Development and Change

Published on behalf of the Institute of Social Studies, The Hague

Revisiting the Natural Resource Curse: Backward Linkages for Export Diversification and Structural Economic Transformation

Maria Savona and Filippo Bontadini

ABSTRACT

This article revisits and empirically tests the conjecture that specialization in natural resource industries (NRI) might not necessarily be a 'curse' for developing countries if it generates opportunities for export diversification in backward-linked sectors à la Hirschman. The article systematizes the evolution of the debate around the NRI 'curse'. Then it empirically tests whether NRI might represent a sufficient 'domestic representative demand' à la Linder to favour diversification into backward-linked sectors such as knowledge-intensive business services and high-tech manufacturing. It focuses on the former and discusses the new opportunities for export diversification led by virtuous pathways of domestic structural change. It finds novel, quantitative empirical support for this conjecture, which complements extant qualitative literature and discusses implications that revisit the NRI curse debate.

INTRODUCTION

This article contributes, by providing novel empirical evidence, to the debate around a natural resource (NR)[1] 'curse'. It tests whether countries with a specialization in natural resource industries (NRI henceforth) might leverage backward linkages in the way suggested by Hirschman (1958) to spur

1. NR is commonly used for non-renewable extractive industries such as oil and gas. Renewables, such as forestry, water and land that produce raw materials and commodities, usually fall into the category of primary activities. Here, we look at both types of sectors, as detailed below. The literature on the NR 'curse' tends to associate natural resources primarily with extractive industries. Broadly speaking, and based on Venables (2016), for countries rich in natural resources, at least 20 per cent of their export or fiscal revenues comes from NR. For countries dependent on natural resources, this share is at least 50 per cent. While the term 'commodity' generally refers to homogeneous goods whose market cannot be easily fragmented, this is often, although not exclusively, the case for production in both renewable and non-renewable natural resource sectors. Henceforth, we refer to both sectors when we use the term commodity.

Development and Change 54(2): 378–421. DOI: 10.1111/dech.12754

export both in knowledge-intensive business services (KIBS) and high-tech manufacturing (HTMF).

The idea of a NR curse emerged from the empirical regularity with which many resource-rich countries were experiencing stagnant economic growth (Auty, 1986). A key argument contributing to this debate — of particular interest here — is the link between NR abundance or dependence, domestic structural change, and the trade performance of NRI versus non-NRI. It has been argued that NR exports might be detrimental to non-NR tradable industries, and hamper or slow down diversification away from NR, usually towards a manufacturing sector that is export driven (Harding and Venables, 2016; Venables, 2016). However, over time, the importance of considering the structure of sectoral (backward and forward) linkages, alongside the levels of exports in NR and non-NR industries, has become increasingly recognized, both at the macro (Baldwin and Venables, 2015; Cust and Poelhekke, 2015) and the micro level in specific industries, where linkages might play a role in the diffusion of innovation to local suppliers (Marin and Stubrin, 2015; Marin et al., 2015; Pietrobelli et al., 2018).

This article is positioned within this literature and its aims are twofold. First, the article challenges the NR curse narrative by offering a novel perspective on the role of backward-linked sectors to NRI, particularly knowledge-intensive business services, that considers trade in value added and global value chains (GVCs). Second, it offers quantitative empirical evidence that complements and generalizes the well-established qualitative literature on specific countries and industries that specialize in NRI, which we review below.

The article builds upon a theoretical — albeit not formalized — conjecture, the Hirschman-Linder hypothesis, put forward in Lopez-Gonzalez et al. (2015, 2019). This conjecture blends the concept of backward linkages à la Hirschman (1958), with that of a 'representative domestic demand' à la Linder (1961: 87). Linder argues that what ultimately affects trade is the emergence of a domestic 'need'. In this framework, a domestic demand that is substantial enough to trigger the development of capabilities to achieve, as a result, a trade comparative advantage, is termed 'representative'. Linder refers to the 'need' as *final demand* and as mainly related to manufactured products. He argues that once domestic demand attains a critical level to become 'domestic representative demand', this makes domestic producers competitive enough to operate in the international market (ibid.: 87).[2]

2. Interestingly, albeit from a very different perspective, the Hirschman-Linder hypothesis in Lopez-Gonzalez et al. (2019) resonates with the position put forward by Baldwin and Venables (2015) and is empirically in line with what Poncet and Starosta de Waldemar (2013) find in terms of the importance of backward-linked sectors to NRI.

In the current context, where trade is increasingly concentrated in intermediaries and countries are inserted in GVCs, Lopez-Gonzalez et al. (2015, 2019) adapt Linder's thesis to domestic *intermediate* demand coming from *manufacturing industries* to KIBS — and consider a representative domestic intermediate demand to KIBS as a determinant of countries' GVC participation in KIBS.

This article extends Lopez-Gonzalez et al. (ibid.) by exploring whether the Hirschman-Linder hypothesis could apply to backward linkages emerging from *NRI demand*, particularly to KIBS.[3] In particular, it asks: 'Can specialization in NRI amount to a representative domestic NRI intermediate demand that drives export of KIBS and high-tech manufacturing?'. We empirically test this research question within a dynamic empirical framework to ascertain whether the domestic intermediate demand arising from the NR sector, distinguishing between extractive industries and agriculture,[4] has a positive impact on the export performance of other sectors, particularly KIBS. We use data from the Organization for Economic Co-operation and Development (OECD) inter-country input output tables (ICIO) to capture domestic intermediate demand as well as value added in exports for a sample of 64 countries over the period 1995–2011.[5]

We find that countries, particularly those with a revealed comparative advantage in NRI, and particularly agriculture, benefit from a significant 'representative domestic demand' for KIBS coming from NRI, which favours trade in KIBS value added. This also holds when looking at domestic intermediate demand for high-tech manufacturing sectors. These results seem to corroborate the idea that vertical linkages matter in the first place and that the presence of backward linkages to NRI might be a way of rethinking export diversification strategies that are grounded in NRI, rather than bypassing them. We then discuss the implications of our findings within the context of strategies of diversification for development.

The article is organized as follows. First it revisits the evolution of the NR curse debate that is relevant to the purpose of this analysis. Then it describes the empirical strategy and the data, presenting some initial descriptive evidence in support of the article's main conjecture. This is followed by a discussion of the econometric results. In the final section we conclude by drawing policy implications that aim to rethink resource-based industrialization (RBI) for development.

3. We also test our conjecture by looking at high-tech manufacturing as a forward-linked sector.
4. In Appendix I we provide a detailed disaggregation of the sectors included in the empirical analysis (see Table AI.1).
5. See: www.oecd-ilibrary.org/trade/data/oecd-wto-statistics-on-trade-in-value-added/trade-in-value-added-edition-2016_2644abe4-en

BACKGROUND

The NR 'Curse' Debate

Countries that are rich in or dependent on natural resources might be 'blessed' or 'cursed', depending on numerous factors. The literature has copiously analysed these factors, as summarized in some recent works (Badeeb et al., 2017; Havranek et al., 2016; van der Ploeg and Poelhekke, 2017). In a nutshell, the 'curse' thesis argues that countries rich in or dependent on NR experience low and/or stagnant growth performance, with detrimental consequences for their development. The core of the theoretical arguments underpinning the 'curse' has broadly remained the same over time (Harding and Venables, 2016; Venables, 2016): crowding out of non-NR sectors, Dutch disease economics, exposure to volatility of commodity prices, reduced opportunities for technological learning, deterioration of institutional quality, and armed conflicts.

However, natural resources are very diverse (e.g. coal rather than oil or diamonds) and they entail very different levels of initial investments, quality of institutions and the public management of rents (Havranek et al., 2016). This makes the presence of a 'curse' largely heterogeneous across countries. In fact, the literature has identified cases of growth-adverse NR dependence (e.g. Angola, Democratic Republic of the Congo and many other African countries) as well as cases of growth-enhancing dependence (e.g. Australia, Botswana, Chile and Norway) (Venables, 2016), so that the evidence on a negative link between NR abundance and development is not conclusive (Badeeb et al., 2017; James, 2015).

Over the last decade some scholars have challenged the existence of the NR curse, by reverting to historical examples (Wright and Czelusta, 2004). Others have argued that the curse would not be inevitable if high-quality institutions were in place, that invest and distribute the revenues from NR in a fair way (Boschini et al., 2013; Brunnschweiler, 2008; Venables, 2016). Some literature has also questioned the empirical soundness of the evidence marshalled in support of the resource curse (see, for example, Brunnschweiler and Bulte, 2008; Lederman and Maloney, 2006; Stijns, 2000). It has been argued that the empirical evidence in support of the curse thesis, as in the seminal work by Sachs and Warner (1995), is based on cross-sectional data, which is not fit to capture the evolution over time of both institutions and technology (James, 2015; van der Ploeg and Poelhekke, 2017; Robinson et al., 2006). Also, natural resource *abundance* is often confused with natural resource *dependence* (Brunnschweiler and Bulte, 2008): when this is disentangled from natural resource rents, the latter can actually have a positive impact on economic growth (Ding and Field, 2005).

In addition, some established development scholars have focused on specific country cases and extractive industries. They have attempted to revisit the narrative of the 'curse' from the perspective of innovation capabilities and linked industries (see the reviews of the different arguments in De Ferranti et al., 2002 and Lederman and Maloney, 2006). For example, Urzúa considers the case of the Chilean knowledge-intensive mining services (KIMS) which include 'exploration services, mine planning services, equipment design, project management, metallurgic process design, and environmental engineering services' (Urzúa, 2012: 2). In this context, it has been argued that the development of KIMS depends very much on the scale of the extractive industry in the country, as it has occurred in KIMS-exporting countries such as Australia, Canada, Chile and South Africa.

International competitiveness in KIMS and participation of KIMS in GVCs also depends on the country's technological development and capabilities and on the extent to which local suppliers can upgrade and replace foreign suppliers. This has now become evident from qualitative evidence on extractive industries in selected countries that development scholars have produced by studying the rise of local suppliers to mining industries in emerging economies (Andersen et al., 2018; Marin et al., 2015) and the creation of opportunities for diversification and technological learning that might enhance their competitiveness (see also Pietrobelli et al., 2018).

The NRI as an Enclave? High Development Linkages and Export Diversification

Another reason why the NR sector has been perceived as detrimental for economic development (especially important for our purpose here) is that it has often been regarded as an enclave (Heeks, 1998), that is, resources are extracted with few linkages with the rest of the domestic economy, often dominated by large foreign companies that ship profits back to their headquarters (Heeks, 1998; Weisskoff and Wolff, 1977).

As an enclave, NR also affects the opportunities in natural resource dependent countries for export diversification (Lederman and Maloney, 2006). In this respect, contributions have focused on the opportunities to diversify away from NRI (Baldwin and Venables, 2015; Harding and Venables, 2016) by fostering the emergence of new sectors through backward or forward linkages (Bloch and Owusu, 2012; Heeks, 1998). Baldwin and Venables (2015), for example, argue that trade policies aimed at industrializing developing countries should consider the interactions between backward and forward linkages between *part* and *final* goods. They conclude that, because linkages create a multiplier effect, devising targeted trade and industrial policies that make sense of the domestic structure of linkages would increase the industrial base and its export performance.

Generally, there seems to be a consensus on the necessity for countries with a specialization in NRI to facilitate the emergence of other sectors in their export portfolio, thereby reducing their dependence on NRI. As a result, export diversification has often been considered a policy goal of many commodity-dependent countries (Massol and Banal-Estañol, 2014). Notwithstanding the consensus in the literature and policy, however, export diversification may be hard to achieve, particularly for countries abundant in NR, when NRI are an enclave that lacks significant linkages with the rest of the economy (Heeks, 1998; Hirschman, 1958).

The enclave argument has hinged largely upon the role of forward and, to a lesser extent, backward linkages. For example, Hidalgo et al. (2007) and Hausmann and Klinger (2006) build the well-known 'product space', where certain products are connected to others based on the joint probability of being exported by the same country (Hausmann et al., 2007; Hidalgo et al., 2007). While the product space approach does not rely on backward or forward linkages, it yields similar conclusions to the traditional enclave view: within the product space, NRI are shown to be among the least connected products and sectors, making it particularly hard to diversify away from these industries.

In this context, Hausmann et al. (2008) argue that industrial policies should favour diversification into products that lie closer to what countries currently export and what they have the capabilities to produce. In contrast, policies that encourage export diversification through *beneficiation*, i.e. fostering forward linkages and trying to move away from NRI to downstream manufacturing processing activities, are considered ill-advised as they are not necessarily based on capability similarity. The argument made by Hausmann et al. (ibid.) aligns with quite a long-standing view in the policy debate of economic development that looked with scepticism at strategies to industrialize resource-abundant countries (Auty, 1986).

However, the more recent qualitative evidence on specific extractive industries, discussed above, has challenged the enclave argument (Adewuyi and Ademola Oyejide, 2012; Bloch and Owusu, 2012; Marin and Stubrin, 2015). This literature observes the dramatic changes that NRI have undergone in recent years. For instance, the mining sector has gone through important technological upgrading (Marin and Stubrin, 2015; Marin et al., 2014), whilst increasing the outsourcing of non-core activities to local suppliers, which has fostered domestic backward linkages (Aragón and Rud, 2013; Barnett and Bell, 2011). In addition, the enclave argument supported by the product space approach and the ensuing policy implications seem to have been crafted only with respect to beneficiation (i.e. arguing the ineffectiveness of diversification into forward-linked industries), and not to diversification into backward-linked sectors. We therefore offer a different perspective below.

The Hirschman-Linder Hypothesis Applied to NRI

The case for building on backward and forward linkages within development policies is not new, and dates back to the seminal work by development economists such as Hirschman (1958) and Rostow (1960).[6] Hirschman took a remarkably original stand with respect to the mainstream growth theory based on factor endowments. The role of linkages in Hirschman's work (1958) serves the purpose of creating new sectors by way of scalable intermediate demand, and therefore represents a useful device to identify strategies of development policy that favour diversification of the sectoral composition of economies. We reiterate that this scalable intermediate demand would be the 'representative domestic demand' à la Linder. Linder (1961) in fact argued that what ultimately affects trade is the emergence of a domestic 'need', the development of capabilities to meet such domestic demand, and the achievement of a 'representative domestic demand' that becomes a trade comparative advantage (ibid.: 87).

As mentioned in the Introduction, here we build upon and extend the work of Lopez-Gonzalez et al. (2015, 2019) by exploring whether the Hirschman-Linder hypothesis could apply to backward linkages emerging from NRI demand, particularly to KIBS.[7] In doing so, we distinguish between mining and agriculture because the latter sector is usually considered to be less prone to NR curse effects than the former (Venables, 2016). However, primary non-extractive activities may still increase countries' dependence, expose them to price volatility and make them less likely to diversify due to the lack of inter-sectoral linkages (Hirschman, 1958; Matsuyama, 2009; Vogel, 1994). For these reasons we include them separately in our analysis, where we consider agriculture, hunting and fishing, which we refer to as agriculture (AGR) for short; and mining and quarrying, which we refer to as mining (MIN) for short. In the remainder of the article, when we refer to both agriculture and mining, we will use the general term NRI.

DATA AND EMPIRICAL STRATEGY

Data

We use the inter-country input-output (ICIO) tables for the years 1995–2011,[8] compiled by the OECD, which cover 33 sectors in 64 countries

6. According to Hirschman (1958), there are different types of externalities, depending on whether activities are related to one another by backward or forward inducement mechanisms, i.e. whether certain sectors, by demanding inputs, induce the growth of supplier industries (input provision or backward linkage effect) or, rather, by supplying output induce the growth of client industries (output provision or forward linkage effect).
7. We also test our conjecture by looking at high-tech manufacturing as backward linked sectors. In Appendix I, Table AI.1 reports the full list of the sectors used in our analysis, and how they are aggregated into KIBS and high-tech manufacturing, in line with the OECD classification, which is based, in turn, on research-and-development expenditure.
8. See: www.oecd-ilibrary.org/trade/data/oecd-wto-statistics-on-trade-in-value-added/trade-in-value-added-edition-2016_2644abe4-en

(including a compound for the rest of the world, that represents all countries not included in the ICIO tables). The ICIO tables enable us to observe inter-sectoral linkages and to trace value added flows from the originating to the destination sector, both domestically and across borders.[9] Rather than considering gross exports, a value added approach allows us to capture each sector's domestic value added contribution to a country's exports, reallocating value added exported to the sectors from which it has originated (Koopman et al., 2014). In this way, we can assess the extent to which the increase of exports in a given sector is driven by domestic productive activity in that sector, as opposed to value added contributions coming from other sectors, either domestic or foreign (i.e. imports).

With the availability of 33 sectors, the data are quite aggregated, and each sector includes a wide range of different activities. By looking at exports, we focus on the share of production that is tradable and meets the quality standards to be competitive on the international market, in line with much of the literature mentioned above (see, among others, Hidalgo et al., 2007). This choice is also consistent with the literature on Dutch disease economics (Corden, 1984; Torvik, 2001), and allows us to focus on the effect of large shares of NRI on export in other sectors.

To maximize the number of observations, we carry out the analysis at the geo-sector level, i.e. looking at each of the two KIBS sectors, computer and related activities (ICT) and business services (BZS), as well as high-tech manufacturing in each country. We carry out a separate analysis for the two KIBS sectors across 64 countries and for six high-tech manufacturing industries also across 64 countries, yielding two panels of 128 and 384 country-sectors, respectively, over the 1995–2011 period.[10]

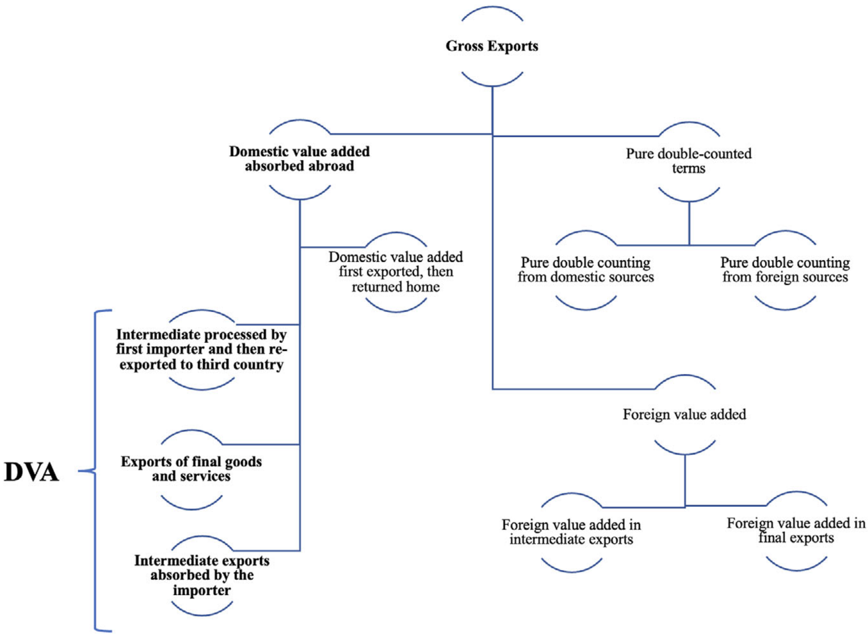
Variables

We operationalize our conjecture on the importance of NRI's domestic intermediate demand by estimating domestic value added (DVA) in exports of sectors other than NRI, because of backward linkages with NRI. For clarity's sake, we discuss here all measures in relation to KIBS, although the same variables have been computed for high-tech manufacturing and we replicate our analysis for these industries too. Our main outcome variable is

9. While a range of inter-country input-output databases are available, we chose the ICIO from the OECD because it offers the largest coverage of countries, while still being based on statistical information from countries, without using imputation methods (Kowalski et al., 2015).

10. The ICIO data provide a balanced panel. However, the World Development Indicators, which we use for our control variables, have some missing values. This makes the final panel we are working with unbalanced. We therefore drop some countries from our analysis altogether: Brazil, Brunei, Vietnam and the Rest of the World compound.

Figure 1. Domestic Value Added (DVA) in Gross Exports



Note: The scheme depicts the different components into which input-output analysis applied to the ICIO data can split gross exports. The figure also highlights the three components that we include in our domestic value added measure.
Source: authors' adaptation from World Bank Group et al. (2017).

the DVA in exports per capita of KIBS, which we compute with the ICIO compiled by the OECD.

We detail at length in Appendix II how we compute the main indicators using standard input-output methodology. Here we consider the indicators we employ and compare these with the different components of trade in value added that the literature has identified. Figure 1 synthesizes this and identifies the portion of value added that our measure captures.

Our main explanatory variable is domestic intermediate demand for KIBS, generated by NRI in per capita terms. For this variable too, we rely on the OECD ICIO tables and we discuss the computation methods in detail in Appendix II. We use input-output tables to isolate the domestic backward linkages that exist between NRI and KIBS that are at the core of our Hirschman-Linder hypothesis, and we divide these by countries' total population.

Finally, we know that both human capital and information and communication technologies (ICT) infrastructure have played a significant role in the expansion of the service sector and its linkages with the rest of the economy (Guerrieri and Meliciani, 2005; Lopez-Gonzalez et al., 2019). For this reason, we rely also on the World Bank World Development Indicators and include the gross enrolment in secondary education to capture human capital and Internet users per thousand inhabitants as a proxy of technological infrastructure, particularly related to ICT.

Econometric Strategy: Baseline Model

Once we have constructed our variables of interest we can test our main conjecture of the Hirschman-Linder hypothesis applied to NRI. The general form of our estimated equation is the following:

$$dvacap_{cit} = \alpha_0 + \beta_1 dvacap_{cit-1} + \beta_2 ddcap_{cit} + \beta_3 schooling_{ct} + \beta_4 internetaccess_{ct} + \alpha_c + \alpha_i + \alpha_t + \varepsilon_{it} \quad (1)$$

In equation (1):

$dvacap_{cit}$ is the log of domestic value added embodied in each country c and sector i's gross exports per capita in each year t. We look at KIBS and high-tech manufacturing separately;

$ddcap_{cit}$ is the log of per capita domestic intermediate demand provided by the NR sector to each KIBS country-sector in year t. Here too we look at intermediate demand for either KIBS or high-tech manufacturing, depending on our outcome variable of interest;

$schooling_{ct}$ captures human capital through years of schooling in each country c and year t;

$internetaccess_{ct}$ is internet users per thousand inhabitants and captures countries' technological infrastructure.

A full list of the variables in equation 9 — as well as in the extensions we discuss below — is provided in Appendix I (Table AI.2).

We also control for country, sector and year fixed effects (FE): α_c, α_i and α_t respectively. Country FE are particularly important here because we have both high-income and developing countries in our sample that have institutions of different quality, which the literature has identified as a key factor in dispelling the natural resource curse (Arezki and van der Ploeg, 2010; Kolstad, 2009; Mehlum et al., 2006).

Two more issues need to be dealt with. First, export of value added in KIBS is likely to be affected by serial correlation, as current levels of exports are often correlated with past ones. Second, the relationship between exports of KIBS and the domestic intermediate demand coming from NRI is likely to go both ways. While we want to test whether increases in the domestic intermediate demand from NRI generate increases in the export of KIBS, it is also possible that causation may run the other way around, through a simultaneous effect.

To deal with both issues, we opt for an autoregressive model, including the lag of the outcome variable on the right-hand side of the equation,

$dvacap_{cit-1}$. It is worth noting that including the lag of our outcome variable makes it impossible to use country-sector fixed effects (while it remains possible to use country and sector fixed effects separately). This is because, in this case, country-sector FE would correlate by construction with the error term in our equation 1 (ε_{it}) with the lag of the outcome variable, leading to what is known in the literature on dynamic models as the Nickell bias (Nickell, 1981).

We illustrate the implications of this with an example. As things stand, our empirical analysis would not be able to control for country-industry specificities; for example, the fact that KIBS sectors in Chile may have developed specifically to meet the demands of the very large copper industry, while KIBS sectors in France, for example, will not have developed in this same direction. These aspects are of course crucial to our investigation, and it is important to fully take them into account.

To achieve this, we augment equation 1 with a time invariant pre-sample mean of our outcome variable ($\overline{dvacap}_{ci}$ in equation 2 below) that allows us to control for country-industry pre-existing and time invariant conditions. This choice is consistent with the well-established literature on dynamic models suggesting that in the presence of highly persistent variables, as is the case for value added flows, pre-sample means are preferable to traditional FE estimators (Blundell et al., 1995, 2002).

$$dvacap_{cit} = \alpha_0 + \beta_o \overline{dvacap}_{ci} + \beta_1 dvacap_{cit-1} + \beta_2 ddcap_{cit} + \beta_3 schooling_{ct} + \beta_4 internetaccess_{ct} + \alpha_c + \alpha_i + \alpha_t + \varepsilon_{it} \quad (2)$$

The approach described above deals appropriately with the issue of serial correlation as it allows us to include the lag of the outcome variables controlling in a flexible way for country, industry and country-industry FE, while also avoiding the risk of the Nickell bias.

The inclusion of the lag of the outcome variable also mitigates concerns for reverse causality as mentioned above. By controlling for the previous level of export of value added per capita we are also, implicitly, controlling for the possibility that countries that already had very well-performing KIBS sectors develop a domestic intermediate demand from their natural resource industries because of this pre-existing advantage.

However, some concern about the direction of causality may still linger and therefore we replicate our results by treating both our explanatory variable and the lag of our outcome variable as endogenous. To accommodate this, we perform a robust version of the system generalized method of moments (GMM) with Windmeijer's (2005) correction for finite sample. The GMM uses lags of our endogenous variables as internal instruments and deals simultaneously with the Nickell bias and reverse causality and allows us therefore to include country-industry fixed effects (α_{ci}), rather than country (α_c) and industry (α_i) fixed effects separately, as shown in equation 3:

$$dvacap_{cit} = \alpha_0 + \beta_1 dvacap_{cit-1} + \beta_2 ddcap_{cit} + \beta_3 schooling_{ct} + \beta_4 internetaccess_{ct} + \alpha_{ci} + \alpha_t + \varepsilon_{it} \quad (3)$$

This alternative specification is significantly more demanding than what is presented in equation 2, since we can only exploit variation within country-industries over time, but we also feel it is more robust and deals with both threats to our identification strategy.

Econometric Strategy: Revealed Comparative Advantage and Productivity in Natural Resource Industries

Using both empirical approaches discussed above, we also wish to test the additional hypothesis that countries with a specialization in NRI experience a stronger relationship between backward linkages stemming from NRI and the export of value added of KIBS and high-tech manufacturing sectors. To test this, we interact our main explanatory variable with a dummy variable *nr_rca* that takes value 1 if the country has a revealed comparative advantage (RCA) in NRI. We measure RCA with a value-added Balassa index:

$$NR\_RCA_{c,i} = \frac{DVA_{c,i} / \sum_i DVA_{c,i}}{\sum_c DVA_{c,i} / \sum_c \sum_i DVA_{c,i}} \ ; \ with\ i \in NRI \quad (4)$$

In equation 4 we retrieve the same measures we have computed in Appendix II (see equation 5*a*), but for NRI, and we compare the share that each sector *i* represents in the total export of country *c* (i.e. the numerator of the ratio) with the share that exports from industry *i* from all countries represent in total exports of all countries and sectors (Balassa, 1965). If this index takes a value above one it means that the country *c* has a revealed comparative advantage in sector *i*. The use of the revealed comparative advantage to assess countries' specialization in NRI has the benefit that our understanding of specialization does not rely on any ex ante and arbitrary definition.

However, the RCA is also a measure of relative specialization: a country with an RCA in NRI above one is a country in which NRI represents a higher proportion in its exports than it does in the world's exports (ibid.). The underlying idea of the RCA is that countries specialize in sectors whose production requirements they are best equipped to meet (Chor, 2010), which may lead to equating specialization and competitiveness (Hidalgo et al., 2007). Competitiveness in a sector is, in turn, often related to productivity: countries that are more efficient at producing in a given sector will be more likely to be more competitive (and to specialize) in this sector (Chor, 2010).

For NRI this reasoning is, however, a little more complex. A country may develop a specialization in NRI and therefore have a Balassa index above one, only because of its endowment in NR, regardless of the sector's productivity. This has bearing on the interpretation of our results and in particular the channels through which NRI intermediate demand may spur export of value added in KIBS (or high-tech manufacturing), depending on the source of RCA in NRI.

On the one hand, very productive NRI allow a country to develop an RCA in NRI, hence requiring more and/or higher-quality KIBS inputs, therefore increasing KIBS export performance. There is thus a 'quality' effect of the intermediate demand spilling over from NRI on the export performance of KIBS. On the other hand, a very large NRI, regardless of its productivity, provides a very large intermediate demand and this 'scale' (or quantity) effect improves KIBS export performance.

These two channels are not mutually exclusive of course, but it is important to disentangle them to understand for which countries our results will be relevant. On the one hand, if improvements in the export of KIBS are conditional on the 'quality' of the intermediate demand to which they are exposed, countries relying mainly on the size of the NRI (which are often developing ones) will be unlikely to see their KIBS sector benefit from NRI domestic intermediate demand. On the other hand, if the 'scale' effect is at play, countries can exploit the size of the NRI intermediate demand, regardless of its 'quality', to increase KIBS export performance.

To ascertain this, we need to control for the 'quality' effect that could drive countries' specialization in NRI. We proxy the quality of the intermediate demand with an index of productivity of NRI,[11] which we compute by dividing the domestic value added of the NRI by its inputs, i.e. its intermediate demand. This is admittedly a crude measure of productivity; but it has the advantage of being readily computable at the sectoral level in our data.[12] It considers productivity as a measure of efficiency in production, as it captures how much value added is produced given the input required by the production process.

Part of the intermediate demand of NRI is already included in our main explanatory variable; we therefore exclude this share of intermediate demand from the calculation of our productivity index.

$$VAIC = \frac{VA}{(IC - IC_{NR-KIBS})} \tag{5}$$

11. As above, we compute this measure of productivity for agriculture and mining separately.
12. An alternative approach would have been to compute labour productivity at the sectoral level; however, employment data at the sectoral level for all the countries in our sample is not available. The world input-output tables (WIOT) would have been an alternative source as they include inter-country input-output tables and sectoral levels of employment, but they cover a significantly smaller number of countries, and include very few developing countries.

Where VA is domestic value added and the denominator is intermediate consumption (IC) minus the intermediate consumption met by the KIBS sectors ($IC_{NR\text{-}KIBS}$). We then augment our equations 2 and 3 with this additional control, obtaining the econometric model we bring to our data and obtain for our specification with pre-sample mean:

$$dvacap_{cit} = \alpha_0 + \beta_o\overline{dvacap}_{ci} + \beta_1 dvacap_{cit-1} + \beta_2 ddcap_{cit} + \beta_3 schooling_{ct} + \beta_4 internetaccess_{ct} + \beta_5 vaic_{ci} + \alpha_c + \alpha_i + \alpha_t + \varepsilon_{it} \quad (6)$$

While for our GMM model it will be:

$$dvacap_{cit} = \alpha_0 + \beta_1 dvacap_{cit-1} + \beta_2 ddcap_{cit} + \beta_3 schooling_{ct} + \beta_4 internetaccess_{ct} + \beta_5 vaic_{ci} + \alpha_{ci} + \alpha_t + \varepsilon_{it} \quad (7)$$

In the next two sections we present first some descriptive evidence on the relationship between domestic intermediate linkages emanating from NRI and export of value added of KIBS and high-tech manufacturing industries, and then turn to the econometric results.

DESCRIPTIVE EVIDENCE

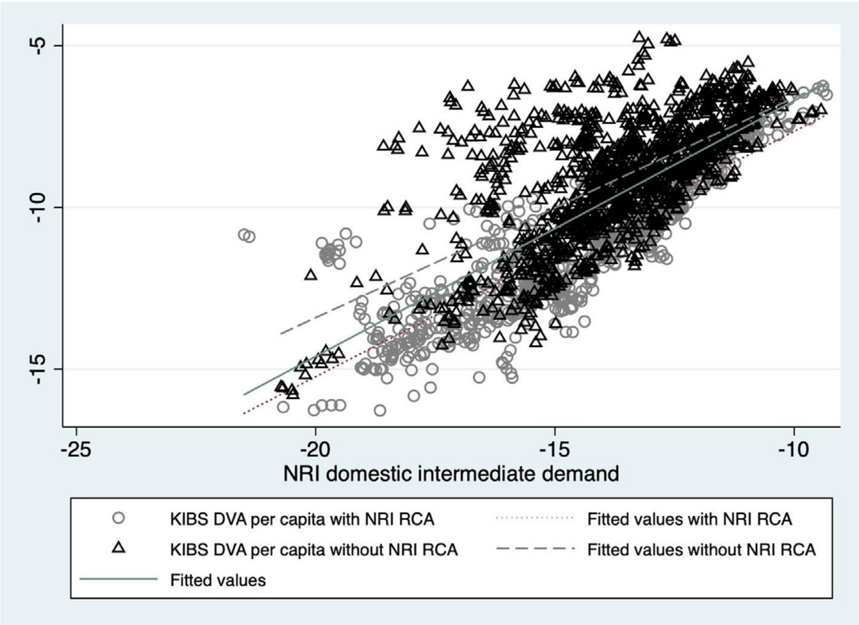
Before we discuss our econometric results in the next section, we present here some descriptive evidence on the relationship between NRI domestic intermediate demand and KIBS domestic value added in exports. Figure 2 plots the natural logs of per capita DVA in the KIBS sector and the logs of per capita intermediate demand emanating from NRI for KIBS. The round and triangular points correspond to countries with and without an RCA in NRI, respectively.[13] The same applies for the dotted and dashed fitted lines, while the solid fitted line is plotted without distinguishing between countries with or without an RCA.

There is a strong and positive relationship between the two variables. We also see that the countries without an RCA in NRI tend to have higher levels of KIBS DVA, although the fitted line has a slightly lower slope; this suggests that the relationship may be less strong. Countries without an RCA in NRI have in fact higher variability of KIBS DVA for similar levels of intermediate demand for KIBS from NRI.

To provide a more concrete view, we replicate Figure 2 in Appendix III (Figure AIII.1), by plotting only countries' averages — computed over years and sectors — for per capita NRI domestic intermediate demand and KIBS

13. Tables AI.3 and AI.4 in Appendix I list all countries with an RCA in AGR and MIN respectively.

Figure 2. Domestic Intermediate Demand from NRI and KIBS Domestic Value Added in Exports



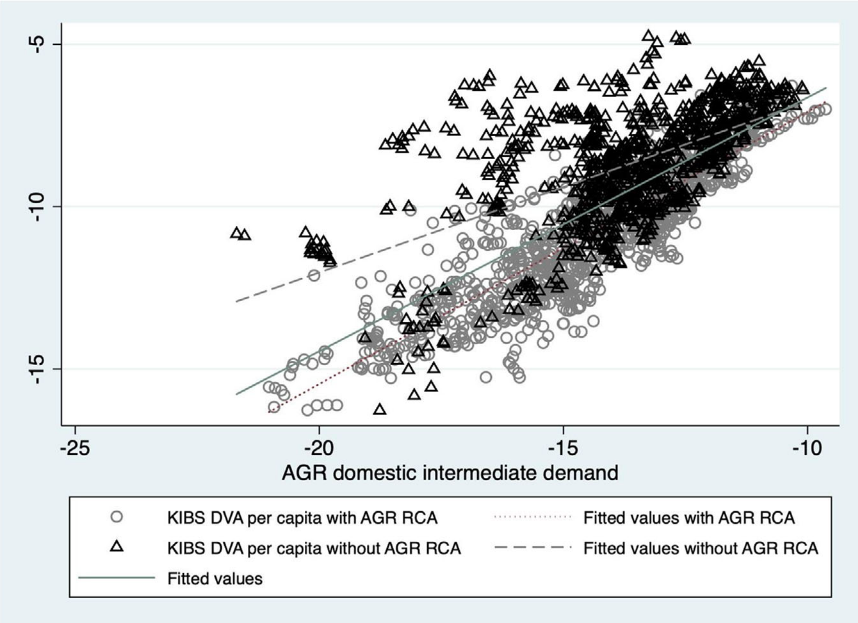
Note: Figure 2 plots the natural log of domestic intermediate demand per capita from natural resource industries (NRI) against the natural log of knowledge-intensive business services domestic value added (KIBS DVA) per capita. These are all negative because the original data from the ICIO tables are measured in US$ millions, which yields values below 1 when divided by the population to obtain per capita measures.
Source: authors' calculations based on ICIO tables. www.oecd-ilibrary.org/trade/data/oecd-wto-statistics-on-trade-in-value-added/trade-in-value-added-edition-2016_2644abe4-en

DVA.[14] We can see that high-income countries with a specialization in natural resources, like Australia (AUS), Canada (CAN) and Norway (NOR) have both the highest per capita intermediate demand for KIBS and the highest per capita export of KIBS DVA. This, however, does not seem to drive the positive relationship between the two variables. Among developing countries, Argentina (ARG), Chile (CHL) and Cost Rica (CRI) also have rather high levels of KIBS DVA in export per capita and intermediate demand from NRI.

However, while the relationship seems to be strong and positive for both high-income and developing countries alike, it is true that only the former have achieved high levels of DVA in KIBS export and domestic intermediate demand emanating from NRI. This points to the fact that while there

14. For completeness, we also provide figures for intermediate demand for AGR and NRI — Figures AIII.2 and AIII.3 in Appendix III — which show a very similar story to the one discussed here.

Figure 3. Domestic Intermediate Demand from AGR and KIBS Domestic Value Added in Exports

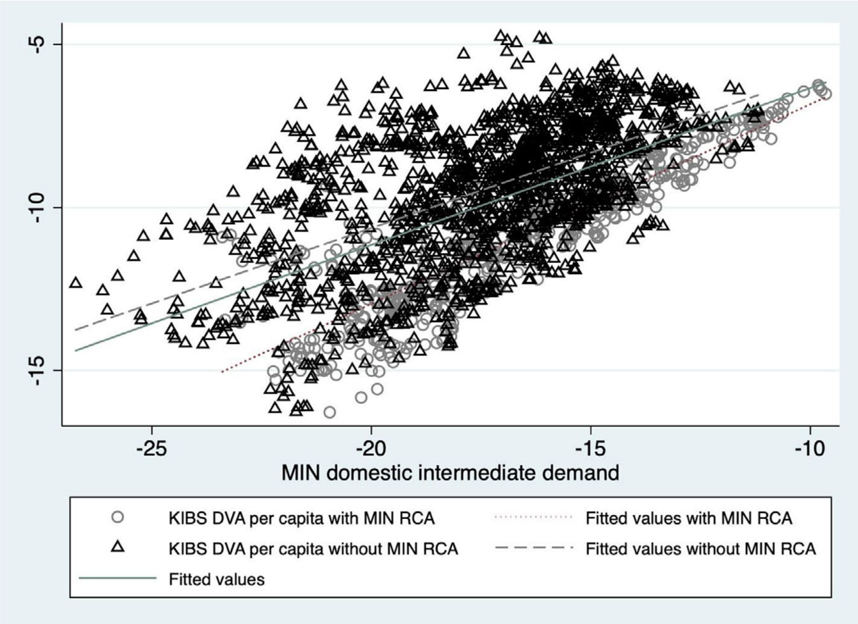


Note: Figure 3 plots the natural log of domestic intermediate demand per capita from AGR against the natural log of knowledge intensive business services domestic value added (KIBS DVA) per capita. These are all negative because the original data from the ICIO tables are measured in US$ millions, which yields values below 1 when divided by the population to obtain per capita measures.
Source: authors' calculations based on ICIO tables. www.oecd-ilibrary.org/trade/data/oecd-wto-statistics-on-trade-in-value-added/trade-in-value-added-edition-2016_2644abe4-en

is potential for domestic linkages to drive economic diversification, this is not an automatic mechanism, as we know from many case studies (see, for example, Marin et al., 2015).

The positive association detected in Figure 2 is borne out even more strongly when we look at the AGR sector alone, in Figure 3: the legend in this figure is the same as for Figure 2. We see again that the countries without an RCA in AGR tend to cluster in the upper-right corner of the graph, which means that they usually have higher levels of both domestic intermediate demand from AGR and KIBS DVA. However, the slope of the fitted line is smaller when compared to the subsample of countries with an RCA in AGR, which suggests that the relationship between intermediate demand from AGR and the export of KIBS DVA may be stronger for countries with an RCA in AGR. This also supports the idea that the relative size of NRI may play a role in influencing the relationship between the domestic intermediate demand originating from this sector and the DVA exported by KIBS.

Figure 4. Domestic Intermediate Demand from MIN and KIBS Domestic Value Added in Exports



Note: Figure 4 plots the natural log of domestic intermediate demand per capita from MIN against the natural log of knowledge intensive business services domestic value added (KIBS DVA) per capita. These are all negative because the original data from the ICIO tables are measured in US$ millions, which yields values below 1 when divided by the population to obtain per capita measures.
Source: authors' calculations based on ICIO tables. www.oecd-ilibrary.org/trade/data/oecd-wto-statistics-on-trade-in-value-added/trade-in-value-added-edition-2016_2644abe4-en

When we turn to the MIN sector in Figure 4, we find once again a positive association between our variables; interestingly we find here that countries without an RCA are located more towards the upper-left quarter of the graph. This hints at the fact that they have rather lower levels of intermediate demand from MIN but higher levels of DVA KIBS. In contrast, countries with an RCA in MIN tend to have lower levels of export of KIBS.

This descriptive evidence supports our main conjecture of a positive association between NRI domestic intermediate demand and DVA exported by KIBS. Relating back to Venables' (2016) distinction between agriculture and mining industries, we find some interesting differences. The positive relationship we detect seems to be particularly strong for the AGR sector, rather than MIN. This may suggest that the enclave thesis might apply to backward linkages from extractive NRI more than to renewable NRI. This would lend further support to the argument of Venables (ibid.), that agricultural natural resources may have fewer negative effects on countries' economic performance.

These figures offer prima facie evidence on the relationship between domestic intermediate demand and DVA exports of KIBS, which is likely to be riddled with endogeneity, particularly due to reverse causality and simultaneity of the relationship. As mentioned, our econometric approach aims to deal with these issues.

ECONOMETRIC RESULTS

We present our results for all NRI, as well as for agriculture and mining separately. Here we focus on the results from our pre-sample mean specification as described in equation 6, but we comment on the results by contrasting them with our GMM approach from equation 7, which we present in Appendix IV for the sake of space. Each table in this section reports the results both with and without our proxy for the quality of the NRI and with and without the dummy for RCA. Naturally, when looking at agriculture and mining separately, both the variables and the domestic intermediate demand per capita have been computed for these sectors alone.

NRI and Backward-linked KIBS

Table 1 presents our key results for export of value added in the KIBS sector and the domestic intermediate demand generated by NRI as a whole. We find that domestic intermediate demand from these industries for KIBS has a positive effect on the export of value added in KIBS in per capita terms. The introduction of our dummy for the presence of an RCA in NRI does not change this result and the positive (though only weakly significant, see Columns 3 and 6 in Table 1) coefficient of the interaction term suggests that the positive relationship between domestic intermediate demand for KIBS and export of value added of KIBS is even stronger for countries that have developed an RCA in NRI.

When we add our control for productivity in the NRI we do not find any significant change in our estimates and the coefficient for this additional control is never significant which suggests that the relationship between our two key variables of interest is not driven by a quality effect of NRI, but rather by the scale effect. It appears that it is the size of domestic intermediate demand generated by NRI that amounts to what Linder refers to as 'domestic representative demand' that leads to higher levels of export of KIBS value added per capita (Linder, 1961: 87). Our preferred specifications (see Columns 3 and 6 in Table 1) suggest that these relationships are not economically negligible either; given that both our outcome and explanatory variables are expressed in logarithms, they can be interpreted in terms of elasticity. A 1 per cent increase in the domestic intermediate demand of NRI for KIBS is associated with a 0.06 per cent increase in the domestic value added included in KIBS exports.

Table 1. Domestic Intermediate Demand from NRI and Export of Value Added in KIBS, Pre-sample Mean Specification

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
Pre-sample mean KIBS DVA per capita (log)	−0.0194	−0.0194	−0.00425	−0.0195	−0.0195	−0.00463
	(0.0214)	(0.0214)	(0.0227)	(0.0214)	(0.0214)	(0.0227)
KIBS DVA per $capita_{t-1}$ (log)	0.853***	0.853***	0.848***	0.852***	0.852***	0.847***
	(0.0344)	(0.0349)	(0.0345)	(0.0344)	(0.0349)	(0.0346)
RCA in NRI dummy		0.00353	0.255**		0.000577	0.247*
		(0.0352)	(0.129)		(0.0353)	(0.131)
NRI domestic intermediate demand for KIBS per capita (log)	0.0709***	0.0709***	0.0612***	0.0716***	0.0716***	0.0621***
	(0.0187)	(0.0187)	(0.0202)	(0.0188)	(0.0188)	(0.0203)
RCA in NRI dummy * intermediate demand for KIBS per capita (log)			0.0180*			0.0177*
			(0.00942)			(0.00952)
Schooling	0.000721	0.000733	0.000690	0.000716	0.000718	0.000677
	(0.000667)	(0.000674)	(0.000679)	(0.000662)	(0.000669)	(0.000675)
Internet access	−0.000588	−0.000607	−0.000273	−0.000456	−0.000459	−0.000145
	(0.000837)	(0.000893)	(0.000918)	(0.000832)	(0.000892)	(0.000910)
Productivity in NRI				0.0526	0.0526	0.0481
				(0.0490)	(0.0492)	(0.0494)
Constant	−0.538	−0.538	−0.596*	−0.550	−0.550	−0.606*
	(0.359)	(0.359)	(0.358)	(0.358)	(0.358)	(0.357)
Observations	1,350	1,350	1,350	1,350	1,350	1,350
R-squared	0.992	0.992	0.992	0.992	0.992	0.992

Notes: The outcome variable is the knowledge intensive business services (KIBS) value added in export per capita, computed excluding KIBS value added embodied in export of natural resource industries (NRI). The pre-sample means (PSM) are computed over the 1995–99 period and the analysis concerns the remaining years 2000–11. Schooling is gross enrolment in secondary education and internet access is internet users per thousand inhabitants. RCA in NRI dummy takes value one if the Balassa index computed in equation 4 is above one. Productivity in NRI is computed as in equation 5. All estimates include country, sector and year fixed effects. Robust standard errors in parentheses.
$^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$
Source: authors' calculations.

In Tables 2 and 3 we replicate the results from Table 1 by looking at agriculture and mining separately. We find overall very consistent results: the interaction between the presence of RCA in either agriculture or mining is positive and strongly statistically significant, indicating that countries with an RCA in these industries are best placed to exploit domestic intermediate demand from these industries to spur export of value added from KIBS. The association also remains economically meaningful when we look at intermediate demand emanating from the agriculture and mining industries separately. For the former, a 1 per cent increase in domestic intermediate demand is associated with a 0.06 per cent increase in DVA in per capita export of KIBS. The elasticity is lower, 0.03 per cent, but still positive and economically meaningful for the mining sector.

In Appendix IV, we replicate these three tables using our GMM approach (see Tables AIV.1–AIV.3), which uses past lags of both the outcome variable and our key explanatory variable as internal instruments and includes country-industry fixed effects. This is an even more robust, but also more demanding, specification that deals appropriately with both serial correlation and reverse causality concerns discussed in the previous section. Our key results are maintained, despite a loss in significance especially concerning the interaction between the RCA dummies and the domestic intermediate demand from NRI. While these results confirm, overall, our initial conjecture concerning the relevance of the Hirschman-Linder hypothesis for the natural resource sector, they also warrant caution in concluding that countries with an RCA in such industries are best placed to benefit from this.

NRI and Backward-linked High-tech Manufacturing

We now turn to testing our Hirschman-Linder hypothesis with respect to the domestic intermediate linkages between natural resource industries and high-tech manufacturing. This is particularly relevant because, as emphasized when reviewing the literature, most of the scholarship has looked at the inter-sectoral linkages originating from NRI to *downstream* manufacturing activities, often arguing that these were not a viable path to diversification towards the manufacturing sector (Auty, 1986; Hausmann et al., 2008). Our approach complements this evidence by focusing on the role of *backward* linkages in spurring the emergence of export in high-tech manufacturing industries.

Our results confirm the Hirschman-Linder hypothesis for high-tech manufacturing too. Interestingly, however, while we find a positive effect of NRI domestic intermediate demand for high-tech manufacturing, the interaction term with the dummy for RCA in NRI is never statistically significant, suggesting that this relationship is irrespective of countries' specialization in NRI (see Tables 4, 5 and 6).

In our GMM specification, which we present in Appendix IV, 'Robustness Checks with GMM' (see Tables AIV.4–AIV.6), we find confirmation

Table 2. Domestic Intermediate Demand from Agriculture Industries and Export of Value Added in KIBS, Pre-sample Mean Specification

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
Pre-sample mean KIBS DVA per capita (log)	−0.0209	−0.0209	0.0103	−0.0211	−0.0211	0.00985
	(0.0215)	(0.0215)	(0.0217)	(0.0215)	(0.0215)	(0.0217)
KIBS DVA per capita$_{t-1}$ (log)	0.851***	0.851***	0.840***	0.850***	0.850***	0.838***
	(0.0348)	(0.0348)	(0.0364)	(0.0349)	(0.0349)	(0.0365)
RCA in agriculture dummy		−0.0350	0.451***		−0.0478	0.434***
		(0.0359)	(0.167)		(0.0365)	(0.166)
Agriculture domestic intermediate demand for KIBS per capita (log)	0.0724***	0.0722***	0.0610***	0.0739***	0.0739***	0.0628***
	(0.0192)	(0.0193)	(0.0188)	(0.0194)	(0.0194)	(0.0189)
RCA in agriculture dummy * intermediate demand for KIBS per capita (log)			0.0365***			0.0362***
			(0.0136)			(0.0135)
Schooling	0.000736	0.000762	0.000504	0.000582	0.000589	0.000339
	(0.000668)	(0.000668)	(0.000652)	(0.000672)	(0.000672)	(0.000656)
Internet access	−0.000641	−0.000617	−0.000197	−0.000442	−0.000372	3.84e-05
	(0.000834)	(0.000836)	(0.000854)	(0.000829)	(0.000832)	(0.000853)
Productivity in agriculture industries				0.0882**	0.104**	0.101**
				(0.0447)	(0.0451)	(0.0446)
Constant	−0.534	−0.520	−0.493	−0.530	−0.510	−0.483
	(0.357)	(0.351)	(0.338)	(0.357)	(0.351)	(0.338)
Observations	1,350	1,350	1,350	1,350	1,350	1,350
R-squared	0.992	0.992	0.992	0.992	0.992	0.992

Notes: The outcome variable is the knowledge intensive business services (KIBS) value added in export per capita, computed excluding KIBS value added embodied in export of agriculture industries, which include agriculture, fishing and hunting activities. The pre-sample means (PSM) are computed over the 1995–99 period and the analysis concerns the remaining years 2000–11. Schooling is gross enrolment in secondary education and internet access is internet users per thousand inhabitants. The RCA in agriculture dummy takes value one if the Balassa index computed in equation 4 is above one. Productivity in agriculture industries is computed as in equation 5. All estimates include country, sector and year fixed effects. Robust standard errors in parentheses. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$

Source: authors' calculations.

Table 3. Domestic Intermediate Demand from Mining Industries and Export of Value Added in KIBS, Pre-sample Mean Specification

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
Pre-sample mean KIBS DVA per capita (log)	−0.00800	−0.00801	0.00440	−0.00794	−0.00793	0.00449
	(0.0210)	(0.0210)	(0.0213)	(0.0210)	(0.0210)	(0.0213)
KIBS DVA per capita$_{t-1}$ (log)	0.882***	0.882***	0.878***	0.881***	0.881***	0.877***
	(0.0291)	(0.0291)	(0.0290)	(0.0292)	(0.0292)	(0.0291)
RCA in mining dummy		−0.0434	0.278*		−0.0511	0.271*
		(0.0345)	(0.147)		(0.0347)	(0.148)
Mining domestic intermediate demand for KIBS per capita (log)	0.0344***	0.0344***	0.0271**	0.0351***	0.0352***	0.0278**
	(0.0102)	(0.0102)	(0.0109)	(0.0104)	(0.0104)	(0.0111)
RCA in mining dummy * intermediate demand for KIBS per capita (log)			0.0194**			0.0194**
			(0.00851)			(0.00852)
Schooling	0.000720	0.000735	0.000810	0.000782	0.000809	0.000885
	(0.000674)	(0.000674)	(0.000665)	(0.000686)	(0.000686)	(0.000676)
Internet access	−0.000521	−0.000500	−0.000292	−0.000573	−0.000558	−0.000349
	(0.000851)	(0.000852)	(0.000859)	(0.000856)	(0.000856)	(0.000865)
Productivity in mining industries				0.0300	0.0353	0.0356
				(0.0294)	(0.0295)	(0.0290)
Constant	−0.542	−0.534	−0.611	−0.553	−0.545	−0.622
	(0.378)	(0.379)	(0.380)	(0.379)	(0.379)	(0.380)
Observations	1,350	1,350	1,350	1,350	1,350	1,350
R-squared	0.992	0.992	0.992	0.992	0.992	0.992

Notes: The outcome variable is the knowledge intensive business services (KIBS) value added in export per capita, computed excluding KIBS value added embodied in export of mining industries, which include mining and quarrying activities. The pre-sample means (PSM) are computed over the 1995–99 period and the analysis concerns the remaining years 2000–11. Schooling is gross enrolment in secondary education and internet access is internet users per thousand inhabitants. RCA in mining dummy takes value one if the Balassa index computed in equation 4 is above one. Productivity in mining industries is computed as in equation 5. All estimates include country, sector and year fixed effects. Robust standard errors in parentheses. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$

Source: authors' calculations.

Table 4. Domestic Intermediate Demand from NRI and Export of Value Added in High-tech Manufacturing, Pre-sample Mean Specification

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
Pre-sample mean high-tech manufacturing DVA per capita (log)	0.105***	0.104***	0.113***	0.104***	0.104***	0.113***
	(0.0179)	(0.0180)	(0.0202)	(0.0180)	(0.0180)	(0.0202)
High-tech manufacturing per capita$_{t-1}$ (log)	0.912***	0.912***	0.911***	0.912***	0.912***	0.910***
	(0.00796)	(0.00799)	(0.00821)	(0.00797)	(0.00800)	(0.00823)
RCA in NRI dummy		0.0162	0.145		0.0160	0.153
		(0.0267)	(0.106)		(0.0267)	(0.106)
NRI domestic intermediate demand for high-tech manufacturing per capita (log)	0.0282***	0.0281***	0.0233***	0.0284***	0.0283***	0.0233***
	(0.00532)	(0.00532)	(0.00705)	(0.00536)	(0.00537)	(0.00704)
RCA in NRI dummy * intermediate demand for high-tech manufacturing per capita (log)			0.00802			0.00856
			(0.00643)			(0.00642)
Schooling	0.000526	0.000588	0.000585	0.000535	0.000596	0.000594
	(0.000585)	(0.000608)	(0.000608)	(0.000585)	(0.000609)	(0.000609)
Internet access	2.54e-05	−5.82e-05	2.07e-05	3.35e-05	−4.90e-05	3.71e-05
	(0.000630)	(0.000662)	(0.000665)	(0.000630)	(0.000662)	(0.000665)
Productivity in NRI				−0.00668	−0.00663	−0.00800
				(0.00715)	(0.00715)	(0.00710)
Constant	0.475***	0.466***	0.449***	0.472***	0.463***	0.444***
	(0.140)	(0.142)	(0.143)	(0.140)	(0.142)	(0.143)
Observations	4,050	4,050	4,050	4,050	4,050	4,050
R-squared	0.985	0.985	0.985	0.985	0.985	0.985

Notes: The outcome variable is the high-tech manufacturing value added in export per capita, computed excluding high-tech manufacturing value added embodied in export of natural resources industries (NRI). The pre-sample means (PSM) are computed over the 1995–99 period and the analysis concerns the remaining years 2000–11. Schooling is gross enrolment in secondary education and internet access is internet users per thousand inhabitants. RCA in NRI dummy takes value one if the Balassa index computed in equation 4 is above one. Productivity in NRI is computed as in equation 5. All estimates include country, sector and year fixed effects. Robust standard errors in parentheses. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$

Source: authors' calculations.

Table 5. Domestic Intermediate Demand from Agriculture Industries and Export of Value Added in High-tech Manufacturing, Pre-sample Mean Specification

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
Pre-sample mean high-tech manufacturing DVA per capita (log)	0.105***	0.105***	0.101***	0.105***	0.105***	0.101***
	(0.0180)	(0.0179)	(0.0194)	(0.0179)	(0.0179)	(0.0195)
High-tech manufacturing DVA per $capita_{t-1}$ (log)	0.912***	0.912***	0.912***	0.912***	0.912***	0.912***
	(0.00798)	(0.00798)	(0.00811)	(0.00798)	(0.00798)	(0.00811)
RCA in agriculture dummy		0.00182	−0.0372		0.00179	−0.0376
		(0.0169)	(0.0939)		(0.0169)	(0.0937)
Agriculture domestic intermediate demand for high-tech manufacturing per capita (log)	0.0283***	0.0283***	0.0298***	0.0283***	0.0283***	0.0298***
	(0.00528)	(0.00529)	(0.00681)	(0.00529)	(0.00529)	(0.00681)
RCA in agriculture dummy * intermediate demand for high-tech manufacturing per capita (log)			−0.00252			−0.00255
			(0.00612)			(0.00610)
Schooling	0.000510	0.000509	0.000512	0.000509	0.000508	0.000511
	(0.000585)	(0.000584)	(0.000585)	(0.000586)	(0.000586)	(0.000586)
Internet access	−1.42e-05	−1.55e-05	−3.29e-05	−1.55e-05	−1.67e-05	−3.45e-05
	(0.000630)	(0.000630)	(0.000633)	(0.000630)	(0.000630)	(0.000633)
Productivity in agriculture industries				0.00107	0.00105	0.00123
				(0.00843)	(0.00843)	(0.00839)
Constant	0.481***	0.480***	0.479***	0.481***	0.480***	0.480***
	(0.141)	(0.141)	(0.141)	(0.141)	(0.141)	(0.141)
Observations	4,050	4,050	4,050	4,050	4,050	4,050
R-squared	0.985	0.985	0.985	0.985	0.985	0.985

Notes: The outcome variable is high-tech manufacturing value added in export per capita, computed excluding high-tech manufacturing value added embodied in export of agriculture industries, which include agriculture, fishing and hunting activities. The pre-sample means (PSM) are computed over the 1995–99 period and the analysis concerns the remaining years 2000–11. Schooling is gross enrolment in secondary education and internet access is internet users per thousand inhabitants. RCA in agriculture dummy takes value one if the Balassa index computed in equation 4 is above one. Productivity in agriculture industries is computed as in equation 5. All estimates include country, sector and year fixed effects. Robust standard errors in parentheses. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$
Source: authors' calculations.

Table 6. Domestic Intermediate Demand from Mining Industries and Export of Value Added in High-tech Manufacturing, Pre-sample Mean Specification

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
Pre-sample mean high-tech manufacturing DVA per capita (log)	0.107***	0.107***	0.110***	0.107***	0.107***	0.111***
	(0.0179)	(0.0179)	(0.0185)	(0.0179)	(0.0179)	(0.0184)
High-tech manufacturing DVA per capita$_{t-1}$ (log)	0.917***	0.917***	0.916***	0.916***	0.916***	0.915***
	(0.00772)	(0.00771)	(0.00779)	(0.00775)	(0.00774)	(0.00782)
RCA in mining dummy		0.0589*	0.201		0.0599**	0.215
		(0.0303)	(0.133)		(0.0304)	(0.134)
Mining domestic intermediate demand for high-tech manufacturing per capita (log)	0.0217***	0.0217***	0.0196***	0.0219***	0.0219***	0.0197***
	(0.00471)	(0.00471)	(0.00517)	(0.00476)	(0.00476)	(0.00518)
RCA in mining dummy * intermediate demand for high-tech manufacturing per capita (log)			0.00730			0.00800
			(0.00701)			(0.00704)
Schooling	0.000531	0.000510	0.000523	0.000534	0.000513	0.000528
	(0.000584)	(0.000583)	(0.000584)	(0.000584)	(0.000583)	(0.000584)
Internet access	0.000222	0.000193	0.000235	0.000227	0.000198	0.000245
	(0.000631)	(0.000632)	(0.000633)	(0.000631)	(0.000632)	(0.000634)
Productivity in mining industries				−0.00644	−0.00674	−0.00779
				(0.00597)	(0.00598)	(0.00597)
Constant	0.510***	0.501***	0.479***	0.514***	0.505***	0.482***
	(0.142)	(0.142)	(0.143)	(0.142)	(0.142)	(0.143)
Observations	4,050	4,050	4,050	4,050	4,050	4,050
R-squared	0.985	0.985	0.985	0.985	0.985	0.985

Notes: The outcome variable is for high-tech manufacturing value added in export per capita, computed excluding for high-tech manufacturing value added embodied in export of mining industries, which include mining and quarrying activities. The pre-sample means (PSM) are computed over the 1995–99 period and the analysis concerns the remaining years 2000–11. Schooling is gross enrolment in secondary education and internet access is internet users per thousand inhabitants. RCA in mining dummy takes value one if the Balassa index computed in equation 4 is above one. Productivity in mining industries is computed as in equation 5. All estimates include country, sector and year fixed effects. Robust standard errors in parentheses. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$
Source: authors' calculations.

of these results, with the interaction between RCA in agriculture industries and domestic intermediate demand from this sector showing a negative and (weakly) significant coefficient, suggesting that countries that have specialized in this industry may be at a disadvantage in exploiting its intermediate demand in order to diversify towards high-tech manufacturing.

DISCUSSION AND CONCLUSIONS

This article has offered a novel angle and fresh empirical evidence to revisit the role of backward and forward linkages à la Hirschman (López-Gonzalez et al., 2015, 2019), in a context of countries abundant with natural resources which face the opportunities and challenges of having to 'diversify away' from NRI. The article has aimed to contribute to the age-old debate on the NR 'curse', which has been recently revamped, by testing our conjectures and providing further empirical evidence.

The question 'How to better achieve export diversification as a development strategy?' is of great relevance among academics and policy makers, despite it not being new. This analysis has offered two new perspectives. First, it has revisited the issue of backward and forward linkages discussed by Hirschman, alongside some trade scholars (see, for example, Baldwin and Venables, 2015), although in a context of NRI specialization. Second, the article has contributed to the debate around diversification via beneficiation — that is, the development of downstream, forward-linked manufacturing industries that process raw materials and natural resources (Hausmann et al., 2008). It has done so by considering diversification by developing backward linkages with KIBS, which have been relatively overlooked in the debate on NRI, while also testing it for high-tech manufacturing sectors.

We have looked at whether specialization in NRI, separately in extractive industries and agriculture, might represent a sizeable and high-quality 'representative domestic demand' à la Linder, that can favour the creation of KIBS and high-tech manufacturing sectors and facilitate export diversification. We have explored whether there is a positive association between NRI specialization and export performance of KIBS and high-tech manufacturing. We find robust evidence in support of our conjectures.

Countries specialized in NRI, particularly in agriculture, show a positive relationship with KIBS value added in exports, while this does not apply to those specialized in extractive industries with respect to their high-tech manufacturing's export performance. Our results seem to support the view that — after all — vertical linkages matter when it comes to identifying patterns of diversification that build upon extant NRI specialization rather than trying to move away from it. Looking at backward-linked sectors — and especially KIBS — is a first step to revisiting the narrative around NRI, and surely one that contributes to the debate around 'premature deindustrialization' put forward by Rodrik (2016).

While we do not explicitly provide evidence for specific industrial policy tools, we hope to offer a background narrative that supports new directions of industrial policy for development. In general, it is not straightforward to identify appropriate policy tools that support domestic and trade diversification in emerging countries, that allow ‘quality’ industrialization or indeed ‘quality’ servicification, especially when countries start from a specialization in natural resources. However, based on our results, we can offer a few reflections on the importance of a coherent set of industrial policies that aim to support industrial development in NR-based emerging countries. First, countries, particularly those abundant and/or specialized in NRI, can identify related backward- or forward-linked sectors that do not necessarily need to be on the technological frontier but nevertheless represent feasible directions for structural transformation. While this is not new, for instance within the product space framework (Hausmann et al., 2007; Hidalgo et al., 2007), we argue that the ability of countries to transition from one set of activities to another one is based on a deliberate policy effort to support technological and sectoral upgrading, rather than similarity in capabilities endowment (Ciarli et al., 2018).

Second, and more generally with reference to the ‘quality’ of specialization in NRI, such a deliberate effort would entail a novel narrative around the support to international technology transfer, via, for instance, the presence of multinational enterprises, most especially in NR-intensive countries. The development of domestic capabilities for upgrading is the result of a patient and long-term process of interaction of foreign and domestic firms, all the more so in a context of international fragmentation of production. Currently there is little reflection on the link between international technology transfer, export diversification and domestic technology upgrading as an explicit policy goal that aims to ensure quality directions to structural transformation (Barrientos et al., 2011; Fu et al., 2011). The conjecture and empirical evidence of this article aim to contribute to the narratives that might support furthering of these reflections.

ACKNOWLEDGEMENTS

The article has greatly benefited from suggestions and discussions with Tommaso Ciarli and Ariel Wirkierman. The authors thank the anonymous referees for their useful comments. They also thank Frederick Guy and the participants of the PhD Conference at Birkbeck College, London (November 2018); the Input-output Conference, Glasgow (July 2019); the UNCTAD International meeting on ‘Services Value-added in Export: Services and Trade Policies for Diversification and Upgrading’, held in Brasilia (October 2019), the Fourth Sino-UK Innovation and Development Forum, held at the University of Oxford (November 2019), and the first EU-funded CatChain Conference on ‘Micro-dynamics, Catching-up and Global Value

Chain' held at Bocconi University, Milan (November 2019). All omissions and errors are solely the authors' responsibility and usual caveats apply. Maria Savona gratefully acknowledges support from the European Union's Horizon 2020 Research and Innovation Programme under grant agreement ID 101004703 PILLARS (Pathways to Inclusive Labour Markets).

APPENDIX I

LIST OF INDUSTRIES, VARIABLES AND COUNTRIES WITH RCAS

Appendix Tables AI.1 and AI.2 show the industries, as well as their grouping, and the list of variables used in the econometric analysis, respectively. In Tables AI.3 and AI.4 we report for each country the number of years in

Table AI.1. Macro Sector Groups and ISIC Codes

Groups		**ISIC Codes**
KIBS	Computer and related activities; Research and development and other business services.	C72TC73; C74.
NRI	Agriculture, hunting, forestry and fishing; Mining and quarrying.	C01T05; C10T14
HTMF	Chemicals and chemical products; Machinery and equipment; Computer, electric and optical equipment; Electrical machinery and apparatus; Motor vehicles, trailers and semi-trailers; Other transport equipment.	C24; C29; C30T33X; C31; C34; C35

Note: The ICIO data are an aggregated version of the 2-digits ISIC Rev.3, so we have identified high-tech manufacturing based on the high and medium-high technology intensity as defined by the OECD. See: www.oecd.org/sti/ind/48350231.pdf
Source: authors' own classification based on the OECD's technology intensity definition.

Table AI.2. List of Variables and Acronyms

Variable name	**Description**	**Source**
dvacap	Domestic value added (DVA) exported, excluding the portion of DVA embodied in exports of NR or AGR or MIN	Authors' own calculations with the OECD ICIO tables
ddcap	Domestic intermediate demand from NRI	Authors' own calculations with the OECD ICIO tables
nr_RCA	NRI revealed comparative advantage, computed as Balassa index	Authors' own calculations with the OECD ICIO tables
vaic	Productivity measure NRI	Authors' own calculations with the OECD ICIO tables
Schooling	Gross enrolment in secondary education	World Bank World Development Indicators
Internet access	Internet users per thousand inhabitants	World Bank World Development Indicators

Source: authors' elaboration; we compute these measures for all our specifications, i.e. looking at KIBS and HTMF, as well as mining and agriculture, both separately and jointly.

Table AI.3. Countries with RCA in AGR

Country	Number of Years with RCA in AGR	Country	Number of Years with RCA in AGR
ARG	17	ISL	17
AUS	17	KHM	17
BGR	17	LTU	15
BRA	17	LVA	17
CAN	10	MAR	17
CHL	17	ME1	3
CHN	17	MYS	17
COL	17	NLD	15
CRI	17	NZL	17
CYP	1	PER	17
CZE	1	PHL	17
DNK	7	POL	5
ESP	16	PRT	12
EST	14	ROU	16
FIN	8	ROW	17
FRA	1	SVK	5
GRC	17	THA	17
HRV	15	TUN	17
HUN	17	TUR	17
IDN	17	VNM	17
IND	17	ZAF	7
IRL	4		

Source: authors' own calculations based on the ICIO tables, see: www.oecd-ilibrary.org/trade/data/oecd-wto-statistics-on-trade-in-value-added/trade-in-value-added-edition-2016_2644abe4-en

Table AI.4. Countries with RCA in MIN

Country	Number of Years with RCA in MIN
ARG	9
AUS	17
BRA	2
BRN	17
CAN	17
CHL	11
CHN	1
COL	17
IDN	17
MAR	6
ME1	17
MYS	17
NOR	17
PER	17
POL	2
ROW	17
RUS	17
SAU	17
TUN	13
VNM	17
ZAF	17

Source: authors' own calculations based on the ICIO tables, see: www.oecd-ilibrary.org/trade/data/oecd-wto-statistics-on-trade-in-value-added/trade-in-value-added-edition-2016_2644abe4-en our sample in which they have a revealed comparative advantage (RCA) in agriculture (AGR) and mining (MIN), respectively.

APPENDIX II

TRADE IN VALUE ADDED: METHODOLOGY AND MAIN INDICATORS

In this Appendix we discuss in detail how we compute the main measures used in our econometric application. Input-output tables rely on the key idea that output (X) equals final demand (F) and intermediate demand. The latter can in turn be expressed as a fraction of total output, which the input-output literature refers to as technical coefficients (A):

$$X = A * X + F \tag{1.a}$$

Input-output tables report both the intermediate and final demand in the form of matrices, which we depict in the example below for three countries, although our applications involved of course all countries and industries included in the ICIO data:

$$\begin{bmatrix} x_a \\ x_b \\ x_c \end{bmatrix} = \begin{bmatrix} a_{a,a} & a_{a,b} & a_{a,c} \\ a_{b,a} & a_{b,b} & a_{b,c} \\ a_{c,a} & a_{c,b} & a_{c,c} \end{bmatrix} * \begin{bmatrix} x_a \\ x_b \\ x_c \end{bmatrix} + \begin{bmatrix} f_a \\ f_b \\ f_c \end{bmatrix} \tag{2.a}$$

In equation 2.*a* above, each element of matrix A represents for each unit of output how much intermediate demand is required. By manipulating equation 1.*a* above we can rewrite it as follows and obtain the Leontief Inverse (B):

$$X = (I - A)^{-1} * F = B * F \tag{3.a}$$

Or in our matrix example:

$$\begin{bmatrix} x_a \\ x_b \\ x_c \end{bmatrix} = \begin{bmatrix} b_{a,a} & b_{a,b} & b_{a,c} \\ b_{b,a} & b_{b,b} & b_{b,c} \\ b_{c,a} & b_{c,b} & b_{c,c} \end{bmatrix} * \begin{bmatrix} f_a \\ f_b \\ f_c \end{bmatrix} \tag{4.a}$$

The equation above represents the relationship between final demand, intermediate linkages, and output. Specifically, each element of B represents the amount of production in each country that is activated by an additional unit of final demand in each country. The key difference with respect to matrix A is that the Leontief Inverse captures all indirect linkages too.

In order to take a value-added approach, we can pre-multiply the Leontief Inverse by a diagonalized vector of value-added shares of output and post-multiply it by a matrix of final demand linking the country of consumption with the country that satisfies the final demand, whereby we obtain:

$$DVA = \begin{bmatrix} v_a & 0 & 0 \\ 0 & v_b & 0 \\ 0 & 0 & v_c \end{bmatrix} * \begin{bmatrix} b_{a,a} & b_{a,b} & b_{a,c} \\ b_{b,a} & b_{b,b} & b_{b,c} \\ b_{c,a} & b_{c,b} & b_{c,c} \end{bmatrix} * \begin{bmatrix} f_{a,a} & f_{a,b} & f_{a,c} \\ f_{b,a} & f_{b,b} & f_{b,c} \\ f_{c,a} & f_{c,b} & f_{c,c} \end{bmatrix} \tag{5.a}$$

Which we can more explicitly write as:

$$= \begin{bmatrix} v_a b_{aa} f_{aa} + v_a b_{ab} f_{ba} + v_a b_{ac} f_{ca} & \boldsymbol{v_a b_{aa} f_{ab} + v_a b_{ab} f_{bb} + v_a b_{ac} f_{cb}} & \boldsymbol{v_a b_{aa} f_{ac} + v_a b_{ab} f_{bc} + v_a b_{ac} f_{cc}} \\ \boldsymbol{v_b b_{ba} f_{aa} + v_b b_{bb} f_{ba} + v_b b_{bc} f_{ca}} & v_b b_{ba} f_{ab} + v_b b_{bb} f_{bb} + v_b b_{bc} f_{cb} & \boldsymbol{v_b b_{ba} f_{ac} + v_b b_{bb} f_{bc} + v_b b_{bc} f_{cc}} \\ \boldsymbol{v_c b_{ca} f_{aa} + v_c b_{cb} f_{ba} + v_c b_{cc} f_{ca}} & \boldsymbol{v_c b_{ca} f_{ab} + v_c b_{cb} f_{bb} + v_c b_{cc} f_{cb}} & v_c b_{ca} f_{ac} + v_c b_{cb} f_{bc} + v_c b_{cc} f_{cc} \end{bmatrix} \tag{6.a}$$

The items in bold in equation 6.*a* represent the portion of value added that is produced in a given country and consumed abroad. For the case of country *a* we can look at the value added produced by the country itself that is consumed by country *b*. This includes the value added that is processed in *a* and consumed in *b* ($v_a b_{aa} f_{ab}$), the value added processed and consumed in *b* ($v_a b_{ab} f_{bb}$) and the value added from *a* processed in *c* and then exported to *b* for final consumption $v_a b_{ac} f_{cb}$. Figure 1 in the main text highlights exactly the portion of value added embodied in trade that this methodology allows us to capture.

Following the discussion above, we isolate for each country and KIBS sector the components of domestic value added that are absorbed by foreign demand obtaining our vector of observations, which we divide by each country's population obtaining *domestic value added in exports per capita in KIBS sector*.

$$DVAcap_{c,i} = \frac{DVA_{c,i}}{Population_c}; \qquad with\ i \in KIBS \tag{7.a}$$

It is worth pointing out that our outcome variable includes value added from KIBS that is also exported indirectly through NRI exports. This is also included in our explanatory variable, that captures the domestic demand for KIBS generated in NRI. This might raise the concern that our results are driven by mechanical links that exist between our two variables of interest by construction. To avoid this pitfall, we exclude from our outcome variable the portion of KIBS value added that is exported through NRI.[15]

We compute our main explanatory variable, domestic intermediate demand for KIBS coming from the NR sector, in a similar way as we computed the outcome variable, but we take the domestically linked value added

15. We achieve this by setting to 0 the rows in the Leontief Inverse that link our KIBS and NR industries.

(DLVA) where each entry is populated with each country-sector's value-added contribution to each sector's output:

$$DLVA = V'(I - A)_d^{-1}F \quad (8.a)$$

This matrix is computed in the same way as in equation 5.a. However, we use $(I - A)_d^{-1}$, a modified version of the Leontief Inverse that only captures the inter-sectoral linkages within the same country. In our example with three countries and only one sector this would amount to setting to zero all the off-diagonal elements of B from equation 5.a:

$$DLVA = \begin{bmatrix} v_1 & 0 & 0 \\ 0 & v_2 & 0 \\ 0 & 0 & v_3 \end{bmatrix} * \begin{bmatrix} b_{1,1} & 0 & 0 \\ 0 & b_{2,2} & 0 \\ 0 & 0 & b_{3,3} \end{bmatrix} * \begin{bmatrix} f_{aa} & f_{ab} & f_{ac} \\ f_{ba} & f_{bb} & f_{bc} \\ f_{ca} & f_{cb} & f_{cc} \end{bmatrix} \quad (7.a)$$

In our data, which include both countries and sectors, this means that we extract the block diagonal of Leontief Inverse, with each block being a square matrix of dimensions equal to the number of sectors included in our data, i.e., 33.

From the resulting matrix we isolate those entries belonging to KIBS rows and to NR columns that correspond to each KIBS industry's contribution in value added to each of the two NR industries' output. We then aggregate across NRI and divide by each country's population and obtain our measure of per capita domestic intermediate linkages between KIBS and NRI.

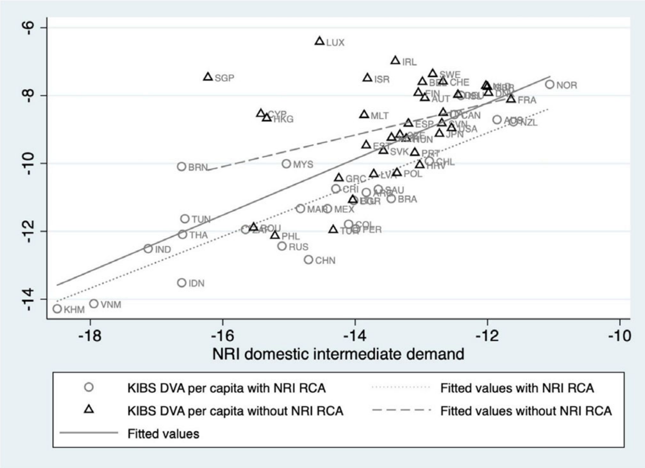
$$DDcap_{c,i} = \frac{DLVA_{c,i}}{Population_c}; \quad with\ i\ \in KIBS \quad (8.a)$$

APPENDIX III

ADDITIONAL DESCRIPTIVE EVIDENCE

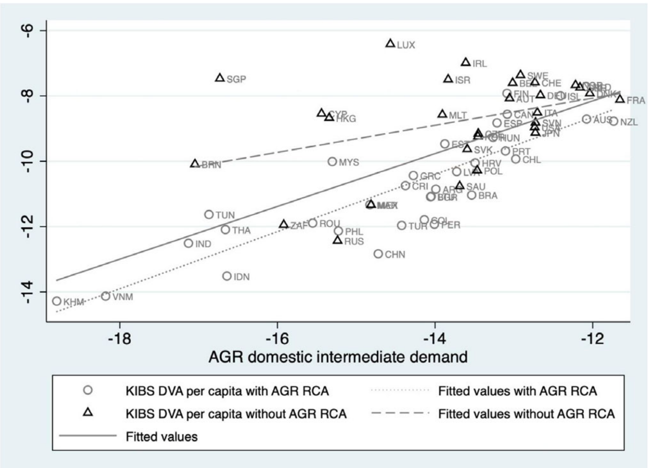
Here we provide additional descriptive evidence. As discussed in the Descriptive Evidence section in the main text, in Figures AIII.1, AIII.2 and AIII.3 we plot countries' average per capita KIBS DVA against the average per capita domestic intermediate demand from NRI, AGR and MIN, respectively.

Figure AIII.1. Domestic Intermediate Demand from NRI and KIBS Domestic Value Added in Exports, Country-level Averages



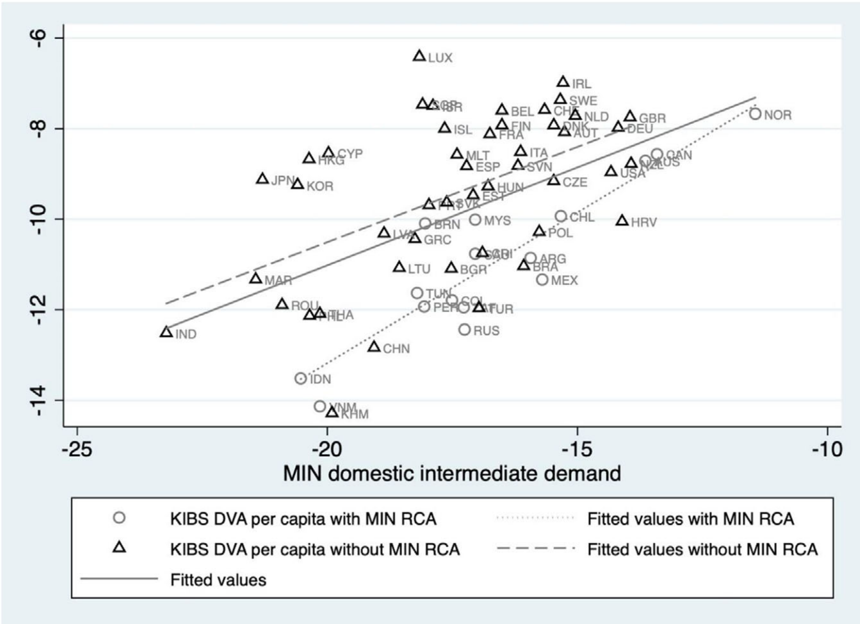
Note: Figure AIII.1 plots the natural log of domestic intermediate demand per capita from NRI against the natural log of KIBS DVA per capita, averaging for each country across years and industries. These are all negative because the original data from the ICIO tables are measured in US$ millions, which yields values below 1 when divided by the population to obtain per capita measures.
Source: authors' calculations based on ICIO tables, see: see: www.oecd-ilibrary.org/trade/data/oecd-wto-statistics-on-trade-in-value-added/trade-in-value-added-edition-2016_2644abe4-en

Figure AIII.2. Domestic Intermediate Demand from AGR and KIBS Domestic Value Added in Exports, Country-level Averages



Note: Figure AIII.2 plots the natural log of domestic intermediate demand per capita from AGR against the natural log of KIBS DVA per capita, averaging for each country across years and industries. These are all negative because the original data from the ICIO tables are measured in US$ millions, which yields values below 1 when divided by the population to obtain per capita measures.
Source: authors' calculations based on ICIO tables, see: www.oecd-ilibrary.org/trade/data/oecd-wto-statistics-on-trade-in-value-added/trade-in-value-added-edition-2016_2644abe4-en

Figure AIII.3. Domestic Intermediate Demand from MIN and KIBS Domestic Value Added in Exports, Country-level Averages



Note: Figure AIII.3 plots the natural log of domestic intermediate demand per capita from MIN against the natural log of KIBS DVA per capita, averaging for each country across years and industries. These are all negative because the original data from the ICIO tables are measured in US$ millions, which yields values below 1 when divided by the population to obtain per capita measures.
Source: authors' calculations based on ICIO tables, see: www.oecd-ilibrary.org/trade/data/oecd-wto-statistics-on-trade-in-value-added/trade-in-value-added-edition-2016_2644abe4-en

APPENDIX IV

ROBUSTNESS CHECKS WITH GMM

Here we provide robustness checks on our econometric analysis, by testing a dynamic autoregressive model with a system GMM approach. This evidence complements the pre-sample mean OLS model discussed in the main text finding overall robust results (Tables AIV.1, AIV.2, AIV.3, AIV.4, AIV.5, AIV.6).

Table AIV.1. Domestic Intermediate Demand from NRI and Export of Value Added in KIBS, GMM

VARIABLES	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
KIBS DVA per capita$_{t-1}$ (log)	0.928***	0.924***	0.942***	0.809***	0.720***	0.801***
	(0.0459)	(0.0463)	(0.0567)	(0.0660)	(0.0937)	(0.0989)
RCA in NRI dummy		−0.0209	1.154		−0.775**	0.0743
		(0.149)	(0.801)		(0.342)	(1.002)
NRI domestic intermediate demand for KIBS per capita (log)	0.136**	0.139**	0.0661	0.152*	0.203**	0.157
	(0.0539)	(0.0586)	(0.0618)	(0.0781)	(0.101)	(0.124)
RCA in NRI dummy * intermediate demand for KIBS per capita (log)			0.0822			0.0139
			(0.0528)			(0.0583)
Schooling	0.000748	0.000776	−0.000912	0.00578*	0.00366	0.00439
	(0.00350)	(0.00332)	(0.00516)	(0.00311)	(0.00448)	(0.00375)
Internet access	−0.00299	−0.00290	−0.00135	−0.00215	0.00138	−0.000975
	(0.00211)	(0.00215)	(0.00182)	(0.00214)	(0.00238)	(0.00228)
Productivity in NRI				−0.219*	0.0748	−0.186
				(0.132)	(0.172)	(0.140)
Constant	1.281	1.538	0.830	−0.0297	0.191	0.338
	(1.072)	(1.050)	(1.110)	(1.110)	(1.397)	(1.169)
Observations	1,756	1,756	1,756	1,756	1,756	1,756
Number of groups	122	122	122	122	122	122
AR(1)	0	0	0	0	0	0
AR(2)	0.206	0.224	0.197	0.308	0.335	0.0664
Hansen overidentification test	0.882	0.835	0.831	0.732	0.829	0.496

Notes: The outcome variable is KIBS value added in export per capita, computed excluding KIBS value added embodied in export of natural resource industries (NRI). We do not use pre-sample means and therefore our analysis is run for all available years, i.e. 1995–2011. Schooling is gross enrolment in secondary education and internet access is internet users per thousand inhabitants. RCA in NRI dummy takes value one if the Balassa index computed in equation 4 is above one. Productivity in NRI is computed as in equation 5. All estimates include country-sector and year fixed effects.

We also report the number of groups (i.e. country-sectors in this case) and the p-values for autocorrelation test of first AR(1) and second AR(2) order and the Hansen test for overidentification. Robust standard errors in parentheses. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$

Source: authors' calculations.

Table AIV.2. Domestic Intermediate Demand from Agriculture Industries and Export of Value Added in KIBS, GMM

VARIABLES	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
KIBS DVA per capita$_{t-1}$ (log)	0.773***	0.693***	0.777***	0.838***	0.771***	0.825***
	(0.0822)	(0.0997)	(0.0701)	(0.0674)	(0.0898)	(0.0764)
RCA in agriculture dummy		−0.310	1.179		−0.188	−0.0536
		(0.227)	(0.728)		(0.165)	(0.893)
Agriculture domestic intermediate demand for KIBS per capita (log)	0.255***	0.268*	0.157*	0.236*	0.274**	0.202**
	(0.0901)	(0.142)	(0.0832)	(0.138)	(0.133)	(0.100)
RCA in agriculture dummy * intermediate demand for KIBS per capita (log)			0.0943*			0.00415
			(0.0546)			(0.0670)
Schooling	0.00492	0.00749	0.00414	0.00288	0.00435*	0.00429
	(0.00378)	(0.00641)	(0.00363)	(0.00348)	(0.00259)	(0.00313)
Internet access	−0.00165	−0.00149	−0.00140	−0.00436**	−0.00387**	−0.00412*
	(0.00249)	(0.00323)	(0.00247)	(0.00217)	(0.00197)	(0.00212)
Productivity in agriculture industries (log)				0.0136	0.0527	0.00737
				(0.225)	(0.186)	(0.134)
Constant	1.019	0.343	−0.124	1.687	1.524	1.037
	(1.238)	(2.261)	(1.229)	(1.769)	(1.377)	(1.296)
Observations	1,756	1,756	1,756	1,756	1,756	1,756
Number of groups	122	122	122	122	122	122
AR(1)	0	0	0	0	0	0
AR(2)	0.258	0.202	0.180	0.659	0.289	0.328
Hansen overidentification test	0.489	0.635	0.679	0.563	0.678	0.971

Notes: The outcome variable is KIBS value added in export per capita, computed excluding KIBS value added embodied in export of agriculture industries, which include agriculture, fishing and hunting activities. We do not use pre-sample means and therefore our analysis is run for all available years, i.e. 1995–2011. Schooling is gross enrolment in secondary education and internet access is internet users per thousand inhabitants. RCA in agriculture dummy takes value one if the Balassa index computed in equation 4 is above one. Productivity in agriculture industries is computed as in equation 5. All estimates include country-sector and year fixed effects. We also report the number of groups (i.e. country-sectors in this case) and the p-values for autocorrelation test of first AR(1) and second AR(2) order and the Hansen test for overidentification. Robust standard errors in parentheses. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$
Source: authors' calculations.

Table AIV.3. Domestic Intermediate Demand from Mining Industries and Export of Value Added in KIBS, GMM

VARIABLES	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
KIBS DVA per $capita_{t-1}$ (log)	0.902***	0.936***	0.865***	0.759***	0.933***	0.883***
	(0.0571)	(0.0933)	(0.0590)	(0.0796)	(0.0632)	(0.0499)
RCA in mining dummy		0.203	−1.728		−0.0648	−1.451*
		(0.294)	(1.123)		(0.357)	(0.877)
Mining domestic intermediate demand for KIBS per capita (log)	0.0636	0.0714**	0.0874*	0.146*	0.0678	0.0733**
	(0.0422)	(0.0337)	(0.0473)	(0.0774)	(0.0418)	(0.0310)
RCA in mining dummy * intermediate demand for KIBS per capita (log)			−0.0933			−0.0778
			(0.0624)			(0.0488)
Schooling	0.00557	0.00420	0.00679**	0.00879*	0.00202	0.00565*
	(0.00340)	(0.00418)	(0.00311)	(0.00451)	(0.00350)	(0.00306)
Internet access	−0.00115	−0.00236	8.68e-05	0.00289	−0.00166	−0.000994
	(0.00207)	(0.00294)	(0.00207)	(0.00247)	(0.00195)	(0.00243)
Productivity in mining industries (log)				−0.0851	−0.0272	−0.183
				(0.110)	(0.128)	(0.163)
Constant	−0.221	0.380	−0.291	−0.778	0.450	−0.163
	(0.980)	(1.065)	(0.816)	(1.372)	(0.973)	(0.832)
Observations	1,756	1,756	1,756	1,756	1,756	1,756
Number of groups	122	122	122	122	122	122
AR(1)	0	0	0	0	0	0
AR(2)	0.183	0.139	0.210	0.269	0.420	0.282
Hansen overidentification test	0.622	0.634	0.745	0.706	0.507	0.997

Notes: The outcome variable is KIBS value added in export per capita, computed excluding KIBS value added embodied in export of export of mining industries, which include mining and quarrying activities. We do not use pre-sample means and therefore our analysis is run for all available years, i.e. 1995–2011. Schooling is gross enrolment in secondary education and internet access is internet users per thousand inhabitants. RCA in mining dummy takes value one if the Balassa index computed in equation 4 is above one. Productivity in mining industries is computed as in equation 5. All estimates include country-sector and year fixed effects.

We also report the number of groups (i.e. country-sectors in this case) and the p-values for autocorrelation test of first AR(1) and second AR(2) order and the Hansen test for overidentification. Robust standard errors in parentheses. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$

Source: Authors' calculations.

Table AIV.4. Domestic Intermediate Demand from NRI and Export of Value Added in High-tech Manufacturing, GMM

VARIABLES	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
High-tech manufacturing per capita$_{t-1}$ (log)	0.753***	0.593***	0.842***	0.745***	0.623***	0.816***
	(0.0439)	(0.0861)	(0.0550)	(0.0471)	(0.0845)	(0.0535)
RCA in NRI dummy		−1.273**	−2.589		−1.073**	−2.977*
		(0.494)	(1.756)		(0.443)	(1.608)
NRI domestic intermediate demand for high-tech manufacturing per capita (log)	0.0907***	0.106***	0.190**	0.0865***	0.108***	0.209***
	(0.0209)	(0.0309)	(0.0839)	(0.0206)	(0.0280)	(0.0607)
RCA in NRI dummy * intermediate demand for high-tech manufacturing per capita (log)			−0.150			−0.176*
			(0.106)			(0.0979)
Schooling	0.0125***	0.0109**	0.00620**	0.0125***	0.0108**	0.00803***
	(0.00315)	(0.00483)	(0.00268)	(0.00317)	(0.00461)	(0.00303)
Internet access	0.00209	0.00288	−0.00247	0.00231	0.00297	−0.00268
	(0.00218)	(0.00431)	(0.00216)	(0.00233)	(0.00391)	(0.00220)
Productivity in NRI				−0.178	0.0123	−0.261
				(0.218)	(0.121)	(0.284)
Constant	−2.521***	−3.358***	0.542	−2.616***	−3.090**	0.554
	(0.839)	(1.134)	(1.167)	(0.886)	(1.242)	(0.991)
Observations	5,268	5,268	5,268	5,268	5,268	5,268
Number of groups	366	366	366	366	366	366
AR(1)	0	0	0	0	0	0
AR(2)	0.00500	0.0134	0.00399	0.00689	0.0117	0.00825
Hansen overidentification test	0.197	0.171	0.303	0.749	0.649	0.756

Notes: The outcome variable is high-tech manufacturing value added in export per capita, computed excluding high-tech manufacturing value added embodied in export of natural resource industries (NRI). We do not use pre-sample means and therefore our analysis is run for all available years, i.e. 1995–2011. Schooling is gross enrolment in secondary education and internet access is internet users per thousand inhabitants. RCA in NRI dummy takes value one if the Balassa index computed in equation 4 is above one. Productivity in NRI is computed as in equation 5. All estimates include country-sector and year fixed effects.

We also report the number of groups (i.e. country-sectors in this case) and the p-values for autocorrelation test of first AR(1) and second AR(2) order and the Hansen test for overidentification. Robust standard errors in parentheses. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$

Source: authors' calculations.

Table AIV.5. Domestic Intermediate Demand from Agriculture Industries and Export of Value Added in High-tech Manufacturing, GMM

VARIABLES	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
High-tech manufacturing DVA per capita$_{t-1}$ (log)	0.756***	0.706***	0.777***	0.753***	0.700***	0.775***
	(0.0447)	(0.0553)	(0.0539)	(0.0468)	(0.0596)	(0.0534)
RCA in agriculture dummy		−0.386**	−3.084*		−0.354*	−2.964**
		(0.191)	(1.618)		(0.194)	(1.507)
Agriculture domestic intermediate demand for high-tech manufacturing per capita (log)	0.0894***	0.0952***	0.190***	0.0851***	0.0839***	0.185***
	(0.0210)	(0.0252)	(0.0656)	(0.0205)	(0.0231)	(0.0664)
RCA in agriculture dummy * intermediate demand for high-tech manufacturing per capita (log)			−0.193*			−0.186*
			(0.104)			(0.0965)
Schooling	0.0125***	0.0141***	0.0124***	0.0117***	0.0135***	0.0132***
	(0.00313)	(0.00425)	(0.00464)	(0.00343)	(0.00465)	(0.00340)
Internet access	0.00202	−0.000567	0.00141	0.00204	0.000364	0.00129
	(0.00210)	(0.00266)	(0.00211)	(0.00238)	(0.00257)	(0.00217)
Productivity in agriculture industries				−0.309	−0.182	0.0437
				(0.367)	(0.279)	(0.271)
Constant	−2.504***	−2.738***	−0.882	−2.487***	−2.942***	−0.981
	(0.866)	(1.040)	(1.054)	(0.864)	(1.106)	(1.161)
Observations	5,268	5,268	5,268	5,268	5,268	5,268
Number of groups	366	366	366	366	366	366
AR(1)	0	0	0	0	0	0
AR(2)	0.00482	0.00504	0.000785	0.00609	0.00599	0.00275
Hansen overidentification test	0.211	0.293	0.810	0.768	0.874	0.737

Notes: The outcome variable is high-tech manufacturing value added in export per capita, computed excluding high-tech manufacturing value added embodied in export of agriculture industries, which include agriculture, fishing and hunting activities. We do not use pre-sample means and therefore our analysis is run for all available years, i.e. 1995–2011. Schooling is gross enrolment in secondary education and internet access is internet users per thousand inhabitants. RCA in agriculture dummy takes value one if the Balassa index computed in equation 4 is above one. Productivity in agriculture industries is computed as in equation 5. All estimates include country-sector and year fixed effects.
We also report the number of groups (i.e. country-sectors in this case) and the p-values for autocorrelation test of first AR(1) and second AR(2) order and the Hansen test for overidentification. Robust standard errors in parentheses. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$
Source: authors' calculations.

Table AIV.6. Domestic Intermediate Demand from Mining Industries and Export of Value Added in High-tech Manufacturing, GMM

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
High-tech manufacturing DVA per capita$_{t-1}$ (log)	0.849***	0.627***	0.816***	0.772***	0.754***	0.810***
	(0.0433)	(0.0982)	(0.0618)	(0.0562)	(0.0718)	(0.0614)
RCA in mining dummy		−0.904*	−2.170		−0.683	−2.216
		(0.504)	(1.887)		(0.513)	(1.595)
Mining domestic intermediate demand for high-tech manufacturing per capita (log)	0.0527***	0.0703***	0.101*	0.0986***	0.0839***	0.0830*
	(0.0169)	(0.0246)	(0.0539)	(0.0224)	(0.0237)	(0.0444)
RCA in mining dummy * intermediate demand for high-tech manufacturing per capita (log)			−0.104			−0.106
			(0.0891)			(0.0755)
Schooling	0.00751***	0.0146***	0.00842**	0.0105***	0.00829**	0.00876***
	(0.00281)	(0.00433)	(0.00354)	(0.00361)	(0.00324)	(0.00321)
Internet access	−0.000358	0.00302	0.00116	0.00132	0.000685	0.000111
	(0.00219)	(0.00272)	(0.00203)	(0.00237)	(0.00213)	(0.00210)
Productivity in mining industries				0.0204	−0.0118	−0.00889
				(0.0571)	(0.0690)	(0.0431)
Constant	−1.545*	−3.859***	−1.124	−1.875**	−1.845*	−1.403
	(0.826)	(1.383)	(1.248)	(0.898)	(0.970)	(1.159)
Observations	5,268	5,268	5,268	5,268	5,268	5,268
Number of groups	366	366	366	366	366	366
AR(1)	0	0	0	0	0	0
AR(2)	0.0375	0.00179	0.00970	0.00350	0.00415	0.0556
Hansen overidentification test	0.233	0.240	0.197	0.255	0.399	0.457

Notes: The outcome variable is high-tech manufacturing value added in export per capita, computed excluding high-tech manufacturing value added embodied in export of export of mining industries, which include mining and quarrying activities. We do not use pre-sample means and therefore our analysis is run for all available years, i.e. 1995–2011. Schooling is gross enrolment in secondary education and internet access is internet users per thousand inhabitants. RCA in mining dummy takes value one if the Balassa index computed in equation 4 is above one. Productivity in mining industries is computed as in equation 5. All estimates include country-sector and year fixed effects.
We also report the number of groups (i.e. country-sectors in this case) and the p-values for autocorrelation test of first AR(1) and second AR(2) order and the Hansen test for overidentification. Robust standard errors in parentheses. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$
Source: authors' calculations.

REFERENCES

Adewuyi, A.O. and T. Ademola Oyejide (2012) 'Determinants of Backward Linkages of Oil and Gas Industry in the Nigerian Economy', *Resources Policy* 37(4): 452–60.

Andersen, A.D., A. Marin and E. Simensen (2018) 'Innovation in Natural Resource-based Industries: A Pathway to Development? Introduction to Special Issue', *Innovation and Development* 8(1): 1–27.

Aragón, B.F.M. and J.P. Rud (2013) 'Natural Resources and Local Communities: Evidence from a Peruvian Gold Mine', *American Economic Journal: Economic Policy* 5(2): 1–25.

Arezki, R. and F. van der Ploeg (2010) 'Trade Policies, Institutions and the Natural Resource Curse', *Applied Economics Letters* 17(15): 1443–51.

Auty, R.M. (1986) 'Resource-based Industrialization and Country Size: Venezuela and Trinidad and Tobago', *Geoforum* 17(3–4): 325–38.

Badeeb, R.A., H.H. Lean and J. Clark (2017) 'The Evolution of the Natural Resource Curse Thesis: A Critical Literature Survey', *Resources Policy* 51(2017): 123–34.

Balassa, B. (1965) 'Trade Liberalisation and "Revealed" Comparative Advantage', *The Manchester School* 33(2): 99–123.

Baldwin, R. and A.J. Venables (2015) 'Trade Policy and Industrialization: When Backward and Forward Linkages Matter', *Research in Economics* 69(2): 123–31.

Barnett, A. and M. Bell (2011) 'Is BHP Billiton's Cluster-programme in Chile Relevant for Africa's Mining Industry?', *Policy Practice Brief* 7: 1–8.

Barrientos, S., G. Gereffi and A. Rossi (2011) 'Economic and Social Upgrading in Global Production Networks: A New Paradigm for a Changing World', *International Labour Review* 150(3–4): 319–40.

Bloch, R. and G. Owusu (2012) 'Linkages in Ghana's Gold Mining Industry: Challenging the Enclave Thesis', *Resources Policy* 37(4): 434–42.

Blundell, R., R. Griffith and J.V. Reenen (1995) 'Dynamic Count Data Models of Technological Innovation', *The Economic Journal* 105(429): 333–44.

Blundell, R., R. Griffith and F. Windmeijer (2002) 'Individual Effects and Dynamics in Count Data Models', *Journal of Econometrics* 108(1): 113–31.

Boschini, A., J. Pettersson and J. Roine (2013) 'The Resource Curse and its Potential Reversal', *World Development* 43: 19–41.

Brunnschweiler, C.N. (2008) 'Cursing the Blessings? Natural Resource Abundance, Institutions, and Economic Growth', *World Development* 36(3): 399–419.

Brunnschweiler, C.N. and E.H. Bulte (2008) 'The Resource Curse Revisited and Revised: A Tale of Paradoxes and Red Herrings', *Journal of Environmental Economics and Management* 55(3): 248–64.

Chor, D. (2010) 'Unpacking Sources of Comparative Advantage: A Quantitative Approach', *Journal of International Economics* 82(2): 152–67.

Ciarli, T., M. Savona, J. Thorpe and S. Ayele (2018) 'Innovation for Inclusive Structural Change. A Framework and Research Agenda'. SPRU Working Paper Series No. 2018–4. Brighton: University of Sussex.

Corden, W.M. (1984) 'Booming Sector and Dutch Disease Economics: Survey and Consolidation', *Oxford Economic Papers* 36: 359–80.

Cust, J. and S. Poelhekke (2015) 'The Local Economic Impacts of Natural Resource Extraction', *Annual Review of Resource Economics* 7(1): 251–68.

Ding, N. and B.C. Field (2005) 'Natural Resource Abundance and Economic Growth', *Land Economics* 81(4): 50.

De Ferranti, D., G. Perry, E.D. Lederman and W.E. Maloney (2002) *From Natural Resources to the Knowledge Economy: Trade and Job Quality*. Washington, DC: World Bank.

Fu, X., C. Pietrobelli and L. Soete (2011) 'The Role of Foreign Technology and Indigenous Innovation in the Emerging Economies: Technological Change and Catching-up', *World Development* 39(7): 1204–12.

Guerrieri, P. and V. Meliciani (2005) 'Technology and International Competitiveness: The Interdependence between Manufacturing and Producer Services', *Structural Change and Economic Dynamics* 16(4): 489–502.

Harding, T. and A.J. Venables (2016) 'The Implications of Natural Resource Exports for Non-resource Trade', *IMF Economic Review* 64(2): 268–302.

Hausmann, R. and B. Klinger (2006) 'Structural Transformation and Patterns of Comparative Advantage in the Product Space'. CID Working Paper. Cambridge, MA: Center for International Development, Harvard University.

Hausmann, R., J. Hwang and D. Rodrik (2007) 'What you Export Matters', *Journal of Economic Growth* 12(1): 1–25.

Hausmann, R., B. Klinger and R. Lawrence (2008) 'Examining Beneficiation'. CID Working Paper Series No. 162. Cambridge, MA: Center for International Development, Harvard University.

Havranek, T., R. Horvath and A. Zeynalov (2016) 'Natural Resources and Economic Growth: A Meta-analysis', *World Development* 88: 134–51.

Heeks, R. (1998) 'Small Enterprise Development and the "Dutch Disease" in a Small Economy: The Case of Brunei'. Institute for Development Policy Management Discussion Paper No. 56. Manchester: University of Manchester.

Hidalgo, C.A. et al. (2007) 'The Product Space Conditions the Development of Nations', *Science* 317: 482–87.

Hirschman, A.O. (1958) *Strategy of Economic Development*. London and New Haven, CT: Yale University Press.

James, A. (2015) 'The Resource Curse: A Statistical Mirage?', *Journal of Development Economics* 114: 55–63.

Kolstad, I. (2009) 'The Resource Curse: Which Institutions Matter?', *Applied Economics Letters* 16(4): 439–42.

Koopman, R., Z. Wang and S-J. Wei (2014) 'Tracing Value-added and Double Counting in Gross Exports', *American Economic Review* 104(2): 459–94.

Kowalski, P., J. Lopez-Gonzalez, A. Ragoussis and C. Ugarte (2015) 'Participation of Developing Countries in Global Value Chains: Implications for Trade and Trade-related Policies'. OECD Trade Policy Paper No. 179. Paris: OECD Publishing.

Lederman, D. and W.F. Maloney (2006) *Natural Resources: Neither Curse nor Destiny*. Palo Alto, CA: Stanford University Press; Washington, DC: World Bank. https://openknowledge.worldbank.org/handle/10986/7183

Linder, S.B. (1961) *An Essay on Trade and Transformation*. Stockholm: Almqvist and Wicksell.

Lopez-Gonzalez, J., V. Meliciani and M. Savona (2015) 'When Linder Meets Hirschman: Inter-industry Linkages and Global Value Chains in Business Service'. SPRU Working Paper Series 2015–20. Brighton: University of Sussex.

Lopez-Gonzalez, J., V. Meliciani and M. Savona (2019) 'When Linder Meets Hirschman: Inter-industry Linkages and Global Value Chains in Business Services', *Industrial and Corporate Change* 28(6): 1555–86.

Marin, A. and L Stubrin (2015) 'Innovation in Natural Resources: New Opportunities and New Challenges, the Case of the Argentinian Seed Industry'. UNU-MERIT Working Papers No. 015. Maastricht: Maastricht University.

Marin, A., L. Navas-Aleman and C. Perez (2014) 'The Possible Dynamic Role of Natural Resource-based Networks in Latin American Development Strategies', in G. Dutrénit and J. Sutz (eds) *National Innovation Systems, Social Inclusion and Development*, pp. 380–412. Cheltenham: Edward Elgar Publishing.

Marin, A., L. Stubrin and J.J. da Silva (2015) 'KIBS Associated to Natural Resource Based Industries. Seeds Innovation and Regional Providers of the Technology Services Embodied in Seeds in Argentina and Brazil, 2000–2014'. IADB Discussion Paper IDB-DP-375. Washington, DC: Inter-American Development Bank.

Massol, O. and A. Banal-Estañol (2014) 'Export Diversification through Resource-based Industrialization: The Case of Natural Gas', *European Journal of Operational Research* 237(3): 1067–82.
Matsuyama, K. (2009) 'Structural Change in an Interdependent World: A Global View of Manufacturing Decline', *Journal of the European Economic Association* 7(2–3): 478–86.
Mehlum, H., K. Moene and R. Torvik (2006) 'Institutions and the Resource Curse', *The Economic Journal* 116(508): 1–20.
Nickell, S. (1981) 'Biases in Dynamic Models with Fixed Effects', *Econometrica: Journal of the Econometric Society* 49(6): 1417–26.
Pietrobelli, C., A. Marin and J. Olivari (2018) 'Innovation in Mining Value Chains: New Evidence from Latin America', *Resources Policy* 58: 1–10.
van der Ploeg, F. and S. Poelhekke (2017) 'The Impact of Natural Resources: Survey of Recent Quantitative Evidence', *The Journal of Development Studies* 53(2): 205–16.
Poncet, S. and F. Starosta de Waldemar (2013) 'Export Upgrading and Growth: The Prerequisite of Domestic Embeddedness', *World Development* 51: 1–15.
Robinson, J.A., R. Torvik and T. Verdier (2006) 'Political Foundations of the Resource Curse: A Simplification and a Comment', *Journal of Development Economics* 106: 194–98.
Rodrik, D. (2016) 'Premature Deindustrialization', *Journal of Economic Growth* 21(1): 1–33.
Rostow, W.W. (1960) *The Stages of Economic Growth: A Non-communist Manifesto*. Cambridge: Cambridge University Press.
Sachs, J.D. and A.M. Warner (1995) 'Natural Resource Abundance and Economic Growth'. NBER Working Paper Series 3. Cambridge, MA: National Bureau of Economic Research.
Stijns, J-P.C. (2000) 'Natural Resource Abundance and Economic Growth Revisited', *Resources Policy* 30(2): 1–40.
Torvik, R. (2001) 'Learning by Doing and the Dutch Disease', *European Economic Review* 45(2): 285–306.
Urzúa, O. (2012) 'Emergence and Development of Knowledge Intensive Mining Services (KIMS)'. Working Paper in Technology Governance and Economic Dynamics No. 41. Tallinn: Tallinn University of Technology, Ragnar Nurkse Department of Innovation and Governance.
Venables, A.J. (2016) 'Using Natural Resources for Development: Why Has it Proven so Difficult?', *Journal of Economic Perspectives* 30(1): 161–84.
Vogel, B.S.J. (1994) 'Structural Changes in Agriculture: Production Linkages and Agricultural Demand-led Industrialization', *Oxford Economic Papers* 46(1): 136–56.
Weisskoff, R. and E. Wolff (1977) 'Linkages and Leakages — Industrial Tracking in an Enclave Economy', *Economic Development and Cultural Change* 25(4): 607–28.
Windmeijer, F. (2005) 'A Finite Sample Correction for the Variance of Linear Efficient Two-step GMM Estimators', *Journal of Econometrics* 126: 25–51.
World Bank Group et al. (2017) *Global Value Chain Development Report 2017: Measuring and Analysing the Impact of GVCs on Economic Development*. Washington, DC: World Bank.
Wright, G. and J. Czelusta (2004) 'The Myth of the Resource Curse', *Challenge* 47(2): 6–38.

Maria Savona (corresponding author; M.Savona@sussex.ac.uk) is Professor of Economics of Innovation at the Science Policy Research Unit (SPRU), University of Sussex, Brighton, UK and Professor of Applied Economics at the Department of Economics and Finance, Luiss University, Rome, Italy.

Filippo Bontadini (fbontadini@luiss.it) is Assistant Professor in Applied Economics at the Department of Business and Management, Luiss University, Rome, Italy, and Associate Fellow at SPRU, University of Sussex, Brighton, UK.