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Promoting Industrial and Export Diversification in Resource-Dependent Countries
The Case of Saudi Arabia

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ABSTRACT

This paper studies the Saudi industrial development, and evaluates major opportunities and challenges that faces Saudi Arabia in its industrial diversification plans. It begins by reviewing the resource curse theory, and then highlights the role of economic policies in mitigating the Dutch Disease. It then reviews two major industrial diversification approaches for resource-dependent countries: the product space strategy (Hidalgo and Hausmann 2009) and resource-based industrialization (RBI) (e.g. Perez 2015). These frameworks are used in two ways; firstly, to assess the current industrial and export structures; and secondly, to discuss possible diversification opportunities for Saudi Arabia. Finally, the paper provides policy recommendations.

Keywords: diversification; industrial development; exports; manufacturing; the Dutch Disease; Saudi Arabia.
JEL Classification Numbers: O110; O140; Q330; F100

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1. Introduction

The diversification of a country's industrial and export sectors is critical for generating employment opportunities, supporting balance of payment stability and sustaining economic growth. In resource-dependent countries, the process of export diversification takes place by reducing the reliance on raw materials and traditional products towards technology-intensive manufacturing (Reinert 2007). However, despite the availability of windfall resource revenues, resource-rich countries, including Saudi Arabia, have not achieved significant production and export diversification. Thus, the Saudi government has recently inaugurated its 2030 Vision, which targets economic diversification away from oil.

This paper makes original contribution to the scarce literature on industrial development and diversification in Saudi Arabia; it studies the Saudi industrial structure, and then it discusses opportunities and challenges facing industrial diversification in the Kingdom. It does so by utilizing two industrial upgrading strategies: the product space network (Hausmann et al. 2014) and resource based industrialization (e.g. Perez 2015).

This study begins with a conceptual framework that discusses theories and literature on industrial development in natural resource-dependent countries, including the resource curse theory and the Dutch Disease literature. Then, it investigates the Saudi manufacturing sector through the lenses of two diversification strategies. Finally, it concludes with policy recommendations.

2. Conceptual framework

This conceptual framework begins by reviewing the resource curse theory, i.e. natural resource exploitation undermines manufacturing sector development and thus hinders economic growth. Then, the section outlines four main empirical and theoretical challenges facing the resource curse theory.

Influential and widely cited studies by Sachs and Warner (1995, 1999) argue that resource abundance, measured by the share of primary exports to GDP, is negatively correlated with economic growth. Using a cross-country analysis for ninety-seven countries for the period 1970-1990, Sachs and Warner estimated that doubling the primary products share in total exports led to a reduction of 0.62 to 1.51 percent of annual GDP growth.

In a later study, Sachs and Warner (2001) show that the Dutch Disease is a main explanation for the resource curse; namely that natural resources crowd out the manufacturing production. They show that the wealth accumulation resulting from natural resources increases the demand for non-traded products and drives their prices up, and more specifically it drives up non-traded inputs, costs and wages. This process squeezes countries' profit in traded products (such as manufacturing products), and makes it harder to compete in the international markets.

Another mechanism through which the Dutch Disease works is exchange rate appreciation. Commodity revenues may force upward pressure on the prevailing real exchange rate, which reduces the competitiveness of non-resource exports (Corden 1984). The decline in British industrial exports during the 1970s, after the discovery of oil, in addition to the Dutch manufacturing decline after the discovery of natural gas in 1959 are recent examples. However, in both countries this negative impact did not last for long (Beck 2011).

There are four major problems with the natural resource curse theory. First, there is strong evidence of the correlation between resource endowment and manufacturing development in several developed nations. Indeed, industrial experiences show that "natural resources are by no means a curse." Ramos maintains that "the good or bad performance of natural-resource rich countries depends on the suitability of their economic policy, and not the mere fact of having natural resources" (Ramos 1998, p.106-7). Historical studies have shown that richness in minerals played a crucial role in developing the manufacturing sector and promoting economic growth (Perez 2015). Wright (1990) and Wright and Czelusta (2004) have argued that resource richness in the United States in the 19th Century was a major factor in making it the world's manufacturing leader:

> "Resource abundance was a significant factor in shaping if not propelling the U.S. path to world leadership in manufacturing. The coefficient of relative mineral intensity in U.S. manufacturing exports actually increased sharply between 1879 and 1914, the very period in which the country became the manufacturing leader… the timing of increases in production of a range of minerals in the United States is striking. Leadership or near-leadership in coal, lead, copper, iron ore, antimony, magnesite, mercury, nickel, silver, and zinc all occurred between 1870 and 1910. Surely this correspondence in timing cannot have been coincidental" (Wright and Czelusta 2004, p.9-11).

Wright and Czelusta have also shown that the oil sector was not an exception. Indeed, oil discoveries have been correlated with a significant growth in the manufacturing sector. According to the US Energy Information Administration (EIA) data, US oil production increased from twelve thousand barrel a day in the late 1860s to more than seven million barrels a day in 1960 (see Figure 1). In the meantime, its share of industrial GDP increased from approximately twenty-one percent in 1840 to approximately forty percent in the period between 1910 and 1960 (Johnston 2012). Furthermore, the oil sector has contributed substantially to the development of the chemical industry throughout the US. This development is an example of linkages and innovation that are fuelled by natural resource abundance (Wright and Czelusta 2004). In California, for example, oil discoveries were followed by rapid and significant economic development. According to Wright and Czelusta (2004):

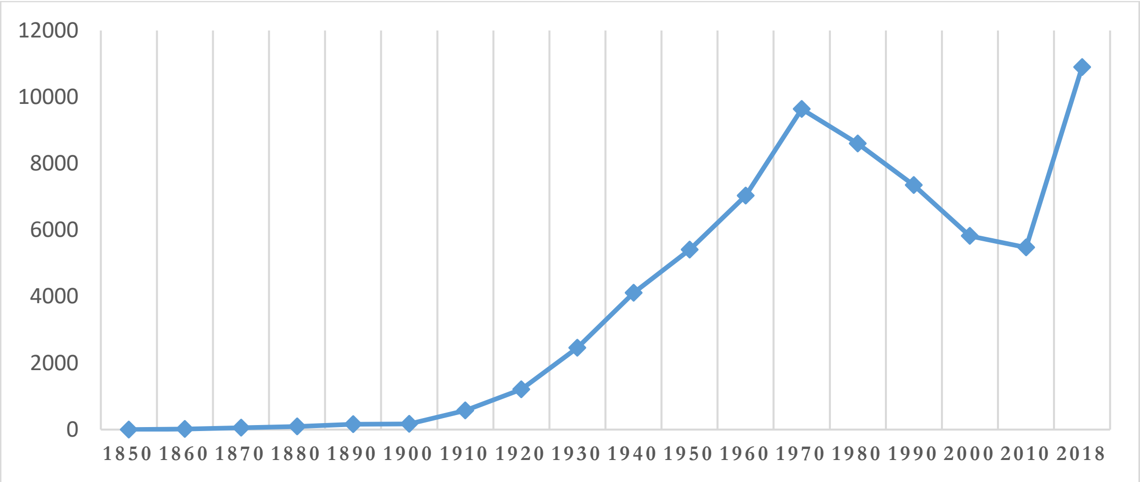
> "Before 1900, California was a remote, peripheral economy. Between 1900 and 1930, California (not Texas) became the leading oil state in the nation, and the result was a 'sudden awakening' of the regional economy. Spurred not just by jobs in oil but also by the dramatic fall in the cost of energy, California's share of national income nearly doubled. Contrary to Dutch disease models, the size of the state's manufacturing sector quadrupled." (p.20).

Although California's industrial performance lagged behind the national level during the late 19th century, the sector grew dramatically in the 20th century after the oil boom (see Figure 2 and Table 1). Between 1899 and 1904[1], the number of industrial establishments increased by thirty-seven percent, and the number of industrial workers rose by twenty-six percent. In comparison, the national number of industrial establishments increased by only four percent and the number of production workers rose by fifteen percent (ibid.). In Los Angeles, oil production has "literally fuelled" different manufacturing sector

[1] This period is crucial in this regard, because in 1903, California became the largest oil producing state in the US (Rhode, 2001).

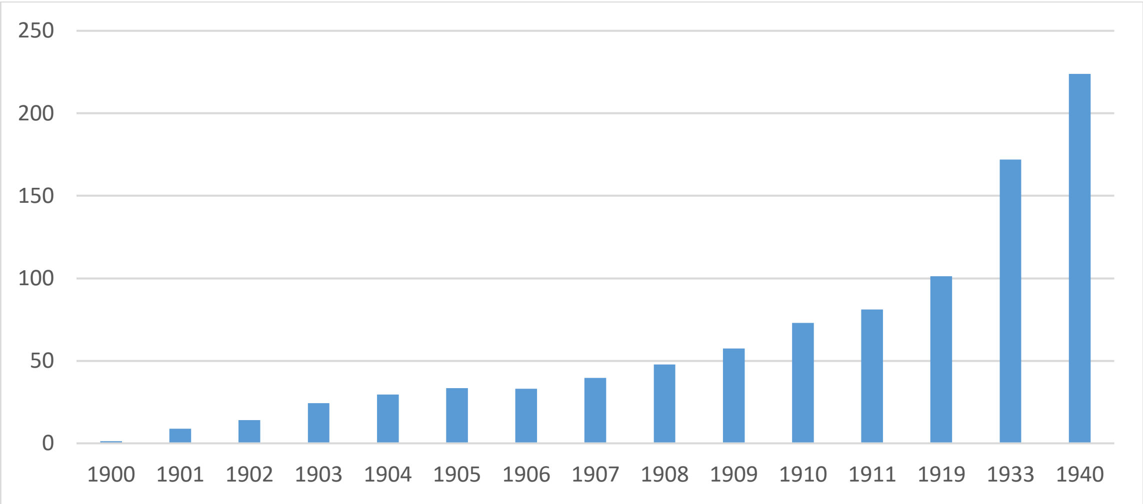
activities. By the mid-1920s, Los Angeles became a leading industrial centre in producing oil machineries and oil-related services (Schmitt et al. 2002).

Figure 1: The US crude oil production (in thousand barrel per day)



Source: The US Energy Information Administration (EIA)

Figure 2: California oil production (in million barrels a year)



Source: Andreano (1970) and Adamson (2010)

Table 1: California manufacturing sector (1859-1997)

Year	No. of establishments	No. of production workers	Wages	Value added
1859	1,218	6,052	5,047	10,792
1879	4,231	39,525	18,427	38,510
1899	4,925	71,976	35,954	86,940
1904	6,755	90,404	57,267	114,739
1919	10,155	217,312	286,033	705,859
1939	11,558	271,290	358,734	1,122,545
1958	28,735	838,671	4,107,200	12,048,000

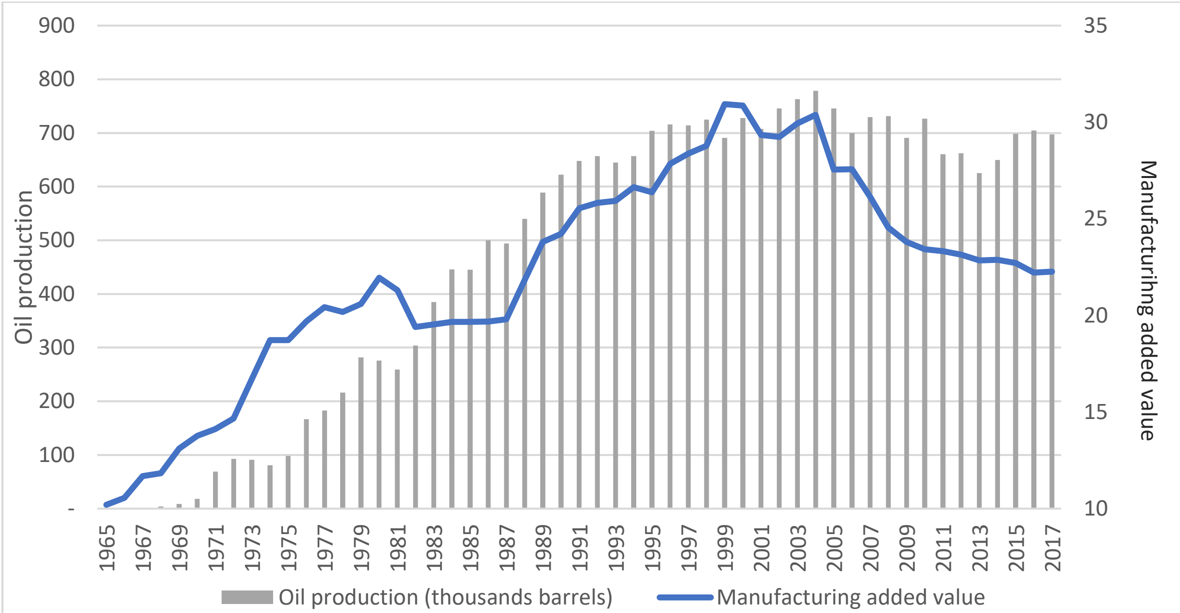
Note: wages and value added are in current thousands USD.
Source: Rhode (2001).

It has also been documented that linkages from mineral resources were important factors in the Canadian economic development process (Watkins 1963). Similarly, studies on Sweden (Venables et al. 2007), Norway (Andersen 1993), Australia (Wright and Czelusta 2004) and Finland (CCSI 2016; Ramos 1998) show the importance of natural resource linkages in developing their manufacturing sectors and the overall economic activity.

Secondly, there are studies that have empirically challenged Sachs and Warner’s findings. By avoiding having GDP in the denominator of the resource dependence indicator (as used by Sachs and Warner), Lederman and Maloney (2007) use natural resources exports per capita (instead of natural resources exports to GDP), and they do not find a negative correlation between natural resource dependence and economic growth. They further show that Australia, Canada, Norway and New Zealand are more dependent on natural resources than Papua New Guinea and the Democratic Republic of Congo. In other words, they argue that the resource curse theory explicitly claims that a country like Norway is not considered resource-dependent because it has diversified its export basket.

Thirdly, Sachs and Warner (2001) do not explain an interesting trend showing countries with poor resource endowment at the beginning of their study period (1970), and as they increased their dependence on natural resources, they grew rapidly in GDP (this trend is shown in *Figure 1* of their paper on page no. 829). These countries are Malaysia, Iceland and Mauritius. A potential explanation for this trend, the researcher argues, is that these countries were able to achieve economic diversification and manufacturing development. Throughout Sachs and Warner's study period (1970-1990), Iceland's manufacturing sector exports as a share of total exports grew from 3.3 percent to 8.1; Malaysia's has grown from 6.5 percent to 53.7 percent; and Mauritius's has grown from 1.8 percent to 65.8 percent (World Bank database). In Malaysia, for instance, oil production increased from one thousand barrels a day in 1965 until it reached its peak of 776 thousand barrels a day in 2004. During the same period, manufacturing added value to GDP increased from ten percent to 30.3 percent (see Figure 3). These trends clearly questions Sachs and Warner's main argument which states that the natural resource accumulation crowds out manufacturing sector activity.

Figure 3: Oil production and the industrial development in Malaysia



Source: British Petroleum Statistical Review of World Energy (2017), and the World Bank database.

Fourthly, it is argued that the reliance on fiscal linkages in addition to the neglect of production linkages from the resource explain the weak manufacturing performance in some resource-dependent countries (Karl 1997). The pioneer development economist Hirschman (1981) argues that resource abundance provides linkages and opportunities for developing and diversifying the industrial sector. These linkages are classified into fiscal, consumption and production linkages. The first shows rents generated by the government from the natural resource in the forms of direct income, royalties or taxes. These rents could be invested in other independent activities within the economy. The second linkage describes the demand for output of unrelated sectors as a result of income generated through the natural resource. The third, production linkages, describes forward and backward linkages from the resource sector. Hirschman considers the production linkages as a major driver for industrial development in these countries. However, this channel has not emerged effectively in many oil and mineral producing countries because of their reliance on fiscal linkages financed by high commodity revenues (Karl 1997).

A major conclusion emerging from the review of the resource curse literature is that the high resource dependence in many developing countries can be explained in terms of underdeveloped manufacturing sectors. Furthermore, having abundance in a natural resource is not a "curse". Indeed, natural resources can fuel economic growth through the development of wide range of industrial and service activities (Kaplinsky et al. 2012; Ramos 1998; Wright and Czelusta 2004). Accordingly, the following section discusses industrial diversification strategies that can be highlighted for the Saudi context.

3. The Saudi Industrial Structure

Because of the importance of targeting suitable sectors in any industrial development plan[2], the literature suggests different strategies for resource-dependent countries. Two major strategies in this regard are the product space theory (PST) and Hirschman's production linkages, which is known as resource based industrialization (RBI).

3.1 The Product Space Theory (PST)

Hausmann and Hidalgo (2011) show nations' economic development as a process of producing and exporting more diverse and more sophisticated products. Their analysis shows that, as countries grow, they extend their export

[2] Targeting suitable sectors is considered a fundamental factor in the success of any industrial policy. For example, Khan and Blankenburg (2009) show that the failure to choose suitable industrial sectors can result in the failure of the whole industrial policy.

baskets towards higher-technology products that are made by few other countries. In this framework, economic development is slow in countries with a production structure categorized by low value-added, agricultural, natural resources products, i.e. low-wage and low-productivity activities. On the other hand, development is expected to be fast in countries producing high-added value and more sophisticated products, i.e. high-wages and high productivity activities.

Hidalgo et al. (2007) have developed a ‘product space’ network which represents all the exported products in the world, and show that a country’s economic development is pre-determined by its capabilities to produce more sophisticated products. ‘Capabilities’ here refers to all the factors needed to produce a specific product, such as capital, human resources and institutions. At the firm’s level, capabilities refer to production knowledge (‘know-how’). This productive knowledge is what explains countries’ economic complexity. Unlike the neo-classical trade theory, this product space theory (PST) considers the industrial knowledge costly to transfer and to acquire (Hausmann et al. 2014).

Hidalgo et al. (2007) use product level data to construct the product space, and measure countries’ diversification using Balassa (1965) concept of revealed comparative advantage (RCA). The RCA is the ratio of a country’s exports of a certain product in its total exports relative to the same share for the entire world. This study uses COMTRADE database data at the HS4 product level that allows the researcher to observe 1,024 products. Then, it is possible to construct the RCA indicator using the following equation:

$$\mathbf{RCA} = \frac{\mathbf{export_{c\,p}} \ / \sum_{\mathbf{p}} \mathbf{export_{c}}}{\sum_{\mathbf{c}} \mathbf{export_{\,p}} \ / \sum_{\mathbf{p}} \sum_{\mathbf{c}} \mathbf{export}}$$

The indicator compares the share of a country (*c*) exporting a product (*p*) to the share of the world exports of that product. If a country has a value of 3 in exporting a certain product, this indicates that this country exports three times the world average, i.e. three times the fair share as Balassa defines it. Appendix 1 provides more details on methodology used to construct the product space.

Following Hidalgo et al. (2007), it is possible to identify the threshold of RCA to be equal to 1.00 to determine whether a country has a comparative advantage in a certain product. Accordingly, Saudi Arabia in 2016 had eighty products with RCA. The table reveals that crude petroleum oil is the largest exported product with RCA of 11.9, generating an export value of 105.4 billion US dollars, and constituting approximately fifty-six percent of the total export basket. Crude petroleum is followed by refined petroleum products with an export value of 18.6 billion USD. The two petroleum items are followed by three petrochemical products: ethylene polymers, propylene polymers, and ethers. The three products have a total export value of around 20.2 billion USD. The table also shows that ethers have the highest RCA value among the all the exported products with a ratio of 24.9. This means that the Saudi ether share of exports is more than twenty-four times the average global export share of ethers.

Table 2 represents these eighty products according to their product groups. The table clearly shows a concentration on exporting minerals (including crude oil), with eight mineral products making more than sixty-nine percent of the total exports basket. The chemical and plastic products are the second and third largest groups with 9.6 and nine percent respectively.

Table 3 represents the largest products exported with RCA according to HS4 classification. The table reveals that crude petroleum oil is the largest exported product with RCA of 11.9, generating an export value of 105.4 billion US dollars, and constituting approximately fifty-six percent of the total export basket. Crude petroleum is followed by refined petroleum products with an export value of 18.6 billion USD. The two petroleum items are followed by three petrochemical products: ethylene polymers, propylene polymers, and ethers. The three products have a total export value of around 20.2 billion USD. The table also shows that ethers have the highest RCA value among the all the exported products with a ratio of 24.9. This means that the Saudi ether share of exports is more than twenty-four times the average global export share of ethers.

Table 2: RCA products according to product groups

HS2	Number of products with RCA>1	Their percentage of total exports
Animal and animal products	5 products	0.48 percent
Vegetable products	1 product	0.07 percent
Foodstuffs	5 products	0.44 percent
Mineral products	8 products	69.50 percent
Chemical and allied industries	27 products	9.61 percent
Plastics and rubbers	4 products	9.00 percent
Raw hides, skins, leather and furs	2 products	0.03 percent
Wood and wood products	3 products	0.41 percent
Textile and textile articles	6 products	0.16 percent
Footwear	None	0 percent
Stone and glass	6 products	0.142 percent
Metals	10 products	1.85 percent
Machinery and electrical products	None	0 percent
Transportation	3 products	1.05 percent
Total	80 products	92.36 percent

Source: own calculations based on the COMTRADE database

Table 3: The largest exported products with RCA

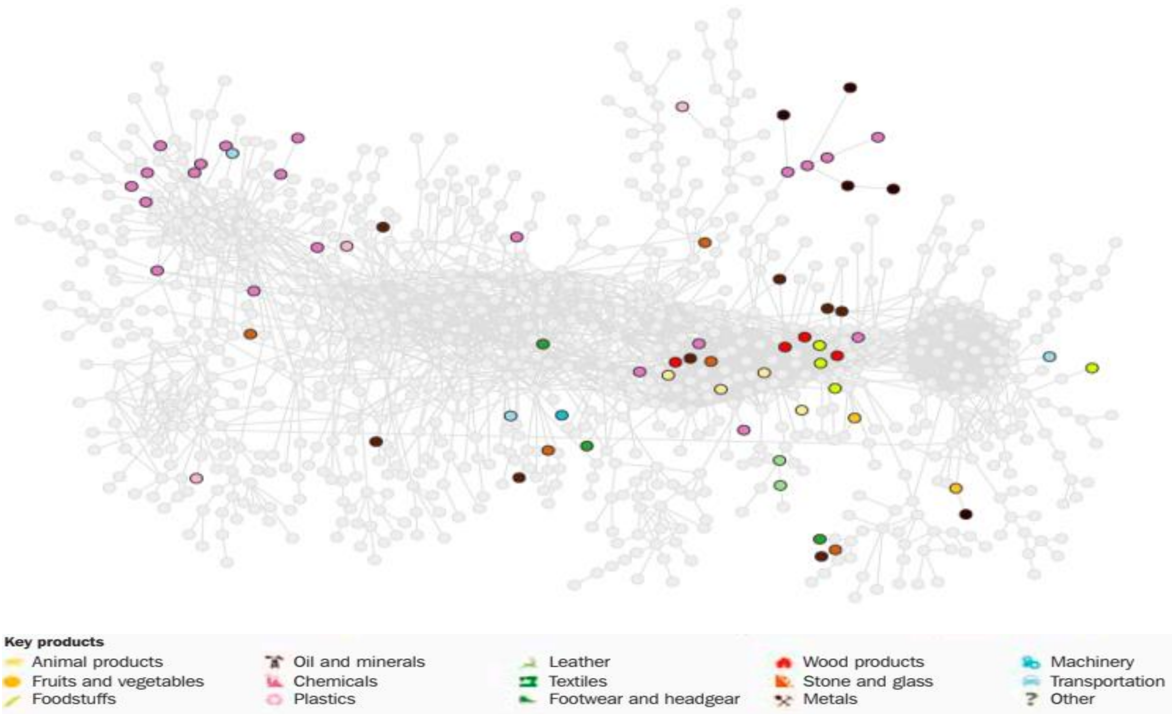
HS4	Description	Export value (in million USD)	RCA
2709	Petroleum oils, crude	105,434.0	11.9
2710	Petroleum oils, refined	18,660.6	2.8
3901	Polymers of ethylene, in primary forms	10,332.0	11.9
3902	Polymers of propylene or of other olefins, in primary forms	5,781.0	12.2
2909	Ethers	4,929.5	24.9
2711	Petroleum gases	4,235.1	1.2
2905	Acyclic alcohols	4,137.5	12.0
2902	Cyclic hydrocarbons	2,489.4	5.0
8904	Tugs and pusher craft	1,624.3	24.8
7601	Unwrought aluminium	1,271.8	2.1
3105	Mineral or chemical fertilizers, mixed	1,124.2	4.0
3102	Mineral or chemical fertilizers, nitrogenous	1,070.5	3.6
2707	Oils and other products of the distillation of high temperature coal tar	1,040.4	4.5
2814	Ammonia	797.6	7.8
3907	Polyacetals	739.7	1.2
7404	Copper waste and scrap	583.3	2.4
2901	Acyclic hydrocarbons	512.5	2.1
3402	Cleaning products	478.1	1.3
2915	Saturated acyclic monocarboxylic acids	469.7	3.1
4819	Cartons, boxes, cases, bags and other packing containers of paper	410.2	1.7
2712	Petroleum jelly	396.8	8.4
2503	Sulphur	394.4	7.8
2009	Fruit juices	374.3	2.2
4818	Toilet paper of a kind used for household or sanitary purposes	357.9	1.2

Source: own calculations based on the COMTRADE database

After constructing the RCA indicator for Saudi Arabia, the products are then visualized into the product space with colours reflecting their product groups. Figure 4 represents the Saudi product space, which is dominated by crude oil, minerals, chemicals and plastic products. These products account for 61.2 percent of the number of products with RCA (90.0 percent of total export value). The figure also shows that the Saudi product space has no machinery and electronics products, which tend to be more central in the network (and more sophisticated) and thus are connected to a higher number of other products. Indeed, Hausmann et al. (2014) explain that the two highest communities in their product complexity index (PCI) are machinery and electronics, indicating that they require advanced industrial capabilities that are difficult to acquire.

For comparison purposes, this section compares the Saudi product space with other resource-dependent developing countries: Venezuela, Chile and Malaysia. Figure 5 shows that Saudi Arabia has a significantly more diversified and more sophisticated export basket than Venezuela. There are eighty products with RCA in Saudi Arabia, whereas Venezuela has only twenty-five. Furthermore, Saudi Arabia has more core products that are more complex and sophisticated. On the other hand, Chile and Malaysia are substantially more diversified than the other two countries with 134 and 222 products with RCA (respectively). The figure also shows that Malaysia has more connected products in the core, which makes it easier for its industry to diversify (jump) into more sophisticated products.

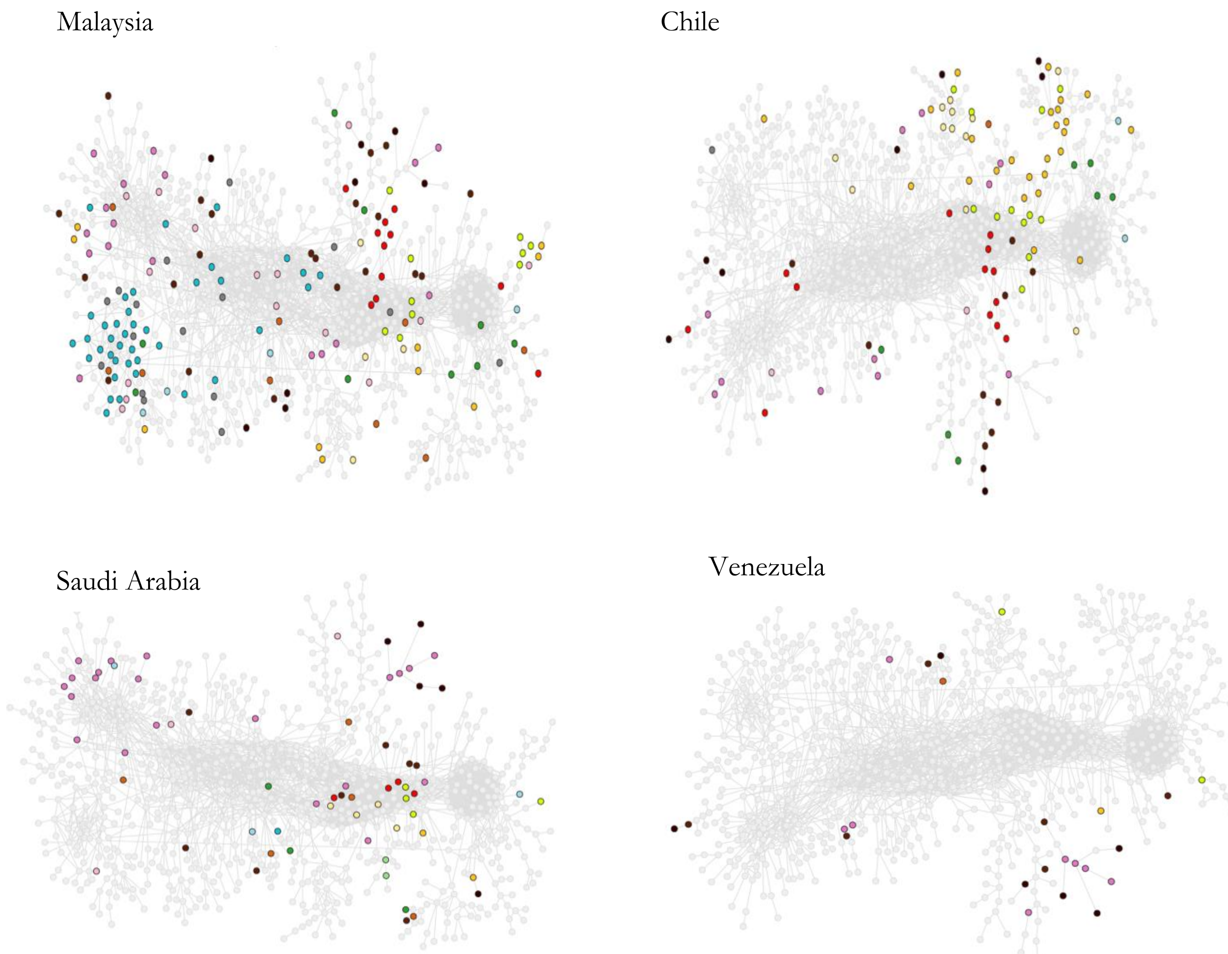
Figure 4: The Saudi product space



Source: based on the Observatory of Economic Complexity

The product space demonstration of Saudi Arabia reveals the lack of diversification in addition to the concentration on peripheral products. This production structure shows a limited set of industrial capabilities and, thus, has a crucial implication for structural transformation. The revealed capabilities, by the current product space, show that it is difficult for Saudi Arabia to jump into a large number of sophisticated products. Transitioning towards more sophisticated products may require the government to invest in industrial infrastructure (e.g. export processing zones), develop the labour force, and offer incentives and financing that can allow the private sector to invest in new and more sophisticated products (Hausmann et al. 2014). The priority in choosing more sophisticated products (i.e. to be targeted in the industrial policy) could be given to "close by" products (i.e. have similar set of required capabilities) to the existing products with RCA. These products are likely to be developed more quickly with a smaller amount of resources, because they require a similar set of capabilities to those eighty products with existing RCA. The following section suggests a set of new industries that are not far from the Saudi comparative advantage and, however, can upgrade the industrial structure significantly.

Figure 5: The product space for selected countries in 2016



Source: based on the Observatory of Economic Complexity

3.2 Resource based industrialization

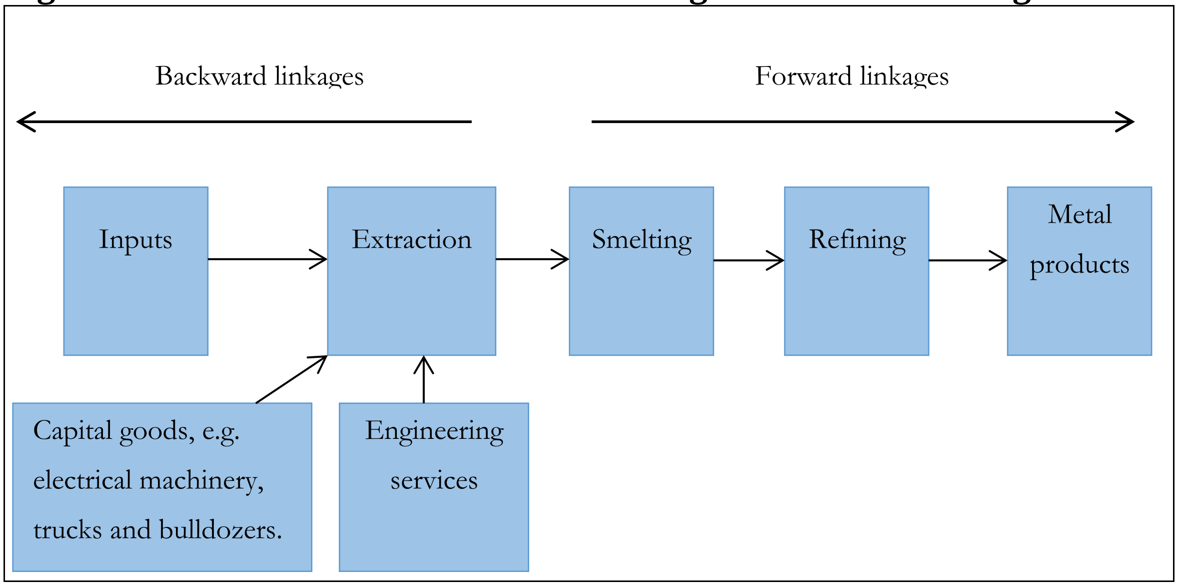
Rather than looking at natural resources' abundance as an obstacle (e.g. the resource curse literature), resource based industrialization (RBI), through technological change, can be seen as a window of opportunities for generating employment, creating wealth and ensuring well-being for resource-dependent countries (Morris et al. 2012; Perez 2015; Ramos 1998). According to Hirschman (1981), RBI is explained by production linkages, which refers to the forward linkages and backward linkages from the resource sector. The former is located downstream and describes the processing of natural resource and its transformation into manufactured products, while the latter is located upstream and refers to the production of input material, equipment and services utilized in the resource exploration and production.

The abundance of resources in developing countries has encouraged exploiting and exporting raw materials. Nonetheless, industrialization in these countries depends on the pace of mastering processing techniques for the natural resources in addition to manufacturing the input material and equipment necessary for the resource extraction (Ramos 1998). Resource rich countries need to emphasize on policies to strengthen upstream activities, such as supplying inputs, equipment, machinery and engineering services in addition to policies to strengthen raw material processing. The targeted sectors in this development strategy are different from those adopted by newly industrialized economies in East Asia (which are relatively poor in natural resources). By contrast, the targeted sectors are expected to be similar to those developed by resource-rich industrialized countries, such as Canada, Australia, New Zealand, and the Scandinavians (Ramos 1998).

The development of industrial clusters around the natural resource could significantly foster the linkages from the resource. In his analysis, Ramos (1998) uses the mining cluster as an example in order to show the importance of both forward and backward linkages from the resource sector (see Figure 6).

He further proposes a RBI strategy that consists of four major phases (see Table 4). In the first phase, developing countries extract resources and export them with very limited local input. Machinery and engineering services are likely to be imported at this phase. In the second phase, exports may include first level processing. The main input materials are targeted in the import substitution strategy in addition to engineering services. In the third phase, the country starts exporting more specialized and sophisticated products, while input materials and basic machinery (that are already targeted in the import substitution strategy) begin to be exported. In the fourth phase, all types of products and services are exported. This includes inputs and machinery, design and maintenance services, and specialized consultation services.

Figure 6: The forward and backward linkages within the mining cluster



Source: Ramos (1998)

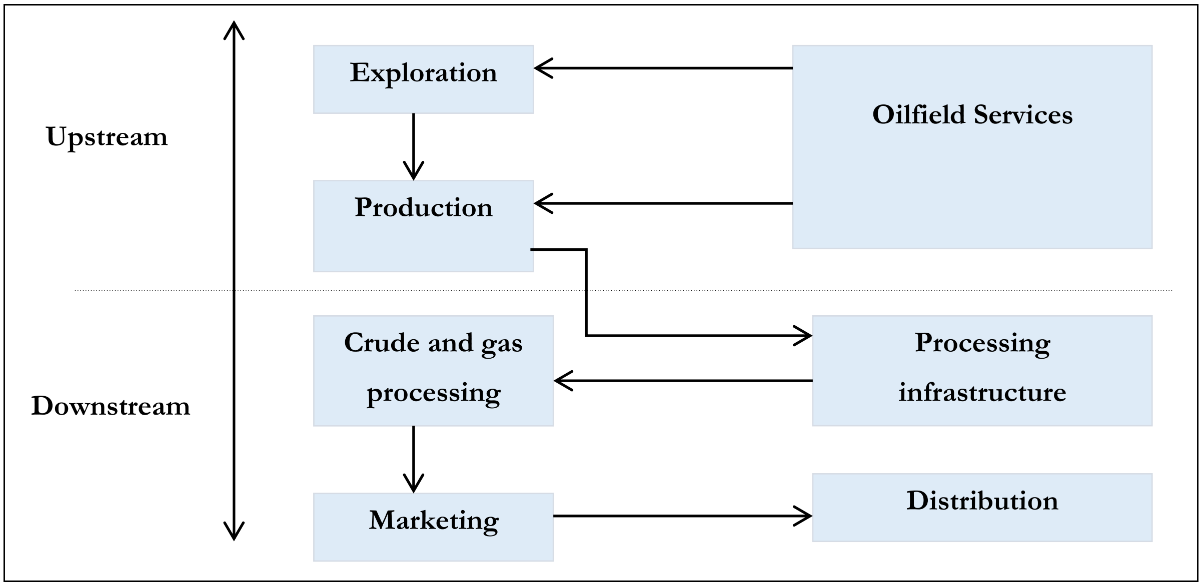
Table 4: The development of a production cluster

	Phase 1	Phase 2	Phase 3	Phase 4
1. **Downstream exports**	Unprocessed natural resource	First level of processing	More specialized first level processing, in addition to second level processing	Investment abroad
1. **Upstream input materials**	Imported	Import substations production of the main inputs for the domestic market	Export of inputs	==
2. **Upstream machinery**	Imported (repairs carried out locally)	Production under license for the domestic market	Export of basic machinery to less sophisticated markets; development of specialized equipment	Export of all types of machinery to sophisticated markets
1. **Upstream engineering** - Production - Project design - Consultancy	- Semi-imported - Imported - Imported	- Domestic - Partly domestic - Partly domestic	- Domestic - Domestic - Domestic (except for specialities)	Export all types of engineering activities

Source: Ramos (1998)

To understand the industrial opportunities that are generated from natural resources in Saudi Arabia, this section focuses mainly on the oil sector. Although Saudi Arabia is rich in a range of other mineral resources such as gas, phosphate, metal, gold and others, the study focuses on the oil cluster because of its large production and reserves in the Kingdom. Furthermore, the oil cluster analyses and its corresponding implications can shed the light on the importance of industrialization within the other natural resources. Accordingly, this section tries to understand the industrial and exports development within the oil cluster by studying the upstream and downstream activities separately (see Figure 7).

Figure 7: The Saudi oil upstream and downstream industries



- **Oil upstream industry**

Despite significant growth in the Saudi oil production over the past eighty years, the upstream manufacturing and services have not developed well. One way to examine the upstream industry is through looking at Saudi Aramco's procurement from domestic suppliers (Kaplinsky et al. 2012). Until 2015, the company had been giving local suppliers priority and support in their bidding process. However, there was no clear local content policy for Aramco's local suppliers. This has been reflected on the local suppliers' limited share of Aramco's procurements, e.g. between 2010-2015, Aramco's local procurement has been around thirty percent, while seventy percent of machinery, materials and services were imported (Aramco 2016).

The large share of imported products and services strongly emphasizes the need for policies towards greater domestic development of the upstream manufacturing and services. Following Ramos (1998) and Perez's (2015) industrial strategies, Saudi Arabia could have been a regional exporter of oil-related manufacturing and services as opposed to being a net importer.

The government and Saudi Aramco were not satisfied with the local content levels. Thus, in cooperation with the Ministry of Energy, Industry, and Mineral Resources (MEIM), Aramco promoted a unique program to support oil upstream manufacturing; they decided to take a further step in growing the linkages from the oil sector by introducing a local content strategy called In Kingdom Total Value Add (IKTVA). Aramco's CEO explained that continuing to import machineries, material and services is not sustainable in the long-term. He also explained that Saudi Arabia and Aramco were missing a mechanism that enables local suppliers to compete with foreign suppliers (Alnasser 2016).

IKTVA targets an increase in Aramco's locally produced purchases from thirty to seventy percent by 2030, creating 500,000 jobs and exporting thirty percent of the locally produced materials. The programme is expected to increase the domestic added value and to promote industrial diversification (Aramco, 2016). To drive, monitor and measure this programme, Aramco developed a formula to rank its suppliers according to their local content level:

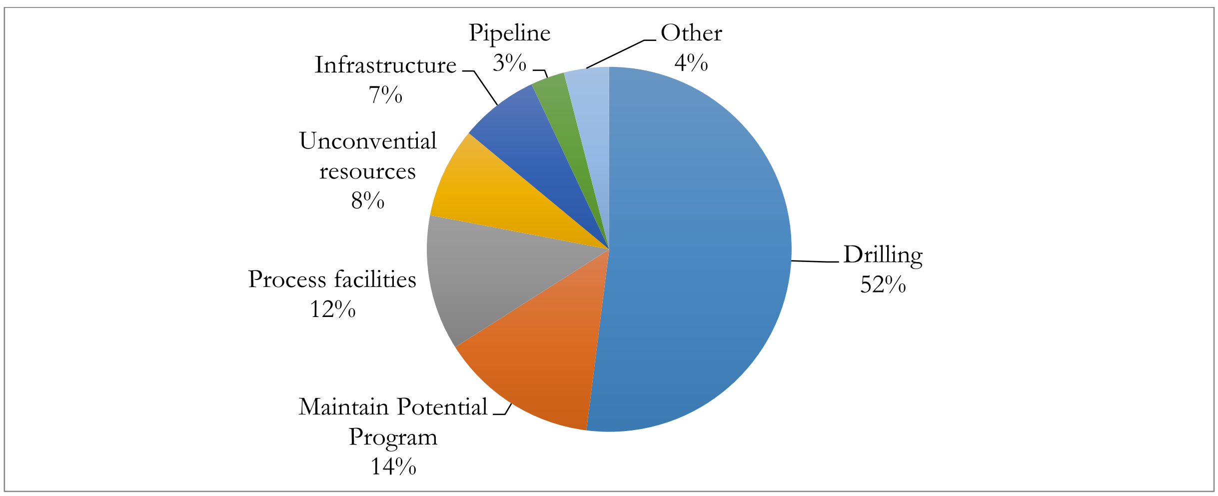
$$\textbf{IKTVA score} = \frac{\mathbf{A+B+C+D+R}}{\mathbf{E}} * \mathbf{100}$$

Where A is the localized goods and services (in USD),
B is the total amount of salaries paid to Saudis (in USD),
C is the training and development paid for Saudis (in USD),
D is the development of small suppliers (i.e. tier two or three suppliers, in USD)

R is the research and development expenditure (in USD), and
E is the expected revenue from Aramco's purchases or contracts (in USD)

To encourage potential suppliers to produce locally, Aramco announced the amount of its expected spending on materials and services in the period (2017-2026) in extensive detail. The amount is projected to be 1.4 trillion SR over ten years, and will be spent as follows: drilling equipment is expected to account for fifty-two percent of the total amount, followed by the Maintain Potential Program[3] with fourteen percent and process facilities with twelve percent (see Figure 8). Within each segment, Aramco has projected details of the quantities needed. The projected demand for drilling equipment, for example, is shown in Table 5

Figure 8: Aramco's projected spending by sectors (1.4 trillion SR over 10 years)



Source: IKTVA (2016)

3 Aramco's Maintain Potential Program (MPP) is responsible for managing all the maintenance, expansion and revamping operations of the company.

Table 5: Projected demand for drilling and equipment (2017-2026)

Item	Quantity
Inflow and injection control devices	1.2 million units
Oil well trees	13,900 units
Hanger assemblies	33,000 units
Casing heads	14,00 units
Cement	6.8 million tons
Mud products (drilling fluids)	636 million gallons

Source: IKTVA (2016)

Since 2016, if a supplier desires to win a new contract, it has to pay attention to its IKTVA score. Therefore, companies such as General Electric (GE), which is a first-tier supplier to Aramco, are negotiating with some of its foreign suppliers to locate their manufacturing in Saudi Arabia in order to increase its score in IKTVA and to ensure the sustainability of their contracts with Aramco. Such a process reduces the reliance on imported products and services and increases the manufacturing added value significantly. In 2016 Siemens announced the production of a gas turbine facility in Dammam (Siemens 2016). Similarly, GE in 2017 announced the establishment of a joint venture firm in Dammam to produce special power turbines (Reuters 2017). In the same year, during the IKTVA annual conference, Schlumberger announced that it would open a drilling equipment facility in Dammam. The facility will specialize in oil and gas extraction equipment. Schlumberger expects that Saudi-workers in the firm will constitute approximately sixty-two percent of the total workforce. Similarly, several other first-tier suppliers have moved some of their production facilities to the Eastern region of Saudi Arabia (Aramco 2017).

By the end of 2018, the local content of Aramco purchasing is expected to be approximately 50 percent. This number is considered the highest in the company's history (Aramco 2019). However, there are several challenges facing Saudi Arabia in its oil related manufacturing development, such as the limited number of high-skilled human resources (mainly technicians). This limited number might hinder the possibility of expanding the upstream industry and absorbing foreign technologies. Amsden (2001) argued that the training of technicians is a crucial factor in industrial development and, above all, in absorbing foreign technologies. "A critical factor in the transfer of technology is the extent to which the technology is completely understood by the transferor" (Teece 1977, p.247). Indeed, reverse engineering (copying and adapting), which is a fundamental mechanism in transferring technologies to developing countries, is not expected to take place without having highly skilled technicians (and engineers) who can learn the tacit of the imported technology (Lall 1992).

At the moment, there are six training institutions that qualify Saudi technicians to meet the demands of the oil cluster. However, there are ten centres currently under development. Furthermore, the Ministry of Labour, in co-ordination with Aramco, plans to establish twelve additional centres by 2030 to meet the high demand for a high quality technical workforce (Aramco 2016).

Another challenge faces the development of local suppliers in the upstream industry is the low economies of scale. In order for local suppliers to gain from economies of scale, they have to increase their production scale by expanding their targeted customers beyond Aramco's operations towards regional and global oil producers. Such an expansion can reduce local suppliers' production cost and increases their competitiveness.

- **Oil downstream**

The development of forward linkages (downstream industry) in oil producing countries is categorized into oil refining and petrochemicals. In oil refining, crude oil is transformed into useful consumption and production products such as gasoline, diesel, fuel oils, jet fuel, kerosene and liquid petroleum gas (LPG). The Saudi refining capacity reached 2.8 million barrels per day in 2017, making Saudi Arabia the fifth largest in the world in terms of refining capacity after the US, China, Russia and India (British Petroleum, 2017).

The Saudi petrochemicals industry, on the other hand, was promoted in the 1970s to stimulate economic diversification in addition to reducing the environmental impact and economic loss of burning the gas associated with crude oil production. This gas is either dissolved with oil or found free above the oil reserves (gas cap). Rather than flaring, the government decided to transform this gas into petrochemical exportable materials. In 1975, the Royal Commission for Jubail and Yanbu (RCJY) was established in order to develop world-class infrastructure of the two cities (Yanbu and Jubail) and to accommodate petrochemical-related plants[4], and the Master Gas System (MGS)[5] was developed to feed these industrial cities. The cost of the two cities, in addition to the MGS, was 35 billion USD (Alzamil et al., 2017).

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[4] Algusaibi (1999) argues that the RCJY with its unique management and governance structures is a critical factor in the later success of the Saudi petrochemicals industry.
[5] The MGS is a system of pipelines and gathering facilities that collect the associated gas by product.

In 1976, the government founded a national company called the Saudi Arabian Basic Industries Corporation (SABIC). However, the company's development was hindered by the lack of know-how in petrochemicals' manufacturing. The first CEO of the company explains that they had capital, infrastructure and raw material (feedstock), but "what we did not have was the technological know-how and the commercial experience in the markets of the world" (Al-Zamil et al. 2017). In order to access the 'know-how' and to transfer petrochemicals technologies, SABIC set up joint ventures with a number of leading foreign chemical producers. Therefore, companies such as Exxon Mobil, Shell, Taiwan Fertilizer Company and Mitsubishi Gas Chemical have established joint venture firms with SABIC.

In order for firms to acquire sophisticated technologies, follow up investment might be necessary to adopt foreign technology (Lall 1992). For SABIC, after signing joint ventures with foreign technology leaders, further major investments were made to acquire know-how in petrochemicals manufacturing. For instance, young Saudis have been sent to the US, Europe, Japan, and Taiwan to get on-the-job training abroad. The on-the-job abroad training was done through agreements with companies that already had joint ventures with SABIC. However, SABIC's administration found that in many cases foreign companies taught Saudis in classes rather than in plants, and thus, the administration threatened to quit these joint-venture agreements if the training was not within the production facilities in order to ensure greater technology transfer (Al-Zamil et al. 2017).

SABIC played a critical role in the development of the Saudi petrochemical industry in two ways: developing human resources to lead many other, smaller petrochemical firms and creating positive information externalities and technology spill-over. Former SABIC employees are now leading (e.g. CEOs) several petrochemicals listed companies. Creating technology spill-over, on the other hand, by SABIC was an opportunity for smaller firms, that had entered the market later, to copy some production and management expertise at zero cost (Al-Zamil et al. 2017).

Since the 1980s, the Saudi petrochemicals industry has been growing steadily. Currently, the industry accounts for the largest export segment after oil. In 2016, it accounted for twenty-one percent of total exports (sixty-seven percent of non-oil exports) generating over 38 billion USD. In terms of employment, the petrochemicals industry provided approximately 121,760 direct jobs in 2017 (GASTAT 2018)[6].

While there has been a substantial development in the Saudi petrochemicals industry since the 1970s, its production output mainly lies within basic, intermediaries and fertilizer products. Table 6 shows the Saudi production capacity since 2006 by major segments. It is important to note that speciality chemicals, which is the most sophisticated segment, accounts for only 0.3 percent of total production capacity. Furthermore, it accounts for less than three percent of total sales. Figure 9 shows total sales of petrochemicals output in 2016, where speciality chemicals are included in the category "Others".

Saudi exports, accordingly, are also skewed towards less sophisticated products. Petrochemicals exports are dominated by basic organics such as

[6] In addition, the petrochemicals sector generates significant indirect jobs, which was estimated to be between 267 and 356 thousand in 2014 (GPCA, 2015).

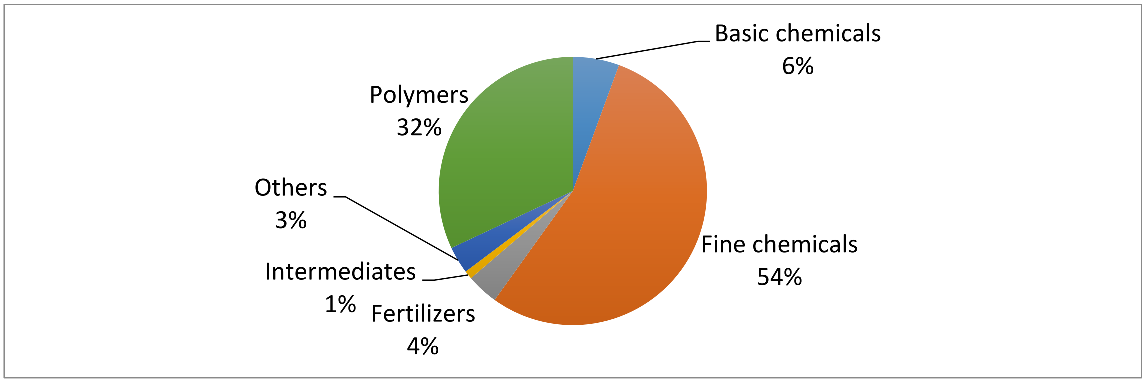
ethers, acyclic alcohol, cyclic hydrocarbons (accounting for approximately thirty percent), and basic polymers (forty-three percent) (see Figure 10). This is unlike other developing countries, such as India, China and Malaysia, that developed speciality and final consumer chemicals. In these countries, speciality and final consumption products, such as rubber tyres, rubber apparel, plastic housewares, soaps, paints and pharmaceuticals dominate petrochemicals exports.

Table 6: Saudi petrochemicals production capacity (in metric tons)

Petrochemicals production	2006		2011		2016	
	Capacity	**Share**	**Capacity**	**Share**	**Capacity**	**Share**
Organics						
- Basic	15630000	35.3%	27760952	35.5%	35597330	36.9%
- Fine chemicals	566285	1.3%	1002575	1.3%	2551154	2.6%
- Intermediates	12064774	27.3%	21151161	27.1%	22110244	22.9%
- Polymers	6375598	14.4%	14047533	18.0%	17352607	18.0%
Basic Inorganics						
- Fertilizer Raw Material	4369800	9.9%	5625961	7.2%	8280105	8.6%
- Inorganic chemicals	909312.5	2.1%	1128313	1.4%	1796175	1.9%
- Mainstream Fertilizers	4210000	9.5%	7310000	9.3%	8430000	8.7%
Specialty Chemicals						
- Specialties	94000	0.2%	164000	0.2%	290800	0.3%
Total	44219769		78190494		96408416	

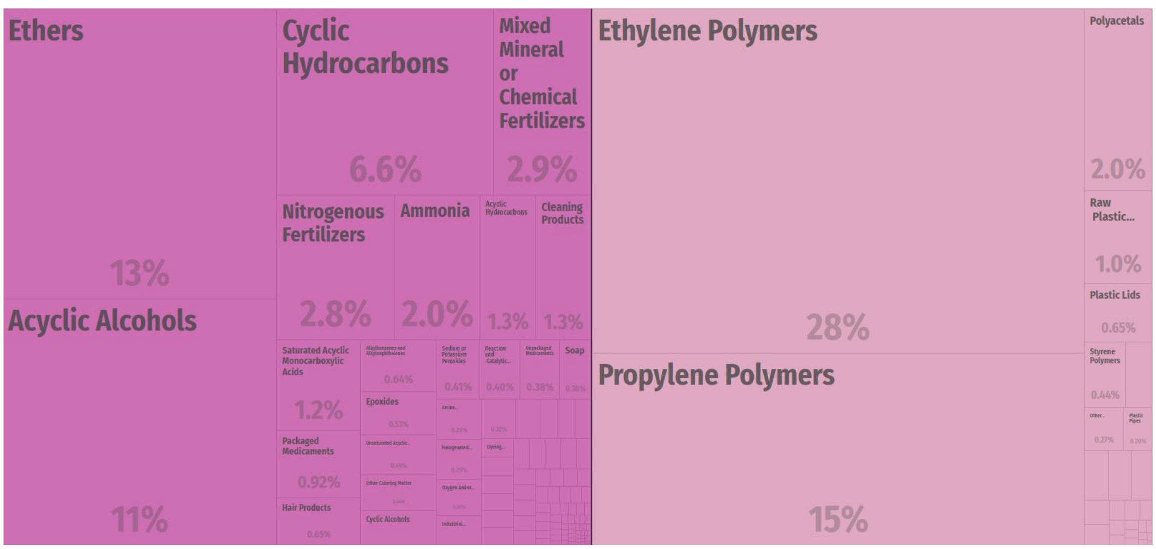
Source: unpublished data from the Gulf Petrochemicals & Chemicals Association.

Figure 9: Saudi petrochemicals sales by major groups (in 2016)



Source: unpublished data from the Gulf Petrochemicals & Chemicals Association.

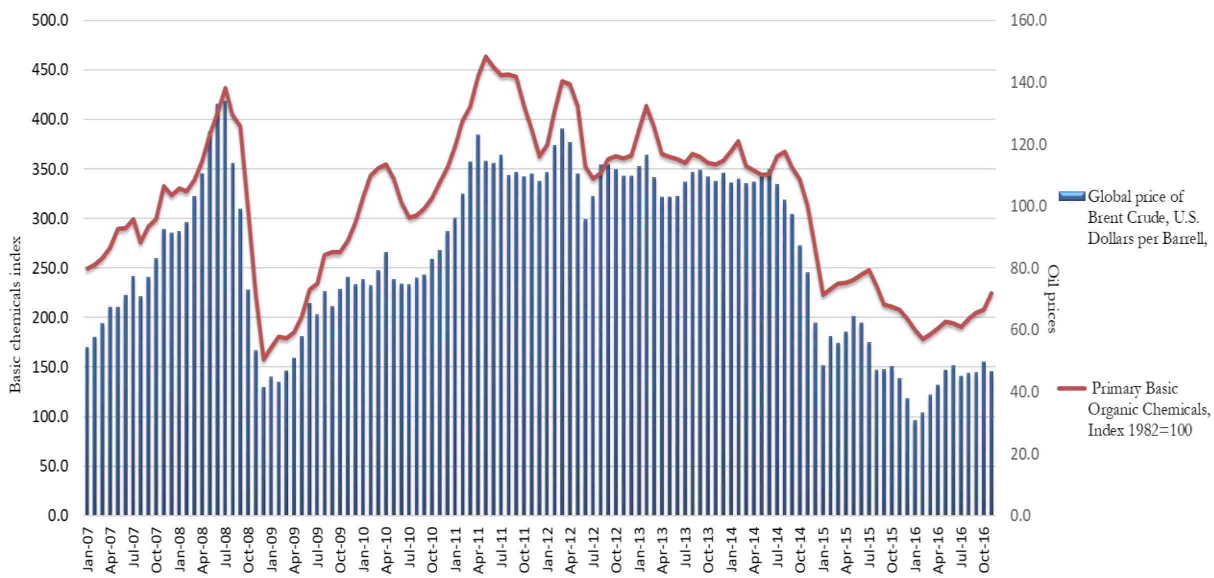
Figure 10: Saudi Petrochemicals exports in 2016



Source: Hausmann et al. (2014).

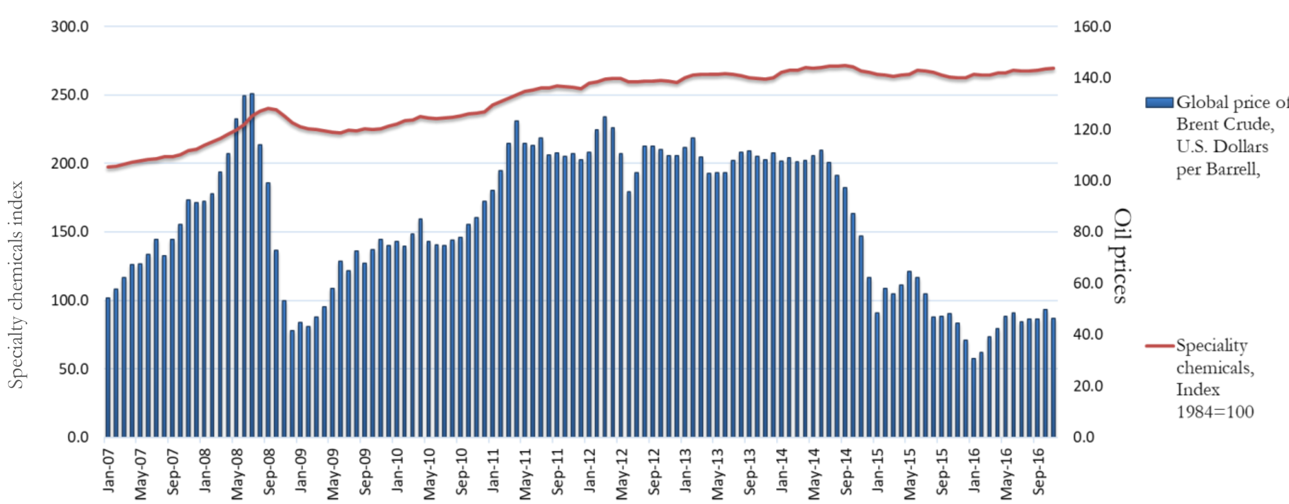
In addition to its low added value, basic petrochemical prices are extremely volatile following the crude oil price. On the other hand, speciality chemicals, which are produced with a limited capacity in Saudi Arabia, are characterized by low price elasticity of demand and high added value. Figure 11 demonstrates the high correlation between oil and basic chemicals. In the meantime, Figure 12 shows no significant correlation between speciality chemicals and oil price. These trends emphasizes the need to diversify away from basic chemicals towards speciality, final consumption chemicals and pharmaceutical, which can lower the Saudi exports volatility following oil price fluctuation.

Figure 11: Basic chemicals and oil prices



Source: FRED database.

Figure 12: Speciality chemicals and oil prices



Source: FRED database.

4. Conclusions

- The paper showed a concentration of industrial and export structures on crude oil, raw minerals and petrochemicals products. This emphasizes the immense need for developing wide range of industrial activities in order to achieve a sustainable economic growth, greater employment opportunities and a stable balance of payment.
- The paper argued for the crucial importance of the government's local content policies and the recently inaugurated National Industrial Development and Logistics Program (NIDLP) which aim to increase the industrial and mineral sectors' participation in total GDP, increase the domestic manufacturing added value, grow the share of non-oil exports, and support the development of the logistics sector.
- The study also argued for the importance of maintaining the current support for resource-based industries and other sectors that are within the Saudi comparative advantage, e.g. aquaculture and poultry farming sectors because of their contribution to the national food security in addition to their low water consumption. However, in the long-term, as the industrial capabilities develop, the study suggests targeting a set of non-resource industrial sectors that can generate greater employment opportunities and increase the sophistication of the industrial basket. These sectors can include machinery, equipment, automobiles and ships.
- Following the experience of recently industrialized countries, such as Korea and China, the paper suggests utilizing industrial policies that can contribute to the development of new manufacturing sectors and activities. These policies may include the development of domestic specialized labour force (mainly technicians) within specific industrial sectors (similar to Aramco's specialized vocational centres). In addition, these policies can include

offering greater incentives for industrial entrepreneurs within new and targeted industries with the purpose of overcoming what is being called in the economic development literature “infant industries market failure”.

- The study highlighted the importance of upgrading the existing industrial supply chains through stimulating backward and forward linkages from existing manufacturing or mining activities. Backward linkages includes exploration, R&D, production and maintenance. On the other hand, forward linkages includes processing, refining, storage and packaging. The study also highlights the prominence of promoting industrial clusters that accommodate industrial producers and suppliers in certain geographical area (such as Modon and the Royal Commission for Jubail and Yanbu). These clusters can stimulate the development of complementary products and logistic services.
- The study investigated the oil industry as an example of natural resource sectors in Saudi Arabia and showed that the sector can be further developed in the upstream and downstream sectors. Currently, the local content within the upstream industry is around 50 percent. However, the government targets reaching 70 percent by 2030. In the downstream industry, despite significant development since the 1970s, the industry is highly concentrated on producing primary and intermediary products that are highly correlated with oil prices. Nevertheless, Saudi Arabia produces limited amounts of specialty, final consumer chemicals and pharmaceutical products that are not highly correlated with oil prices and are characterized by higher value added.
- A major conclusion from studying the oil sector in Saudi Arabia is that there is a need to build comprehensive clusters around all the existing natural resources, including phosphate, copper, gold, and metals. Building these

clusters can take place through supporting wide range of downstream and upstream activities. This paper embraces Perez (2015) view in this regard:

> "It is no longer useful to see natural resources as just the extracting or farming activity on its own, but rather to embrace and promote the complete network, from capital goods and other investment requirements through the production and various processing activities, all the way to packaging, distribution and end use"(p.18).

Appendix A

The product space network is constructed using product level rather than aggregate sector level data. Hausmann et al. (2014) use export data because it is more comprehensive and more readily available than the industrial output data. Although the authors are aware of some limitations in using export data[7], this does not undermine the strength of the model or invalidate it (Felipe and Rhee, 2015). Figure A shows the product space adapted from Hausmann et al. (2014) using 1240 products (using a 4 digits Harmonized System).

The product space shows a network connecting products that are more likely to be co-exported. This method is based on a product complexity measure called the Product Complexity Index (PCI), which represents the capabilities required for its production. “It is calculated as the mathematical limit of a measure based on how many countries export the product and how diversified those exporters are” (Hausmann et al. 2014). Accordingly, the authors use the PCI to devise the Economic Complexity Index (ECI), which tries to measure the complexity of countries’ exports. The higher the ECI is for a country, the more complex its exports are.

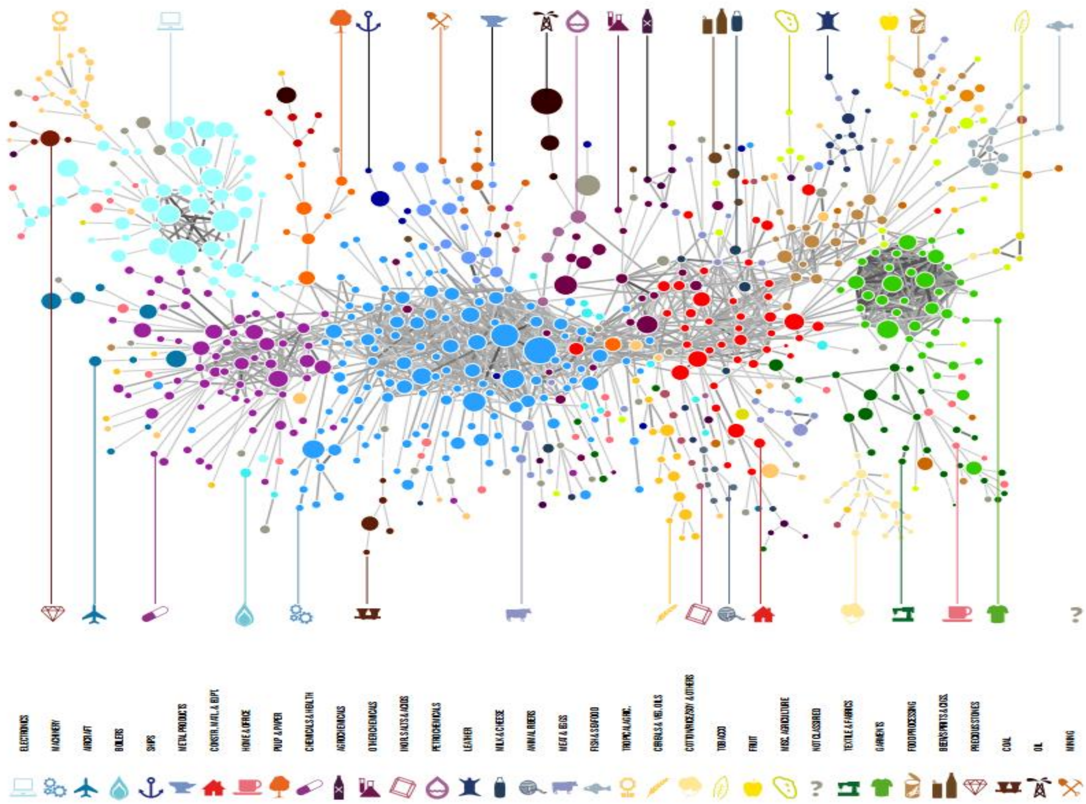
Each circle in the product space represents a product. The different colours symbolize product groups. The link between two products represents the similarities in the required capabilities to produce them. For example, the link between cotton and shirts is stronger than the link between cotton and automobiles. The similarity between the capabilities needed to produce the two

[7] The product space theory is based on the utilization of export data. While it is widely considered a proxy for industrial output, in some cases it deviates from the actual industrial production. This can be explained by the domestic market size and trade openness. Nonetheless, highly disaggregated industrial output for large number of products and countries is not available.

products is presumed by the likelihood of co-exporting both of them. For example, the likelihood of a country to export shirts given it exports cotton and vice versa is the conditional probability P(shirts/cotton) and P(cotton/shirts). Hence, products that show few common capabilities are not likely to be co-exported and connected in the product space (Hausmann et al. 2014).

An important implication of the product space is the lack of connectivity for products at the periphery (isolated) relative to those in the core. Core products, which include machinery, transportation and chemical products, are considered sophisticated products with high added value. On the other hand, peripheral products, which include petroleum, tropical agriculture and animal products, are considered simple products with low added value. Furthermore, they are considerably less connected to other products than those in the core. This reflects the difficulty facing countries concentrating on producing peripheral products (such as the case of Saudi Arabia with its concentration on petroleum products) to diversify their production structure. On the other hand, countries that produce an abundance of core products find it relatively easy to jump from one product to another.

Figure A: The Product space network



Source: Hausmann et al. (2014)

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