Manufacturing development in catching up countries: locating demand-driven policy interventions from a long-term perspective*

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Abstract

This paper discusses the role of demand-driven industrial policy instruments in underpinning industrialization in catching up countries. From a long-term perspective, the analysis identifies when, in the development of a manufacturing industry, the use of demand-driven policy instruments has been most prominent. What instruments have been used? How were they used? What kind of contribution have such instruments made to the development of the industry? Demand for manufactured goods can be interpreted in two ways: On the one hand, as a framework condition outside the direct control of policy makers; on the other hand, as a variable that is actionable for policy makers responsible to boost industrial development. The evidence stems from case studies from the car manufacturing industry in the Republic of Korea, aircraft manufacturing in Brazil, and lithium processing in Chile. The findings underscore that demand-driven policy instruments are better understood within dynamic policy mixes in interaction with and complementing supply-driven policy interventions. Policy interventions are part of the institutional factors that combine with innovation and changes in demand conditions to open up windows of opportunity for industrialization.

Keywords: Demand, industrial policy, industrialization, catching up, windows of opportunity
JEL codes: O14, O25, O33, O47

*This document was prepared as a background paper for the United Nations Industrial Development Organization's Industrial Development Report 2018. Overall guidance and support from Michele Clara is acknowledged. Comments and suggestions from Alejandro Lavopa, Nobuya Harauchi, Ha-Joon Chang, John Weiss, Andreas Chai and participants at an Expert Group Meeting at UNIDO informed discussion in several sections of this paper.
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1 Introduction

Structural change is a term commonly used to describe an economy's transformation from an agriculture-based to a more diversified, technologically complex manufacturing-driven economy. The process is challenging, it requires sustained commitment of resources and careful management of systems of supply, systems of demand and of the interactions between them over time. Rostow's (1959) seminal work on the stages of economic growth already highlighted the importance of dynamic interactions between supply and demand and the patterns of manufacturing as the modern sector of the economy. The author also stressed the importance of a sectoral approach to advance toward dynamic theories of production or rather, industrialization and economic development.

From an evolutionary perspective, Saviotti and Pyka (2013) conclude that explanations of long-run economic development should consider the interplay between supply and demand. From the supply side, the authors underscore three elements, namely changes in productive efficiency, the emergence of new sectors, and the tendency of economies to increase quality and product differentiation. From the demand side, they highlight the dynamics of disposable income and varying preference systems. The combination of supply and demand is necessary "because each one individually would not suffice to generate long-run economic development" (Saviotti and Pyka 2013, p. 461).

Regarding innovation, from a supply-side perspective, this is an activity with major implications for productivity growth; technological change and the creation of domestic scientific and technological capabilities are key drivers of industrialization. However, innovation is not enough to achieve intended development goals. The creation of an adequate demand for those innovations, eventually leading to new sectors, is needed for long-run economic development to be both possible and sustainable (Saviotti 2001; Saviotti and Pyka 2013).

From a policy perspective, Salazar-Xirinachs, Nübler, and Kozul-Wright (2014) assert that a balanced mix of demand- and supply-side policies should assist countries skip slow growth traps and enhance their ability to provide high-quality jobs. However, the scope of industrial modernisation and technological upgrading changes through time as countries gain technological and productive capabilities. Stiglitz (2017) endorses strategies toward economic diversification, understood as a process of opening the space for learning and upgrading, just as it is a process of enhancing the scope of production, investment and protection against factors affecting external markets for trade and investment. After all, industrial development –and economic development at large- is a self-discovery process about the productive activities a country is or can be good at (Hausmann and Rodrik 2003).

Stiglitz (2017) stresses the importance of macroeconomic stability for sustainable long-term strategies built around technological change and learning. He recommends strategies to capture external demand and the generation of revenues in foreign currency, combined with interventions to ensure full-employment of the less skilled. Moreover, he endorses industrial policies that impose restrictions on the exploitation of natural resources for exports, without adding value to those resources at the source. In the author's view, demand-driven industrial policies can enhance diversification and promote

economic transformation in ways consistent with poverty reduction targets; supporting an expanding domestic middle class should encourage expansion of domestic markets for manufactured products.

Interest in the building of technological, institutional and productive capabilities for industrialization from the supply side is pervasive. However, policy makers in both developed and developing countries are increasingly attentive to learn about mechanisms that allow them to steer demand for manufactured products in ways that help domestic agents maintain international leadership, preserve or reintegrate or even increase manufacturing activities and related employment in domestic soil (Buttonwood 2017; The Economist 2017b). Policy makers seek to capture increasing shares of external demand through exports, while expanding internal demand for domestically produced manufacturing goods. This paper draws inspiration from these growing concerns on the dynamics of demand for manufacturing products.

Building on case studies from three countries at various stages in the catching up process, this paper addresses the following questions: What is the role of demand-driven industrial policy interventions in supporting long-term development of manufacturing industries? How to characterize those interventions in terms of their targets and implementation strategies over time? What lessons learnt can inform more recent industrialization strategies in catching up countries? The intention is to illustrate how policy interventions have been tooled to respond to the dynamics of demand for manufactured goods as a driver of industrialization and catching up. The analysis draws from Lee and Malerba (2017) who understand catching up as "the process of closing the gap in global market shares between firms in leading countries and firms in latecomer countries" (p.339). This notion can be extended to mean the closing the gap in global market shares between industries or countries.

As we discuss in Section 2, the dynamics of demand for manufactured goods is interpreted here as providing windows of opportunity to boost industrialization. Policy makers can react to such windows in diverse ways. On the one hand, demand can be interpreted as a framework condition partially or completely outside the control of policy makers, for instance demand in foreign and domestic markets due to business cycle or macroeconomic developments, but also changes in the insertion into global value chains. In these cases, governments can play at least two distinct roles (Lin and Chang 2009; Salazar-Xirinachs, Nübler, and Kozul-Wright 2014).

- Governments can facilitate the removal of market failures so that domestic firms can build on current comparative advantages to tackle emerging demand opportunities. Industrial policies from this perspective target entrepreneurial behaviours or business and investment environments conditioning competitiveness and profitability of firms. Of importance are exchange rate and monetary policies, investment in general infrastructure -power supplies, roads, ports-, and the governance of international trade and investment.
- Governments can promote technological change and the building of productive capacities so that domestic firms can enter sectors that it would otherwise be impossible to develop given

the country's traditional comparative advantages (Lin and Chang 2009; Salazar-Xirinachs, Nübler, and Kozul-Wright 2014).

In either case policy interventions can target specific market segments or industries considered of strategic importance for competitiveness and long term economic development (Lin and Chang 2009). On the other hand, demand for manufactured goods can be "actionable" through industrial policy. While public procurement comes immediately to mind, the set of demand-driven industrial policy interventions available for policy makers is quite broad; they imply distinct degrees of intervention in the economic system and show varied degrees of adherence to current rules governing international trade and investment (Santiago and Weiss 2017). Factors such as size of the economy and of domestic markets, the strength of domestic technological and manufacturing capabilities, relative endowment of resources with high value for manufacturing, the extent of international collaboration and forms of insertion into global value chains, the importance granted to domestic or external markets, and even the definition and balance between often conflicting policy priorities[1] determine a country's ability to manage demand for manufactured products.

The paper proceeds as follows. Section 2 discusses recent contributions to literature on 'windows of opportunity' for industrial catching up. Conditions of demand for manufacturing goods, together with changes in institutional frameworks and/or technological innovation offer opportunities for industrialization; developing minimum productive capacities determines readiness to respond to those opportunities. Section 3 presents the methodological underpinnings of this study. Section 4 is split in three main parts. First, from the perspective of demand for manufactured goods as a framework condition, Chile is making efforts to build domestic capacities for lithium processing. The case illustrates how such a natural resource rich country seeks to tap into a significant window of opportunity resulting from increased global demand for lithium-based manufactured products. These efforts contrast with the experience of the Democratic Republic of the Congo (DRC) which has found it challenging to benefit from a window of opportunity associated with another mineral, Coltan, with significant use in global manufacturing. Second, we explore how policy interventions have assisted Korean car manufacturers strategically and sequentially, to tap into demand for automobiles. In the initial stages of development of the industry, external demand for cars was used as a framework condition allowing the domestic industry to take off and gain speed. As the industry matured, demand became a more actionable variable, particularly in response to raising concerns about the impact of automobiles on environmental pollution. Third, the aircraft manufacturing industry in Brazil is a case where direct public intervention helped to create market entry conditions, managing demand –mainly through public procurement- for the latecomer producer, Embraer. As the industry consolidated, government presence began to loosen, giving way to the private sector as driver of Embraer's growth. Section 5 concludes.

[1] UNIDO (2016) discusses possible trade-offs between economic, social and environmental dimensions pertinent to consider as part of industrial transformation strategies.

2 Demand for manufacturing and windows of opportunity for industrialization

Active industrial policies have contributed to successful industrialization in catching up countries. Weiss (2015) asserts that industrialization unfolds in stages with some, although not precise, empirical regularity in the balance and goals pursued through government interventions, either horizontal measures of general applicability, or vertical measures applied selectively depending on specific policy priorities and economic development targets. Public interventions influence the ability to supply a steady stream of manufactured goods, the conditions of demand for those products or both.

The notion of catching up is consistent with views of industrial development as a sequential and cumulative process, occurring in stages characterised by specific market and institutional conditions and changing importance of distinct economic agents. Catching up is a recursive process where latecomers constantly seek entry into an industry and gradually catch up, in some cases forge ahead, and eventually decline (Lee and Malerba 2017). Lee and Malerba (2017) identify (i) an initial entry and growth stage which highlights the importance of initial conditions, including natural resource endowments, historical legacies, presence and quality of infrastructure, and other social and economic macro and micro factors; (ii) the catch-up phase where key factors are the country or sector or firm's ability to undertake dynamic processes of learning and capability building, sustained over a long period of time. In this period countries or sectors or firms capitalize and add value to initial conditions according to well-designed strategies, and often building on the footsteps of market leaders; (iii) the advanced stage of forging ahead refers to the moment where followers shake up established market structures and overtake leaders thereby signalling changes in the geography of global leadership.

The literature documents cases of successful catching up built around windows of opportunity or discontinuities in the dynamics of a sector or a system. Catching up implies the ability to spot and capitalize on scientific or technological breakthroughs, propitious international environments around intellectual property rights, the surge of international demand for certain commodity products, or even regulatory reforms (Perez and Soete 1988; Lee and Malerba 2017). Windows of opportunity can guide the speed and direction of industrialization and inform development goals over time. At country level, successful experiences have involved the use of external demand, in combination with other policy instruments, as temporary mechanism to compensate for underdeveloped domestic markets, giving local firms the space to develop productive and technological capabilities (Stiglitz 1996).

Lee and Malerba (2017) identify three kinds of windows of opportunity that can emerge during the long-run evolution of an industry:

- Changes in knowledge or technology: Related to technological revolutions and changes in knowledge bases characteristic of an industry; an example is the transition from analogue to digital. Strategic decisions around emerging, innovative technologies can detonate dynamic processes leading to changes in the positioning of leaders and followers in specific markets.
- Changes in demand conditions, actors and networks: Refers to processes leading to the emergence of new types of demands or new set of consumers, major shocks to local demand

or business cycles. Changed demands may enable entry to otherwise crowded markets, or compromise leadership of incumbent firms or countries in specific markets.

- Changes in institutions and public policy: Drastic institutional reforms can alter the rules of the game for economic agents, influencing entrepreneurial behaviours or the nature of business and investment environments. The result is changing competitiveness and profitability of firms. Institutional shocks can force economic agents to innovate and to adapt behaviours according to new environments domestically and/or abroad.

According to Lee and Malerba (2017), catching up, and eventually changes in industrial leadership, occurs when the opening of one or multiple windows of opportunity combines with corresponding "responses of firms and other components of the sectoral system of the latecomer and incumbent countries" (p.338). The authors stress that sectoral differences determine, the type of windows that open and the corresponding responses of incumbents and followers. Regarding windows of opportunity from the perspective of demand, the authors identify three main types:

- Creation of new demands through innovation, major scientific discoveries or the opening of opportunities to exploit and add value on natural resource endowments;
- Rapid growth of domestic demand. Because incumbents are unable to satisfy this demand, there is room for new agents to enter and subsequent grow in the market; and,
- Abrupt changes in business cycles and/or in market demand that either create opportunities for incumbents to consolidate leading positions, or for new agents to challenge those positions and capture increasing market shares. Players are compelled to assume risks and make strategic decisions around investment, production and the dynamics of market demand.

Examples of demand-related windows of opportunity can be observed in the mobile phone market. A first event, leading to the overtaking of Motorola's leadership by Nokia, involved rapid increases in the demand of both individual and business users that accompanied the emergence of digital technologies. A second event, which allowed Samsung to overtake Nokia as market leader, was the replacement of the "old" digital technologies driven by a surge in demand for smartphones featuring more attractive custom-built touch interfaces (Giachetti and Marchi 2017). From a policy perspective, the first event was possible thanks to the European Union's support for digital Global System for Mobile (GSM) standards, while the United States was open to multiple standards.

In the wine industry, Morrison and Rabellotti (2017) take account of the fierce competition and changing leadership positions between "old world" and "new world" [2] wine producers since the early 1990s. Arguably, the demand window that allowed new world producers to gain market shares was related to decreases in consumption by traditional consuming countries, the entry of new inexperienced consumers from the UK, the United States, and Scandinavian countries, and the reduced importance of large distribution. In the early 2000s, old world producers could recover

[2] Emphasis in the original by the authors.

prominence through innovation, increased attention to marketing and branding, the introduction of sophisticated and varied wines to serve more sophisticated consumers globally. The upsurge of demand from China and other Asian markets should open a new window of opportunity for wine producers. Regarding institutional factors, European policy and regulation contributed significantly to the emergence of new world producers in the early 1990s. The combination of subsidy and regulatory controls locked old world producers into existing products, markets, and technologies. Similarly, the radical reform registered in the late 2000s has allowed old world producers, now in their follower role, to regain market share in a new, more geographically diversified wine industry.

The following sections discuss three catching up experiences with an emphasis on the role of demand-driven policies as part of institutional factors shaping windows of opportunity for industrialization.

3 Methodology

This paper builds on evidence from secondary data sources mainly. We proceeded as follows: First, we searched the scholarly literature for studies on successful cases of industrialization in catching up countries. The next step was to locate information on the role of demand-driven industrial policy interventions in underpinning catching up. Demand-driven policy instruments were analysed either individually or as part of policy mixes, in combination with other demand or supply-oriented instruments. Additional evidence stemmed from articles in the grey literature, policy briefs, government websites, and reports produced by government organisations and international organisations with a stake in industrial development or industrial policy. Statistical data was obtained from government websites or industry associations, as well as from the United Nations Comtrade dataset and OECD Key Short-Term Economic Indicators.

The approach to the analysis was two-fold. First, a historical perspective helped us to identify and characterize various stages of the catching up process followed by an industry. Emphasis was placed on those moments of significant changes in productive and/or technological capabilities, or of active promotion of domestic demand as driver of industrialization. These moments helped us frame government interventions around technological windows of opportunity. Alternatively, it was possible to identify how government interventions have helped the domestic industry to respond to existing or emerging windows of opportunity.

Second, we built on a framework introduced in Santiago and Weiss (2017), to identify how demand-driven industrial policy interventions were implemented over time; this, according to the objectives pursued by the governments of the countries under study. The framework allowed us to characterize governments as direct consumers –through public procurement for example; as regulators, setting rules of the game in the market; as knowledge brokers linking producers and consumers; or as active promoters of private demand for industrial innovations generated by domestic firms. In addition to traditional economic development targets, the analysis considered policy interventions built around sustainability and/or inclusiveness considerations.

4 Demand-driven industrial policy instruments and industrialization: a long-run perspective

This section examines three distinct industries in three different countries, namely the case of lithium processing in Chile, then the case of Korea's automotive industry and finally, the airplane manufacturing industry in Brazil. The intention is to locate demand windows of opportunity, and how demand-driven industrial policies have guided the corresponding response in each case.

4.1 Capturing global demand while adding value to natural resources endowments: Lithium in Chile

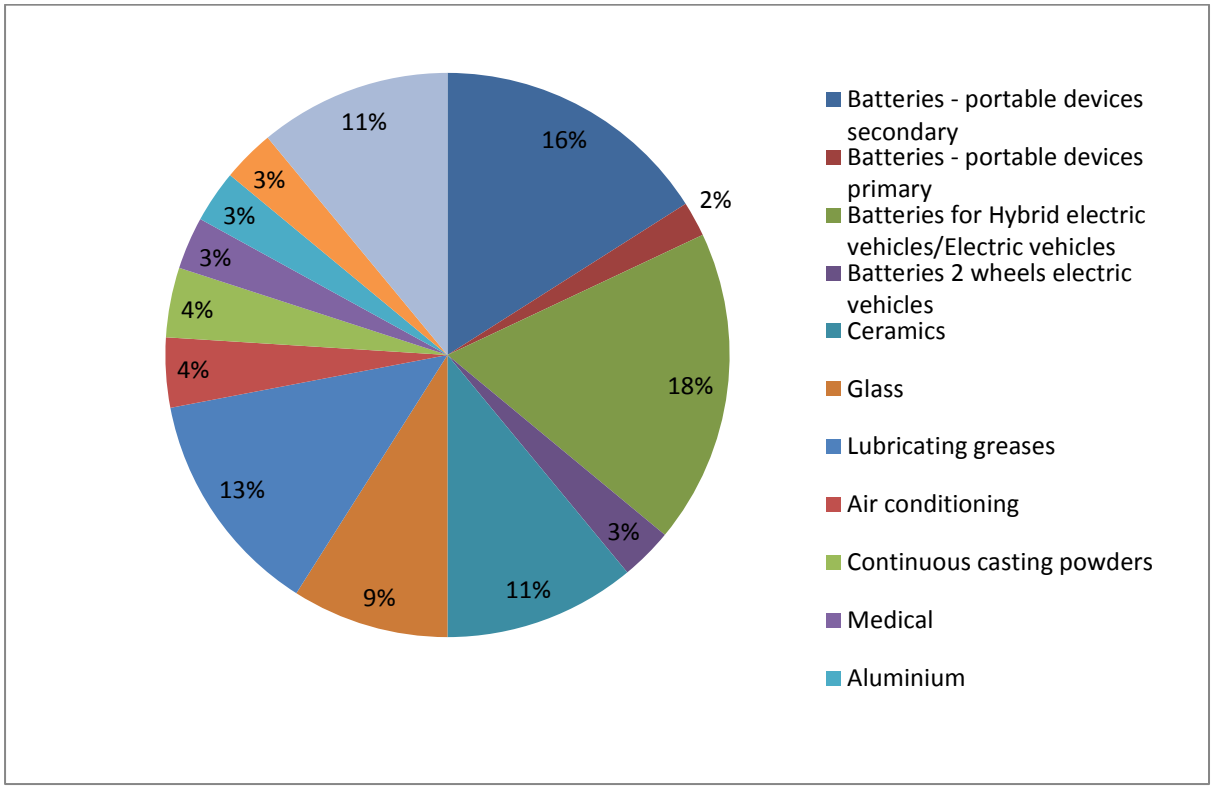
A country's ability to capitalize on external demand –as a variable outside of their direct control- is constrained by their capacity to establish minimum initial conditions, including technological, productive and institutional capabilities. Recent efforts of Chilean authorities to build on their massive reserves of lithium, a metal with widespread use for the manufacturing of products with applications in transport, communications and other sectors helps to illustrate this process.

4.1.1 A booming global demand for lithium

A significant global demand window exists for lithium-based products (

Figure 1). In 2016, demand for lithium grew by 12 percent on annual terms, fuelled mainly by booming global demand for lithium-based batteries (US Geological Survey 2017); the latter is expected to double current market value of approximate US$ 20-22 billion (CORFO and INVESTCHILE 2017). As demand for lithium exceeds its supply, international prices are soaring; in 2015-2016 alone, spot prices grew about 40% to 60 percent (US Geological Survey 2017). Technology companies in the United States and Asia are pursuing strategies to secure a steady and varied lithium supply. This involves strategic alliances and joint ventures with exploration companies (US Geological Survey 2017).

Figure 1. Lithium consumption by application



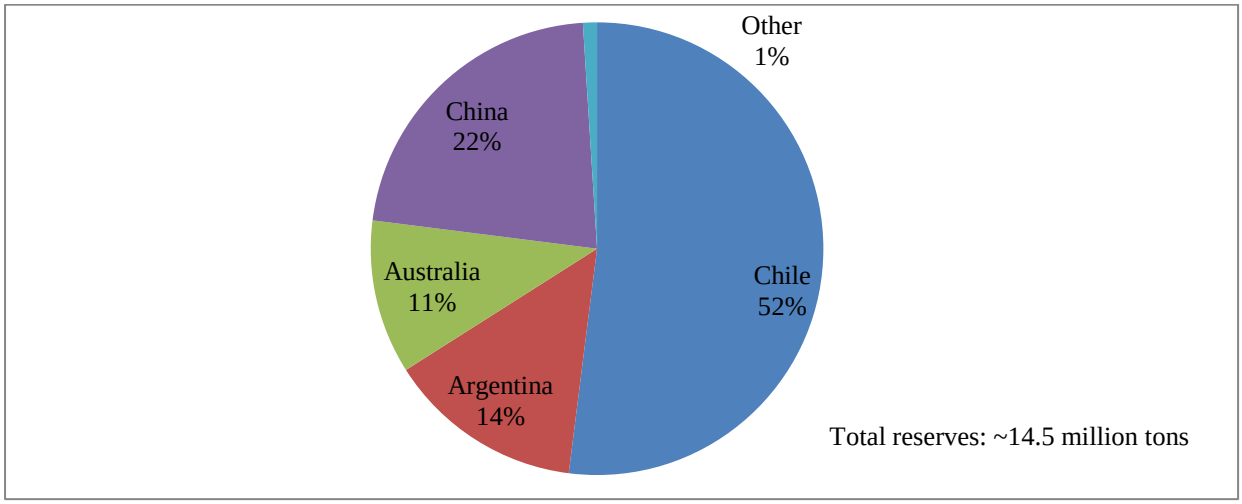
Note: Values for Hybrid electric vehicles/Electric vehicles and 2 wheels electric vehicles.
Source: Extracted from CORFO and INVESTCHILE (2017).

High and growing global demand for lithium-based manufactured products bring significant opportunities for lithium producer countries to add and capture value from this raw material. This dynamic is compounded by environmental concerns and the push for alternative, non-conventional energy sources where lithium batteries can find significant applications. The process is not free of bottlenecks, while countries are showing differentiated responses to this demand window. Countries such as Argentina and Bolivia need to improve their respective business and investment environments, although the authorities in the former country are said to be taking decisive steps in this direction (The Economist 2017a). In 2016, the opening of a new production site in Argentina resulted in an increase of 60 percent in the country's production of lithium (US Geological Survey 2017). Australia is also making considerable strides, despite the cumbersome conditions for lithium extraction processes in the country (The Economist 2017a). Although Chile maintains tight controls and quotas on lithium extraction, it seems to offer a friendlier environment for businesses in the sector and has been quicker to react to booming global demand for lithium-based products.

*4.1.2 **The lithium industry in Chile***

Chile belongs to the "lithium triangle" -together with Argentina and Bolivia-, a region that hosts the world's most significant lithium deposits (Figure 2). The world's largest and highest-grade lithium brine deposits are located at the Salinas of Maricunga and Pedernales, a region within the Atacama Plateau, on the Chile-Argentina border (O'Brien and Nickel 2015; Corfo 2017; Sanderson 2017).

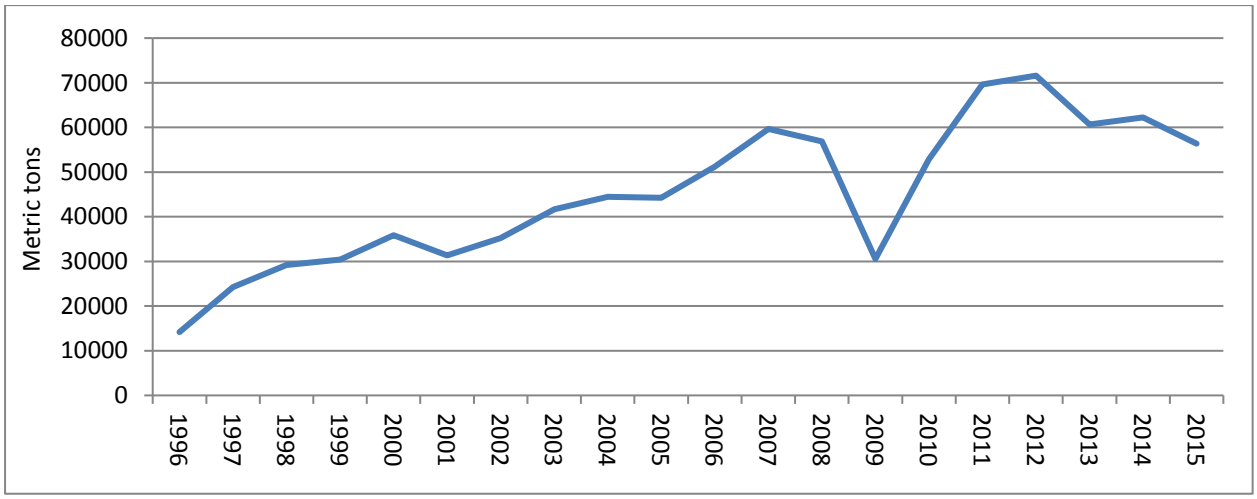
Figure 2. Distribution of lithium mine reserves in the world[1], 2016



Note: According to the US Geological Survey, data on lithium mine reserves may not reflect identified lithium resources which can result in a larger number of countries, and a larger amount of lithium available.
Source: US Geological Survey (2017).

Data on production are available for Chile since 1996, when it reported production of about 24,246 tons of lithium carbonate equivalent (LCE). The country's annual output shows a clear upward trend (Figure 3). In 2016 it was the second largest lithium producer in the world, with about 34 percent of total production (US Geological Survey 2017); output is expected to exceed 300,000 tons LCE by 2035 (O'Brien and Nickel 2015; Corfo 2017; Sanderson 2017).

Figure 3. Lithium production in Chile (1996-2015)

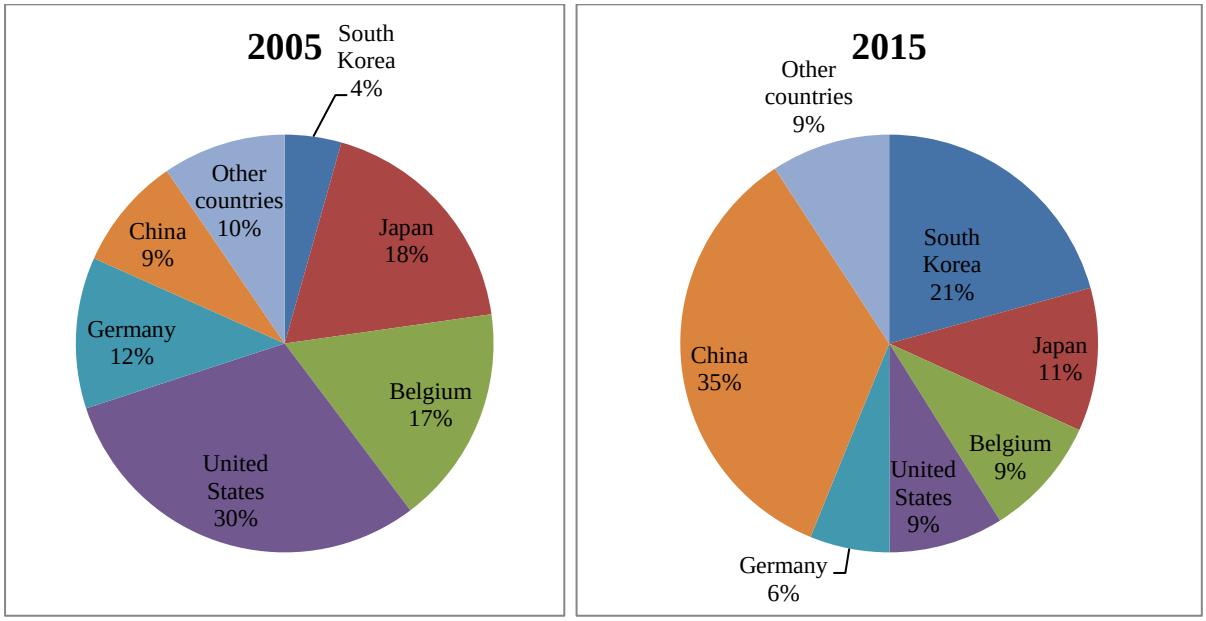


Note: Lithium production includes lithium carbonate, lithium chloride, lithium hydroxide.
Source: SERNAGEOMIN-Anuario de la Minería in Comisión Chilena del Cobre (2017).

Regarding trade, while in 2005 only 9 percent of total Chilean lithium exports went to China, by 2015 this country had become the most prominent trading partner absorbing more than a third of Chilean lithium exports (

Figure 4). Expressed in tones, the rise is even more significant, from 3,754 tons to 27,290 tons, equivalent to about 22 percent annual growth over a decade.

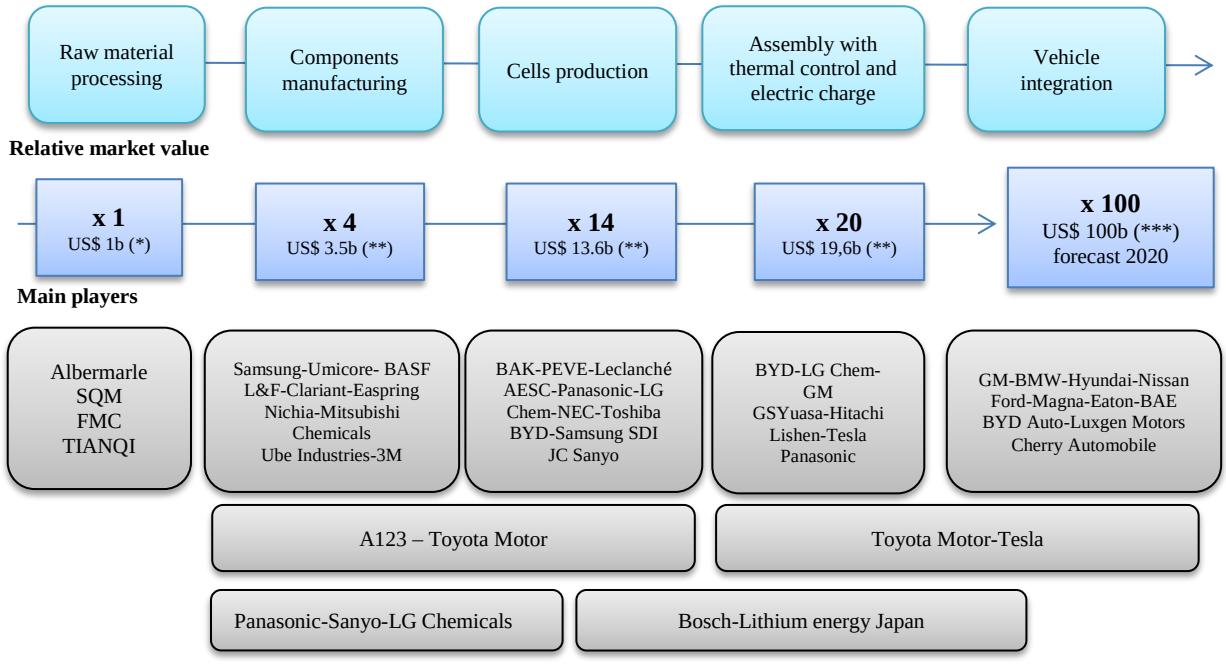
Figure 4. Chile: Lithium exports by main trading partner, 2005-2015



Note: COCHILCO's database is based on the National Customs Service; lithium exports are measured in tons and lithium compounds including lithium carbonate, lithium chloride, lithium hydroxide and lithium brine.
Source: Authors based on COCHILCO (2017).

The lithium value chain for electric vehicles includes many players at various stages of the industry (Figure 5). Because Chile is currently positioned at a very early stage in the value chain, there is enormous potential for the country to benefit by moving downstream towards the more technologically complex, higher value-added stages.

Figure 5. Lithium value chain for electric vehicles



Note: * FMC 2013, ** Avicenne Energy 2015, *** Global Electric Vehicles Market & Volume (Plug-in battery, hybrid fuel cell) Motors 2015 in CORFO and INVESTCHILE (2017).

Source: Extracted from CORFO and INVESTCHILE (2017).

4.1.3 Capitalizing on global demand? From building the institutional framework around lithium extraction to the promotion of domestic processing capacities

The Chilean government started to pay attention to lithium production in the 1950s, at a time of great international interest in radioactive minerals. In 1955, the Chilean Economic Development Agency (CORFO) signed a cooperation agreement with the European Union to develop nuclear energy for peaceful applications, and in 1965 the government created the Chilean Commission for Nuclear Energy (CCHEN).[3] In 1975, the government adopted new nuclear regulations (Reglamento de terminos nucleares), Decr.No 450, which declared lithium a material of nuclear interest reserved to the state. The regulation is also set to protect the fragile natural environment around production sites (The Economist 2017a). Commercialization of lithium requires authorization of CCHEN which also ensures that lithium sales by authorized companies fall within agreed quotas.

Also in 1975, CORFO subscribed a contract with the firm Foote Mineral Co. for the exploitation of lithium in the region of El Solar, in the Atacama Desert. By 1980, the partnership gave origin to Sociedad Chilena de Litio, and an ownership distribution of 45 percent for CORFO and 55 percent for Foote Mineral Co. Sociedad Chilena de Litio was expected to produce and export up to 200,000 metric tons of lithium over a period ending in 2001. However, such a period was extended up to 2014 with five-year renewal windows up to the stipulated limit of 200,000 metric tons.

In 1983, enactment of the Code of Mining confirmed the Chilean government's exclusive rights to benefit from the country's lithium reserves. It ratified that the metal is not susceptible of mining concessions, except for those preceding publication of the Code. Only CORFO owns mining property in El Salar de Atacama with concessions granted for the extraction of Lithium; CORFO has leased those rights to Sociedad Chilena de Litio and SQM, a filial of Sociedad Química y Minera de Chile. Today only two companies have been granted extraction rights, the American-based firm Albemarle® and Sociedad Quimica Minera de Chile. Additionally, the Code of Mining has granted the State priority purchasing right over mining products (COCHILCO 2009; Subsecretaría de Minería Chile 2013).

In 2012, the government took the first steps to privatize lithium mining and reserves as a measure to stimulate the domestic economy. It also sought to counteract the negative effects resulting from depleting copper reserves and production. The government introduced a Contrato Especial de Operacion de Litio (Special Contract for Lithium Operations) which involved the launch of tenders to exploit lithium concessions under 20-year contracts, involving royalties of 7 percent on annual sales of the raw material. However, these tenders were cancelled due to potential conflicts of interest with the Ministry of Mines (Wacaster 2015).

[3] CCHEN and CORFO are the main public organisms involved in lithium mining in Chile, together with SERNAGEOMIN (Servicio Nacional the Geologia y Mineria), DGA (Direccion General de Aguas) and state-owned mining enterprises (SERNAGEOMIN 2013).

Recent steps towards facilitating foreign investment in the processing of domestic lithium production include, on March 30th, 2017, the launch of an international bid to attract investment in the domestic development of lithium-based industries, including lithium batteries and their components. Conducted through CORFO and the Foreign Investment Promotion Agency, InvestChile, this process is expected to attract South Korean, Chinese, European and Japanese companies. The winning companies -to be announced by end of 2017- will benefit from guaranteed access to up to 25 percent of Albermale's lithium production over a period of about 27 years. These firms will be granted the lowest price available of lithium in the export market during the previous six month-period. Just to note that Albermale's was recently authorized a quota increase from 25,000 tons in 2015, to around 80,000 tons a year. An additional factor driving the attractiveness of this bidding is its pairing with significant investment plans in infrastructure for alternative energy sources, notably solar power generation.

It is still early to draw conclusions on the ability of Chilean authorities to develop a lithium domestic processing industry. The evidence suggests the strategy is one of building on existing competitive advantages, attracting foreign partners with the desired productive and technological capabilities to reshape the country's insertion into the lithium global value chain. This strategy resonates with Stiglitz's (2017) endorsement of efforts toward economic diversification that help developing regions traditionally dependent on commodities to reduce exposure and vulnerability relative to global markets. However, it remains unclear if the Chilean government's role will limit to facilitating the emergence of lithium processing activities, or if more proactive domestic technological capability building efforts will be deployed as well. This notwithstanding, the Chilean case contrasts with that of the Democratic Republic of Congo, where the necessary conditions to add value and benefit from the high global demand for another raw material, Coltan, remain outstanding (Box 1).

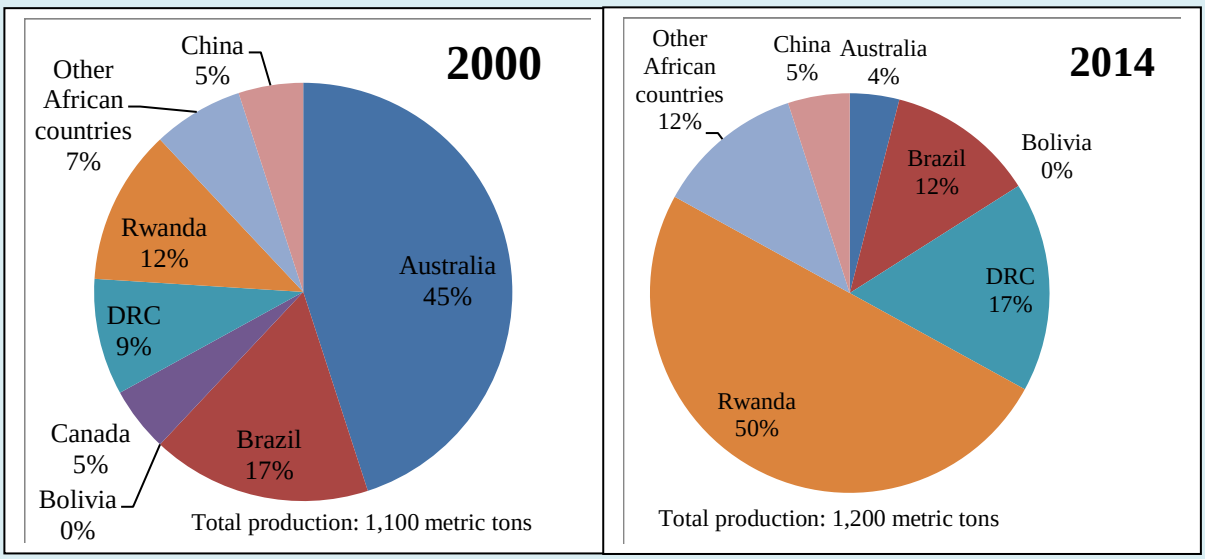
Box 1. Coltan in the Democratic Republic of Congo: A missed window of opportunity for natural resource-based industrialization?

Coltan, an abbreviation of the mineral Colombo-tantalite, is internationally known as Tantalum. Tantalum is a very dense, highly durable dull metallic ore. Discovered in 1802, it was first used to produce lamp filaments. In the 1940s, Tantalum was introduced as input to produce capacitors. Global demand for the mineral increased dramatically with the development of radars, military radio communication equipment, and other ICT technologies. Globally, the electronics industry records increasing demand for Coltan; about 60 percent of world production is used in capacitors for the manufacturing of mobile phones, video cameras, PCs and game consoles. Coltan is a key input for high-tech cutters, air and space technology, turbines, among other applications (Bleischwitz, Dittrich, and Pierdicca 2012; Hayes and Burge 2003). Substitutes for Coltan exist but their performance is considered inferior. The rapidly expanding global demand for Tantalum observed in the past 15 years is expected to continue in the near future (Bleischwitz, Dittrich, and Pierdicca 2012; HCSS 2013).

Tantalite was first discovered in the Democratic Republic of Congo (DRC) in 1910, with the largest deposits located in the Eastern Kivu provinces. In 2009 there were 23 Coltan mining sites in this

region. After extraction, the material is exported raw for further processing. Today, the DRC, together with Rwanda[i], are among the world's largest producers of Coltan. Indeed, one can observe a clear geographical shift, from Australia with 45 percent of total production in 2000, towards Rwanda and DRC in 2014 (Figure 6).

Figure 6. Tantalum production* by country of origin, 2000-2014



Note: *Total tantalum concentrates[ii].
Source: US Geological Survey (2015).

Coltan usually occurs in streambeds, alluvial deposits and in soft rock and can be extracted somewhat easily (Hayes and Burge 2003). These characteristics explain, at least to some extent, that extraction in the DRC is predominantly based on informal artisanal, small-scale mining. Artisanal mining is very flexible and reacts quickly to price incentives, much faster than industrial mining (HCSS 2013). In fact, after the first DRC war in 1996, industrial mining of tantalum was completely ceased.

Although no precise data[iii] on artisanal mining of Coltan exist, 16 percent of the total population in the DRC are said to depend on this activity (Bleischwitz, Dittrich, and Pierdicca 2012). Unfortunately, artisanal and small-scale miners are usually controlled by small locally based armed warring groups or militias. Severe environmental and social challenges accompany conflicts in the mining zones and remain unaddressed by the government (Hayes and Burge 2003).

Various policy interventions adopted at the international level and few at the national level seek to decouple the minerals from conflict. For example, in 2002, the government adopted a Mining Code under guidance of the World Bank and the International Monetary Fund. The Code gives priority to private sector development and large-scale mining. The Code and the Mining Regulations offer the legal framework and differentiate between three modes of production: industrial mining, small-scale mining and artisanal mining. All three modes apply for different tax regimes and permit systems (Geenen 2012). The government has set in place some additional fiscal and customs incentives directly targeting the mining sector (https://www.investindrc.cd/fr/secteurs/mines).

Despite these regulatory efforts, there is no evidence of effective government interventions to stimulate the development of endogenous institutional and industrial capacities to extracting and beneficiation of Coltan, and to ensure safety and decent living standards for the population involved in its production, while the long-lasting conflicts in the Kivu region remain (Bleischwitz, Dittrich, and Pierdicca 2012). Lack of transparency, corruption, poor enforcement of property rights and dearth of state control over the territory constrain the DRC's prospects of benefiting from the demand window of opportunity associated with Coltan (Bleischwitz, Dittrich, and Pierdicca 2012; HCSS 2013; UN Security Council 2015).

Notes: [i.] Despite claims that Rwanda´s increased production contains portions of Coltan smuggled from DRC's Kivu provinces (US Geological Survey 2015; OECD 2015; UN Security Council 2015; The Hague Centre for Strategic Studies 2013; UNEP-MONUSCO-OSESG 2015), with the help of Canadian-based corporations, it is expected to host the first Coltan processing plant in the region (Brenda 2016). [ii.]The USGS does not report the amount of tantalum ultimately recovered from these concentrates, which may be considerably low because of losses experienced during processing. Mine production data published in USGS Minerals Yearbook and Mineral Commodity Summaries, available at http://minerals.usgs.gov/ minerals/. The data indicate that the total amount of tantalum contained in tantalum and tin concentrates averaged about 1,300 metric tons per year (t/yr) (expressed as tantalum contained in concentrate) over 2000 to 2014. Tantalum derived from mining is a component of total supply, which also includes secondary production (recycling), and contributions from releases of inventories (The Hague Centre for Strategic Studies 2013).[iii] Tantalum is not openly traded and there is no stock or spot market where prices can be compared. Purchasing is kept confidential between buyer and seller. Any estimation of the total amount of Coltan produced in DRC and traded internationally is limited by data availability, comparability and reliability and difficulties to trace illegal trade in Eastern Congo (Bleischwitz, Dittrich, and Pierdicca 2012; US Geological Survey 2015).
Source: Authors.

4.2 The development of Korea's automotive industry

Korea is a paradigmatic case of successful catching up achieved through an active and effective government-led export-oriented strategy. Starting in the 1960s, the Korean economy has achieved a radical structural change to become a global industrial and innovation leader (OECD 2012a). Because of its high-level of income per capita attained, and its ability to sustain a high growth pattern, Korea is considered a recent graduate to the group of most industrialized, developed economies. From a policy perspective, the Korean experience can be described as one of: "A deliberate national development strategy which fostered industrialisation in heavy and chemical industries through sequenced and complementary policy interventions. The government targeted the creation of domestic industrial capacities (through a mix of export promotion and import controls), the development of education and skills, infrastructure building, and actively managed capital markets." (OECD 2012a, 19).

At the core of this successful catching up strategy lies the implementation of a series of consecutive Five-Year Economic Development Plans, starting in 1962 (Table 1). The Plans set clear targets linked to specific lines of action and resources allocation; the government was careful to revise and upgrade targets according to progress and achievement of objectives. Equally relevant was the sequencing and coherence built into key policy interventions, while the highest priority for industrial policy was the development of knowledge-intensive industries. Heavy investment in human capital –through literacy and excellence in training and research- was aligned with rising demand for skilled labour according

to the changing needs of the domestic industry. From a demand-side perspective, trade policies selectively combined import restrictions and export incentives, while managed exchange rates favoured export markets as the main source of demand for domestic products.

Table 1. Korea's multi-annual economic development plans 1960-2017

Plans	**Key objectives:**
Five-Year Economic Development Plans (FYEDP)	
1st FYEDP (1962-66)	Building domestic light industry: Textiles, etc.
2nd FYEDP (1967-72)	Building key domestic heavy and chemical industries: Steel, machinery, chemicals, shipbuilding, etc.
3rd FYEDP (1972-76)	Industrial restructuring: Building heavy and chemical industries (industrial complexes).
4th FYEDP (1977-81)	Industrial restructuring: Strengthening heavy and chemical industries (building the bases for technological capabilities).
5th FYEDP (1984-86)	Economic stabilisation: Industrial competitiveness by opening the economy and rationalisation.
6th FYEDP (1987-91)	Regulatory and deregulatory reforms: Supporting high-tech industries; building high-tech and innovative capabilities.
7th FYEDP (1992-96)	Revitalisation of the economy: Establishing a basis for balanced development of industrial sectors and companies.
Other multiannual year plans in the transition to an economy with lower government intervention	
Five-Year Plan for New Economy (1993-1998)	Replaced 7th Five-Year Economic Development Plan and sets out various reform agenda (fiscal, financial, regulatory reforms) and accelerated external liberalization with improved social equity.
First Five-Year Green Growth Plan (2009-2013)	"Low carbon, green growth" was the vision for national development in 2009 and the green growth plan pursued three objectives: 1. Dealing with climate change and achieving energy independence; 2. Creating new engines of growth; and 3. Raising overall quality of life of the country.
Second Basic Plan for Sustainable Development (2011-2030)	Main goals: Promoting economic activity and improving quality of life of the socially vulnerable, improving income and living quality for rural areas and protecting citizens against environmental change.
Second Five-Year Plan for Green Growth (2014-2018)	Main goals: "Creating green spaces in the national territory" and "expanding the foundation for green welfare" and "Realizing a sustainable green society".
Third Basic Plan for Sustainable	Main goals: "Integrated and secure society" and "Inclusive and innovative economy" are among four goals; strategies include fostering integration of

Development (2016-2035)	social segments and gender equality, solving the regional gap and promoting inclusive growth.

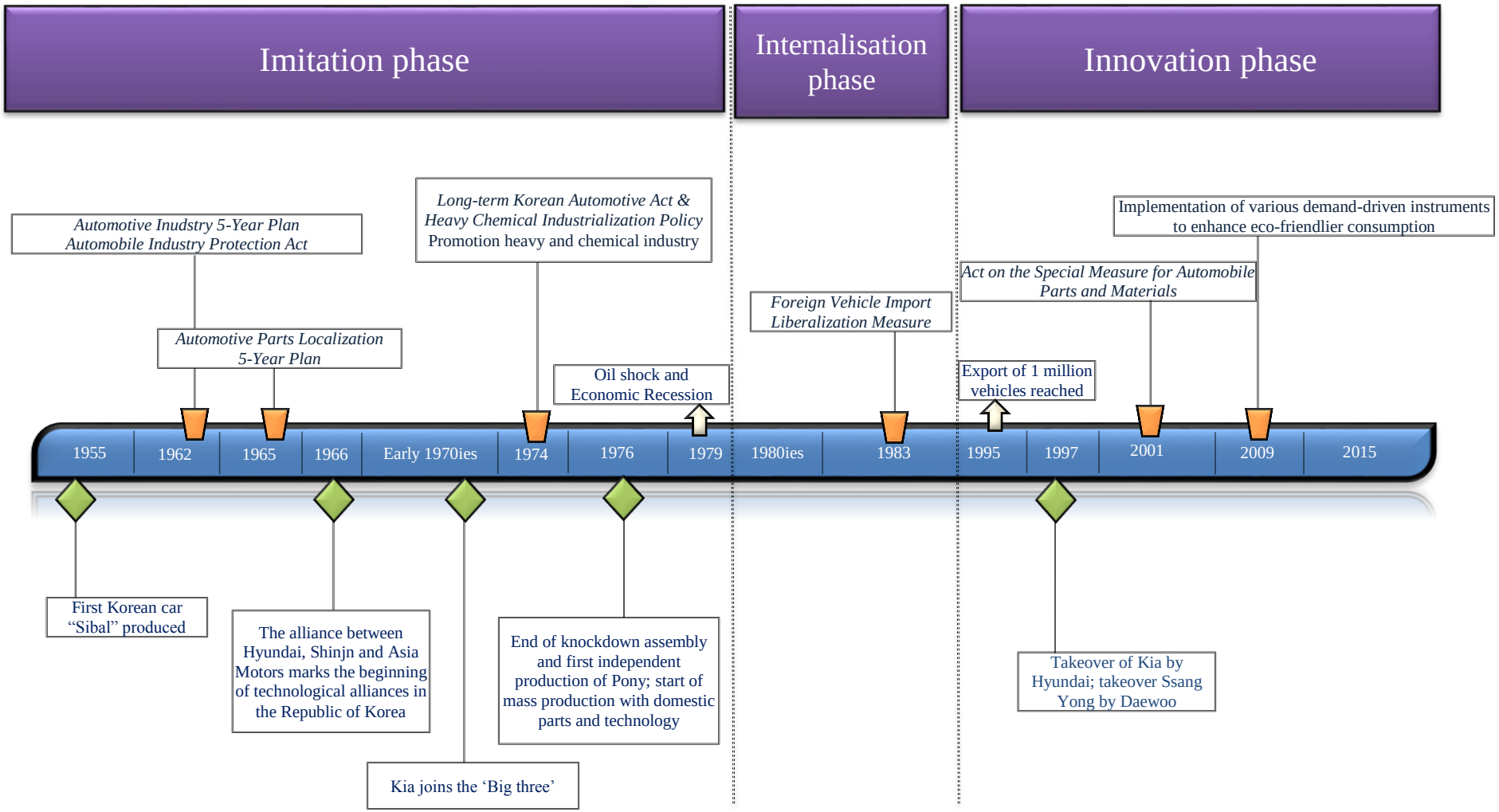
Source: OECD (2012b, 2017).

The seven Five-Year Economic Ddevelopment plans implemented over the period 1962-1997 marked the initial catching up phase characterized by an intense government intervention. Through time, modernisation and technological upgrading changed gradually. From a focus on creating domestic scientific and technological capabilities and learning from foreign best practices in the early stages of rapid industrialization, to more focused support to business ventures and in line with the rising demand and economic leadership of the private sector (OECD 2012a). As government presence gradually phased out, a booming private sector took over responsibility to sustain long-term economic dynamics.

The strategic approach to industrialization described above is characteristic of the way the Korean government supported development of the domestic car manufacturing industry. Webb (2007) identified three main phases in the development of the industry (Figure 7). Each phase can be characterized by a different mix of demand- and supply-driven policy instruments used to foster the accumulation of both manufacturing and technological capabilities.

In a nutshell, the 1960s marked the beginnings of what Webb (2007) identifies as the imitation phase, lasting until the end of the 1970s. This phase was characterized by protectionist policies, as imports of foreign vehicles were widely restricted. The main objective of public interventions was to build and consolidate a world-class, highly competitive domestic manufacturing base, reaching economies of scale and acquiring foreign technologies. An aggressive export-orientation provided the main impetus from the demand side. The imitation phase was superseded in the 1980s by the internalization phase, a decade marked by market liberalisation and an increasing variety of products as import restrictions were relieved. The eighties were investment driven, with a significant expansion in manufacturing and technological capabilities. By the 1990s the Korean car manufacturing industry entered a transition towards an innovation phase; it reached significant maturity, competitiveness and technological capabilities. In this period, the Korean population experienced significant gains in personal disposable incomes, while growing environmental pressures became evident both locally and for the international community. The introduction of various demand-driven instruments signals the Korean government attempts to create an institutional window of opportunity to spur development of green technologies and domestic consumption of eco-friendly cars.

Figure 7. Development of Korea's automotive industry: a long-term view



Source: Authors based on Cho et al. (2014); Webb (2007) and OECD (1999).

4.2.1 The imitation phase 1960s and 1970s

The beginnings of Korea's automobile industry can be traced back to the 1930s under the Japanese colonial rule; Korea started a rudimentary and limited production of automotive parts and automotive maintenance services. It is only in 1955 that the first ever Korean car, "Sibal", was produced using a mix of domestic materials and spare parts from the United States military. Seven years later, in 1962, the first modern assembly line was introduced to produce the model "Saenara". At this stage, the dominant manufacturing process was the knockdown or assembly method.

The 1960s and 1970s were marked by technological learning from the West –particularly the United States and Japan, and the development of basic capabilities for car assembling, production of auto-parts and achieving economies of scale under government protection. Growth of the industry was underpinned by cheap labour, while the building of scientific institutions, including government research institutions, contributed significantly to technology development of domestic firms. The 1970s were characterized by massive investment and expansion in manufacturing capabilities (Bartzokas 2005; Webb 2007).

Significant policy-related events include the establishment of the Act of Standardization, the Road Traffic Act and the Automotive Traffic Enterprise Act in 1962, followed by adoption of the first Automotive Industry Five-Year Plan and the Automobile Industry Protection Act in 1962 (Cho, Kim, and Kim 2014; Webb 2007; OECD 2012b). The latter two documents provided protection to the domestic industry and fostered economies of scale by restricting the number of assembly plants and enforcing local content requirements. However, the result was the creation of monopolies –under the complacence of the Ministry of Trade and Industry- rather than internal competition.

In 1965, the government implemented new local content requirements through the Automotive Parts Localization 5-Year Plan which given its limited results, was superseded by a new Automotive Parts 3-Year Plan in 1969 (Cho, Kim, and Kim 2014; Wäldchen 2013). Local content requirements amounted to 80-99 percent for passenger cars (McElroy, Creaner, and Workman 1985). In 1966, the Korean automotive industry was consolidated in three big manufacturers: Hyundai Motor (an influential chaebol[4]), Shinjin Automotive Corporation and Asia Motor. These firms established technological alliances: Asia Motor partnered with SERI to bring capital goods and technology, while Hyundai entered a technological alliance and assembly agreement with Ford (Cho, Kim, and Kim 2014).

In the 1970s, the government started to promote the chemical and heavy industries[5] –at the time, the latter

[4] Chaebols are usually privately-owned business conglomerates managed by family members and enjoy a very close relationship to the government. The influence of chaebols in the government plans was very strong until the 1990s. With the Asian crisis, reforms were imposed on chaebols, as they were seen as lacking transparency, inefficient and a blockage to market reforms (Wäldchen 2013).

[5] The government implemented a policy mix to promote the chemical and heavy industries, including subsidised long-term credits, tax incentives, the establishment of vocational schools and government-led research centres.

included the automotive industry. In 1973 the Long-term Automobile Promotion Plan was introduced to speed up the localization of automotive parts manufacturers, to boost mass production and exports, and to facilitate vertical and horizontal integration within the industry. The government introduced specific targets for production costs, plant capacity, local content ratio and cubic capacity of the engine. The new Plan invited producers to submit proposals for the launching of a mass-produced Korean cheap car with export potential and a prominent level of local content. In 1976, Hyundai was selected to manufacture the first Korean car; the firm started independent production of its "Pony" model incorporating foreign and domestic technology. In exchange for public funding the company committed to export 5,000 units per year. In this period the knockdown assembly method began to be replaced by domestic production of auto parts. Some 18,000 units of Pony were exported within three years of release, signalling a new phase in the development of the automotive industry away from limited knockdown processes.

In 1976, the government set a new goal, namely to produce 1 million cars by 1981 and 2 million units by 1986 (Catalan 2010; Cho, Kim and Kim 2014; Wäldchen 2013; OECD 2012b). In 1977 the government designated the automotive industry a strategic export sector (Catalan 2010). In 1978, it decided to allocate to the machinery industry, which included the automotive industry, some 55.7 percent of the funding available to support the manufacturing industry (Cho, Kim, and Kim 2014). In the early 1970s, Kia joined the big three producers taking over Asia Motor. Accordingly, Kia, Daewoo (former Shinjin) and Hyundai became the relevant players in the domestic industry.

During the imitation phase, the government acted as strong regulator. The most significant policy tools included local content requirements, restriction on imports, limited variety of models produced, attraction of foreign direct investment (FDI), adoption of tariff- and non-tariff barriers, subsidized loans, export subsidies, tax incentives, together with the building of scientific organisations to serve the industry and the promotion of technological learning through licensing (Bartzokas 2005; Cho, Kim, and Kim 2014; Truett and Truett 2014; Webb 2007). In line with the classic infant industry approach, import restrictions during the catch-up phase ensured domestic demand for local manufacturers (OECD 2012a).

4.2.2 The internalization phase, the 1980s

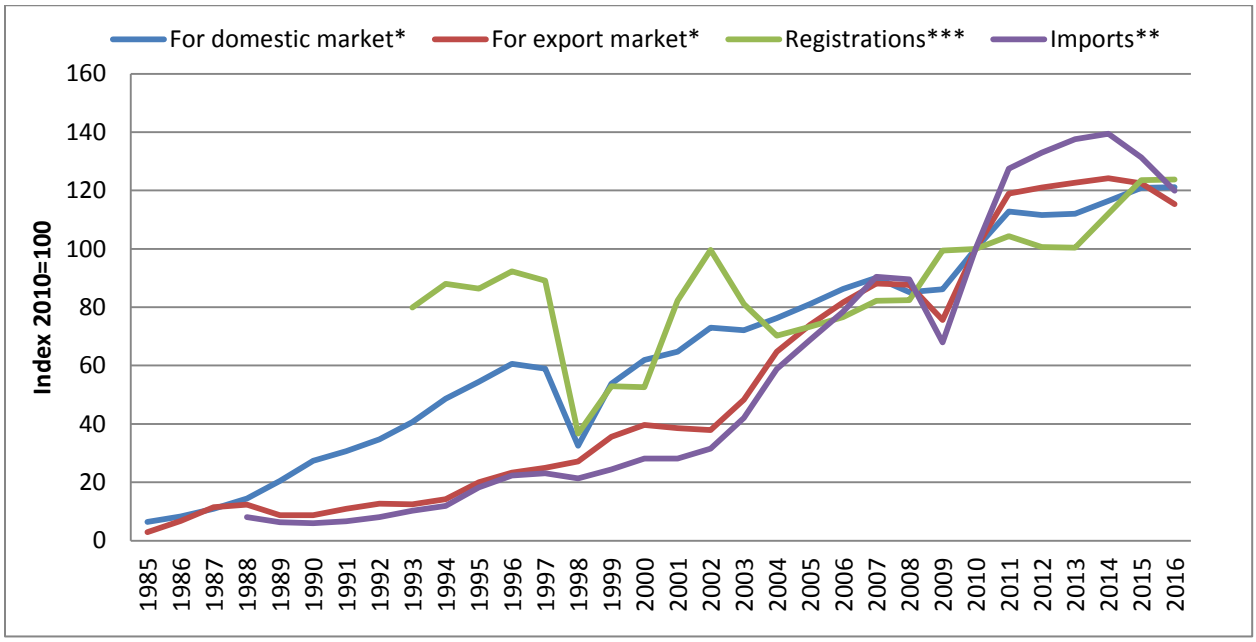
During the "internalization" phase, development of the automotive industry was challenged by the consequences of the economic crisis and the oil shocks of 1979. The government intervened promoting a new restructuring and consolidation reducing the number of domestic car manufacturers, together with a gradual phasing out of protectionist measures (Cho, Kim, and Kim 2014). This restructuring was possible thanks to the level of maturity reached by the domestic automotive industry (Jaymin Lee 2011). The

These were accompanied by import controls and export promotion measures such as export credits and the creation of the Korean Trade-Investment Promotion Agency (OECD 2012b).

enhancement of manufacturing capabilities, the expansion in technology-intensive industries, and the promotion of private R&D were significant drivers in the 1980s and the 1990s (Bartzokas 2005).

Korean manufacturers began building competitive advantage based on two factors: First, meeting consumer preferences through, for example, development of larger cars and offering an increased variety of vehicles. Second, raising competitiveness based on both price and quality. The drivers included enhanced quality controls, expanding after sales service networks, a wider range of models for export and more aggressive marketing strategies. From a demand perspective, a significant window of opportunity opened towards the end of the 1980s and the early 1990s as domestic demand for cars began to expand rapidly, while exports continued at a steady pace (Figure 8).

Figure 8. Korean automotive indexes[τ] and income per capita, 1985-2016



Notes: [τ]The data refer to Korean automotive index of shipment for domestic and export market, index of imports of passenger cars and index of new car registrations. *Korean automotive index includes manufacture of motor vehicles, trailers and semi-trailers. Data based on KOSIS Monthly Survey of Mining and Manufacturing; Data reported based on Korean Statistical Industrial Classification consistent with ISIC (KOSTAT 2017a). Shipment is defined as *"The release of manufactured goods from companies is deemed shipment. However, if payment is received while the goods are not delivered yet, in principle, it is not considered shipment."* Manufactured goods released from companies for sales, etc., are divided into domestic shipment and shipment for export (KOSTAT 2017b); Data available from 1985-2016. **Data on automotive imports include Manufacture of motor vehicles, trailers and semi-trailers; based on ISIC, Rev. 3 (Harmonized system 1988); Data available from 1988-2016. ***New car registrations: New passenger car registrations include imported, new or restored cars not previously registered in Korea. Direct source: KOSTAT (OECD 2017); Data available from 1993-2016.
Source: Authors with information from KOSIS (2017), Comtrade (2017) and OECD (2017).

In 1983 adoption of the Foreign Vehicle Import Liberalization Measure set the intention to start phasing out import restrictions on foreign vehicles by 1986, and to eliminate them completely by 1989. According to KAIDA, the Korean Automobile Importers and Distributors Association, in January 1987 Korea began

imports of foreign cars for the first time -restricted to large cars with engine capacities of 2L or more and small cars of 1L. In April 1988, the government allowed imports of all types of automobiles. However, imported car sales remained insignificant at the time, partly because of high custom taxes on imported cars -50 percent in 1987 and 25 percent in 1989. Further cuts drove import duties down to 20 percent in 1991 and 8 percent by 1995 -a level that remains to date (Korea Automobile Importers and Distributors Association 2017).[6] Against this background of liberalization, Hyundai entered a joint venture with Mitsubishi under the premise that Hyundai would keep its independent management, while technological collaboration was strengthened (Cho, Kim, and Kim 2014). Moreover, after the second oil crisis of 1979, Hyundai was quick to enter the United States market where the demand for smaller cars was increasing rapidly (Wäldchen 2013).

Despite the relaxation in protectionist policies during the 1980s, the government maintained its active regulator role. This time however, it introduced additional fiscal measures to stimulate domestic demand. According to Cho, Kim, and Kim (2014), demand-driven policies in this period encouraged diversification in the consumer base and consumer protection. The government implemented competition policies and increased support for innovation along the deregulation process in the 1980s (OECD 2012b).

4.2.3 The innovation phase: 1990s to present

With the 1990s began an innovation-driven stage. The policy focus and the overall dynamics of the industry searched to deepen innovation capabilities within a rapidly growing domestic market (Bartzokas 2005; Cho, Kim, and Kim 2014). Following the crisis at the end of the decade, a new restructuring took place, with Hyundai taking over Kia, while Daewoo took over SsangYong (OECD 1999). Automotive producers started to focus more on qualitative than quantitative growth. Additionally, rising personal incomes accompanied a change in preferences for larger cars (Lee 1997). The government began to withdraw while the private sector increasingly took the lead driving economic dynamics (OECD 2012b).

In 1995, Korea achieved a milestone of a million exported vehicles, while variety of models increased, leading to higher demand (Cho, Kim, and Kim 2014). The year 1997 marked a crucial turning point due to the Asian crisis, domestic demand experienced a drastic fall, with a slight decrease in imports and relatively stable exports mainly to Western Europe and North America (Lee 1997). However, domestic demand recovered quite rapidly boosting new car registrations. New passenger car registration increased dramatically from 2.1 million in 1990 up to about 10 million in 2002 (Lee and Cho 2009). This surge in domestic demand resulted in a reduction in Korean exports of cars, while imports of cars reported a

[6] The 8% tariff on imported cars is exempted for manufacturers that meet the origin criteria under applicable free trade agreements; then the duty rate is between 0 and 4%. Various non-tariff barriers continue to protect the domestic market (Aggarwal and Evenett 2010; OECD 2017; PwC 2016).

steady increase. The downside of this dynamics was larger traffic congestion, energy waste and air pollution that led the government to impose heavy taxes on automobiles and gasolines (Lee 1997).

During the innovation phase, while the government has maintained its strong regulator role, it has become a more active facilitator and co-generator of innovation. In 2001, the government adopted the Act on Special Measure for Automotive Parts and Materials and a technology development fund to continue supporting the automotive industry. This initiative coincided with the start of innovation in green technologies, including hybrid cars, electric and fuel-cell vehicles (Cho, Kim, and Kim 2014). In 2003, the government included alternative automobiles within the ten strategic future growth engines for the Korean economy. In this same year, 80 percent of Korea's R&D resources and outputs concentrated in ICT and automobiles (Bartzokas 2005).

The government has continued market liberalization. In 2005, for the first time, diesel passenger cars entered the domestic market thereby increasing consumer choices. This decision responded to a request from domestic car manufacturers to improve domestic consumption (Lee and Cho 2009). This notwithstanding, government taxes on diesel engines are higher than those on petrol ones due to their higher contribution to air pollution (OECD 2017).

The surge of a new economic crisis in 2008/09 depressed domestic demand in line with sluggish global demand. Yet, new car registrations have maintained an upward trend until 2012 suggesting that demand for cars is still not satiated in the country. In 2013, the Korean automotive market entered a new phase of stagnation due to an economic slowdown that affected the domestic and export markets. According to the Korean Automobile Manufacturing Association (KAMA), production and supply fell at least to some extent due to labour strikes, shrinking consumer confidence and an increase in household debts (Korea Automobile Manufacturers Association 2014). And yet, sales of imported vehicles increased by 20 percent, reaching a new record, fuelled by the introduction of new mid and small-size models, tariff reductions associated with the Korea-European Union/United States free trade agreements, the increased popularity of European diesel cars and aggressive marketing strategies implemented by importers. Increased consumer choice through imports has also accompanied a reduction in price differentials between Korean-manufactured and imported vehicles (Korea Automobile Manufacturers Association 2014). In 2014, the recovery of the domestic market has renewed impetus in new car registrations.

4.2.3.1 Greening the industry

In 2008, Low Carbon, Green Growth became the vision of the national Korean development strategy (Table 1); beginning a transition towards greener consumption and production patterns (OECD 2012b). To spur greener developments in the automotive industry, the Korean government has implemented various other instruments to increase domestic demand for cars, and to promote more environment friendly choices for cars. For example, in 2009 a 70 percent cut on registration and acquisition taxes was

provided to consumers, both domestic and foreign, who replaced their pre-2000 car for a newer one with lower greenhouse gas emissions. This measure, considered a direct and positive influence to boost domestic purchases is ongoing; it is valid for consumers who scrap their old cars within two months from registering a brand new one (Aggarwal and Evenett 2010; OECD 2017). In 2009, the government announced tax incentives for the acquisition of hybrid, plug-in hybrid, electric and hydrogen cars, with tax rebates of up to 1.3 million KRW (extended until the end of 2015). Furthermore, since 2012 electric vehicles up to KRW 2 million are exempt from consumption tax.

In 2010, the government introduced subsidies targeting electric car buyers; the amount provided so far exceeds US$ 92 million. Subsidies for hybrid cars were introduced in 2014 (OECD 2017). The government has set a target of 800,000 electric cars in use by 2020; an ambitious figure considering that in 2014 there were about 140,000 electric cars in use only. To boost purchases of new electric cars, in 2015 the government introduced a subsidy of US$ 900 in addition to existing tax incentives for the purchase of new energy vehicles (OECD 2017). According to OECD, annual purchases of electric vehicles more than tripled between 2011 and 2014, although the share of hybrid cars in total vehicle registrations increased only from 0.02 percent in 2008 to 0.87 percent in the first quarter of 2016 (OECD 2017). The main barriers for hybrid electric cars still lie in the speed of adoption, conditioned by low gasoline and diesel prices, low consumer risk tolerance and high purchase prices (Lee, Kim, and Shin 2016).

The government is planning to introduce a bonus-malus programme in 2020, similar to the French system, where incentives are provided for the purchase and technological innovation of vehicles with low CO2 emissions and higher taxes on purchases of highly polluting cars; these taxes will be used to finance the subsidies for more eco-friendly cars (OECD 2017).

4.2.4 A focus on policy and strategy

It is difficult to ignore success in the catching up strategy of the Korean automotive industry. Coinciding with the start of the innovation phase, over the last 15 years, Korea has enjoyed a stable position among the world's top five producers (Table 2). Clearly however, China poses the strongest threat, notably in the segment of new energy vehicles where Korea is focusing future development efforts.

Table 2. Korean position in the global ranking of automotive producers

Japan	1	1	2	2
United States	2	4	6	4
Germany	3	3	3	3
Korea	5	5	4	5

China	14	2	1	1

Source: OICA (2017).

The strategic management of demand has been a key driver of the development of the Korean car manufacturing industry. From the initial targeting of external demand and protection of the domestic market, the balance has slowly shifted towards an increased contribution and reliance on domestic consumers fuelled by rising personal incomes. Today, one can observe a more even contribution of both external and domestic markets (Figure 8).

From a policy perspective, the Korean government has supported development of the domestic automotive industry through a mix of supply- and demand-driven instruments over time (Table 3). In the beginnings of the automotive industry the government played a strong regulator and protective role, building on an export-orientation and the creation of economies of scale. Policy tools used at the time included export subsidies, restriction on imports and FDI flows, imposition of local content requirements, provision of subsidized loans, technology licensing, tax incentives and tariff- and non-tariff barriers. As the industry picked up pace, government interventions continued to be driven by regulation, but increasingly by promoting innovation. This was possible thanks to initial efforts at setting framework conditions through investment in R&D infrastructure and progressive introduction of direct incentives for firms to carry out innovation. The management of demand has become more active as environmental concerns have risen significantly.

Table 3. Policy mixes characteristic of the development of the Korean automobile industry

Policy instruments			
Supply-driven:			
Export subsidies	X		
Restriction of foreign direct investment	X		
Subsidized loans	X		
Technology licensing	X		
Scientific institution building	X	X	
Joint ventures		X	
Technology development fund			X
Industrial R&D promotion			
Producer tax incentives	X		X
Demand-driven:			

Consumer tax incentives		X	X
Consumer subsidies			X
Mix supply- and demand-driven:			
Local content requirements	X	X	X
Tariff- and non-tariff barriers	X	X	X
Restriction of imports	X		
Competitiveness policies		X	X

Source: Authors based on Aggarwal and Evenett (2010); Bartzokas (2005); Cho, Kim and Kim (2014); Lee and Cho (2009); OECD (2017); Truett and Truett (2014) and Webb (2007).

Domestic market protection during the imitation phase helped to enhance productivity, while restriction on imports limited consumer choice in benefit of domestically produced cars. Local content requirements and the use of tariff and non-tariff barriers remain until today. Joint ventures, consumer tax incentives and competitiveness policies have been used to strengthen competitiveness. The rise in disposable incomes and market liberalization have fuelled growth in domestic demand. As increased air pollution has become a growing concern, the government is focusing its regulatory power on specific segments rather than the whole automotive market. Indeed, development of a new generation of vehicles is accompanied by consumption-enhancing and innovation-oriented interventions.

4.3 Embraer's history and the role of the government in the development of the Brazilian aircraft industry

The history of the commercial aircraft industry in Brazil and of Embraer, its dominant company, is one of the most widely discussed cases of industrial development (Ramamurti 1987; Frischtak 1992; Marques 2004; Goldstein 2002a, 2002b; Cassiolato, Bernardes, and Lastres 2002; Vértesy 2011; Vértesy and Szirmai 2010). Such an attention is justified by the fact that Embraer has made it to the top three companies producing commercial aircraft, and has been among the top five manufactured product exporters of Brazil, and for a period, a market leader in regional jet deliveries. Although Brazil has long been home to aircraft design and manufacturing, large-scale industrial activities are linked to the foundation of Embraer.

This case study looks closely at two key moments in the history of Embraer, which, in diverse ways, required policy and management interventions that proved to be critical for establishing subsequent growth trajectories. The first moment focuses on the 1969 establishment of Embraer, followed by its successful entry in the global commuter aircraft segment. The second one focuses on the changes that took place in the early 1990s followed by Embraer's entry in the regional jet segment.

At both moments, a virtuous combination of factors helped usher in a new phase in the development of the industry. These factors, as articulated for the aircraft industry by Vértesy (2017), include a

constellation of windows of opportunity -demand for a specific aircraft type, the availability of technology on the market-, corresponding innovation strategy, and the availability of the necessary preconditions. The case of Embraer shows how a combination of entrepreneurship and public interventions helped create conditions for a latecomer producer to effectively enter markets dominated by giants, and how government interventions helped reshape precarious demand windows to ensure sustainable growth paths. It is important to highlight at the outset that the aircraft industry is rather peculiar, due to its very high capital and technology intensity, and the long lead times between the design of an aircraft prototype, its entry into service and the eventual break-even point. Various forms of public interventions are rather wide-spread in all market segments in the context of advanced, industrialized countries just as in late industrializers.

4.3.1 The Emergence of Embraer

One of the main reasons for setting up Embraer in 1969 was to commercialize a new aircraft design of the Aerospace Technology Centre (CTA), an advanced public research institute in the field. The CTA and the closely related Institute of Aeronautical Technology (ITA) specialized in technical training, both located in Sao Jose dos Campos in the state of Sao Paulo, represent the scientific and engineering knowledge base of the industry in Brazil. The two institutes are also important bridges between the smaller-scale activities of Brazilian small aircraft license production and local design before and during World War II, and the large-scale activities characterizing the period starting with the 1970s.

The emergence of the Brazilian aircraft industry relied on a combination of commercial and military interests, carefully timed public interventions as well as innovative entrepreneurship. The establishment of a mostly government-owned company to produce military and commercial aircraft locally may seem to be in the strategic interest of the military (which had governed Brazil since 1964). Nevertheless, an explicit commercial orientation has been crucial throughout the history of the company. The very design of the prototype that became the EMB-110 "Bandeirante" was conceived to fill a local market niche, which was the need to replace aging DC-3s with another propeller-driven aircraft able to serve remote airports with limited infrastructure. It was also designed with export in mind, as will be discussed below.

Following the introduction of the 19-seater "Bandeirante", Embraer launched the EMB-121 "Xingu" in 1976, a pressurized small plane aiming for the executive market, the EMB-312 "Tucano" in 1980, a military trainer, and the 30-seater, pressurized turboprop, the EMB-120 "Brasilia" in 1985. The "Bandeirante" and the "Brasilia", as well as the "Tucano" became successful in the domestic and the export markets; about 500, 350 and 320 were produced of these types, respectively.

A combination of public procurement, protectionist policies, provision of finance were critical to boost demand for Embraer's aircraft. The Brazilian Air Force's initial procurement of "Bandeirantes" payed for production and development expenditures. Customers of Embraer could also benefit from financing

through BNDES, the Brazilian state development bank and export finance funds of Banco do Brazil, a state-owned commercial bank. Embraer was exempt from duties on import of inputs as a weapon-producing company, as well as from trade and production taxes, all of which further reduced the price of the aircraft which relied heavily on imported parts and components. A 50 percent import duty on aircraft of the types produced locally encouraged domestic buyers to prefer Embraer (Goldstein 2002a).

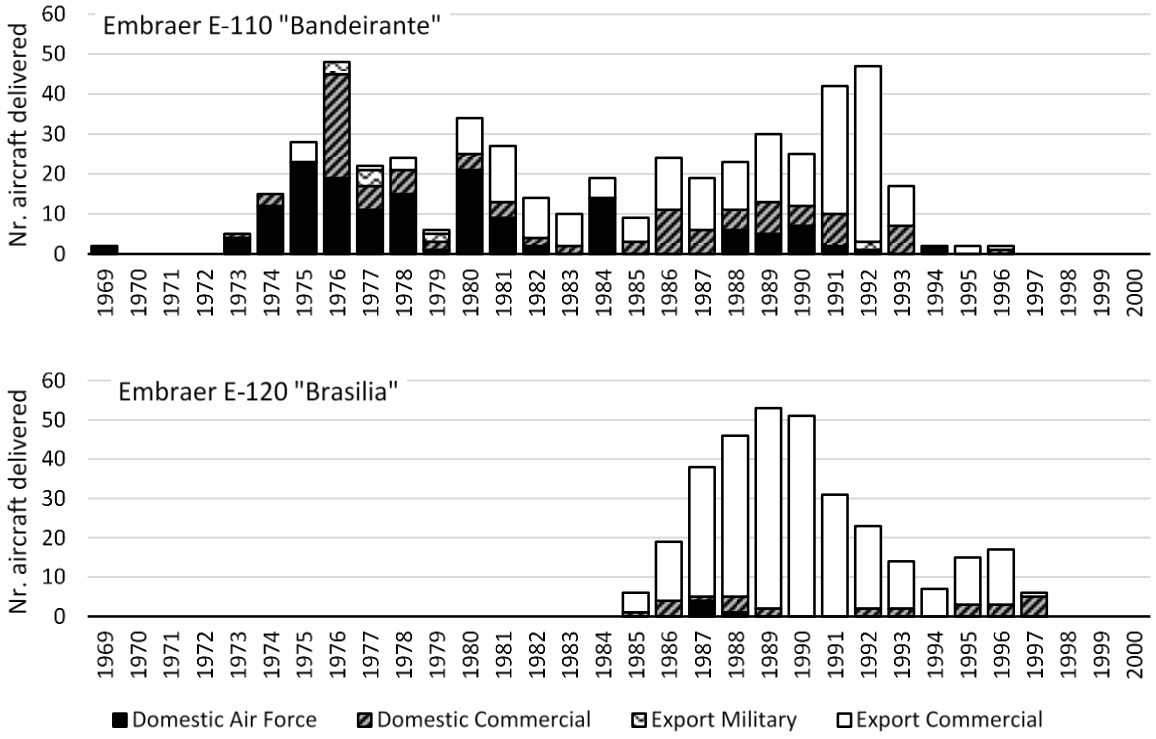
Embraer acquired crucial technological capabilities making use of publicly funded licensing agreements to locally assemble jet trainer aircraft (the MB-326) of the Italian Aermacchi and several smaller aircraft from the Piper company of the US. Embraer also entered joint venture with the Italian Aermacchi and Aeritalia which successfully co-developed the AMX ground attack jet aircraft in the 1980s. The presence of CTA and ITA and highly skilled scientists and engineers assisted the Brazilian aircraft industry to efficiently absorb modern technologies and use them for improving local designs. Embraer's strength lied in designing and assembling systems, and its parts and component suppliers were mostly located in Europe and North America. Although the local share varied by product, this overall approach did not change substantially as the global aircraft industry became ever more vertically specialized. Nevertheless, the involvement of foreign suppliers also increased trust among buyers and facilitated exports.

Figure 9 illustrates the gradual shift in demand for Embraer turboprops along the production cycle. The Brazilian Air Force purchased about two-thirds of the aircraft delivered by the newly established company in the 1970s, Brazilian air carriers accounted for an additional 20 percent of sales in the period. By the end of the 1980s, Embraer established itself as an international player in the commuter aircraft market, with over 140 of its newly produced EMB-110 "Bandeirante" and EMB-120 "Brasilia" aircraft sold in the United States alone. The export success is rooted in many factors. Embraer systematically followed an internationalization strategy, designing aircraft in a way to facilitate certification by the United States Federal Aviation Authority (FAA). Additional certifications and sells were obtained in Uruguay (1975), France, the United Kingdom and Australia (1977). The 1978 FAA certification of the "Bandeirante" was just as much the outcome of strong diplomatic efforts to counter the opposition of United States producers, as well as the demand posed by United States airlines interested in less costly aircraft following the oil crisis.

An additional factor facilitating entry to the United States market was a major deregulation in 1978. While it resulted in the closure of jet service to smaller airports, a niche opened for shorter and cheaper commuter service offered by turboprop aircraft. Embraer became a first mover in a fast-expanding market; its only United States-made direct competitor was Fairchild's "Metro III". To meet increased demand, Embraer expanded production capacity. By the early 1980s, exports amounted to nearly 50 percent of total sales (over 100 million US$ in 1981). The "Brasilia", a derivative, more advanced version of the "Bandeirante", became an instant success, as it responded to customer needs of low operating costs,

high speed and more comfortable cruising altitude. The overwhelming majority of these aircraft was sold abroad (Figure 9).

Figure 9. Selected Embraer turboprop deliveries by type of buyer (1969-2000)



Note: Data combines deliveries of the EMB-110 "Bandeirante" and EMB-120 "Brasilia" types, and excludes executive aircraft, military trainers and regional jet deliveries in the period.
Source: Authors' calculations using aircraft delivery statistics from airlinerlist.com and Vértesy (2011).

*4.3.2 **Embraer's privatization and rise to leadership in the regional jet market***

The industrial development structures that worked from the 1970s until the mid-1980s failed after a political and financial crisis hit Brazil, and as the end of the Cold War brought along a major drop in global demand and aerospace finance. The crisis and the change of political regime amplified the problems of the state-owned enterprise. While cash-flow from the sale of its military aircraft dropped, the government discontinued the export financing scheme, Embraer was developing new aircraft projects that did not respect marketing considerations (Frischtak 1992; Goldstein 2002b). Furthermore, excessive bureaucracy prevented the company from entering and realizing joint ventures. After a lengthy search for options, Embraer and the Brazilian aircraft industry underwent a fundamental reorganization of its technological learning, innovation and productive activities.

Embraer was privatized to non-industry-related investors in 1994 after several failed attempts. The Brazilian government retained an about 7 percent ownership, including a golden share with the right to veto decisions on the key strategic direction of the company. The government also agreed to

recapitalizing the Embraer and assuming its considerable debts, while the new investors injected further funds. The company was consolidated, spinning off activities which were not associated with its new core strategy of co-design and system integration.

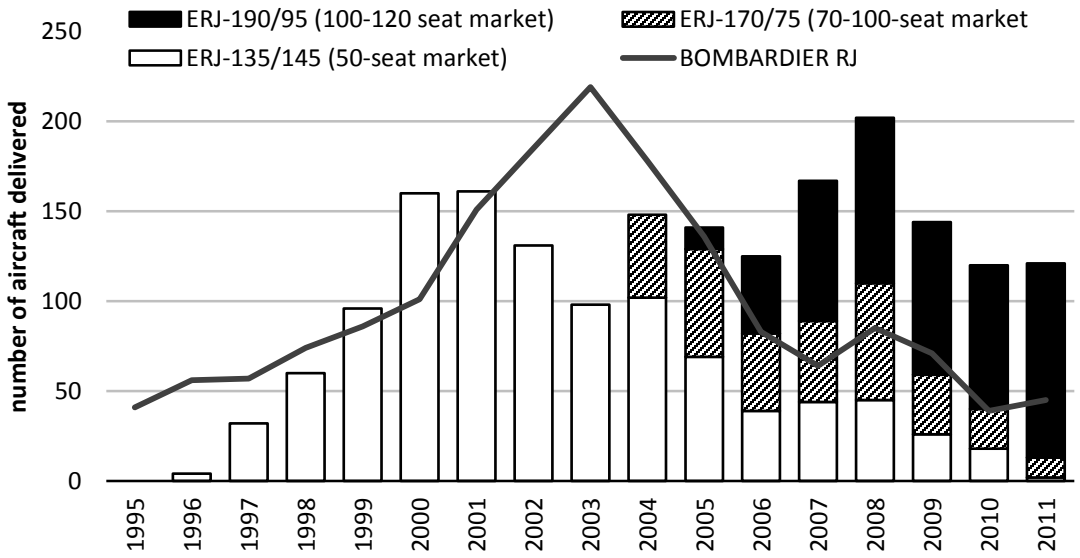
Apart from the privatization, consolidation and recapitalization of Embraer, at least three other key factors necessitated intervention for the company to be able to respond to the global market niche it identified in the 50-70 seat regional jet market. First, the government provided additional financial support to Embraer, in the form of funding research and development through BNDES and Ministry of Science and Technology funding schemes. Second, the Banco de Brasil's PROEX export promotion programme offered customers an interest rate equalization scheme. The programme, which offered an up to 3.5 percent rebate on interest rates on loans to offset what was called the "Brazil Cost", became a main target in the Brazil-Canada trade dispute at the World Trade Organization. The fact that Canada, home to Embraer's main competitor and the market leader in regional jets, Bombardier, protested what it saw as illegal state support[7] already indicates the successful return of Embraer to the export markets. Third, Embraer introduced an organizational innovation to use a risk-sharing partnership model to gain access to advanced technology and additional development funding. Agreeing to share risks and revenues based on their contribution, Embraer secured a range of European and American partners in the development of its new ERJ-135/145 family of regional jets in the 35-50 seat range.

Relatively lower fuel prices, economic growth, customer preference for jets over turboprop planes, and "scope clauses" (agreements between United States airlines and pilot unions regulating the diffusion of the lower cost regional services) all boosted demand for smaller sized regional jets. While many companies aimed to respond to this window of opportunity, Bombardier became the first mover and soon a market leader, overtaking the two incumbents, Fokker and British Aerospace owing to better management and launching more efficient products of the CRJ family (Vértesy 2017). During the crisis years and before the privatization and reorganization, Embraer was unable to perform a strategic response similarly to Bombardier. However, following the changes, the ERJ-135/145 family became a strong competitor of Bombardier in the global market by the late 1990s (

[7] The prolonged dispute, which started in 1998 and involved retaliatory measures as well as a counter claim by Embraer, produced a ruling in 2002.

Figure 10).

Figure 10. Embraer's commercial regional jet production by type, contrasted with Bombardier (1995-2011)



Source: Embraer and Bombardier Annual Reports, Vertesy (2017).

Recognizing sales potential in the larger, 70-120 seat regional jet market, Embraer launched a clean-sheet development project in the early 2000s. The design and development of the ERJ-170/190 family benefitted from a 1 billion-dollar BNDES credit line and a streamlined list of risk-sharing partners. Embraer took a 45 percent stake in the project. The 80-seater ERJ-170 first flew in February 2002, received FAA certification two years later and was delivered to the launch customer. A slightly stretched version with 88 seats, the ERJ-175 was introduced a year later. The first 110-seater ERJ-190 flew in 2004, followed by the 122-seater ERJ-195 a few months later. The American low-cost carrier JetBlue became the launch customer with an order of 100 and option for another 100 planes. With the introduction of the 190/195 planes, Embraer became a direct competitor the smallest types of Airbus and Boeing.

A major order for a medium-sized jet transport aircraft, the KC-390, with a 1.5-billion-dollar development cost helped Embraer and the Brazilian aircraft industry weather the global financial crisis as well as set foot in the military transport market, where the replacement of aging Lockheed C-130s offer potential sales. In fact, European and South American air forces soon declared intention to buy the new aircraft. Beyond the military use, Embraer also reports potential demand for the KC-390 or a stretched derivative in the air cargo market.

In the regional jet segment, Embraer is currently launching a re-engined model of the ERJ-170/190 family, the "E2-Jets", which aim to increase fuel efficiency. At the same time, it faces renewed competition in different fronts. The recently launched C-Series regional jets of Bombardier are

technologically the most advanced types in the market with significant efficiency gains, although with significantly higher sales prices. The regional jet market sees a number of competitors, including the recent entrant Sukhoi Superjet, as well as new entrants including China's COMAC with the ARJ-21 and Japan's Mitsubishi MRJ.

*4.3.3 **Policy lessons from the Embraer experience***

Since the emergence of Embraer, the Brazilian aircraft industry has stood on two legs, serving both commercial and military customers in Brazil and abroad. While the trainers, jet fighters, and ground attack aircraft served the needs of the Brazilian Air Force, the commercial aircraft, apart from the initially produced "Bandeirante", were mainly exported. Airlines in Brazil (apart from the relatively recent *Azul*) have flown imported mid-sized and large civil aircraft rather than regional jets, exceeding the size of Embraer's products. Embraer's commuters and regional jets were best equipped to serve the hub-and-spoke systems and regional routes in the North America and Europe. Exports offered a stream of revenues. The market orientation was essential for the long-term growth of Embraer, but it alone does not explain the success. Policy interventions were crucial to enable the company to respond to emerging demand in certain market segments. The Embraer experience provides some key policy factors sustaining successful catching up.

- Timing: Establishing well-defined targets for the construction of technological capabilities, and the phasing out of reliance on public support;
- Combining the pulling capacity of a state-owned enterprise with an entrepreneurial culture. Even if it was established as a state-owned enterprise, elements of an entrepreneurial culture were present throughout its history. The linkages with the Brazilian Air Force or the government were strategically used to finance development, access technology and facilitate export market access, but the initiatives were supplied by the company leaders (Ramamurti 1987; Silva 2004). In addition, a key role of the government was its support for the emergence of the aerospace innovation system in Brazil with central institutes such as the technological research organization CTA and ITA, the institute for training aeronautical engineers;
- The government provided a variety of direct and indirect support "tools" over time through different channels. These included contributions to financing R&D and the development of new aircraft; military procurement; providing export financing and credit through state development bank; facilitate access to advanced foreign technology; outright market protection (during the emergence phase); exemption from taxes and duties; diplomatic support (for certification and military exports).

5 Conclusion

As a long-term process, industrial development requires sustained commitment of resources and carefully crafted industrialization strategies. Building on a framework of windows of opportunity, this paper showed that industrialization involves developing the ability to respond to distinct combinations of factors. Technological breakthroughs, changes in regulatory environments and modifications in demand conditions for certain manufacturing products or for natural resources of high value for manufacturing activities determine opportunities to boost industrialization. This notion is consistent with literature on economic development as a catching up processes which occurs in stages, each of which can be identified by specific events. This paper focused particularly on the kind of policies that allow countries to respond to demand windows of opportunity.

In pursuing industrialization, policy makers have at their disposal a complex and varied set of policy instruments that target supply factors, or demand conditions, or both. In effect, demand-driven interventions are usually implemented as part of broader policy mixes including supply-driven measures; demand-driven interventions help to close the loop by shaping market dynamics and actual consumer behaviours according to intended industrial development targets. Striking the balance between supply- and demand-driven industrial policy interventions is challenging, often constrained by the ability of policy makers to manage demand.

The paper argued that as a driver of industrialization, demand for manufacturing goods can be a framework condition outside government control, or a variable suited for more direct policy action. Either case leads governments to assume different roles. Situations when demand for manufacturing goods is perceived as a framework condition should not prevent government intervention; in such cases, policy makers usually focus on supply-driven interventions, setting framework conditions for industrialization. Certainly, the debate remains on the extent of desired government intervention. In line with advocates of industrialization as a process that builds on existing or observed comparative advantage, the case of Chile illustrated strategies to remove market failures, build on a perceived favourable business environment to facilitate access to productive and technological capacities for lithium processing so far not available in the country. No clear indication is found on future support for the parallel building of domestic technological capabilities and learning from foreign direct investment. And yet, the contrasting experience of Chile and the Democratic Republic of Congo illustrated that to benefit from demand windows related to natural resources endowments, there is need for strong governance, the ability to set clear objectives and a deep understanding of the country context (UNIDO 2011).

Demand-driven interventions should be timed and adjusted according to the requirements of specific phases in the catching up process. Altenburg (2011) asserts that the duration of policy interventions is case specific and is matter of open debate. For instance, at initial stages in the development of the Korean

car manufacturing industry, and Embraer in Brazil, demand-driven interventions focused on helping the domestic industries tackle existing or emerging demands for their products. The emphasis was on external demand for Korean automakers, while Embraer was supported through public demand. Once the respective incumbent industries reached certain level of maturity, the governments started to withdraw protection while enhancing market orientation. This was not a question of either or, but one of balancing external and domestic demand in favour of industrialization. Moreover, in the case Korea, the government is pursuing a policy mix suited for the development of more environment friendly new energy vehicles.

As documented in Santiago and Weiss (2017), in implementing demand-driven industrial policy interventions, governments assume various roles. Demand-driven policy instruments are heterogeneous and can be tailored to suite the distinct roles and policy objectives. In the case of the aircraft industry in Brazil, the government boosted demand through public procurement, accompanied by skill and technological development support as well as financial and non-financial regulating measures. The government played various, often simultaneous roles over time. The use of consumer subsidies in Korea illustrates how governments can be knowledge brokers linking systems of production with systems of consumption. In both Korea and Brazil, the respective governments have been actively involved in the promotion and generation of innovations stemming from strategic industries. A finding that substantiates notions of the entrepreneurial nature of the state (Mazzucato 2011). In general, and coincident with Morrison and Rabellotti (2017), governments can make significant contributions to industrialization by introducing regulatory measures that send shock waves to domestic agents, or that unlock the potential of those same agents to tackle emerging windows of opportunity.

There is no single recipe and all country experiences differ in terms preconditions as government, technological and manufacturing capabilities, financial resources, skills, political environment, business environment, domestic market sizes, historical background and integration to world markets. Developing countries need to understand well their capacities and their available policy space to choose effective policy mixes (Peres and Primi 2009; Shadlen and Fonseca 2013).

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