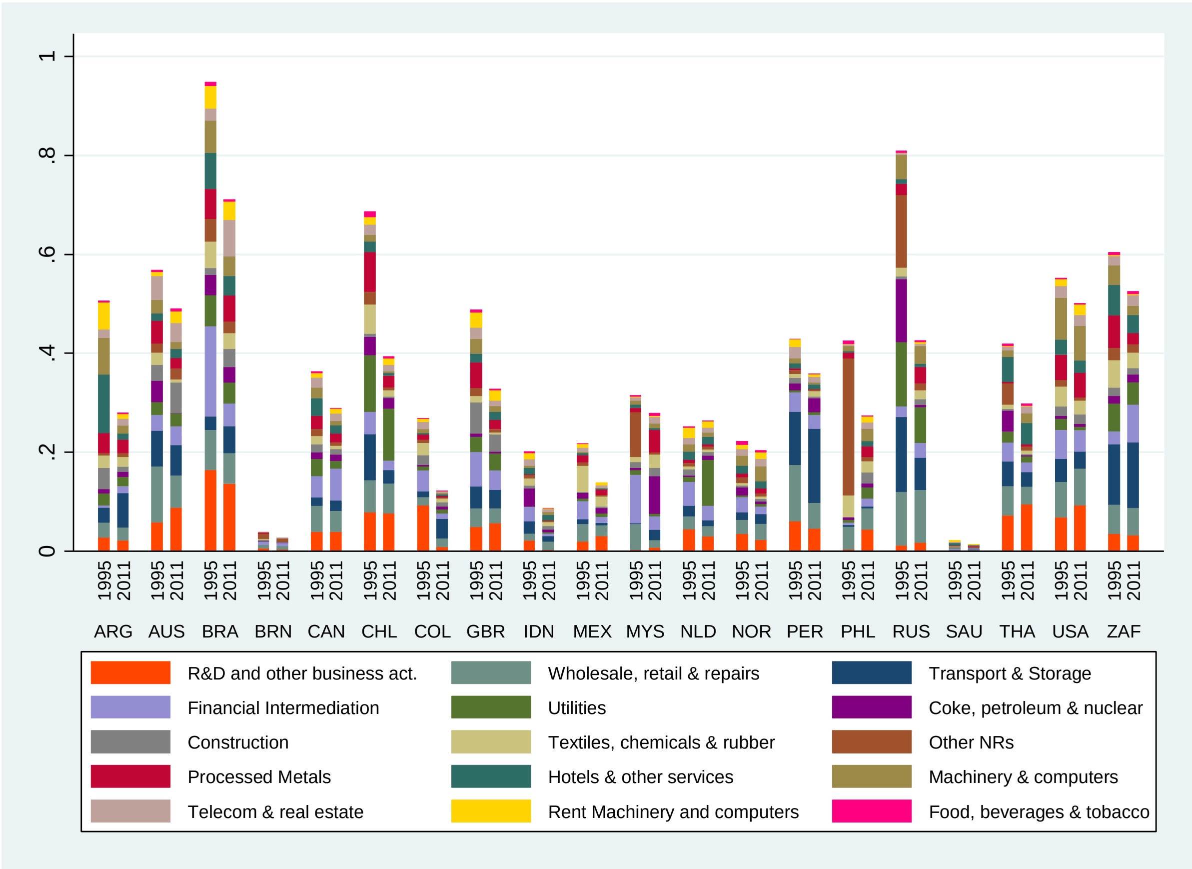
Finally, oil-specialised high-income countries also had important reductions in DBL and IBL values, most notably Saudi Arabia. DBLs and IBLs in Saudi Arabia were reduced by 27% and 40%, while in Brunei DBLs increased by 4% and IBLs fell by 26%. In both cases, mining IBL values remain well below the average despite the average IBL values also falling in the period. All in all, these two countries have by far the highest degree of enclaveness in the mining sector. For instance, in 2011 the mining IBL value was 0.02 whereas the average IBL was 0.37 in Saudi Arabia – meaning that an increase in demand for mining has practically no impact on the demand for other sectors' output.

4.2 Breakdown of backward linkages by sector

The sectors that are mostly connected to mining are service, most notably Wholesale and retail trade; repairs (C50T52) and R&D and other business activities (C73T74)[12], transport and storage (C60T63) and financial intermediation (C65T67)[13]. With the exception of wholesale and retail trade, most of these services are considered to be modern (according to the average sector productivity).

[12] This C74T74 sector aggregates sectors 73 and 74 in the ISIC Rev. 3 classification. Sector 73 covers: research and experimental development on natural sciences and engineering (731) and on social sciences and humanities (732). Sector 74 covers: Legal, accounting, book-keeping, and auditing activities; tax consultancy; market research and public opinion polling; business and management consultancy (741); architectural, engineering, and other technical activities (742); advertising (743). It also includes other business activities, such as labour recruitment and provision of personnel (7491); investigation and security activities (7492); building-cleaning (7493); photography (7494), packaging (7495) and other activities (7499) from bill collecting and business brokerage to translation and secretarial services.

[13] This is according to the ISIC Rev.3 sector classification used in OECD IOTs.



Source: Own elaboration with OECD data

Figure 6: Distribution of IBLs across sectors (1995 and 2011)

In Latin America, the value of IBLs, the flows between mining and other sectors, represented 23% of DBL values[14] in 2011 (down from 34% in 1995). Likewise, the most important sectors are services which have already been mentioned. The R&D and other business activities sector has increased its importance and is now the most important supplier to the mining sector in Brazil and Mexico. In Chile, it is the second most important backward linkage for mining after the utilities sector (C40T41). Colombia is an exception to this trend, where R&D and other business services lost its importance substantially in the period considered. Transport and storage became central for mining operations in Peru, Argentina, and Colombia.

On average, in high-income countries, IBLs represented 24% of DBL values in 2011 (down from 27% in 1995). Likewise, the mining sector connects to the same type of services as they do in Latin America. R&D and other business services are among the most important sectors. Interestingly, in Norway and the US, there is a strong linkage between the manufacturing sector – i.e. Machinery and computers – and the mining sector. On average, financial intermediation plays a bigger role in these countries than it does in Latin America.

[14] This means that if the DBL value is 1.59 for example, and mining represents 1.08, the IBL value would be 0.51 representing 68% of the DBL or total backward linkage value.

In middle-income countries, IBLs represent 25% of DBL values (down from 28% in 1995) and have significant differences when compared to Latin America: There is a much higher reliance on the coke, petroleum, and nuclear energy sector (with the exception of South Africa where the most important sector is transport and storage) and less on the R&D and other business services sector. Only Thailand has a strong connection between mining and the latter sector.

Finally, Brunei and Saudi Arabia have extremely low IBLs: on average, 1.8% of DBL values in 2011 which are mainly linked to the financial and, wholesale, retail, and repair sectors.

4.3 Backward Leakages

From 1995 to 2011, the ratio of backward leakages to linkages (DBLs) in the mining sector increased on average by 9% across the sample, and in most cases the value was above that observed for the average sector. The highest increase was observed in Latin America (14%) and the lowest in high-income countries (6%)[15],[16].

The backward leakage ratio in the mining sector increased substantially for Argentina and Chile (36% and 25%). For Colombia and Mexico, it remained quite high and did not change much during the period. In Peru, the ratio, while somewhat high, remained stable.

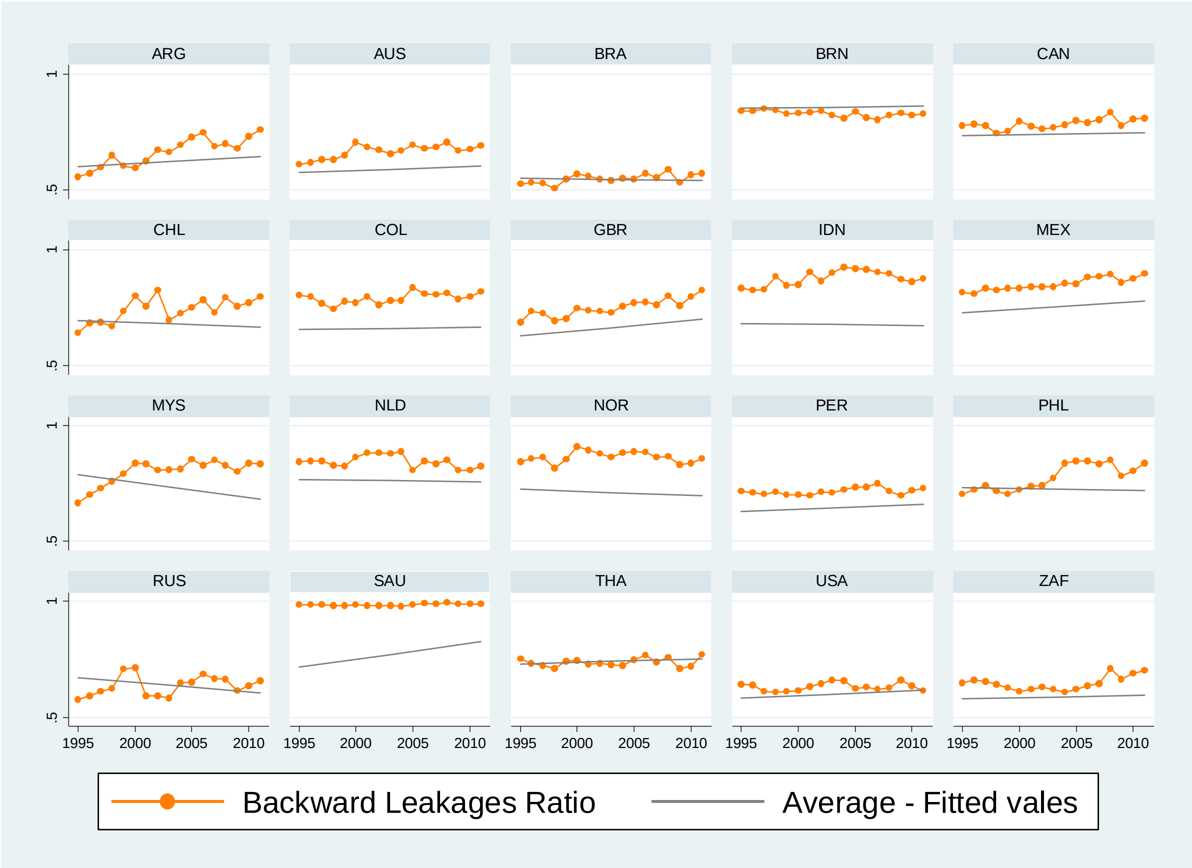
In the high-income group, Great Britain's backward leakage ratio in the mining sector increased by 20%, followed by Australia (12%). The remaining countries had no important increases or, as in the case of the USA and the Netherlands, the ratio dropped slightly.

The backward leakage ratio in the mining sector remained quite stable in most middle-income countries – with the Philippines having the biggest increase of 24%. In oil-specialised countries, there were no changes.

It is worth noting that in 2011 Brazil had the lowest level of backward leakage ratio in mining (0.57) followed by the USA (0.62) and Russia (0.66) in 2011. While for the USA a higher availability of domestically sourced inputs could be the reason behind this, it is not clear whether this would be the same for Brazil and Russia.

[15] The ratio in oil-specialised countries did not increase, however, in this region mining IBL values are close to zero.

[16] This ratio provides a more interesting picture as it describes changes in domestically sourced inputs demand relative to imported inputs demand. Also, if the mining leakage value itself is observed, changes are almost unnoticeable (the average increment was 1% across the sample).



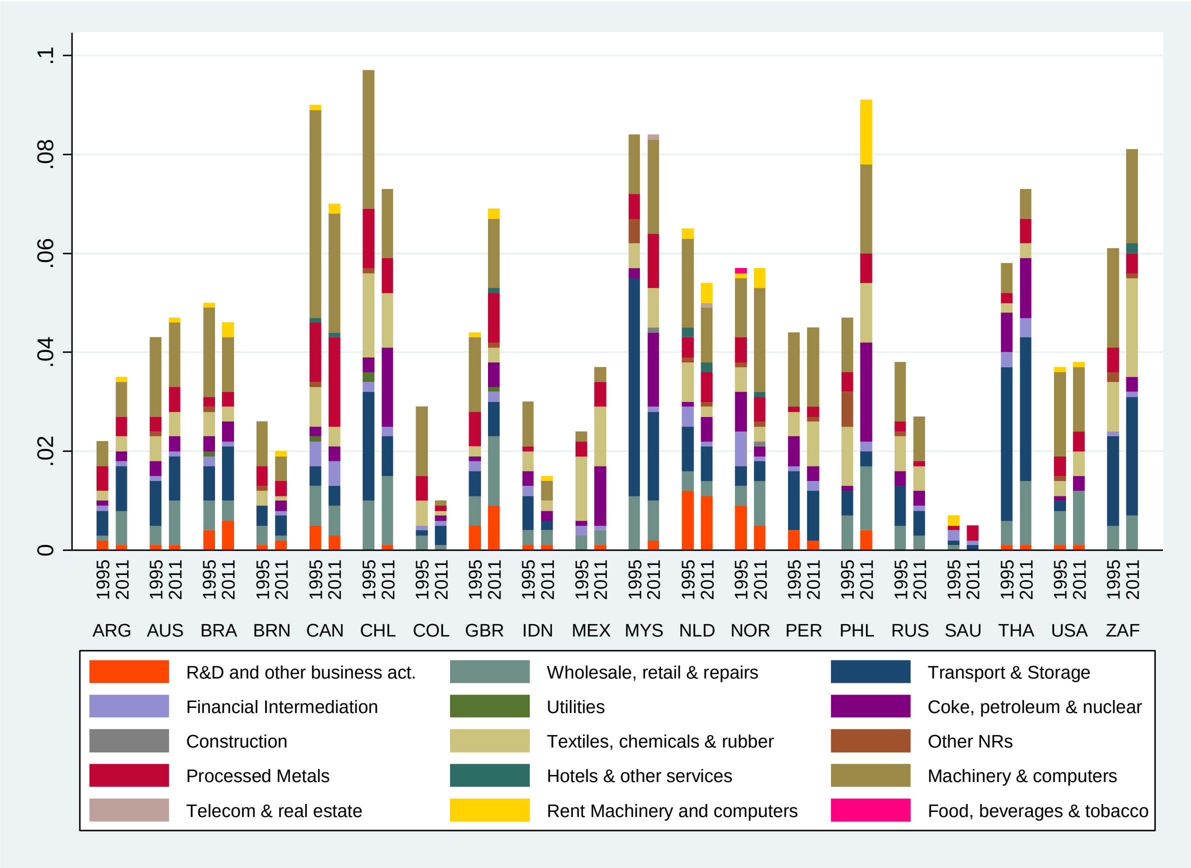
Source: Own elaboration with OECD data

Figure 7. Ratio of backward leakages to backward linkages in the mining sector and unweighted average leakages ratio

4.4 Breakdown of backward leakages by sector

The analysis of backward leakages in most countries indicates that imports in the mining sector include services - i.e. transport and storage and wholesale, retail, and repairs – but also manufactures – i.e. machinery, chemicals, and processed metals.

Most foreign inputs come from the machinery and equipment (C29) and transport and storage sectors. However, the former sector has lost some of its importance over the period analysed. Processed metals' industries (C27, C28 and C29) and the chemicals sector (C24) have also been an important source of foreign inputs. It is interesting to notice that the imports from the refinery sector, i.e. Coke, petroleum, and nuclear energy (C23), sector have increased substantially in the region. Only Brazil has a relatively high level of R&D and other business activities imports. Interestingly, backward leakages levels only grew noticeably in Mexico and in Argentina.



Source: Own elaboration with OECD data

Figure 8: Distribution of backward leakages of the mining sector (1995 and 2011)

Much like Latin America, backward leakages in high-income countries are mainly accounted for by machinery and equipment, processed metals, and chemicals. However, high-income countries have a higher proportion of imports from the service sectors – namely R&D and other business activities and, wholesale, retail, and repairs.

In the group of middle-income countries, transport and storage; machinery and equipment; and wholesale, retail and repairs were the main industries from which inputs were imported. An increase in imports from the refinery sector was also observed.

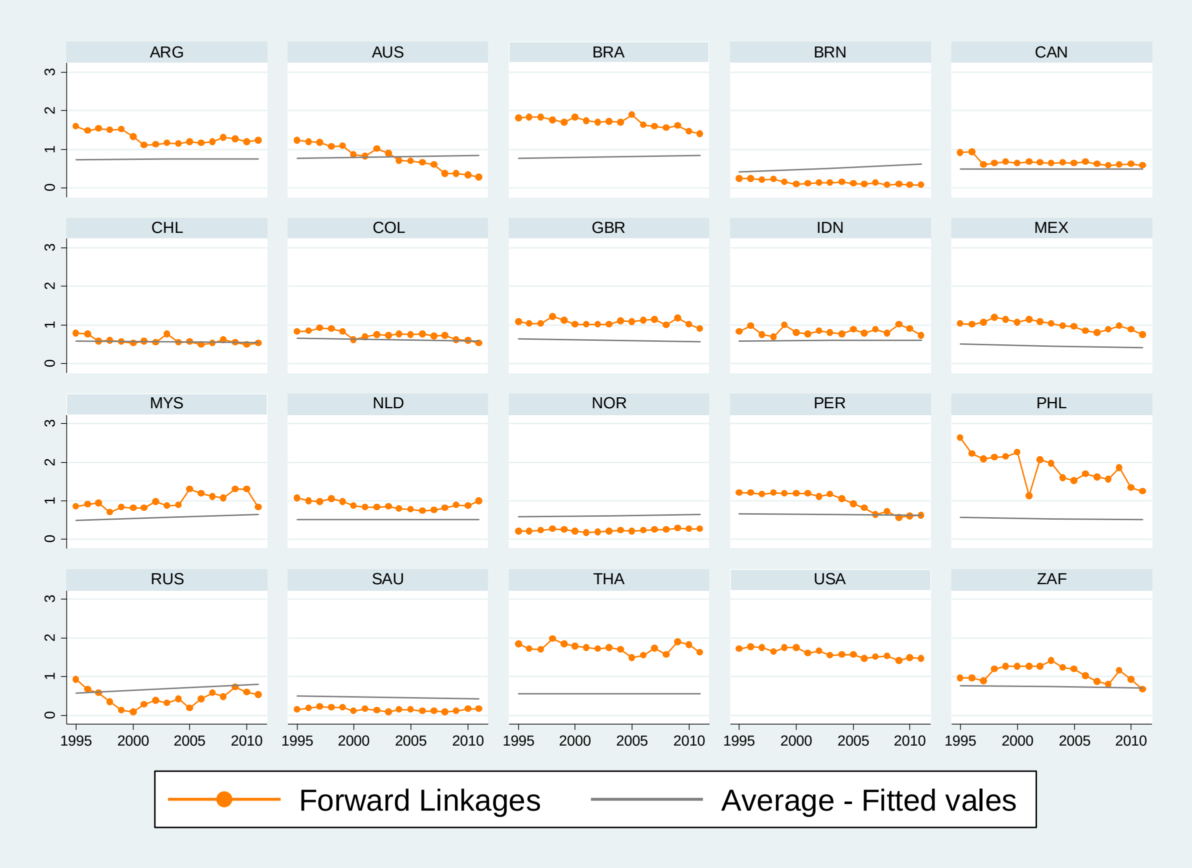
Finally, oil-specialised countries have extremely low backward leakage values (consistent with extremely low values for backward linkages). Leakages are focused on transport and storage; processed metals and minerals; and the machinery and equipment sector.

4.5 Forward linkages

Forward linkages in the case of mining are also a proxy for inter-industrial synergies but from a supply perspective. A higher indirect forward linkage (IFL) coefficient for mining would indicate a higher utilisation of mining's output as input in other sectors.

On average, mining forward linkages (ILFs) declined by one fourth (26%) from 1996 to 2011[17] across the sample – the same reduction observed in backward linkages (IBLs)[18]. Relative to the average IFL value, mining tends to be higher in most countries.

Latin America had the steepest fall in mining IFL values in the period (32%) with Peru experiencing the largest reductions (48%). This was followed by Colombia with reductions amounting to 36% and Chile (35%). The smallest changes took place in Argentina and Brazil, where values dropped by 23% (in both countries) but remained quite high relative to other countries.



Source: Own elaboration with OECD data

Figure 9: Forward linkages of the mining sector and forward linkages of the unweighted average sector

[17] As with IBLs, this reduction in mining IFL values is much higher than the reduction for the average sector IFL value (3%) across the sample.
[18] For country-level details see table 3 in Annex.

IFLs in high-income countries had the smallest reductions (21%) yet changes were quite different among countries. Australia's mining IFLs were reduced by 77% - the largest reduction in the sample – whereas Canada's were reduced by 38%. In comparison, the US, Great Britain, and the Netherlands had minor reductions in mining IFL values. Norway's IFL values had an increase of 29% during the period. It is worth noticing as well that the values in the US and the Netherlands are among the highest in the sample.

Middle-income countries had on average a reduction in mining IFL values of 25% – largely driven by the reductions observed in the Philippines (55%) whose initial levels were the highest in the sample. This was followed by reductions in Russia (41%) and South Africa (31%). Thailand and Indonesia had mild reductions, while values in Malaysia remained stable. Lastly, oil-specialised countries, on average, had a decline of 30% in mining IFL values. This change does not mean much as the initial levels were already quite close to zero.

4.6 Breakdown of forward linkages by sector

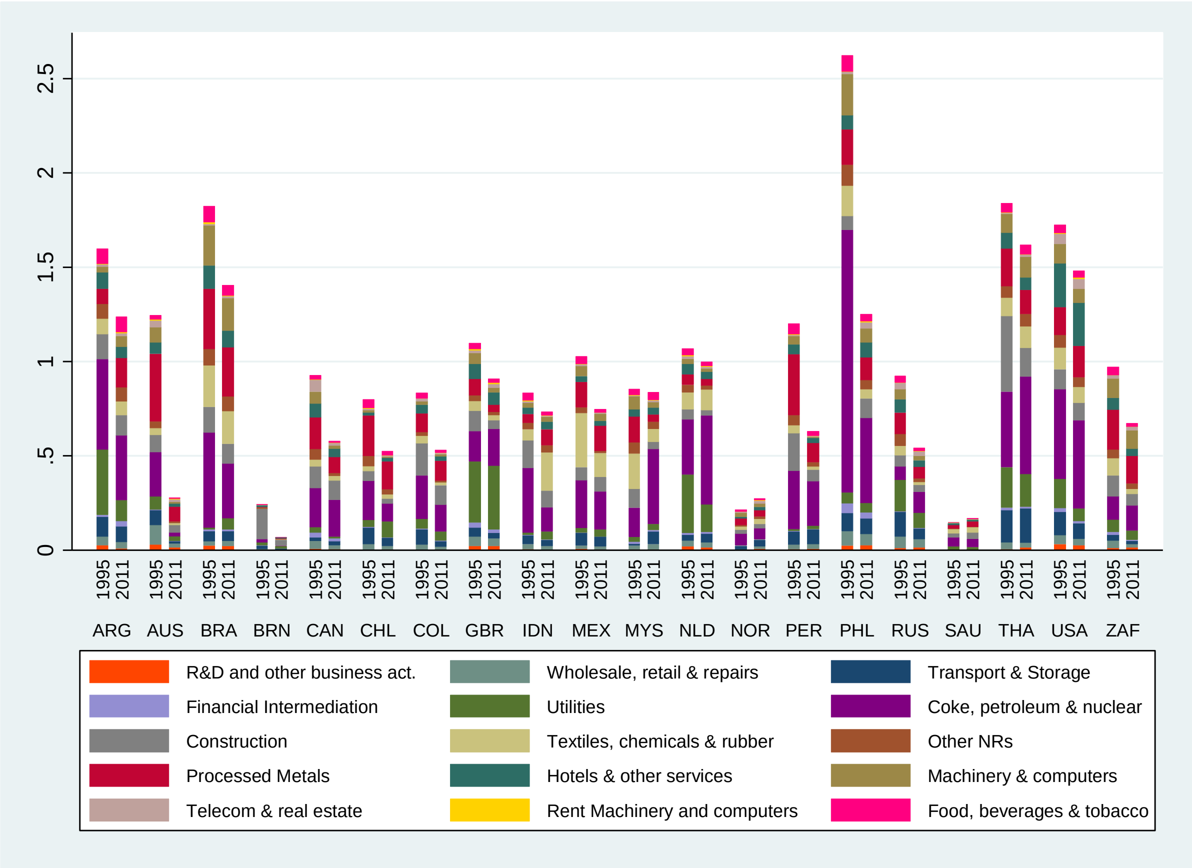
Forward linkages (IFLs) in mining are concentrated in refinery, i.e. Coke, petroleum, and nuclear energy (C23), processed metals and minerals (C27, C28 and C29) as well as the utilities (C40T41) and chemicals (C24) sectors.

However, in Latin America, the IFLs to the refinery sector have noticeably declined – especially in Chile and Brazil. This applies also, although to a lesser degree, to the chemical sector. In Mexico, the most important reduction of forward linkages took place in the chemical sector, in Argentina in the utilities sector, and in Peru in the processed metals and minerals sector.

In high-income countries, forward linkages developed heterogeneously: Australia and Canada had important reductions in IFL values. However, Australia was the country in the sample with the largest fall in IFL values. In the US and the Netherlands, forward linkages remained quite stable – only linkages to the utilities sector declined noticeably. In Norway, IFL coefficients increased especially in the transport and storage sector.

In middle-income countries, forward linkages became smaller over the period but only considerably so for Russia and the Philippines. Mining linkages to the refinery sector became a lot more important in Malaysia and, to a lesser extent in Thailand. Contrariwise, in Indonesia and the Philippines, these were reduced by more than half.

While values are extremely low in oil-specialised countries, in Brunei, forward linkage connections are highly concentrated in the construction sector whereas in Saudi Arabia it also includes refinery, chemicals, and processed metals and minerals.



Source: Own elaboration with OECD data

Figure 10: Distribution of forward linkages across sectors (1995 and 2011)

4.7 Forward leakages

Forward leakages measures by how much the input availability of foreign sectors increases as the domestic output increases. Forward leakage values in mining increased by 53% and if we consider the leakage ratio, i.e. forward leakages to forward linkages, an average increase of 81% is observed.

The group with the steepest increase in the forward leakage ratio in the mining sector was Latin America (94%). In terms of increases, the largest in terms of the leakage ratio took place in Peru (164%) and the smallest in Mexico (38%). It is worth noting that forward leakage values in mining were particularly high in Peru (2.38) and Chile (2.34) in 2011.

The smallest increases of the forward leakage ratio were found in the high-income group where, on average, it increased by 69%. However, there are very different trends in this group: the forward leakage ratio in Australia grew by 212% whereas in Canada it grew only by 17%. Norway was the only country in the sample which actually reduced this ratio by 8%. Australia also had the highest forward leakage value in this group (2.56).

On average, the ratio of forward leakage increased by 76% in middle-income countries. The biggest increases in this ratio took place in the Philippines (112%) and the lowest in Indonesia (19%). The highest forward leakage values were found in Malaysia (2.08) and South Africa (2.02).

Lastly, forward leakages in the oil-specialised countries are characterised by the highest values in the sample: In 2011, these values were 2.61 in Brunei and 2.43 in Saudi Arabia. Increases in the forward leakage ratio were somewhat low for Brunei (30%) and rather high for Saudi Arabia (156%).

Source: Own elaboration with OECD data

Figure 11: Forward leakages (left axis) and the forward leakages to forward linkages ratio (right axis) in the mining sector

4.8 The Size of Mining and Inter-Industrial Linkages

One argument proposed by the Dutch disease hypothesis states that the larger the high-value commodity sector becomes the more enclave this will become. Therefore, IBL and IFL coefficients, the proxy for such inter-industrial connectivity, should be lower as the economic importance of the sector grows across countries and time, according to this hypothesis.

While the importance of mining in terms of GDP and exports has grown between 1995 and 2011, IBL and IFL coefficients declined in the majority of countries included in our sample.

Pearson correlation coefficients indicate a negative relation between IBLs and mining's contribution to GDP and/or exports across the sample (significant at the 5% level). Only the Netherlands and Thailand showed no statistically negative correlation in either case[19].

Likewise, in most countries there was a negative relation between IFLs and mining's contribution to GDP and/or exports (at the 5% level) – the major exceptions being Indonesia and Russia[20]. Contrariwise, Norway and Malaysia had a positive correlation between IFLs and the mining share of GDP and exports (yet only Malaysia's positive correlation between mining's share of GDP and IFLs was statistically significant at the 5% level).

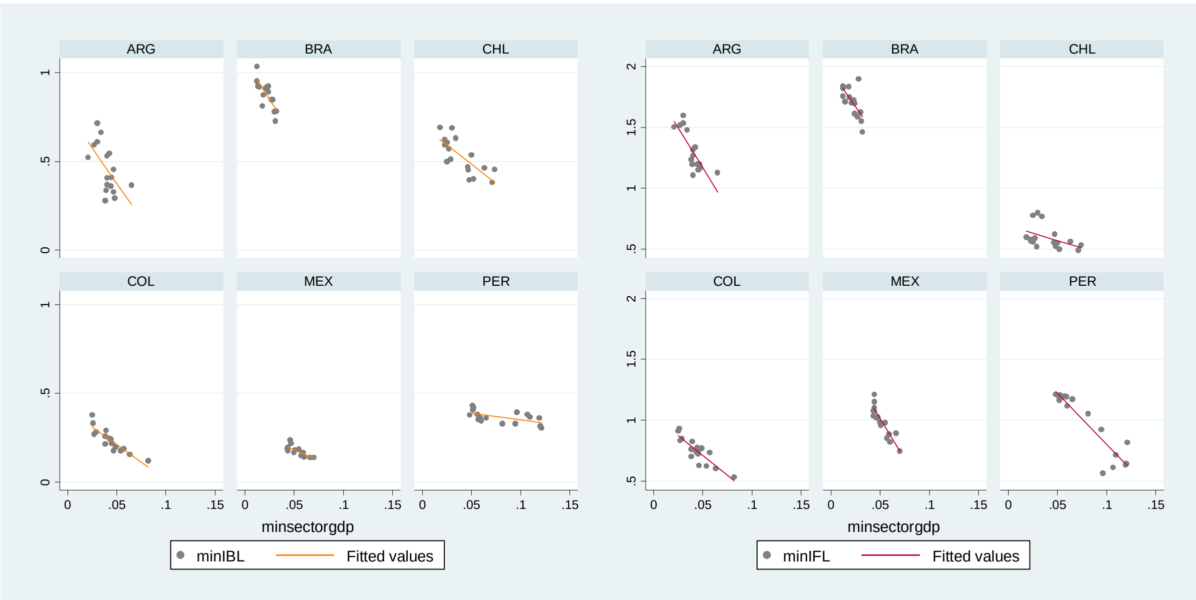


Figure 12. Correlation between contribution of mining to GDP and IBLs (left) and IFLs (right) in Latin America (LCN)

[19] Argentina, Peru, Indonesia, Malaysia, Russia, and the USA showed a statistically significant negative correlation between IBLs and the mining share in the GDP but not with exports. Great Britain had a statistically significant negative correlation between IBLs and the share of mining exports but not with the GDP.

[20] Chile, The Netherlands, Great Britain, the Philippines and Thailand had a statistically significant negative correlation between IBLs and the share of mining exports but not of GDP.

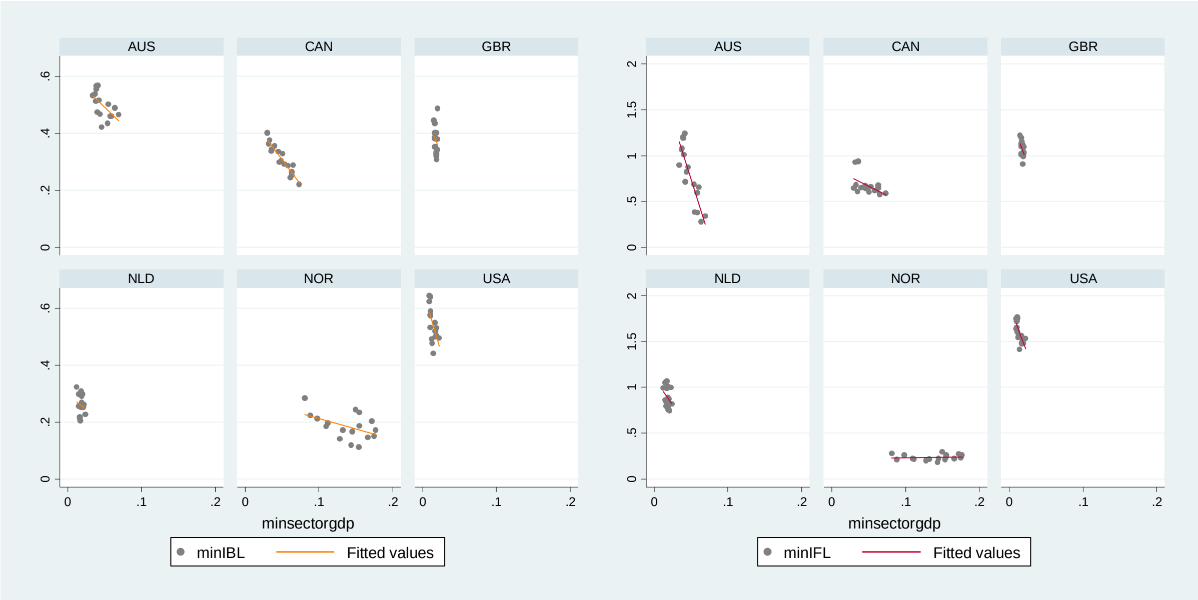


Figure 13. Correlation between contribution of mining to GDP and IBLs (left) and IFLs (right) in high-income countries (HIC)

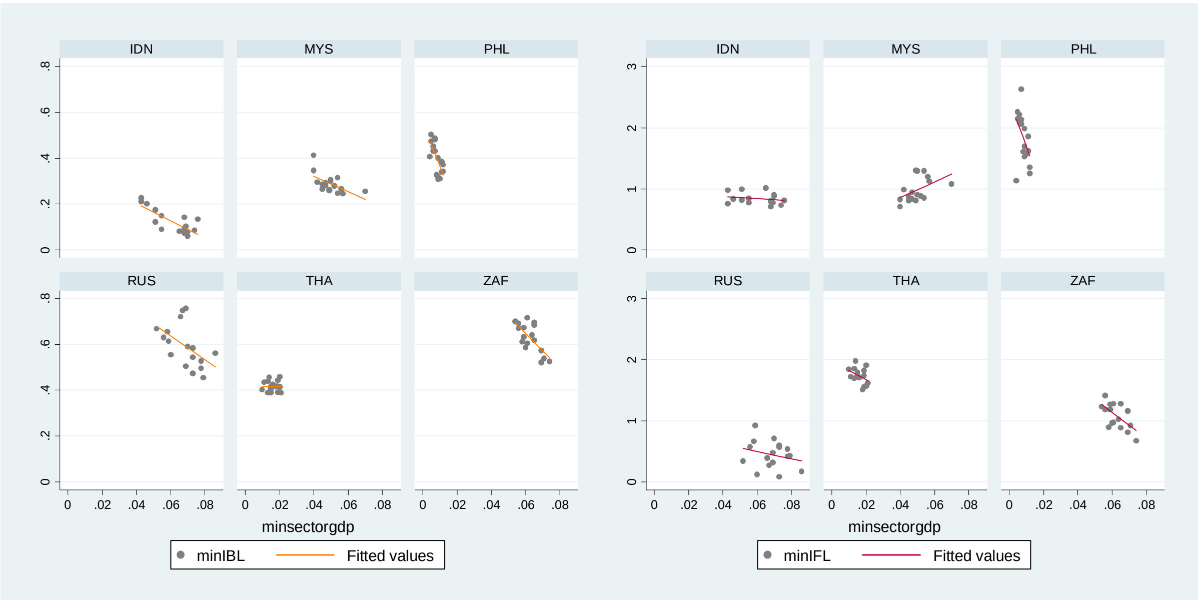


Figure 14. Correlation between contribution of mining to GDP and IBLs (left) and IFLs (right) in middle income countries (MIC)

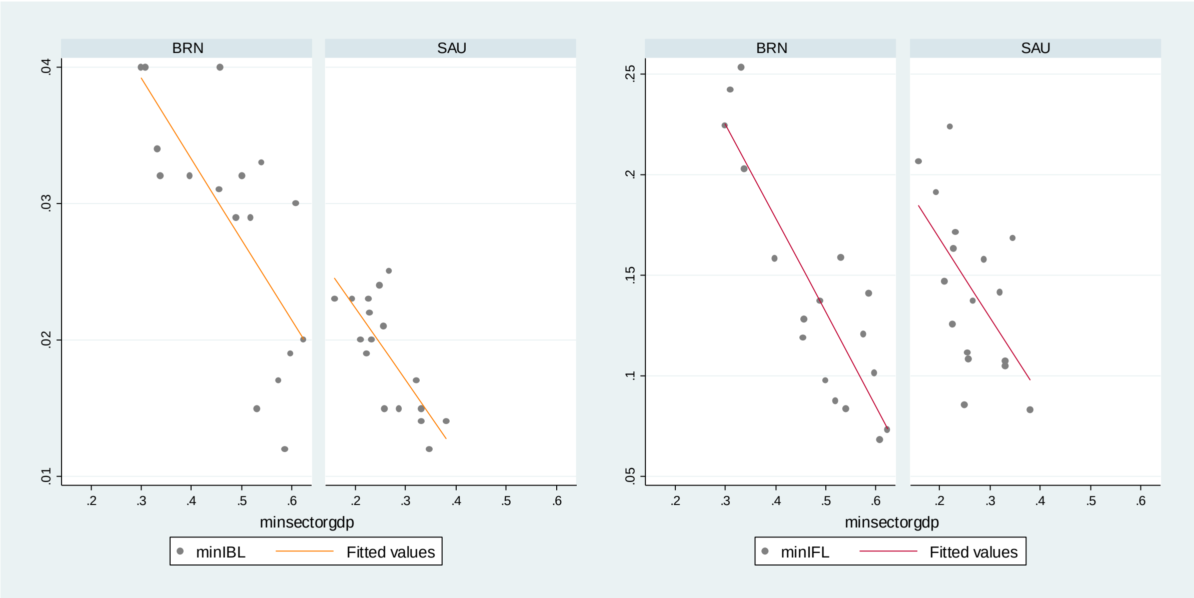


Figure 15. Correlation between contribution of mining to GDP and IBLs (left) and IFLs (right) in oil-specialised high-income countries (OS-HIC)

Finally, to further examine the relationship between IBLs and mining's share in GDP we undertake a panel regression exercise using fixed effects and observations for all 20 countries in the sample across 17 years. Results show that an increase of 1% in the share of mining GDP is associated with a change of -0.0655 in the value of backward linkages (IBLs) (significant at the 1% level) and of -0.208 in the value of forward linkages (IFLs) (significant at the 5% level). Likewise, an expansion of the mining exports is also negatively correlated to both backward and forward linkages, however, only for the latter linkages are results statistically significant: A 1% increase in mining exports corresponds to a decline of -0.310 in the value of forward linkages (IFLs) (significant at the 1% level).

VARIABLES	(1) IBLs	(2) IBLs	(3) IFLs	(4) IFLs
Mining share GDP (log)	-0.0655***		-0.208**	
	(0.0226)		(0.0940)	
Mining share exports (log)		-0.0116		-0.310***
		(0.0249)		(0.0693)
Constant	0.202**	0.392***	0.405	0.323*
	(0.0808)	(0.0717)	(0.329)	(0.168)
Observations	340	340	340	340
R-squared	0.436	0.411	0.276	0.411
Number of countries	20	20	20	20
Country FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES

While this regression exercise controls for year trends, controlling for commodity prices by considering the actual composition of each country's mining sector could provide more accurate results. Having said this, an expansion of the mining sector does seem to be consistently correlated to lower inter-industrial linkages in our sample, providing some support for our hypothesis.

5. Conclusion

The development of inter-industrial linkages for the mining sector has stagnated for most countries in our sample during the period studied (1995-2011). We find that, on average, there is a negative correlation between backward and forward linkages, and changes in the importance of the mining sector (both in terms of share of exports and GDP). However, changes in such measures diverge across country groups. Backward and forward linkages in mining have been reduced more steeply in Latin American and oil-specialised countries. In contrast, the group of high-income countries, and some middle-income countries, had the smallest reductions, or even increments, in those measures.

In terms of the sectors that backward linkages are mostly concentrated in, there is a tendency across regions, but especially in Latin America and high-income countries to employ service sectors which would typically be described as knowledge intensive[21], examples being R&D and business sectors, transport and storage and financial intermediation. The only exception to this would be the wholesale, trade, and repair sector.

Regarding backward leakages, there was an overall increase in the ratio of backward leakages to backward linkages. However, for most countries, the increment was not particularly high. The sectors that are most strongly involved in imports include machinery, equipment, and computers as well chemical products. A significant difference is that the high-income group tends to have a much higher level of imports of the R&D and other business activity sector – probably due to higher knowledge requirements in the operations of mining firms in such countries.

While the dependence on inputs from other regions remained quite stable on average, processing of mining output by non-domestic sectors is on the rise for most countries in our sample. This is in line with the fact that the expansion of emerging markets, particularly China, drove the global demand for mining commodities. This trend was more pronounced in Latin America and in the oil-specialised countries where the forward leakage ratio increased more steeply than in the other country groups.

It is also important to consider the levels of inter-industrial connectivity. In 2011, Brazil, the USA, and South Africa had, in that order, the highest indirect backward linkages values. Whereas the countries with the highest values of forward linkages were Thailand, the USA, and Brazil, in that order. Brunei and Saudi Arabia had the lowest levels – which were close to zero - in both measures.

Nevertheless, as explained earlier, there are significant differences among regions and countries. Latin American and oil-specialised countries showed a stronger tendency toward the reduction of inter-industrial linkages, as predicted by the resource curse. Countries that were particularly successful in avoiding such trend were high-income countries, i.e. Norway, the USA, the Netherlands, and middle-income countries, i.e.

[21] It is important to keep in mind that the R&D and business services sector aggregates R&D activities and knowledge-intensive business services, i.e. legal and management consultancy. However, it also includes activities that are not knowledge intensive, such as labour recruitment and provision of personnel, cleaning of buildings, and surveillance activities.

Thailand and Malaysia. This is consistent with a body of literature that refers to these countries as prime examples of how natural resources can turn into a blessing instead of a curse[22].

Furthermore, values for inter-industrial connectivity remain rather high in Brazil, South Africa, Chile, Russia, and Australia – in spite of the reductions observed in the period of analysis. These countries have relied on extractive resources historically and experienced high rates of growth during the 2000s commodities boom. Yet, economic long-term performance, with the exception of Australia and to some extent of Chile, has not been optimal. Moreover, even successful cases, like Malaysia or Thailand, now face the risk of the 'middle-income trap' (Jitsuchon, 2012; Rasiah, 2011). Thus, future research must address how industrial connectivity and other aspects related to structural change, i.e. productivity, play out – especially in the face of commodity price booms and busts - in order to explain differences in long-term growth.

To conclude, Latin America is still characterised by its high, and ever-growing, commodity dependence (Adler & Sosa, 2011) and the outlining of its inter-industrial connectivity in the mining sector shows – at best – a mixed scenario. Its performance vis-à-vis other groups of countries calls for stronger active policies that stimulate linkages to key sectors for innovation and technological upgrading necessary for the development of knowledge-based economies and broad-based growth.

[22] For example: Wright & Czelusta, (2004) in the case of the USA, Larsen (2006) and Ville & Wicken (2012) in the case of Norway, Gylfason (2001), Sovacool (2010) and Noh (2013) in the case of Thailand and Malaysia.

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Annex

Table 3. Extractive Industries: Mining, Refinery and Processed Metals and Minerals

Country	ARG	ARG	AUS	AUS	BRA	BRA	BRN	BRN	CAN	CAN	CHL	CHL	COL	COL	GBR	GBR	IDN	IDN	MEX	MEX
Year	**1995**	**2011**	**1995**	**2011**	**1995**	**2011**	**1995**	**2011**	**1995**	**2011**	**1995**	**2011**	**1995**	**2011**	**1995**	**2011**	**1995**	**2011**	**1995**	**2011**
Mining %GDP	0.03	0.04	0.04	0.06	0.01	0.04	0.31	0.61	0.03	0.07	0.03	0.05	0.03	0.08	0.02	0.02	0.05	0.07	0.05	0.07
Mining %Exports	0.06	0.05	0.16	0.45	0.05	0.20	0.77	0.91	0.07	0.20	0.12	0.16	0.24	0.46	0.05	0.05	0.22	0.29	0.08	0.14
Refinery %GDP	0.03	0.02	0.02	0.00	0.02	0.02	0.01	0.00	0.01	0.03	0.02	0.02	0.01	0.03	0.01	0.01	0.04	0.03	0.02	0.03
Refinery %Exports	0.02	0.03	0.02	0.01	0.02	0.01	0.02	0.00	0.01	0.03	0.00	0.01	0.03	0.08	0.02	0.04	0.02	0.02	0.01	0.02
Proc. Metals %GDP	0.01	0.01	0.02	0.01	0.01	0.02	0.00	0.00	0.01	0.01	0.03	0.04	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02
Proc. Metals %Exports	0.02	0.02	0.06	0.03	0.03	0.03	0.00	0.00	0.03	0.04	0.09	0.12	0.01	0.03	0.02	0.01	0.01	0.02	0.03	0.03

Country	MYS	MYS	NLD	NLD	NOR	NOR	PER	PER	PHL	PHL	RUS	RUS	SAU	SAU	THA	THA	USA	USA	ZAF	ZAF
Year	**1995**	**2011**	**1995**	**2011**	**1995**	**2011**	**1995**	**2011**	**1995**	**2011**	**1995**	**2011**	**1995**	**2011**	**1995**	**2011**	**1995**	**2011**	**1995**	**2011**
Mining %GDP	0.05	0.05	0.02	0.02	0.09	0.17	0.05	0.12	0.01	0.01	0.06	0.08	0.21	0.35	0.01	0.02	0.01	0.02	0.06	0.07
Mining %Exports	0.05	0.10	0.03	0.04	0.30	0.44	0.22	0.49	0.01	0.03	0.16	0.30	0.70	0.78	0.00	0.01	0.01	0.02	0.19	0.30
Refinery %GDP	0.01	0.06	0.01	0.04	0.01	0.01	0.02	0.04	0.06	0.05	0.02	0.05	0.03	0.03	0.02	0.05	0.01	0.03	0.02	0.04
Refinery %Exports	0.02	0.05	0.03	0.08	0.02	0.02	0.04	0.05	0.01	0.01	0.05	0.15	0.10	0.07	0.00	0.04	0.01	0.07	0.03	0.07
Proc. Metals %GDP	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.01	0.02	0.02	0.01	0.01	0.01	0.02	0.01	0.01	0.02	0.01
Proc. Metals %Exports	0.01	0.02	0.02	0.02	0.03	0.02	0.43	0.40	0.01	0.02	0.07	0.06	0.00	0.00	0.01	0.02	0.02	0.01	0.06	0.06
Average Backward Leakage	1.24	1.28	1.21	1.24	1.18	1.16	1.08	1.13	1.17	1.16	1.09	1.12	1.17	1.16	1.21	1.30	1.06	1.08	1.08	1.13

Table 4. Summary

Region	LCN	LCN	LCN	LCN	LCN	LCN	LCN	LCN	LCN	LCN	LCN	LCN	LCN	LCN	LCN	LCN	LCN	LCN	LCN
Country	ARG	ARG		BRA	BRA		CHL	CHL		COL	COL		MEX	MEX		PER	PER		Average
Year	1995	2011	Change	1995	2011	Change	1995	2011	Change	1995	2011	Change	1995	2011	Change	1995	2011	Change	Change
Mining DBL	1.84	1.42	-23%	2.05	1.86	-9%	1.74	1.45	-17%	1.28	1.23	-4%	1.25	1.16	-7%	1.46	1.44	-1%	-10%
Mining DBL (-1USD)	0.84	0.42	-50%	1.05	0.86	-18%	0.74	0.45	-39%	0.28	0.23	-18%	0.25	0.16	-36%	0.46	0.44	-4%	-28%
Mining IBL	0.72	0.28	-61%	0.95	0.71	-25%	0.69	0.39	-43%	0.27	0.12	-56%	0.22	0.14	-36%	0.43	0.36	-16%	-40%
Mining Backward Leakage	1.03	1.08	5%	1.07	1.06	-1%	1.12	1.16	4%	1.03	1.01	-2%	1.02	1.04	2%	1.05	1.05	0%	1%
Mining Backward Leakage Ratio	0.56	0.76	36%	0.52	0.57	10%	0.64	0.8	25%	0.8	0.82	2%	0.82	0.9	10%	0.72	0.73	1%	14%
Mining IFL	1.6	1.24	-23%	1.82	1.4	-23%	0.8	0.52	-35%	0.83	0.53	-36%	1.03	0.75	-27%	1.2	0.63	-48%	-32%
Mining Forward Leakage	0.39	0.72	85%	0.66	1.22	85%	1.73	2.34	35%	1.13	1.83	62%	1.09	1.28	17%	1.23	2.38	93%	63%
Mining Forward Leakage Ratio	0.15	0.30	110%	0.23	0.48	113%	0.93	1.48	59%	0.611	1.113	82%	0.53	0.73	38%	0.33	0.87	164%	94%
Average IFL	0.76	0.74	-3%	0.77	0.81	5%	0.67	0.55	-18%	0.67	0.61	-9%	0.47	0.41	-13%	0.66	0.63	-5%	-7%
Average DBL	1.73	1.69	-2%	1.9	1.94	2%	1.68	1.67	-1%	1.66	1.66	0%	1.53	1.48	-3%	1.69	1.69	0%	-1%
Average IBL	0.65	0.6	-8%	0.77	0.83	8%	0.59	0.58	-2%	0.58	0.54	-7%	0.46	0.42	-9%	0.61	0.6	-2%	-3%
Average Backward Leakage	1.04	1.09	5%	1.04	1.06	2%	1.09	1.13	4%	1.09	1.11	2%	1.12	1.17	4%	1.08	1.13	5%	4%

Summary (Cont.)

Region	HIC	HIC	HIC	HIC	HIC	HIC	HIC	HIC	HIC	HIC	HIC	HIC	HIC	HIC	HIC	HIC	HIC	HIC	HIC
Country	AUS	AUS		CAN	CAN		GBR	GBR		NLD	NLD		NOR	NOR		USA	USA		Average
Year	1995	2011	Change	1995	2011	Change	1995	2011	Change	1995	2011	Change	1995	2011	Change	1995	2011	Change	Change
Mining DBL	1.72	1.58	-8%	1.41	1.34	-5%	1.55	1.39	-10%	1.27	1.29	2%	1.26	1.23	-2%	1.66	1.71	3%	-4%
Mining DBL (-1USD)	0.72	0.58	-19%	0.41	0.34	-17%	0.55	0.39	-29%	0.27	0.29	7%	0.26	0.23	-12%	0.66	0.71	8%	-10%
Mining IBL	0.57	0.49	-14%	0.36	0.29	-19%	0.49	0.33	-33%	0.25	0.26	4%	0.22	0.2	-9%	0.57	0.53	-7%	-13%
Mining Backward Leakage	1.05	1.09	4%	1.1	1.09	-1%	1.07	1.15	7%	1.07	1.07	0%	1.06	1.06	0%	1.07	1.05	-2%	1%
Mining Backward Leakage Ratio	0.61	0.69	13%	0.78	0.81	4%	0.69	0.83	20%	0.85	0.83	-2%	0.84	0.86	2%	0.64	0.62	-3%	6%
Mining IFL	1.24	0.28	-77%	0.93	0.58	-38%	1.1	0.91	-17%	1.07	1	-7%	0.21	0.27	29%	1.72	1.48	-14%	-21%
Mining Forward Leakage	1.44	2.56	78%	1.45	1.4	-3%	0.96	1.39	45%	1.28	1.99	55%	1.77	1.7	-4%	0.27	0.41	52%	37%
Mining Forward Leakage Ratio	0.60	1.87	212%	0.73	0.86	17%	0.44	0.71	59%	0.62	0.98	60%	1.42	1.30	-8%	0.44	0.76	73%	69%
Average IFL	0.77	0.81	5%	0.52	0.5	-4%	0.63	0.54	-14%	0.51	0.52	2%	0.62	0.67	8%	0.75	0.7	-7%	-2%
Average DBL	1.9	1.84	-3%	1.56	1.55	-1%	1.71	1.65	-4%	1.58	1.65	4%	1.61	1.69	5%	1.8	1.75	-3%	0%
Average IBL	0.78	0.73	-6%	0.49	0.48	-2%	0.6	0.54	-10%	0.5	0.54	8%	0.53	0.61	15%	0.68	0.65	-4%	0%
Average Backward Leakage	1.08	1.12	4%	1.14	1.18	4%	1.11	1.2	8%	1.21	1.24	2%	1.18	1.16	-2%	1.06	1.08	2%	3%

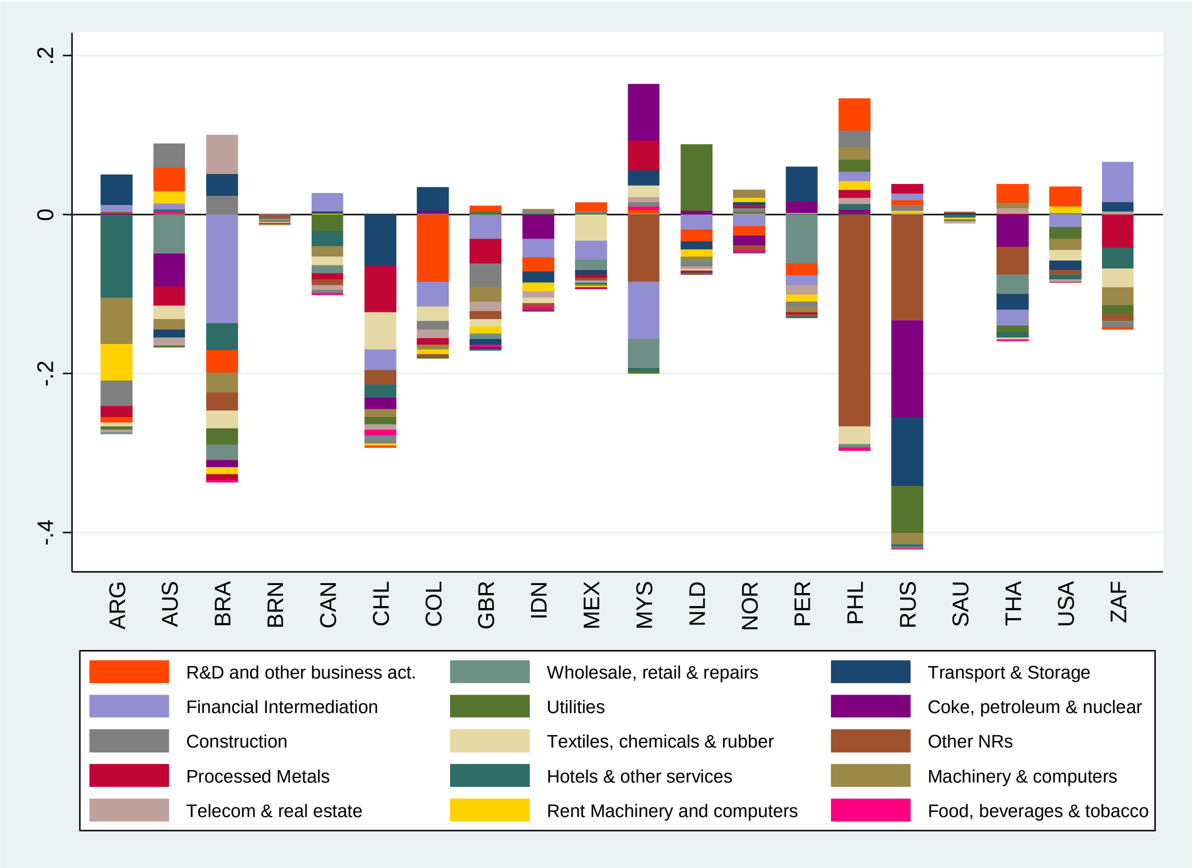
Summary (Cont.)

Region	MIC	MIC	MIC	MIC	MIC	MIC	MIC	MIC	MIC	MIC	MIC	MIC	MIC	MIC	MIC	MIC	MIC	MIC	MIC
Country	IDN	IDN		MYS	MYS		PHL	PHL		RUS	RUS		THA	THA		ZAF	ZAF		Average
Year	1995	2011	Change	1995	2011	Change	1995	2011	Change	1995	2011	Change	1995	2011	Change	1995	2011	Change	Change
Mining DBL	1.24	1.19	-4%	1.65	1.3	-21%	1.49	1.36	-9%	1.81	1.56	-14%	1.42	1.43	1%	1.64	1.55	-5%	-9%
Mining DBL (-1USD)	0.24	0.19	-21%	0.65	0.3	-54%	0.49	0.36	-27%	0.81	0.56	-31%	0.42	0.43	2%	0.64	0.55	-14%	-24%
Mining IBL	0.2	0.09	-55%	0.31	0.28	-10%	0.48	0.34	-29%	0.61	0.49	-20%	0.4	0.39	-3%	0.6	0.52	-13%	-22%
Mining Backward Leakage	1.03	1.04	1%	1.1	1.09	-1%	1.05	1.14	9%	1.04	1.03	-1%	1.06	1.1	4%	1.06	1.09	3%	2%
Mining Backward Leakage Ratio	0.83	0.87	5%	0.67	0.83	24%	0.71	0.84	18%	0.58	0.66	14%	0.75	0.77	3%	0.65	0.7	8%	12%
Mining IFL	0.83	0.73	-12%	0.86	0.84	-2%	2.62	1.25	-52%	0.92	0.54	-41%	1.84	1.62	-12%	0.97	0.67	-31%	-25%
Mining Forward Leakage	1.67	1.95	17%	1.45	2.08	43%	0.73	1.48	103%	1.48	1.97	33%	0.32	0.84	163%	1.24	2.02	63%	70%
Mining Forward Leakage Ratio	0.89	1.06	19%	0.66	1.12	69%	0.41	0.86	112%	0.98	1.51	0.53	0.09	0.15	63%	0.37	0.61	68%	64%
Average IFL	0.58	0.63	9%	0.45	0.61	36%	0.56	0.49	-13%	0.56	0.79	41%	0.53	0.5	-6%	0.72	0.68	-6%	10%
Average DBL	1.63	1.64	1%	1.57	1.81	15%	1.69	1.63	-4%	1.71	1.83	7%	1.58	1.61	2%	1.8	1.86	3%	4%
Average IBL	0.55	0.56	2%	0.47	0.65	38%	0.55	0.53	-4%	0.64	0.76	19%	0.47	0.48	2%	0.7	0.77	10%	11%
Average Backward Leakage	1.12	1.11	-1%	1.24	1.28	3%	1.17	1.16	-1%	1.09	1.12	3%	1.21	1.3	7%	1.08	1.13	5%	3%

Summary (Cont.)

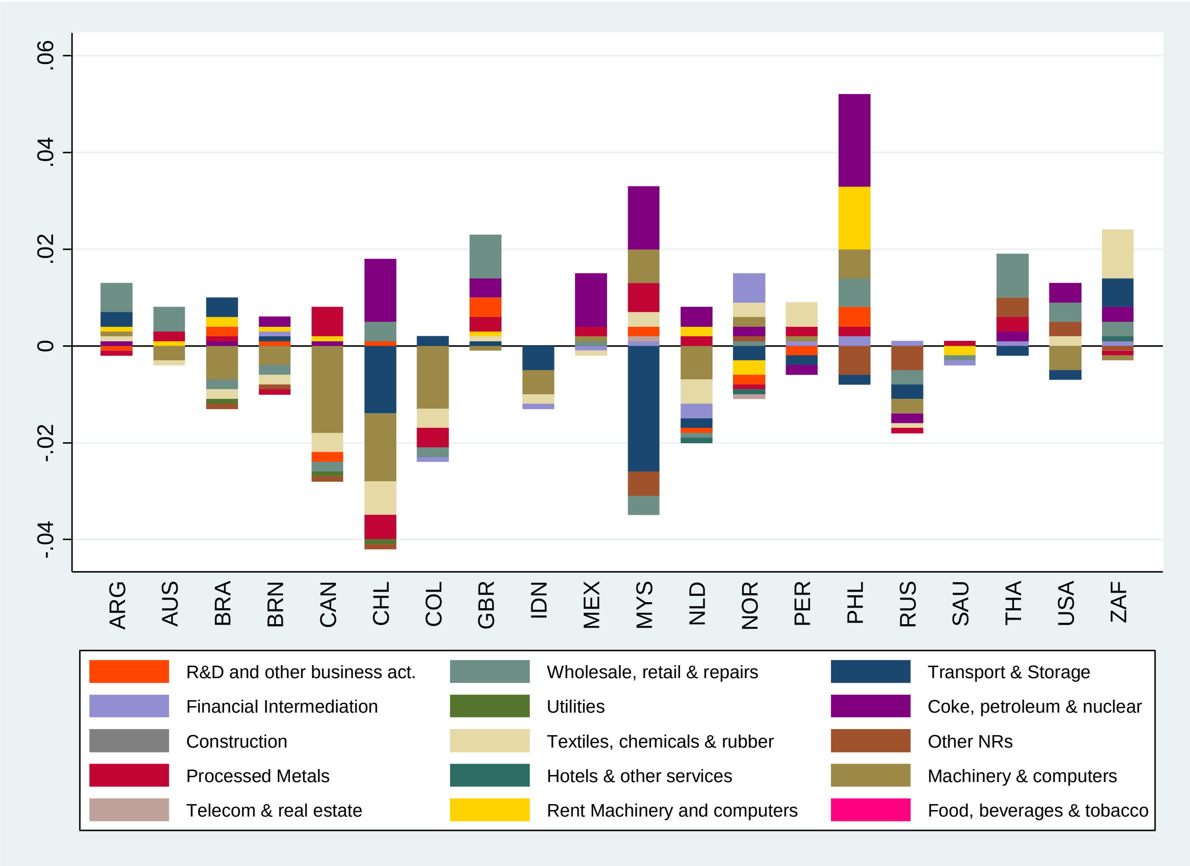
Region	OSHIC	OSHIC	OSHIC	OSHIC	OSHIC	OSHIC	OSHIC	**All**
Country	BRN	BRN	BRN	SAU	SAU	SAU	Average	**Average**
Year	1995	2011	Change	1995	2011	Change	Change	**Change**
Mining DBL	1.23	1.24	1%	1.02	1.02	0%	0%	-7%
Mining DBL (-1USD)	0.23	0.24	4%	0.02	0.02	0%	2%	-18%
Mining IBL	0.04	0.03	-25%	0.02	0.01	-50%	-38%	-26%
Mining Backward Leakage	1.03	1.02	-1%	1.01	1.01	0%	0%	1%
Mining Backward Leakage Ratio	0.84	0.83	-1%	0.99	0.99	0%	-1%	9%
Mining IFL	0.24	0.07	-71%	0.15	0.17	13%	-29%	-26%
Mining Forward Leakage	2.25	2.61	16%	2.08	2.43	17%	16%	53%
Mining Forward Leakage Ratio	1.57	2.04974	30%	0.27995	0.72	156%	93%	81%
Average IFL	0.93	0.49	-47%	0.48	0.41	-15%	-31%	-3%
Average DBL	1.44	1.37	-5%	1.51	1.45	-4%	-4%	1%
Average IBL	0.39	0.31	-21%	0.42	0.37	-12%	-16%	1%
Average Backward Leakage	1.18	1.23	4%	1.17	1.16	-1%	2%	3%

Figure 16. Changes in IBLs 1995-2011



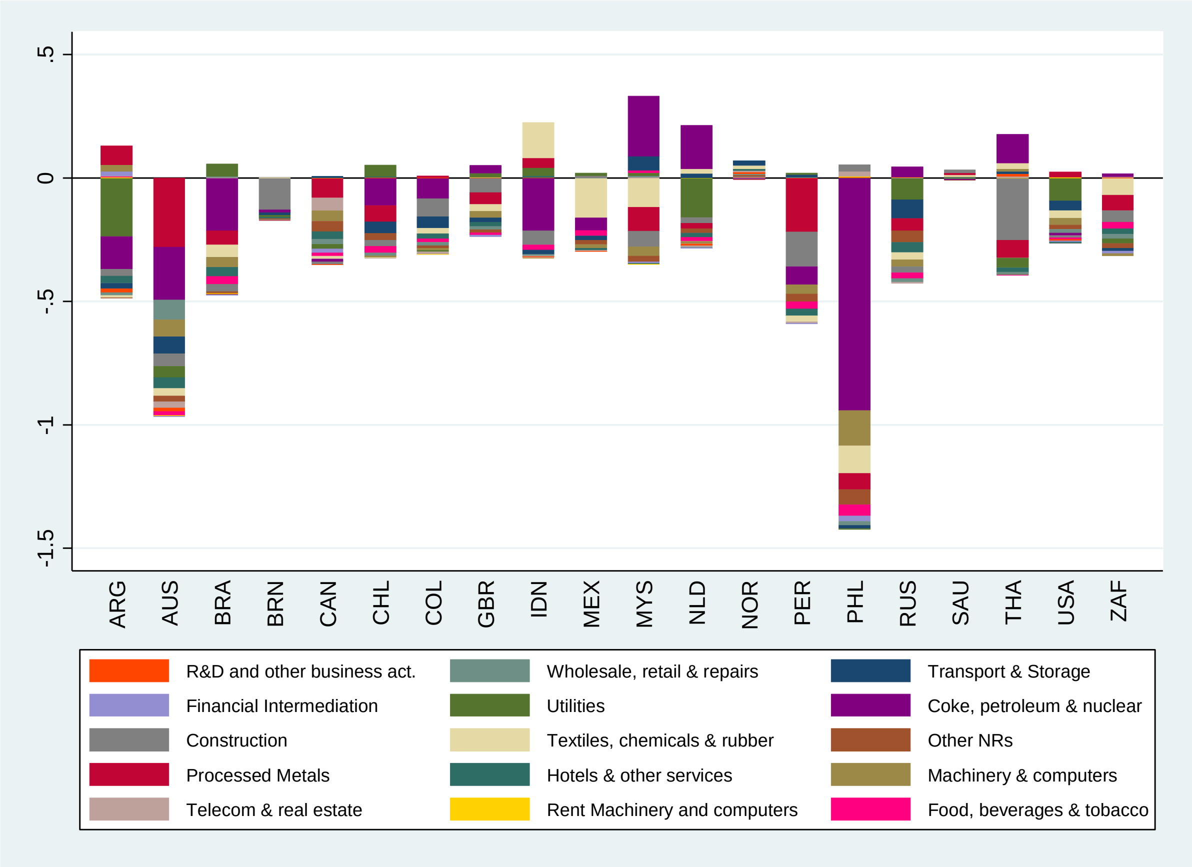
Source: Own elaboration with OECD data

Figure 17. Changes in backward leakages 1995-2011



Source: Own elaboration with OECD data

Figure 17. Changes in forward linkages 1995-2011



Source: Own elaboration with OECD data

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