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MANUFACTURING DEVELOPMENT IN CATCHING UP COUNTRIES: LOCATING DEMAND-DRIVEN POLICY INTERVENTIONS FROM A LONG-TERM PERSPECTIVE

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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, this analysis identifies at what point the use of demand-driven policy instruments was most prominent in the development of a given manufacturing industry. What instruments were used? How were they used? How did these instruments contribute to the development of the industry? Demand for manufactured goods can be interpreted in two ways: either as a driving force outside the direct control of policymakers; or as a measure used by policymakers to boost industrial development. We use the results from case studies of the automotive industry in the Republic of Korea, aircraft manufacturing in Brazil and lithium processing in Chile. Our findings highlight that demand-driven policy instruments are better understood within dynamic policy mixes in combination with and complementing supply-driven policy interventions. Policy interventions combined with innovation and changes in demand conditions open up windows of opportunity for industrialization.

Keywords: Demand, industrial policy, industrialization, catching up, windows of opportunity

JEL codes: O14, O25, O33, O47

1 Introduction

Structural change is a term commonly used to describe an economy's transformation from an agriculture-based one to a more diversified, technologically complex, manufacturing-driven economy. The process is challenging, and requires sustained commitment of resources and prudent management of supply and demand and of the interaction of the two over time. Rostow's (1959) seminal work on the stages of economic growth emphasizes the significance of dynamic interactions of supply and demand and the patterns of manufacturing. The author also stresses the importance of a sectoral approach to promote industrialization and economic development.

According to Saviotti and Pyka (2013), analyses of long-run economic development should consider the interaction of supply and demand. On the supply side, three factors are of significance, namely 1) changes in productive efficiency, 2) the emergence of new sectors, and 3) the tendency of the economy to increase quality and product differentiation. On the demand side, Saviotti and Pyka emphasize 1) the dynamics of disposable income and 2) varying preference systems. A combination of supply and demand is necessary, "because each one individually would not suffice to generate long-run economic development" (Saviotti and Pyka 2013:461).

From the supply-side perspective, innovation has major implications for productivity growth; moreover, technological change and the creation of domestic scientific and technological capabilities are key drivers of industrialization. However, innovation does not suffice to achieve the intended development goals. The creation of adequate demand for such innovations, eventually leading to the creation of new sectors, is necessary for long-run economic development to be both possible and sustainable (Saviotti, 2001; Saviotti and Pyka, 2013).

Salazar-Xirinachs, Nübler and Kozul-Wright (2014) conclude that a balanced mix of demand- and supply-side policies helps countries avoid slow growth traps and enhances their ability to create high-quality jobs. However, the scope of industrial modernization and technological upgrading changes over time as countries gain technological and productive capabilities. Stiglitz (2017) endorses economic diversification strategies, understood as a process of opening 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 in general—is a country's process of self-discovery about which productive activities it 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 implementing strategies that capture external demand and generate foreign currency revenues, combined with interventions to ensure full employment of less-skilled workers. He also advocates industrial policies that impose restrictions on the exploitation of natural resources for exports, without adding value to those resources. According to Stiglitz, 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 the expansion of domestic markets for manufactured products.

Interest in building technological, institutional and productive capabilities for industrialization from the supply side is pervasive. Policymakers from both developed and developing countries are increasingly turning their attention to mechanisms that allow them to influence demand for manufactured products in ways that help domestic agents maintain international leadership, sustain or reintegrate or perhaps even increase their manufacturing activities and domestic employment (Buttonwood, 2017; The Economist, 2017b). Policymakers can capture increasing shares of external demand through exports while expanding internal demand for domestically produced manufactured goods. This paper draws inspiration from this growing interest in the dynamics of demand for manufactured products.

Building on case studies from three countries that are 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 promoting long-term development of manufacturing industries? What are the features of such interventions in terms of their targets and implementation strategies over time? What lessons can be drawn to inform more recent industrialization strategies in catching up countries? The aim of this paper is to illustrate how policy interventions have been used to respond to the dynamics of demand for manufactured goods as a driver of industrialization and catching up. The analysis draws on Lee and Malerba (2017) who define 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 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. Policymakers can make use of such windows in diverse ways. On the one hand, demand can be interpreted as a framework condition partially or fully outside the control of policymakers; for instance, demand in foreign and domestic markets attributable to business cycle or macroeconomic developments, but also

to changes in the insertion in global value chains. In such 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 domestic firms can build on current comparative advantages to tackle emerging demand opportunities. Industrial policies can thus target entrepreneurial behaviour or business and investment environments to condition the competitiveness and profitability of firms. Exchange rate and monetary policies, investment in general infrastructure and power supplies, roads, ports and the governance of international trade and investment play an important role in this regard.
- Governments can promote technological change and the building of productive capacities in order for domestic firms to enter industries they would otherwise not be able to given the country's traditional comparative advantages (Lin and Chang, 2009; Salazar-Xirinachs, Nübler and Kozul-Wright, 2014).

Policy interventions in both cases 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, there is actually a broad set of demand-driven industrial policy interventions available for policymakers; 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 the domestic market, 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 in global value chains, the significance assigned 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 the literature on 'windows of opportunity' for industrial catching up. The conditions of demand for manufacturing goods, together with changes in institutional frameworks and/or technological innovation offer opportunities for industrialization; developing minimum productive capacities

[1] UNIDO (2016) discusses possible trade-offs between economic, social and environmental dimensions that are considered part of industrial transformation strategies.

determines readiness to respond to those opportunities. Section 3 presents the methodological underpinnings of this study. Section 4 is divided into three main parts. First, from the perspective of demand for manufactured goods as a framework condition, Chile is undertaking efforts to build domestic capacities for lithium processing. The case study illustrates how 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 the mineral Coltan, with a significant use in global manufacturing. Second, we explore how policy interventions have assisted automotive manufacturers in the Republic of Korea 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 in which direct public intervention helped create market entry conditions, managing demand—primarily through public procurement—for the latecomer producer, Embraer. As the industry consolidated, government presence began to loosen, giving way to the private sector as the driver of Embraer's growth. Section 5 concludes.

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 clear-cut, 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 that occurs in stages characterized by specific market and institutional conditions and the changing significance of distinct economic agents. Catching up is a recursive process with latecomers continuously seeking entry into an industry and gradually catching up—in some cases forging ahead—and eventually declining (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, the presence and

quality of infrastructure, and other social and macro- and micro-economic factors; (ii) the catch up phase, the key factor being the country, sector or firm's ability to undertake dynamic processes of learning and capacity building, sustained over a long period of time. During this period, countries, 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 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 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 channel the speed and direction of industrialization and inform development goals over time. At country level, successful experiences have used external demand in combination with other policy instruments as a 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 over the long-term development of an industry:

- Changes in knowledge or technology: related to technological revolutions and changes in the knowledge base characteristic of an industry; one example is the transition from analogue to digital. Strategic decisions on emerging innovative technologies can initiate dynamic processes leading to changes in the positioning of leaders and followers in specific markets.
- Changes in demand conditions, actors and networks: entails processes leading to the emergence of new types of demand or new sets of consumers, and major shocks to local demand or business cycles. Changes in demand may facilitate entry to otherwise crowded markets, or compromise the 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 behaviour or the nature of business and investment environments. The result is changing competitiveness and firms' profitability. Institutional shocks can force economic agents to innovate and adapt behaviours in accordance with new domestic and/ or foreign environments.

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 is combined 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 demand through innovation, major scientific discoveries or the opening of opportunities to exploit and add value to 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 growth 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 these 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. The first factor leading to the overtaking by Nokia of Motorola's leadership was rapid increases in demand by both individual and business users, which accompanied the emergence of digital technologies. A second factor, which ultimately helped Samsung overtake Nokia as the market leader, was the replacement of "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 development was attributable 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) examine 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 consumer countries, the entry of new inexperienced consumers from the UK, the United States and Scandinavian countries, and the reduced significance of large distribution. In the early 2000s, old world producers recovered prominence through innovation, an increased focus on marketing and branding and the introduction of sophisticated and varied wines to serve more sophisticated consumers globally. The upsurge of demand from China and other Asian markets opened a new window of opportunity for wine producers. As regards institutional factors, European policy and regulation significantly contributed 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 reforms that took place in the late 2000s allowed old world producers—now in a follower role—to regain market shares 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 the institutional factors that shape windows of opportunity for industrialization.

3 Methodology

This paper primarily builds on evidence from secondary data sources. First, we searched the literature for studies on successful cases of industrialization in catching up countries. Next, we looked for 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 information was derived from articles in grey literature, policy briefs, government websites and reports produced by government and international organizations 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 identify and characterize various stages of the catching up process an industry underwent. Emphasis was placed on periods marked by significant changes in an industry's productive and/or

[2] Emphasis in the original by the authors.

technological capabilities, or by the active promotion of domestic demand as a driver of industrialization. These periods helped us frame government interventions around technological windows of opportunity. Alternatively, it was possible to identify how government interventions have helped the domestic industry 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 according to the objectives pursued by the governments of the countries being studied. The framework allowed us to characterize governments as direct consumers, through public procurement, for example; as regulators setting the 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.

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

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

4.1 Capturing global demand while adding value to natural resource endowments: lithium in Chile

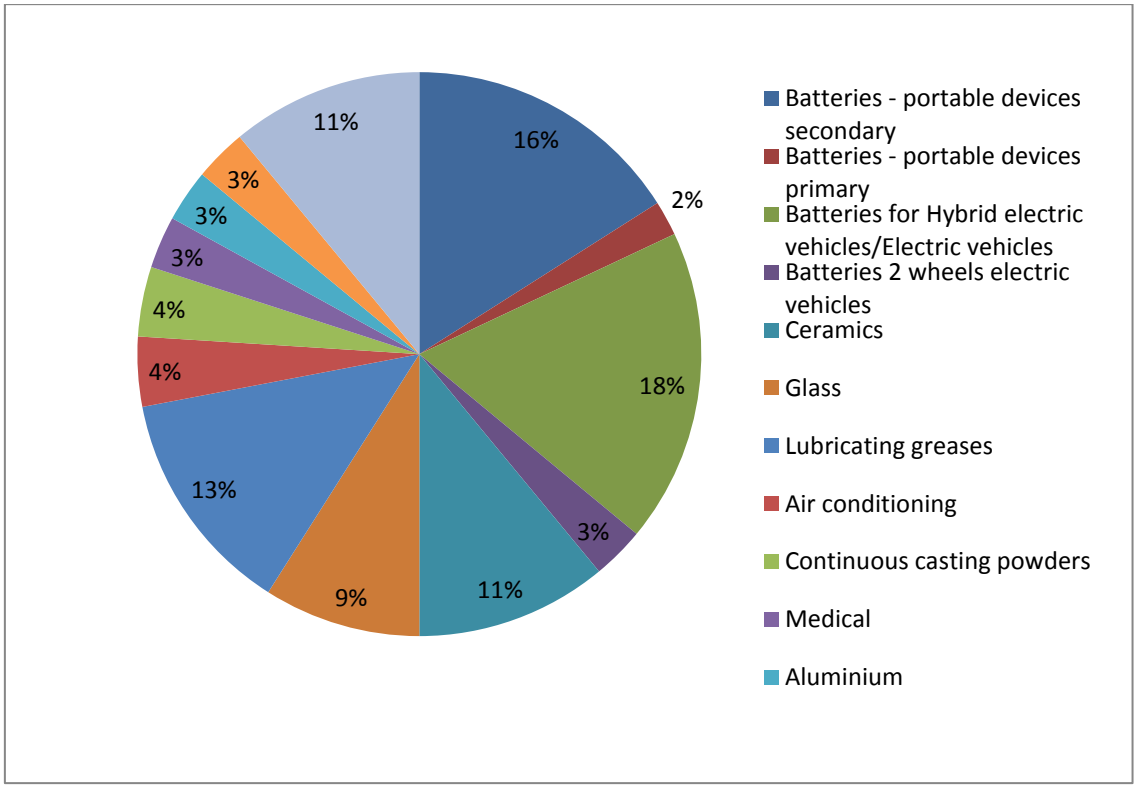
A country's ability to capitalize on external demand—as a variable outside their direct control—is constrained by its capacity to establish minimum initial conditions, including technological, productive and institutional capabilities. Recent efforts by the Chilean authorities to build on their massive lithium reserves, a metal with widespread use for the manufacturing of products applied in transport, communications and other industries, illustrates 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 per cent annually, fuelled mainly by booming global demand for lithium-based batteries (US Geological Survey, 2017); the latter is expected to double the current market value of approximately USD 20-22 billion (CORFO and INVESTCHILE, 2017). As the demand for lithium exceeds its supply, international prices are soaring; in 2015-2016 alone, spot prices rose by about 40 per cent to 60 per cent (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



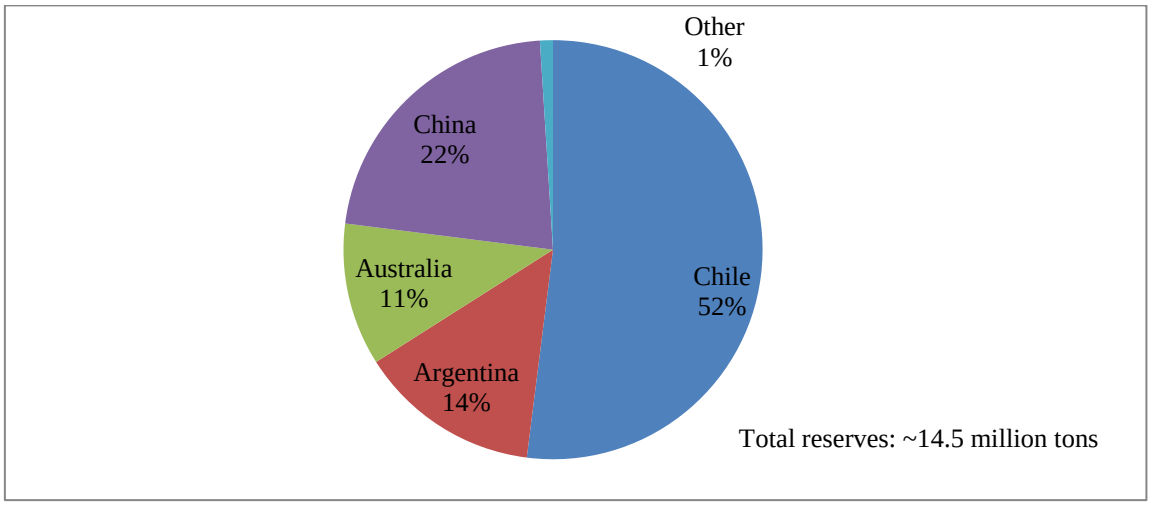
Note: Values for hybrid electric vehicles/Electric vehicles and 2 wheel electric vehicles.
Source: Extracted from CORFO and INVESTCHILE (2017).

High and growing global demand for lithium-based manufactured products opens significant opportunities for lithium producing 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 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 a 60 per cent increase in the country's production of lithium (US Geological Survey, 2017). Australia is also making considerable strides, despite the cumbersome conditions for the lithium extraction process 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 involved in the industry and has been quicker to react to booming global demand for lithium-based products.

4.1.2 The lithium industry in Chile

Chile, together with Argentina and Bolivia, belongs to the "lithium triangle", 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 Chilean-Argentinian border (O'Brien and Nickel, 2015; Corfo, 2017; Sanderson, 2017).

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

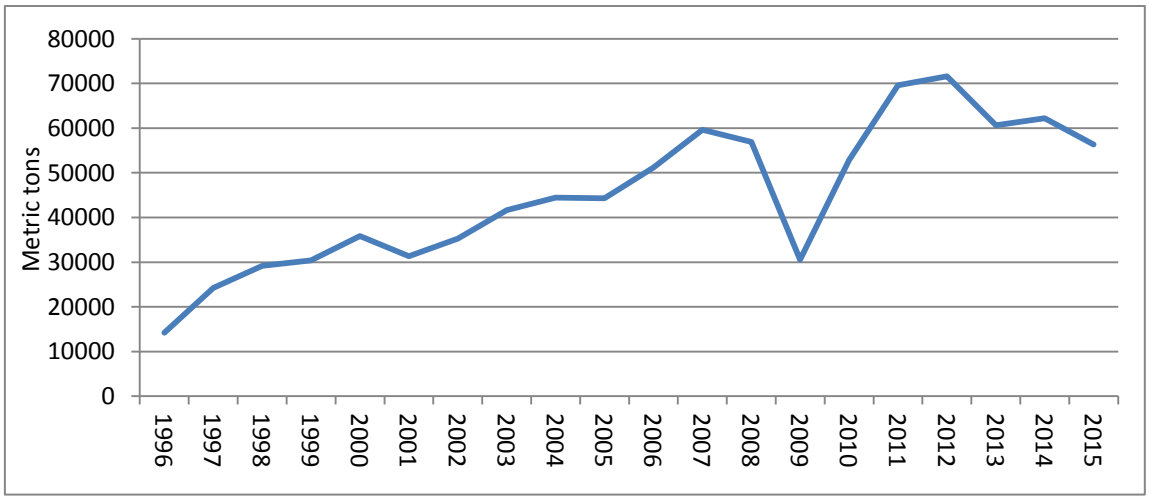


Note: According to the US Geological Survey, data on lithium mine reserves may not reflect identified lithium resources, which can result in a larger number of countries and a larger amount of available lithium.
Source: US Geological Survey (2017).

Data on production in Chile have been available since 1996, when its reported production was around 24,246 tons of lithium carbonate equivalent (LCE). The country's annual output shows a clear upward trend (Figure 3). In 2016, Chile was the second largest lithium producer in the world, with about 34 per cent 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).

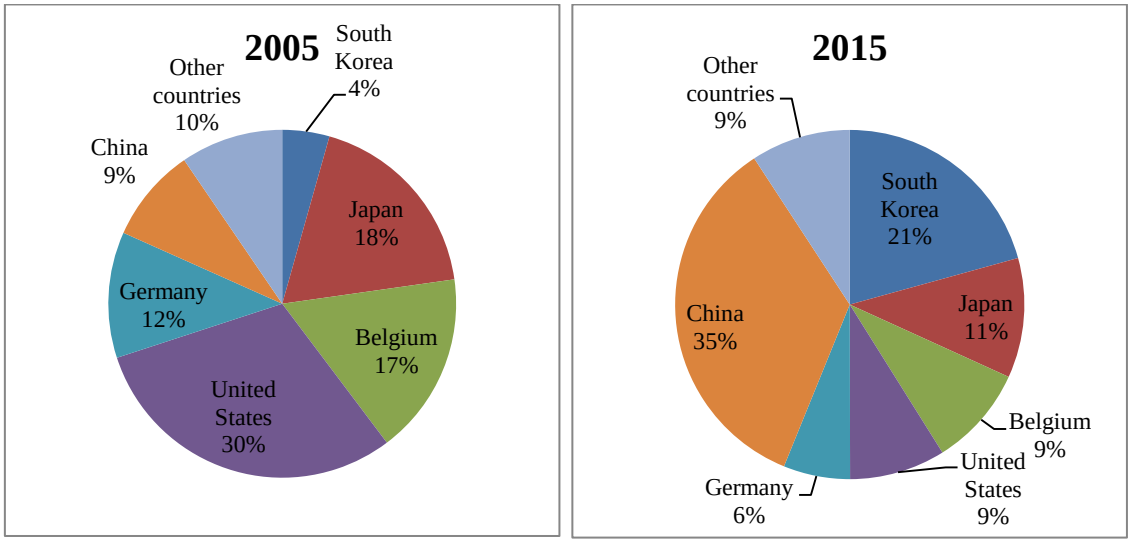
Regarding trade, while only 9 per cent of total Chilean lithium exports went to China in 2005, it had become Chile's leading trading partner by 2015, absorbing more than one-third of Chile's lithium exports (Figure 4). Expressed in tons, the rise is even more significant, from 3,754 tons to 27,290 tons, which is equivalent to about 22 per cent annual growth over a decade.

Figure 3 Lithium production in Chile (1996-2015)



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

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 numerous 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.

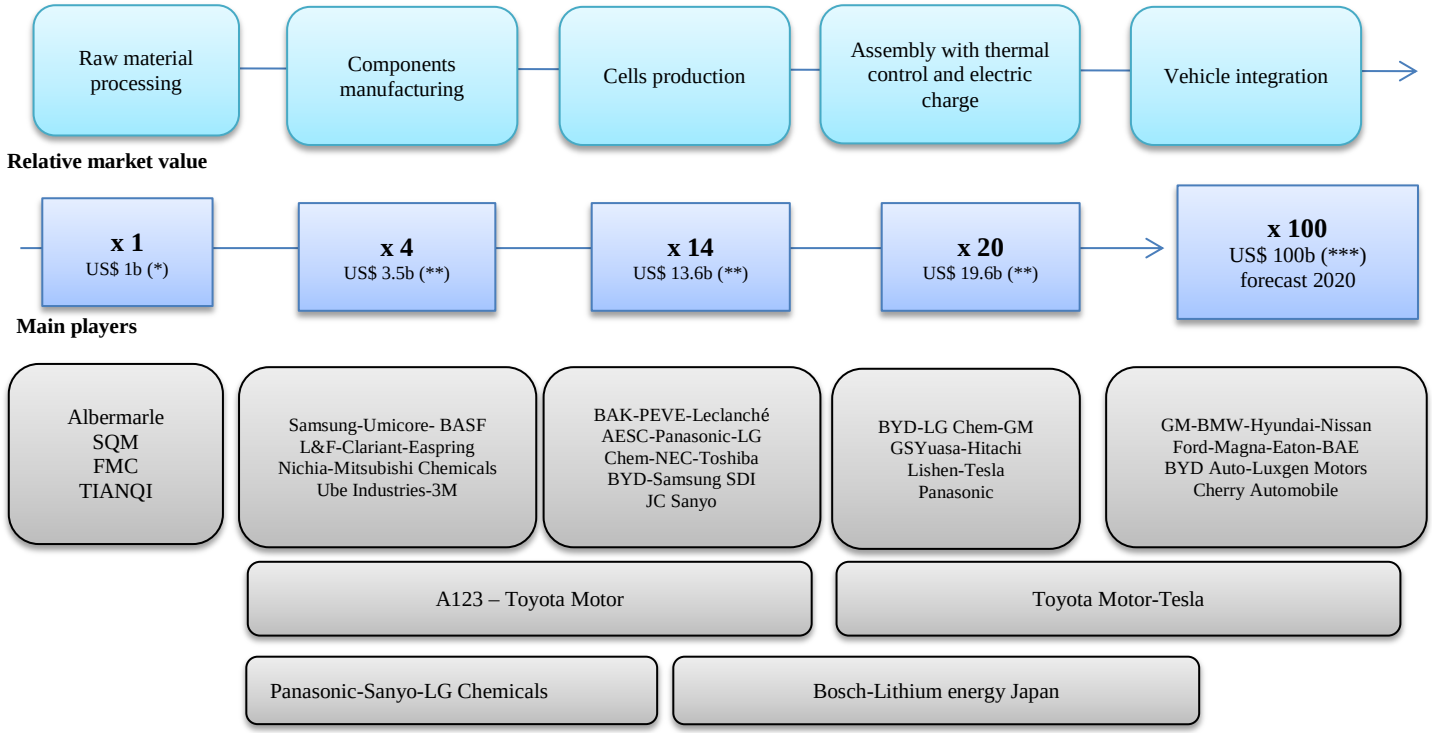
4.1.3 Capitalizing on global demand? From building the institutional framework around lithium extraction to the promotion of domestic processing capacities

The Chilean government began focusing on 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 for the state. The regulation also aims to protect the fragile natural environment around production sites (The Economist, 2017a). The commercialization of lithium requires authorization from CCHEN which also ensures that lithium sales by authorized companies fall within agreed quotas.

Also in 1975, CORFO concluded 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 established Sociedad Chilena de Litio, with an ownership distribution of 45 per cent for CORFO and 55 per cent for Foote Mineral Co. Sociedad Chilena de Litio was expected to produce and export up to 200,000 metric tons of lithium until 2001. However, this period was extended to 2014, with five-year renewal windows up to the stipulated limit of 200,000 metric tons.

[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).

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).

In 1983, the enactment of the Code of Mining reinforced the Chilean government's exclusive rights to benefit from the country's lithium reserves. It stipulated that no mining concession would be granted for the metal, except for those preceding the 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, an affiliate of Sociedad Química y Minera de Chile. To date, only two companies have been granted extraction rights, the US-based firm Albemarle® and Sociedad Quimica Minera de Chile. Additionally, the Code of Mining has granted the State priority purchasing rights over mining products (COCHILCO, 2009; Subsecretaría de Minería Chile, 2013).

In 2012, the government took first steps to privatize lithium mining and its 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 per cent 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).

Recent steps towards facilitating foreign investment in the processing of domestic lithium production include the launch of an international bid on 30 March 2017 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 companies from the Republic of Korea, China, Europe and Japan. The winning companies, which were to be announced at the end of 2017, will benefit from guaranteed access to up to 25 per cent of Albermale's lithium production over a period of around 27 years. These firms will be granted the lowest available price for lithium in the export market during the previous six-month period. Albermale was recently authorized a quota increase from 25,000 tons in 2015 to around 80,000 tons per year. An additional factor driving the attractiveness of this bidding system is its pairing with significant investment plans in infrastructure for alternative energy sources, notably solar power generation.

It is still too early to draw conclusions on the ability of Chilean authorities to develop a domestic lithium processing industry. Evidence suggests that the strategy is one of building on existing competitive advantages, thereby 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 towards economic diversification that support the development of regions traditionally dependent on commodities

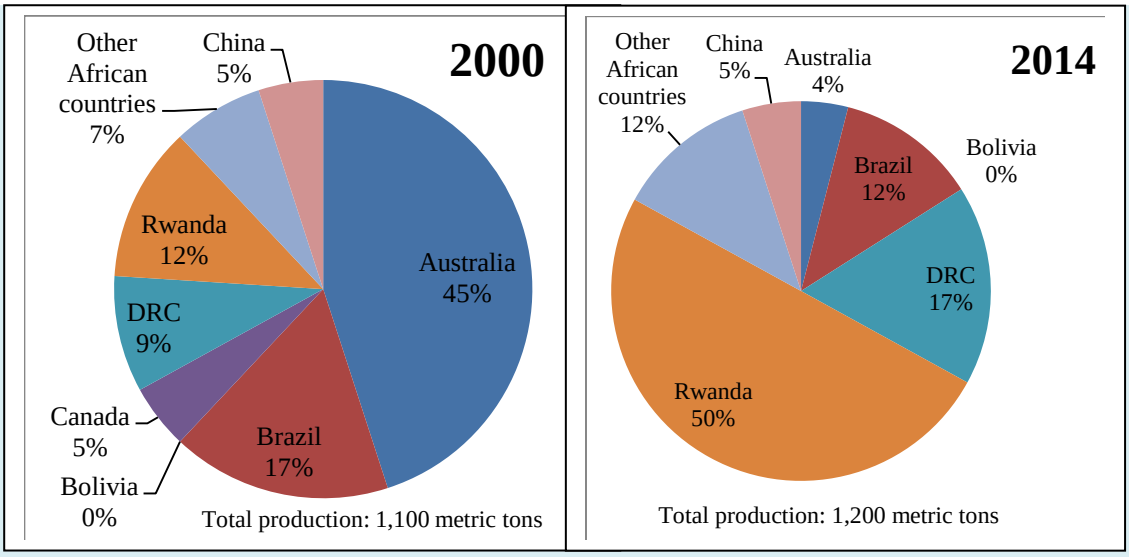
to reduce their exposure and vulnerability relative to global markets. However, it remains unclear whether the Chilean government's role will limit the emergence of lithium processing activities or whether more proactive domestic technological capability building efforts will be deployed as well. This 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, namely Coltan, remain outstanding (**Error! Reference source not found.**).

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 an input to produce capacitors. Global demand for the mineral increased markedly with the development of radars, military radio communication equipment and other ICT technologies. Globally, the electronics industry has recorded increasing demand for coltan; about 60 per cent 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 and turbines, among other applications (Bleischwitz, Dittrich and Pierdicca, 2012; Hayes and Burge, 2003). Substitutes for coltan do exist but their performance is considered inferior. The rapidly expanding global demand for tantalum observed over 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 raw material is exported 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 per cent of total production in 2000, towards Rwanda and the 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 fairly 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). After the first DRC war in 1996, industrial mining of tantalum completely ceased.

Although no precise data[iii] on artisanal mining of coltan exist, 16 per cent of the total population of 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 a few at the national level sought to decouple the minerals from the conflict. For example, in 2002, the government adopted a Mining Code under the guidance of the World Bank and International Monetary Fund. The Code gives priority to private sector development and large-scale mining. The Code and Mining Regulations provide the legal framework and differentiate between three modes of production: industrial mining, small-scale mining and artisanal mining. Different tax regimes and permit systems apply to the three modes (Geenen, 2012). The government has introduced

some additional fiscal and customs incentives that directly target the mining industry (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 extract coltan and promote coltan beneficiation, and to ensure safety and decent living standards for the population involved in its production, while the long-lasting conflicts in the Kivu region continue (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 shares 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), Rwanda is expected to host the first coltan processing plant in the regions with the help of Canadian-based corporations (Brenda, 2016). [ii] The USGS does not report the amount of tantalum ultimately recovered from these concentrates, which might be extremely low due to losses that occur during processing. Mine production data are published in the 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) between 2000 and 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 the 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 the Republic of Korea's automotive industry

The Republic of 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 Republic of Korea's economy has undergone a radical structural change to become a global industrial and innovation leader (OECD, 2012a). Due to the high level of income per capita it attained and its ability to sustain a high growth pattern, the Republic of Korea has become a recent graduate to the group of most industrialized economies. From a policy perspective, the Republic of Korea's experience can be described as: "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 resource allocation; the government was careful to revise and upgrade the targets in accordance with the progress and achievement of objectives. Equally relevant was the sequencing and coherence included in 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 based on the changing needs of the domestic industry. From the 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 The Republic of 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 base for technological capabilities)
5th FYEDP (1984-86)	Economic stabilization: industrial competitiveness by opening the economy and rationalization
6th FYEDP (1987-91)	Regulatory and deregulatory reforms: supporting high-tech industries; building high-tech and innovative capabilities
7th FYEDP (1992-96)	Revitalization of the economy: establishing a basis for balanced development of industrial sectors and companies
Other multi-annual 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 set out various reforms (fiscal, financial, regulatory) 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 the country's overall quality of life.
Second Basic Plan for Sustainable Development (2011-2030)	Main goals: promoting economic activity and improving the quality of life of socially vulnerable groups, improving income conditions and living quality in 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", "expanding the foundation for green welfare" and "realizing a sustainable green society".
Third Basic Plan for Sustainable Development (2016-2035)	Main goals: "Integrated and secure society" and "Inclusive and innovative economy" are among four goals; strategies include fostering integration of social segments and gender equality, resolving the regional gap and promoting inclusive growth.

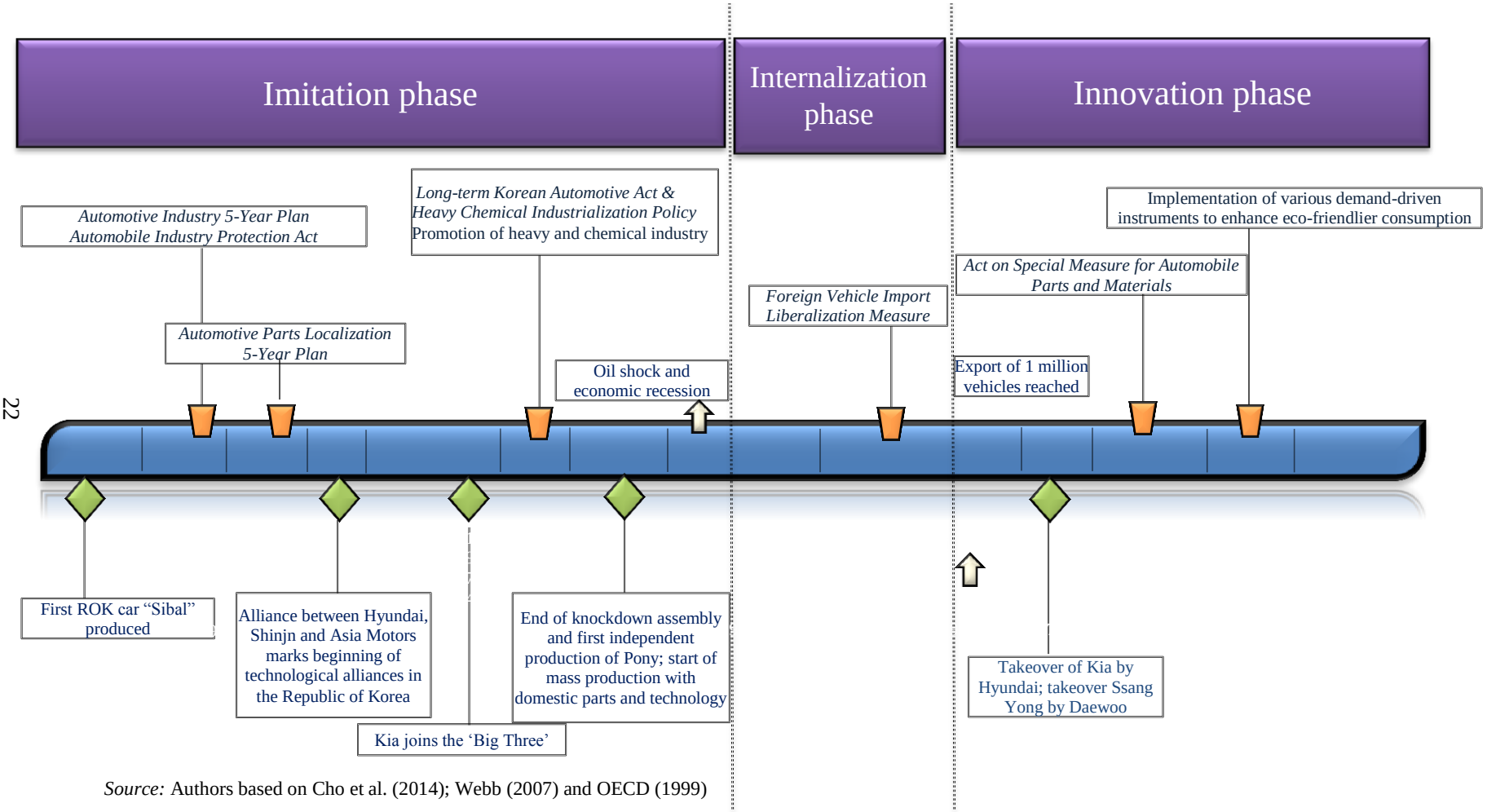
Source: OECD (2012b, 2017).

The seven Five-Year Economic Development plans implemented over the period 1962-1997 marked the initial catching up phase, characterized by intense government intervention. Over time, modernization and technological upgrading gradually changed. The Republic of Korea's development began with 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 for business ventures in line with rising demand and economic leadership of the private sector (OECD, 2012a). As government presence gradually phased out, a booming private sector took over the responsibility of sustaining long-term economic growth.

The strategic approach to industrialization described above is characteristic of the means used by the Republic of Korea's government to promote the domestic automotive industry's development. Webb (2007) identifies three main phases in the industry's development (**Error! Reference source not found.**). 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 beginning of what Webb (2007) refers to 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 at the time 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 liberalization 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 automotive industry had entered an innovation phase and ultimately reached significant maturity, competitiveness and technological capabilities. During this period, the Republic of Korea's population experienced considerable gains in terms of personal disposable income, while growing environmental pressures became evident both locally and internationally. The introduction of various demand-driven instruments signalled attempts by the government of the Republic of Korea to create an institutional window of opportunity to spur the development of green technologies and the domestic consumption of eco-friendly cars.

Figure 7 **Development of the Republic 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 of the 1960s and 70s

The beginnings of the automotive industry in the Republic of Korea can be traced back to the 1930s under Japanese colonial rule; the Republic of Korea launched a rudimentary and limited production of automotive parts and maintenance services. Only in 1955 was the first ever car, "Sibal", produced in the Republic of Korea, 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 point, the dominant manufacturing process was the knockdown or assembly method.

The 1960s and 70s were marked by technological learning from industrialized countries—particularly the United States and Japan—and the development of basic capabilities for car assembly, the production of automotive parts and the achievement of economies of scale under government protection. The growth of the industry was underpinned by cheap labour, while the building of scientific institutions, including government research institutions, contributed significantly to the technological development of domestic firms. The 1970s were characterized by massive investments 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 the 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 for 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—instead of 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). The local content requirement amounted to 80 per cent to 99 per cent for passenger cars (McElroy, Creaner and Workman, 1985). In 1966, the Republic of Korea's automotive industry was consolidated in three big car manufacturers: Hyundai Motor (an influential chaebol[4]), Shinjin Automotive Corporation and Asia Motor. These firms established technological alliances: Asia

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

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 began promoting chemical and heavy industries[5] – at the time, the latter included the automotive industry. In 1973, the Long-term Automobile Promotion Plan was introduced to accelerate 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 engines' cubic capacity. The new Plan invited producers to submit proposals to launch a mass-produced cheap car in the Republic of Korea with export potential and a prominent level of local content. In 1976, Hyundai was selected to manufacture the Republic of Korea's first car; the firm launched 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 being replaced by the domestic production of automotive parts. Some 18,000 units of Pony were exported within three years of release, signalling a new phase in the automotive industry's development away from limited knockdown processes.

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

During the imitation phase, the government acted as a strong regulator. The most significant policy tools included local content requirements, restrictions on imports, limited model variety, attraction of foreign direct investment (FDI), adoption of tariff- and non-tariff barriers, subsidized loans, export subsidies, tax incentives, in addition to the building of scientific organizations 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

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

line with the classic infant industry approach, import restrictions during the catching up phase ensured domestic demand for local products (OECD, 2012a).

4.2.2 The internalization phase, the 1980s

During the "internalization" phase, the development of the automotive industry faced the consequences of the economic crisis and the oil shocks of 1979. The government intervened by promoting 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 due to the level of maturity the domestic automotive industry had reached at that point (Jaymin Lee, 2011). The enhancement of manufacturing capabilities, the expansion of technology-intensive industries and the promotion of private R&D were significant drivers in the 1980s and 90s (Bartzokas, 2005).

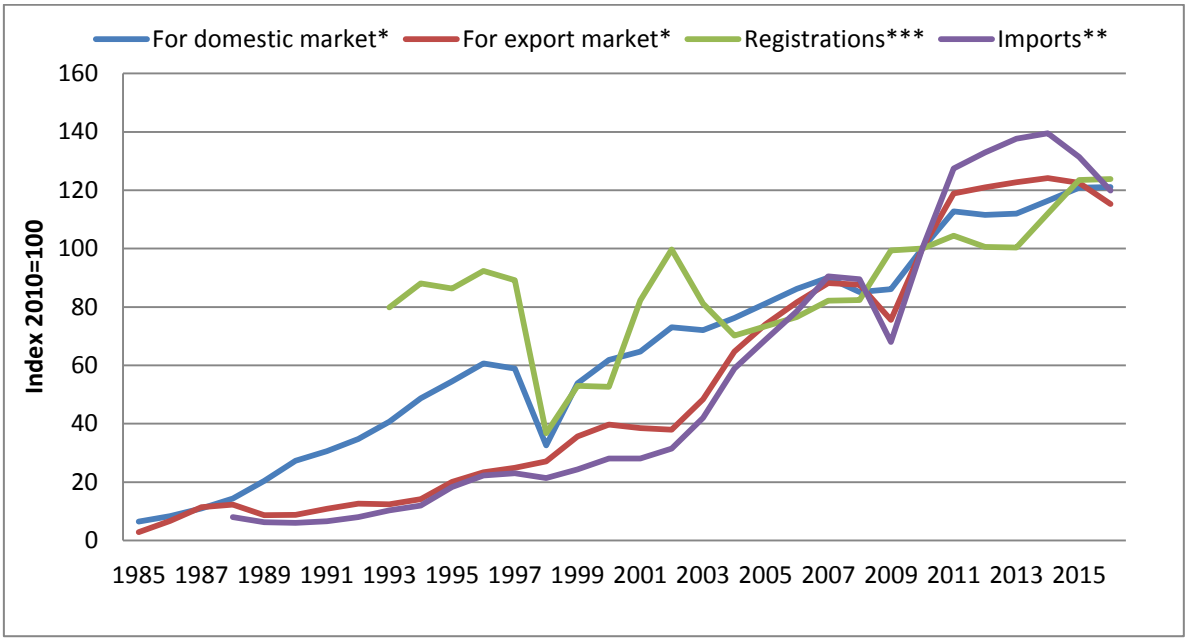
The Republic of Korea's manufacturers began building their competitive advantage based on two factors: first, meeting consumer preferences through the development of larger cars, for example, as well as offering an increased variety of vehicles. Second, raising competitiveness based on both price and 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 early 1990s as domestic demand for cars began to expand rapidly, while exports continued at a steady pace (Figure 8).

In 1983, the adoption of the Foreign Vehicle Import Liberalization Measure intended 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, the Republic of Korea began importing foreign cars for the first time, albeit restricted to large cars with an engine capacity of 2L or more and small cars with an engine capacity 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 per cent in 1987 and 25 per cent in 1989). Further cuts drove import duties down to 20 per cent in 1991 and 8 per cent 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

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

(Cho, Kim and Kim, 2014). Moreover, after the second oil crisis of 1979, Hyundai was quick to enter the United States market where demand for smaller cars was increasing rapidly (Wäldchen, 2013).

Figure 8 The Republic of Korea's automotive indexes and income per capita, 1985-2016



Notes: The data refer to the Republic of Korea's automotive index of shipment for the domestic and export market, the index of imports of passenger cars and the index of new car registrations. *The Republic of Korea's automotive index includes the manufacture of motor vehicles, trailers and semi-trailers. Data based on KOSIS Monthly Survey of Mining and Manufacturing; Data reported based on the Republic of Korea's 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."* (KOSTAT, 2017b). 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 the manufacture of motor vehicles, trailers and semi-trailers; based on ISIC, Rev. 3 (harmonized system of 1988); Data available from 1988-2016. ***New car registrations: New passenger car registrations include imported, new or restored cars not previously registered in the Republic of Korea. Direct source: KOSTAT (OECD, 2017); Data available from 1993-2016.

Source: Authors, with information from KOSIS (2017), Comtrade (2017) and OECD (2017).

Despite the relaxation of protectionist policies throughout the 1980s, the government maintained its active role as regulator. 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 its support for innovation along the deregulation process in the 1980s (OECD, 2012b).

4.2.3 The innovation phase: 1990s to present

The country's innovation-driven stage began in the 1990s. The policy focus and overall dynamics of the industry aimed 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 began focusing 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 in driving economic dynamics (OECD, 2012b).

In 1995, the Republic of Korea achieved the milestone of one million exported vehicles, while the 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, with domestic demand experiencing a drastic fall and imports slightly decreasing despite relatively stable exports primarily to Western Europe and North America (Lee, 1997). However, domestic demand recovered quite rapidly, boosting new car registrations. New passenger car registrations increased considerably from 2.1 million in 1990 up to around 10 million in 2002 (Lee and Cho, 2009). This surge in domestic demand resulted in a reduction in car exports from the Republic of Korea, while imports of cars recorded a steady increase. The downside of this dynamics was higher traffic congestion, energy waste and air pollution, leading the government to impose heavy taxes on automobiles and gasoline (Lee, 1997).

During the innovation phase, while the government maintained its strong role as regulator, it became a more active facilitator and co-generator of innovation. In 2001, the government adopted the Act on Special Measures for Automotive Parts and Materials and a technology development fund to continue supporting the automotive industry. This initiative coincided with the inception 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 among the ten strategic future growth engines of the economy of the Republic of Korea. That same year, 80 per cent of the Republic of Korea's R&D resources and outputs concentrated in ICT and automobiles (Bartzokas, 2005).

The government has continued to pursue market liberalization. In 2005, diesel passenger cars entered the domestic market for the first time, thereby increasing consumer choice. This decision was a response to a request by domestic car manufacturers to improve domestic consumption (Lee and Cho, 2009). This notwithstanding, government taxes on diesel engines

are higher than those on cars running on petrol 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 maintained an upward trend until 2012, suggesting that demand for cars has still not been satiated in the country. In 2013, the automotive market in the Republic of Korea entered a new phase of stagnation attributable to the economic slowdown that affected 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 debt (Korea Automobile Manufacturers Association, 2014). Nonetheless, sales of imported vehicles increased by 20 per cent, reaching a new record, fuelled by the introduction of new mid- and small-size models, tariff reductions associated with the Republic of Korea-European Union/United States free trade agreements, the increased popularity of European diesel cars and the aggressive marketing strategies implemented by importers. Increased consumer choice through imports has also accompanied a reduction in price differentials between vehicles manufactured in the Republic of Korea and imported vehicles (Korea Automobile Manufacturers Association, 2014). In 2014, the recovery of the domestic market renewed impetus in new car registrations.

4.2.4 Greening the industry

In 2008, low carbon and green growth became the vision of the Republic of Korea's National Development Strategy (Table 1), initiating a transition towards greener consumption and production patterns (OECD, 2012b). To spur greener developments in the automotive industry, the government of the Republic of Korea has implemented various other instruments to increase domestic demand for cars and to promote more environment friendly car choices. For example, in 2009, a 70 percent cut on registration and acquisition taxes was offered to both domestic and foreign consumers, who replaced their pre-2000 cars 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 dispose of their old cars within two months of registering a brand new one (Aggarwal and Evenett, 2010; OECD, 2017). In 2009, the government announced tax incentives for those purchasing a hybrid, plug-in hybrid, electric or hydrogen cars, with tax rebates of up to KRW 1.3 million (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 USD 92 million. Subsidies for hybrid cars were introduced in 2014 (OECD, 2017). The government has set a target of 800,000 electric cars to be in use by 2020; an ambitious figure considering that in 2014, only around 140,000 electric cars were in use. To boost purchases of new electric cars, the government introduced a subsidy of USD 900 in 2015, in addition to existing tax incentives for new energy vehicle purchases (OECD, 2017). According to the OECD, annual purchases of electric vehicles more than tripled between 2011 and 2014, although the share of hybrid cars in total vehicle registrations only increased from 0.02 per cent in 2008 to 0.87 per cent in the first quarter of 2016 (OECD, 2017). The main barriers for hybrid electric cars are 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 CO_2 emissions and higher taxes on purchases of highly polluting cars; these taxes will be used to finance subsidies for more eco-friendly cars (OECD, 2017).

4.2.5 A focus on policy and strategy

It is difficult to ignore the success in the catching up strategy of the Republic of Korea's automotive industry. Coinciding with the commencement of the innovation phase, over the last 15 years, the Republic of 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, an area that the Republic of Korea aims to focus its future development efforts on.

Table 2 The position in the global ranking of automotive producers

Japan	1	1	2	2
United States	2	4	6	4
Germany	3	3	3	3
Republic of 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 car manufacturing industry in the Republic of Korea. 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, we observe a more even contribution across both external and domestic markets (Figure 8).

From a policy perspective, the government of the Republic of Korea has supported the development of the domestic automotive industry through a mix of supply- and demand-driven instruments over time (Table 3). When the automotive industry began to take off, the government played the role of strong regulator and protector, focusing on export orientation and the creation of economies of scale. The policy tools used at the time included export subsidies, restrictions on imports and FDI flows, imposition of local content requirements, the 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, was being replaced by the promotion of innovation. This was possible due to initial efforts to establish framework conditions through investment in R&D infrastructure and the progressive introduction of direct incentives for firms to engage in innovation. The management of demand has become more important as environmental concerns have risen considerably.

Table 3 Policy mixes characteristic of the development of the Republic of Korea's automotive 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 enhance productivity, while restrictions on imports limited consumer choice to the benefit of domestically produced cars. Local content requirements and the use of tariff and non-tariff barriers continue to this day. Joint ventures, consumer tax incentives and competitiveness policies have been used to strengthen competitiveness. The rise in disposable income and market liberalization has fuelled growth in domestic demand. As increased air pollution has become a growing concern, the government has focused its regulatory power on specific segments rather than the entire automotive market. Indeed, the 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, the leading aerospace 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 attention is justified by the fact that Embraer has become one of 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 examines two key periods in the history of Embraer, which, in diverse ways, involved policy and management interventions that proved to be critical for establishing subsequent growth trajectories. The first period covers the 1969 establishment of Embraer, followed by its successful entry in the global commuter aircraft segment. The second period focuses on the changes that took place in the early 1990s, followed by Embraer's entry in the regional jet segment.

In both periods, a virtuous combination of factors helped usher in a new phase in the industry's development. These factors, as discussed for the aircraft industry by Vértesy (2017), included a constellation of windows of opportunity—demand for a specific aircraft type and the availability of technology on the market—corresponding innovation strategy and the necessary preconditions. The case of Embraer demonstrates how a combination of entrepreneurship and public interventions helped create conditions for a latecomer producer to effectively enter a market dominated by giants, and how government interventions helped reshape precarious demand windows to ensure sustainable growth. 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 fairly widespread in all market segments in the context of advanced, industrialized countries, just as in that of 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), both of them located in Sao Jose dos Campos in the state of Sao Paulo, specialized in technical training and represented the industry's scientific and engineering knowledge base 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 have been in the strategic interest of the military (which had governed Brazil since 1964). Nevertheless, an explicit commercial orientation has been crucial throughout the company's history. The very design of the prototype that became the EMB-110 "Bandeirante" was conceived to fill a local market niche, namely 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 aimed at 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 both the domestic and export markets; about 500, 350 and 320 of these types were produced, respectively.

A combination of public procurement, protectionist policies and the provision of finance were crucial in boosting demand for Embraer aircraft. The Brazilian Air Force's initial procurement of "Bandeirante" paid for the production and development expenditures. Embraer customers 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 import duties on inputs as a weapons-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 per cent import duty on locally produced aircraft types encouraged domestic buyers to prefer Embraer (Goldstein, 2002a).

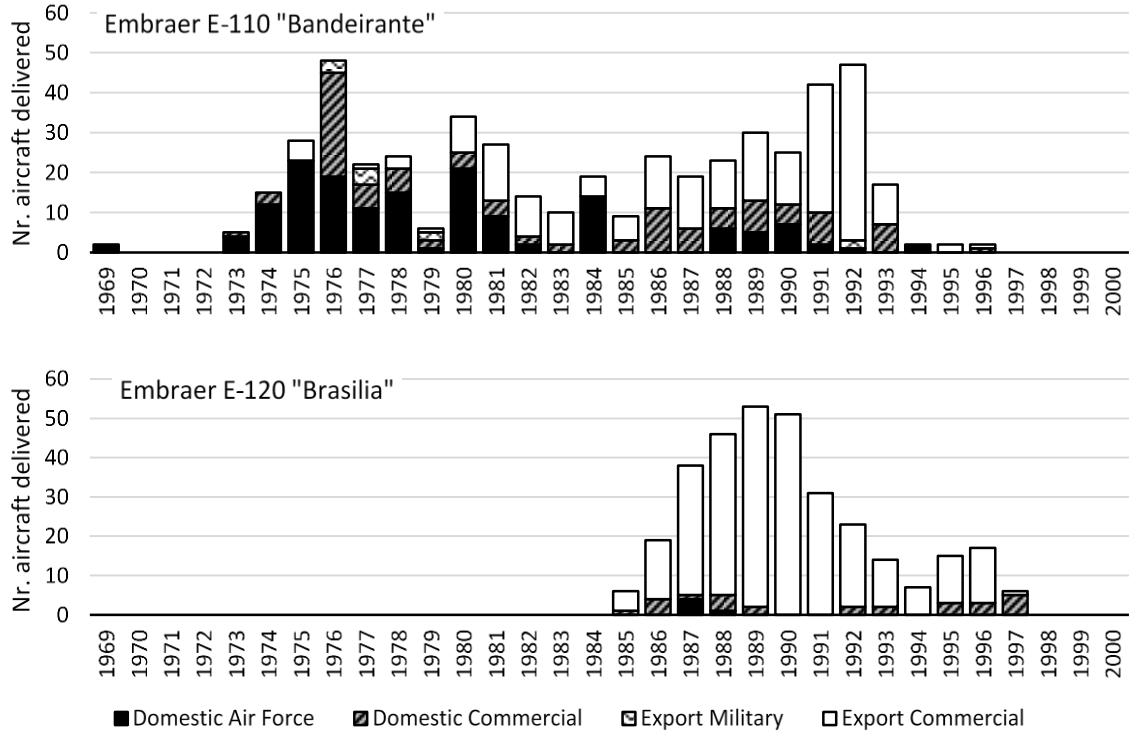
Embraer acquired crucial technological capabilities, making use of publicly funded licensing agreements to locally assemble jet trainer aircraft (MB-326) of the Italian Aermacchi and several smaller aircraft from the Piper Company of the US. Embraer also entered a joint venture with the Italian Aermacchi and Aeritalia, which successfully co-developed the AMX ground attack jet aircraft in the 1980s. The presence of CTA, ITA and highly skilled scientists and engineers assisted the Brazilian aircraft industry in efficiently absorbing modern technologies and use them to improve local designs. Embraer's strength lied in designing and assembling systems, and its parts and components suppliers were mostly located in Europe and North America. Although the local share varied by product, this overall approach did not substantially change as the global aircraft industry became ever more vertically specialized. 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 per cent 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 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 services offered by turboprop aircraft. Embraer became a first mover in a fast expanding market; its only United States-produced direct competitor was Fairchild's "Metro III". To meet increased demand, Embraer expanded its production capacity. By the early 1980s, exports amounted to nearly 50 per cent of total sales (over 100 million USD

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 buyer type (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 were effective from the 1970s until the mid-1980s failed following the political and financial crisis that hit Brazil, and the major drop in global demand and aerospace finance that the end of the Cold War brought with it. The crisis and change in 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 and Embraer developed 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.

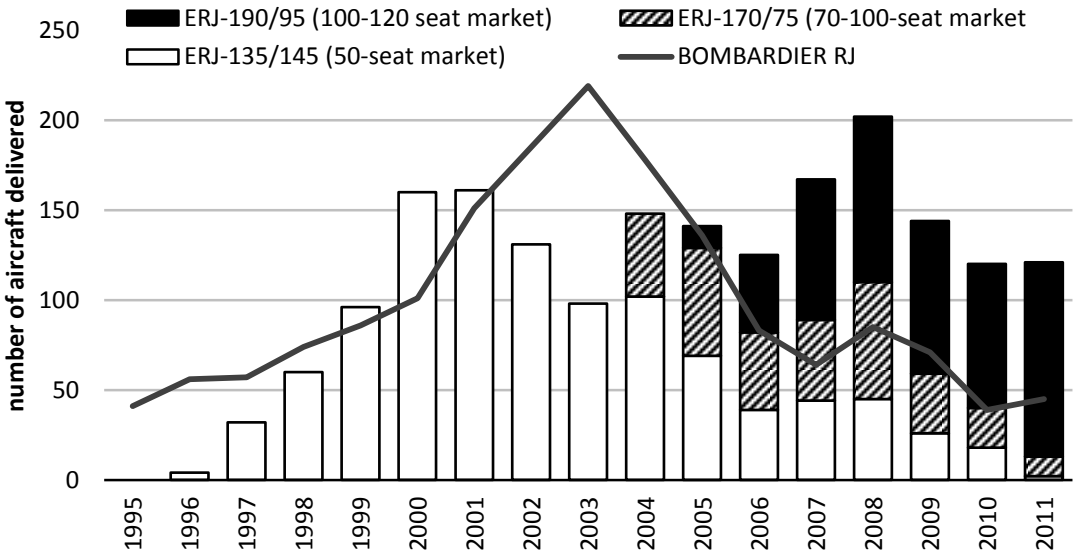
After several failed attempts, Embraer was privatized to non-industry-related investors in 1994. The Brazilian government retained around 7 per cent ownership, including a golden share with the right to veto decisions on the key strategic direction of the company. The government also agreed to recapitalize Embraer, which had accumulated 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 required intervention in order 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 Brazil's PROEX export promotion programme offered customers an interest rate equalization scheme. The programme, which offered an up to 3.5 per cent 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 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 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 lower cost regional services) all boosted demand for smaller-sized regional jets. While many companies attempted 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 the launch of more efficient products of the CRJ family (Vértesy, 2017). During the crisis years and prior to its privatization and reorganization, Embraer was unsuccessful in finding a strategic response similar to Bombardier's. However, following the reorganization of the company, the ERJ-135/145 family had become a strong competitor of Bombardier in the global market by the late 1990s (Figure 10).

[7] A ruling on the prolonged dispute, which started in 1998 and involved retaliatory measures as well as a counter claim by Embraer, was issued in 2002.

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



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

Recognizing the sales potential of the larger 70-120 seat regional jet in the 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 USD 1 billion BNDES credit line and a streamlined list of risk-sharing partners. Embraer took a 45 per cent stake in the project. The test flight of the 80-seater ERJ-170 took place in February 2002, and it 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 one 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 planes and an option for another 100. With the introduction of the 190/195 planes, Embraer became a direct competitor of the smallest Airbus and Boeing planes.

A major order for a medium-sized jet transport aircraft, the KC-390, with a USD 1.5 billion development cost helped Embraer and the Brazilian aircraft industry weather the global financial crisis as well as to set foot in the military transport market, where the replacement of aging Lockheed C-130s offered potential sales. In fact, European and South American air forces soon declared their intention to buy the new aircraft. Beyond a military use, Embraer also reported a 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", with the aim of increasing fuel efficiency. At the same time, it faces renewed competition on 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 considerably higher sales prices. The regional jet market has a number of competitors, including the recent entrant Sukhoi Superjet, as well as new entrants such as China's COMAC with its ARJ-21 and Japan's Mitsubishi MRJ.

4.3.3 Policy lessons from Embraer's experience

Since the emergence of Embraer, the Brazilian aircraft industry has been firmly standing 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 mostly 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 North America and Europe. Exports offered a stream of revenues. Market orientation was essential for Embraer's long-term growth, but this alone does not explain the company's success. Policy interventions were crucial to enable the company to respond to emerging demand in certain market segments. The Embraer experience highlights some key policy factors that have sustained its 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 pull capacity of a state-owned enterprise with an entrepreneurial culture. Even though Embraer was established as a state-owned enterprise, elements of an entrepreneurial culture have been present throughout its history. Its linkages with the Brazilian Air Force or the government were strategically used to finance development, gain access to technology and to facilitate access to the export market: the initiatives were promoted 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 the support of 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 the financing of R&D and

the development of new aircraft; military procurement; providing export financing and credits through the state development bank; facilitating access to advanced foreign technology; outright market protection (during the emergence phase); exemption from taxes and duties; and diplomatic support (for certification and military exports).

5 Conclusion

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

In pursuing industrialization, policymakers have a complex and varied set of policy instruments at their disposal, which target supply factors, 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 close the loop by shaping market dynamics and actual consumer behaviour 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 policymakers to manage demand.

This paper argues 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 in which demand for manufacturing goods is perceived as a framework condition should not prevent government interventions; in such cases, policymakers usually focus on supply-driven interventions, setting the framework conditions for industrialization. The debate certainly remains open 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 illustrates strategies to remove market failures, build on a perceived favourable business environment to facilitate access to productive and technological capacities for lithium processing which had previously not been 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 illustrates that to benefit from demand windows related to natural resources endowments, there is a need for strong governance, the ability to set clear objectives and a profound 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 a matter of open debate. For instance, during the initial stages of the development of the automotive industry in the Republic of Korea and Embraer in Brazil, demand-driven interventions focused on helping domestic industries tackle existing or emerging demands for their products. The emphasis for automakers in the Republic of Korea was on external demand, while Embraer was supported through public demand. Once the respective incumbent industries reached a certain level of maturity, the governments started withdrawing their protective measures and 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 of the Republic of Korea, the government is now pursuing a policy mix suited for the development of more environment friendly new energy vehicles.

As documented in Santiago and Weiss (2017), by implementing demand-driven industrial policy interventions, governments assume various roles. Demand-driven policy instruments are heterogeneous and can be tailored to suit distinct roles and policy objectives. In the case of Brazil's aircraft industry, the government boosted demand through public procurement, accompanied by support for skills and technological development as well as financial and non-financial regulating measures. The government played various, often simultaneous roles over time. The use of consumer subsidies in the Republic of Korea illustrates how governments can be knowledge brokers, linking systems of production with systems of consumption. In the cases of both the Republic of 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 the notion of the entrepreneurial nature of the state (Mazzucato, 2011). In general, and coinciding 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 seize emerging windows of opportunity.

There is no single recipe for successful industrialization, and all country experiences differ in terms of preconditions including form of government, technological and manufacturing capabilities, financial resources, skills, political environment, business environment, domestic

market size, historical background and integration in world markets. Developing countries need to understand their capacities and available policy space in order to choose effective policy mixes (Peres and Primi, 2009; Shadlen and Fonseca, 2013).

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