Industrial Policy and Global Value Chains: The experience of Guangdong, China and Malaysia in the Electronics Industry

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Preface

This dissertation is the result of my own work and includes nothing which is the outcome of work done in collaboration except as declared in the Preface and specified in the text.

It is not substantially the same as any that I have submitted, or, is being concurrently submitted for a degree or diploma or other qualification at the University of Cambridge or any other University or similar institution except as declared in the Preface and specified in the text. I further state that no substantial part of my dissertation has already been submitted, or, is being concurrently submitted for any such degree, diploma or other qualification at the University of Cambridge or any other University or similar institution except as declared in the Preface and specified in the text

It does not exceed the prescribed word limit for the relevant Degree Committee.

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Abbreviations

AFC	Asian Financial Crisis
AmCham	American Chamber of Commerce
ASIC	Application Specific Integrated Circuit
CAS	Chinese Academy of Sciences
CBS	China Bureau of Statistics
CCID	China Centre for Information Industry Development
CEIYCC	China Electronics Industry Yearbook Compilation Committee
CEO	Chief Executive Officer
CMOS	Complementary Metal Oxide Silicon
COCOM	Coordinating Committee for Multilateral Export Controls
CREST	Collaborative Research in Engineering Science and Technology
CRT	Cathode Ray Tube
DISF	Domestic Industrial Strategic Fund
DRAM	Dynamic Random-Access Memory
DSM	Department of Statistics Malaysia
E&E	Electronics and Electrical
EMS	Electronics Manufacturing Service
EPU	Economic Planning Unit
EPZ	Export Processing Zones
ERP	Effective Rate of Protection
ETDZ	Economic and Technological Development Zones
ETP	Economic Transformation Programme
FDI	Foreign Direct Investment
FIDA	Federal Industrial Development Authority
FIE	Foreign Invested Enterprise
FOB	Free on Board
FREEPENCA	Free Industrial Zone Penang Companies' Association
FTZ	Free Trade Zone
FYP	Five Year Plan
GBS	Guangdong Bureau of Statistics
GDEMI	Guangdong Department of Electronics and Machinery Industry
GDP	Gross Domestic Product
GDRC	Guangdong Development and Reform Commission
GDST	Guangdong Department of Science and Technology
GEIA	Guangdong Electronics Industry Annals
GEIC	Guangdong Economic and Information Commission
GETC	Guangdong Economic and Trade Commission
GFC	Global Financial Crisis
GPN	Global Production Network
GTP	Government Transformation Programme
GVC	Global Value Chain
GYCC	Guangdong Yearbook Compilation Committee
HICOM	Heavy Industries Corporation of Malaysia
HIDZ	High-Tech Industrial Development Zones

HKTM	Hong Kong, Macau and Taiwan
HNTE	High and New Technology Enterprises
HRDF	Human Resources Development Fund
IC	Integrated Circuit
ICA	Industrial Coordination Act
ICT	Information and Communications Technology
IIA	Investment Incentives Act
IMP	Industrial Master Plan
IoT	Internet of Things
IP	Intellectual Property
IRDA	Iskandar Regional Development Authority
IRPA	Intensification of Research in Priority Areas
IT	Information Technology
ITA	Information Technology Agreement
ITRI	Industrial Technology Research Institute of Taiwan
JV	Joint Venture
KHTM	Kulim High-Tech Park
LCD	Liquid Crystal Display
LED	Light Emitting Diode
LMW	Licensed Manufacturing Warehouse
M&A	Merger and Acquisition
MAEI	Malaysian American Electronics Industries
MARA	Majlis Amanah Rakyat
MATRADE	Malaysia External Trade Development Corporation
MCA	Malaysian Chinese Association
MEI	Ministry of Electronic Industry
MIC	Malaysian Indian Congress
MIDA	Malaysia Investment Development Agency
MIDF	Malaysia Industrial Finance
MIGHT	Malaysian Industry-Government Group for High Technology
MII	Ministry of Information Industries
MIIT	Ministry of Industry and Information Technology
MIMOS	Malaysian Institute for Microelectronics Systems
MISC	Malaysian Standard Industrial Classification
MITI	Ministry of Trade and Industry
MLP	National Medium- and Long-Term Plan for the Development of Science and Technology
MNC	Multi-national Corporation
MoE	Ministry of Education
MoF	Ministry of Finance
MOST	Ministry of Science and Technology
MOSTI	Ministry of Science, Technology and Innovation
MP	Malaysia Plan
MPT	Ministry of Post and Telecommunications
MSC	Multimedia Super Corridor
MTDC	Malaysian Technology Development Corporation

NCER	Northern Economic Corridor
NCIA	Northern Corridor Implementation Authority
NDRC	National Development and Reform Commission
NEP	New Economic Policy
NKEA	New Key Economic Area
OEM	Original Equipment Manufacturer
PC	Personal Computer
PCB	Printed Circuit Board
PDC	Penang Development Corporation
PEMANDU	Performance Management and Delivery Unit
PERNAS	Perbadan NAsional
PIA	Promotion of Investments Act
PIO	Pioneer Industries Ordinance
PMO	Prime Ministers’ Office
PRD	Pearl River Delta
PSDC	Penang Skills Development Centre
R&D	Research and Development
RDA	Regional Development Agency
RFID	Radio-frequency Identification
RM	Ringgit Malaysian
RMB	Renminbi
S&T	Science and Technology
SEDC	State Economic Development Corporation
SEG	Shenzhen Electronics Group
SEI	Strategic Emerging Industries
SEZ	Special Economic Zones
SIRIM	Scientific and Industrial Research Institute of Malaysia
SME	Small and Medium Enterprise
SMT	Surface Mount Technology
SOE	State-Owned Enterprise
SOSHE	State-Owned Holding Enterprise
TEEAM	Electrical and Electronics Association of Malaysia
TiVA	Trade in Value Added
TPM	Technology Park Malaysia
UMNO	United Malays National Organisation
UNIDO	United Nations Industrial Development Organisation
US	United States
USD	United States Dollars
UTM	University Technology Malaysia
VDP	Vendor Development Programme
WFOE	Wholly Foreign Owned Enterprise
WTO	World Trade Organization
YRD	Yangtze River Delta

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1 Introduction

Trade and financial liberalization, intellectual property protection and privatization have been the recommended recipe for economic development in the past four decades (Chang, 2002; 2011). However, no developing countries have managed to make the transition to an advanced industrial economy during the past thirty years. The exception to this pessimist landscape is China, which even though still far from the economic frontier in per capita terms, has been growing at a seemingly unstoppable rate. China has embedded herself in global trade and investment flows at an accelerating pace since the 1980s, but at the same time has intervened repeatedly to advance its industrial development, in a similar manner to that of Japan, South Korea and Taiwan before it (Nolan, 2001). China's use of industrial policy instruments, that at times contravene World Trade Organisation (WTO) rules, have created mounting tension with China's biggest trading partner, the United States (U.S.). In contrast to the Chinese 'miracle', the U.S., once a bastion of free trade, has witnessed widespread popular discontent with globalization and the ensuing loss of manufacturing jobs. Rapidly increasing offshoring and outsourcing practices, especially since the 1990s, have reduced demand for U.S. labour and have contributed to a decline on average real wages (Milberg and Winkler, 2013). These developments have sparked renewed attention by policy-makers and academics on industrial policy and its implementation in a highly globalized and connected world (OECD, 2013; Bianchi and Labory, 2006, 2018).

Despite the re-introduction of industrial policy into mainstream discourse, the expansion of Global Value Chains (GVCs), particularly since the 1990s, is seen as a critical obstacle in its contemporary implementation. It has been suggested that in the context of GVCs, industrial policy requires a radical rethink, with the state's role confined to facilitating integration, foregoing interventionist measures such as vertically-integrated 'national champion' initiatives (Milberg et al, 2013; Gereffi and Sturgeon, 2013; Yeung, 2014, 2016; Coe and Yeung, 2015) or tariffs, that could discourage GVCs from taking root (Baldwin, 2014). However, a systematic theoretical examination on the role of industrial policy within GVCs is lacking, especially one that takes into account the diversity of industrial policy interventions and their multiple rationales. Moreover, industrial policy continues to be implemented in various ways in regions that have integrated into GVCs – regardless of the advance of trade and investment liberalization - and these constitute a source of empirical evidence that has not been examined by the literature.

This thesis aims to fill these gaps by creating a theoretical framework to link the theory of industrial policy with that of GVCs with insights from the innovation economics literature. Using a mixed methods approach (interviews to key actors, archive research, analyses of official documents and descriptive statistical analyses), the framework is then used to examine the empirical case studies of industrial policy in the electronics industry in Guangdong province of China and in Malaysia.

The next sections discuss: the development of the electronics GVC to provide background for the two case studies included in this research (Section 1.1); a brief summary of the arguments presented (Section 1.2); the methodology used (Section 1.3) and the structure of the thesis (Section 1.4).

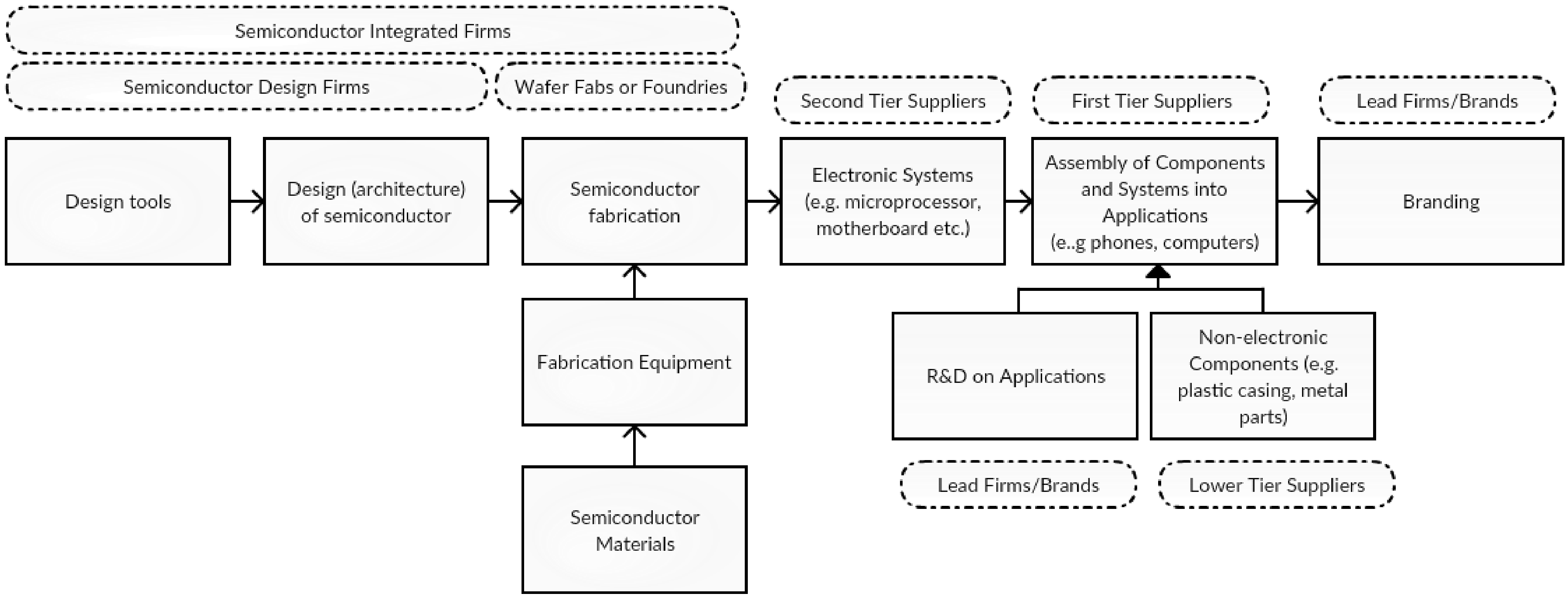
1.1 The Electronics Global Value Chain

The global electronics industry has been the object of many studies in the literature on GVCs (Ernst, 1992, 2006, 2016; Hobday, 2001; Gagnes and van Assche, 2011; Sturgeon and Kawakami, 2011; Sturgeon, 2002; Yeung, 2007), industrial policy (Matthews and Cho, 2000; Ning, 2009) and innovation (Yap and Rasiah, 2017; Lee and Malerba, 2016). This is because the electronics industry is highly integrated in global networks (UNCTAD, 2013), is technologically sophisticated, especially when it comes to semiconductors, and almost all of the East Asian 'miracle' economies successfully created lead firms or first tier suppliers in it.

The electronics industry was one of the first to be organized in the form of complex, sprawling GVCs, spanning several countries. Ernst wrote in 1985: "inside almost any electronic product – whether it is a computer or a consumer item – components can be found which have been made in more than a dozen factories in at least half a dozen countries. Even one subassembly may be the result of an odyssey" (Ernst, 1985:25). A rather simplified representation of the electronics GVCs is presented in Figure (1.1). The most sophisticated component, and the one that makes electronics 'tick', is the semiconductor or chip. Discrete semiconductors are simpler than integrated ones.

Integrated semiconductor firms both design and manufacture chips (e.g. Samsung), but this process is increasingly undertaken by firms who design the chips (e.g. ARM) and outsource their manufacture to companies known as wafer fabs or foundries (e.g TSMC). The function of the chip in the final product is decided by the lead firm that often conducts product R&D and design. A final product requires not only several different chips, but also a myriad of other components, which are manufactured and assembled by several suppliers in different tiers. Chips are usually assembled into systems by second tier suppliers, while simple non-electronic components are undertaken by lower tier suppliers and final assembly is undertaken by first tier suppliers.

Figure 1.1 The electronics global value chain



Source: Author's illustration drawing on https://ec.europa.eu/digital-single-market/en/news/electronics-value-chain-infographic and Sturgeon and Kawakami (2011).

The governance and spatial organization of the electronics GVC has evolved over time, owing to entrants from new regions and advances in product and process technology.

Electronics GVCs started emerging in the end of the 1950s, when US-based electronics firms gradually established product assembly first in Japan and later in Taiwan and Hong Kong. Assembly of semiconductors was offshored in 1970s and that of hard disk drives in the 1980s (Ernst, 1985, 1997c). Japanese firms quickly rose to prominence towards the end of the 1970s, providing low-cost, miniaturized and customizable consumer electronics based on the application of Just-in-Time supply management and lead production techniques (Ernst, 1994). Japanese firms also started to offshore production following the sharp appreciation of the yen in 1985, often bringing their own suppliers to overseas production locations (Ernst, 1994). The rapid growth of export platforms for MNCs (e.g. export zones or free trade zones) in many locations such as Singapore, South Korea, Malaysia, Hong Kong in the 1970s and in the Philippines, Thailand, Indonesia, the Caribbean, China and Sri Lanka in the 1980s facilitated the expansion of electronics GVCs. They key decision factor for offshoring was cost; according to some estimates the overall cost of p roducing in Southeast Asia was 30% of that in the US (Ernst, 1985b).

The governance pattern of electronics GVCs changed rapidly in the 1990s, particularly for US firms (Sturgeon, 1997; see also Chapter 2). The growing attention of lead firms on core competences encouraged outsourcing of capital-intensive and mature production stages. The suppliers who started undertaking production on behalf of lead firms were created either as spinoffs of the original electronics lead firms (for example Celestica which was span off from IBM), or with existing parts suppliers purchasing production facilities off lead firms (for example Flextronics and Selectron expanded by purchasing facilities from IBM and HP) (Sturgeon, 2006). These suppliers are referred to as 'contract manufacturers', 'electronics manufacturing service (EMS) firms', 'original design manufacturers (ODM)' and 'first tier suppliers' with the terms used interchangeably in the literature. The growth of first tier suppliers facilitated the emergence of lead firms that were never involved in manufacturing but focused on software development and branding, such as Sun Microsystems and Cisco (ibid.). Compared to their US counterparts, Japanese and South Korean lead firms are still more hierarchical, preferring to retain some production activities in-house (Sturgeon, 2006; Ernst, 1994).

Contract manufacturers have to pool customers together in order to be profitable, reducing the asset specificity of their investments. They also need to have a global presence to serve the lead firms and operate at very low margins. To maintain profitability, contract manufacturers usually add a range of high value-added services, such as assembly, packaging, testing and design (Sturgeon, 1997, 1998, 2000, 2002). In this way, the de-verticalisation of lead firms has been followed by increasing vertical integration by first tier suppliers. The contract manufacturing market is now dominated by firms from the US and firms from Taiwan, notably Foxconn, which expanded by adding assembly locations in China.

Even though firms from the US remain dominant in the electronics value chain, new firms have entered the leading ranks, although these come from only a handful of countries (Table 1.1). South Korean firm Samsung is perhaps the most notable exception, having become a global brand in consumer electronics and having developed frontier capabilities in semiconductor production and design. By contrast, Taiwanese firms Asus, Acer and HTC have struggled to establish a strong brand presence in the US (Sturgeon and Lester, 2004; Ernst, 2013). More recently, Chinese firms Huawei, Oppo, Vivo, ZTE and TCL have become big brands in mobile phones and other consumer electronics segments (with Huawei and ZTE also leading in telecommunications equipment), while the country has developed some capabilities in semiconductor design (Ernst and Naughton, 2012).

Table 1.1 Top 10 vendors in key electronics value chain segments, 2016

Semiconductor Vendors[1]	Market Share by Revenue (%)	Fabless semiconductor firms	Market Share by Revenue (%)	Contract Manufacturers[2]	Market Share by Revenue (%)	Smartphone Vendors	Market Share by Units (%)	Computer Vendors[2] 2016	Market Share by Units (%)
Intel (USA)	15.7	Qualcomm (USA)	17.0	Foxconn (TWN)	31.9	Samsung (KOR)	20.9	HP (USA)	20.8
Samsung (KOR)	11.7	Broadcom (SGP)	15.3	Pegatron (TWN)	7.0	Apple (US)	14.5	Lenovo (CHN)	19.9
Qualcomm (USA)	4.5	MediaTek (TWN)	9.7	Flex (USA)	5.7	Huawei (CHN)	9.3	Dell (USA)	15.6
SK Hynix (KOR)	4.3	Nvidia (USA)	7.0	Wistron (TWN)	4.5	Oppo (CHN)	6.3	Apple (USA)	6.9
Broadcom (SGP)	3.8	Apple (USA)	7.1	Jabil (USA)	3.7	Vivo (CHN)	5.1	Asus (TWN)	6.6
Micron (USA)	3.8	AMD (USA)	4.7	Quanta Computer (TWN)	3.5	ZTE (CHN)	3.9	Acer (TWN)	6.3
Texas Instruments (USA)	3.5	HiSilicon (CHN)	4.3	Compal Electronics (TWN)	3.2	LG (KOR)	3.7		
Toshiba (JPN)	2.9	Xilinx (USA)	2.5	Inventec (TWN)	1.6	Lenovo (CHN)	3.6		
NXP Semiconductors (NLD)	2.7	Marvell (USA)	2.6	TPV Technology (HKG)	1.4	Xiaomi (CHN)	3.6		
MediaTek (TWN)	2.5	Unigroup[3] (CHN)	2.0	Sanmina-SCI (USA)	1.3	TCL (CHN)	2.6		

Notes: Parentheses include the country firms are based in. Hong Kong: HKG, JPN: Japan, KOR: South Korea, NLD: Netherlands, SGP: Singapore, TWN: Taiwan, USA: United States of America. [1]Includes integrated IC vendors and fabless firms [2] Data for 2014 [1]Only top 6 vendors available. [2]Includes firms Spreadtrum and RDA.
Source: Data from Gartner (2017a, 2017b), IC Insights (2017, 2018), MMI (2015).

1.2 GVCs and industrial policy in Guangdong and Malaysia

While integration into GVCs can provide opportunities for upgrading, developing country firms often find it difficult to accumulate enough capabilities to operate at the technological frontier, even after decades of supplying lead firms. Drawing on three literatures (industrial policy, GVCs and technological capabilities), this thesis argues that in the absence of industrial policy it is difficult for firms to overcome the market failures associated with industrialization and technological learning and achieve sustained upgrading. Industrial policy can complement the endogenous incentives firms have for investing in innovation by improving the innovation system (e.g. science and technology infrastructure) and by directly shaping prices (e.g. R&D subsidies) (Lall, 1992; Pack and Westphal, 1986; Cimoli, Dosi and Stiglitz, 2009). Industrial policy can also be used to promote integration into desired GVCs (e.g. tax incentives for FDI) that are deemed to offer better opportunities for technological learning. By investing in capability accumulation, firms are then better able to harness integration into GVCs to upgrade.

Guangdong and Malaysia were chosen as two case studies to highlight the dynamics of industrial policy, innovation and GVCs in contemporary industrial development. Guangdong province actively pursued integration into global, trade and production flows to achieve industrial development. It is also one of the main production bases of electronics in China and is home to some of the most dynamic local firms in the industry, although it still hosts vast labour intensive operations. These features make Guangdong an excellent case study for the role of GVCs and industrial policies in industrial upgrading. Choosing another Chinese province would no doubt have illustrated a different industrial development path compared to that of Guangdong, shaped by the specific policies and patterns of integration followed in that province, but the study would then run the risk of being too China-specific for a framework that aims to be widely relevant. For this reason, Malaysia was chosen as the second case study. Malaysia also developed primarily by attracting FDI in the electronics industry and has experienced some upgrading, albeit limited as the country has not developed any brand firms or first tier suppliers of its own, and subsidiaries do not engage in frontier innovation activities. The active pursuit of integration of Guangdong and Malaysia into electronics GVCs and their mixed track records means that the two case studies have the potential to illustrate ways in which industrial policies complement upgrading within GVCs, and ways in which policies fail to stimulate it.

This research argues that in the case of Guangdong, industrial policies by the central, provincial and local governments created rents for learning for domestic firms. These rents allowed firms to build their capabilities and use integration into electronics GVCs to upgrade, creating a virtuous circle. Policies evolved over time, pushing firms to integrate, then expand in scale and finally, to become innovative. Nevertheless, weaknesses persist related to low investments in public higher education and basic research, as well as in providing access to credit for the burgeoning private sector. In the case of Malaysia, industrial policies did not create adequate incentives for indigenous firms to invest in technological learning and investments in the innovation system did not leverage linkages with already-established local firms. As a result, Malaysia's small domestic electronics sector took advantage of within-GVC opportunities to learn and grow, but has stagnated.

1.3 Methodology

This research uses an eclectic methodology. The overall approach is qualitative, relying on two case studies - Guangdong province of China and Malaysia (Chapters 4 and 5) – to illustrate the relevance of the theoretical framework built in Chapter 3. The case studies were constructed by tapping into five main sources of qualitative and quantitative information that facilitated triangulation:

- *Original policy documents at country and regional level and government reports on implemented policies.* Most documents consulted are available online in government websites. In the case of Guangdong, policy documents were also collected from collected volumes published by government agencies and annual yearbooks.
- *Relevant information reported by the press.* The online database Factiva, which offers a rich variety of press sources, including of specialist publications that report on the electronics industry, was used extensively for this research. The database is accessible through the University of Cambridge Library.

- *Semi-structured field interviews with policymakers, business people and other experts.* In total, 31 interviews were carried out in Guangdong and Beijing over a period of six months (January to April 2015, November 2015 and March 2017) and 30 interviews were carried out in Malaysia over a period of three months (February to April 2016). Interviews lasted on average for an hour to an hour and a half. Notes were always taken by the author during these interviews and voice recordings also exist for nine interviews. All interviewees have been anonymized for this research. Approximately 12 of the interviews were conducted in Mandarin with the author. A research assistant that is fluent in Mandarin was present to ensure that there was no miscommunication. The research assistant also provided interpretation services for an additional two interviews conducted in Cantonese.
- *Statistical data obtained online and through archival research.* In the case of Guangdong, information was collected from the following annual statistical yearbooks: the Guangdong Statistical Yearbook, the Guangdong Industrial Statistical Yearbook, the Guangdong Yearbook, the Guangdong S&T Yearbook, the China Electronics and Information Statistical Yearbook, the China Electronics Industry Yearbook and the China Industrial Statistical Yearbook. The Chinese database CNKI contains online copies for most of the reference years. As it is not accessible from the University of Cambridge Library the author obtained the information during fieldwork in China. For reference years not available online, the author collected information from volumes contained in the Sun Yat-Sen University Library in Guangzhou, China and from purchased material. In the case of Malaysia, information was collected from the Annual Industrial Surveys, the Annual Manufacturing Surveys and the MIDA Annual Reports. As few of these are available online, the author obtained most of the data from research in the Library of the Department of Statistics Malaysia and the MIDA Information Centre. Time series was constructed based on the cleaned collected data and any caveats, such as statistical breaks and changes in reported firm size over time, are reported in the relevant chapters.

Case studies have been used in economics and development studies, particularly in the fields of political economy, innovation and industrial organization, including global value chains (Starr, 2014). Case studies allow for an in-depth exploration of complex phenomena that may display multiple causalities that are hard to define and measure. They also allow the researcher to deviate from testing hypotheses that result in zero/one judgments or test for causality, towards answering “how” certain phenomena have unfolded (Yin, 2014 [1994]). Multiple case studies offer the potential to ‘test’ the understanding that a researcher has of a phenomenon against a larger amount of evidence. In this research, the two case studies of Guangdong province of China and Malaysia permit an evaluation of the framework on industrial policy in the context of GVCs developed here. This is a first step to future work that will include more case studies.

However, it should be noted that the method here is not that of a comparative study. The use of the latter in studies of political economy often has the objective to compare and contrast experiences of countries or regions that are similar in certain respects (e.g. natural endowments) but show a diverging performance in terms of economic development (for example Haggard, 1990). The comparison allows the researcher to locate the factors that differ across the case studies and may account for the divergence in economic performance. In contrast to the comparative method, this research applies a theoretical framework across two case studies in order to provide richer evidence to support its validity and usefulness (as in Evans, 1995; Wade, 1990; Kohli, 2004). Nevertheless, a brief comparison of the findings of the two case studies is presented in the conclusion of this research.

1.4 Structure of the thesis

Chapter 2 summarizes the debate on industrial policy. It reviews the main rationales that have been put forward including infant industry arguments and the nature of technological capability accumulation.

Chapter 3 puts forward the theoretical framework adopted by this research. It starts by a historical review of the GVC literature and critically reviews the role of the state in the context of GVCs. It then goes on to use insights from the innovation literature to build a framework for the role of industrial policy in integration and upgrading within GVCs.

Chapters 4 and 5 discuss the role of industrial policy in achieving integration and upgrading in the electronics industry in the province of Guangdong, China and Malaysia respectively. Both of the Chapters follow a chronological approach discussing the different policy phases and their respective results.

Chapter 6 summarizes the conclusions of this thesis.

2 Why Should We Care About Industrial Policy?

2.1 Introduction

Industrial policy is firmly back on the agenda in developed countries, aiming to stem the trend of deindustrialization, find and support new growth areas, accelerate the development of environmental technologies and respond to the rise of BRICS, and China in particular (Naudé, 2010; OECD, 2013; Aiginger, 2007; Bianchi and Labory, 2006). For example, the US launched the *Advanced Manufacturing Partnership* in 2011, a strategy of rejuvenating manufacturing in the US by coordinating investment efforts of industry, universities, and the federal government in emerging technologies, such as robotics, nanomanufacturing and advanced materials. Actions also include federal funding of research projects in manufacturing technologies as well as of a network of 14 Manufacturing Innovation Institutes to bridge the gap between early stage research and commercialization (Bonvillian, 2017).

The benefits of industrial policy have been debated many times in the past and there exist comprehensive reviews on its theoretical justifications as well as a rich body of empirical work documenting its successful implementation in the East Asian “tigers” (Johnson, 1982; Amsden, 1989; Wade, 1990; Chang, 1994). However, industrial policy still remains a current topic, with exciting areas to be explored both theoretically and empirically. For one, as economic theories evolve, our understanding of why industrial policy is necessary and under what conditions it can be successful also changes and becomes more complex, even as the basic intuition remains the same. Moreover, the emerging opportunities and challenges that arise from shifts in the organization of trade and production and the moving technological frontier have an impact on industrial policy rationales and implementation. Finally, the shifting domestic political economy landscapes also require new responses. For example, demographic ageing, popular reactions to an uncontrolled globalisation that has failed to compensate the ‘losers’ and the weakening of trade unions paint a new context for industrial policy compared to he post-war period.

The main object of inquiry of this research is the theoretical and empirical exploration of how industrial policy should respond to the expansion of global value chains (GVCs).

The first step in this direction is a holistic review of the rationales for industrial policy that have been offered so far in the literature, presented in this Chapter.

Not all policies that come under the rubric of 'industrial policy' share the same aim. From initiating industrialization in a subsistence economy, to shifting resources towards sectors with higher productivity potential in an industrialized economy, to propping up 'sundown' industries, the aim can vary at different stages of development. However, what unites all these perspectives is the understanding that production specialization in manufacturing can provide more long-term potential for sustained economic development than specialization in simple primary production or services (Chang et al, 2013; Szirmai, 2012). Moreover, market forces do not necessarily bring about the desired specialization, making government action necessary. The definition of industrial policy that more closely aligns with our perspective is that of Chang's (1994), who defined it as a policy 'aimed at particular industries (and firms as their components) to achieve the outcomes that are perceived by the state to be efficient for the economy as a whole' (p. 69). Several different instruments can fall under this umbrella, defined by their domain of action (Table 2.1)

The next sections of this chapter will elaborate on the different rationales for industrial policy. In Section 2.2 the case for free trade will be presented first, as industrial policy can be better understood as a departure from faith in free markets. Section 2.3 will explore the arguments for supporting infant industry on the basis of externalities. Section 2.4 will extend the industrial policy argument to structural issues domestically and internationally. Section 2.5 will look specifically at technological development as the goal of industrial policy, a view that encompasses many of the previous rationales. Section 2.6 will briefly review the institutional basis for implementing industrial policy and finally Section 2.7 will mention the reduction of policy space and the expansion of global value chains as contemporary challenges for the implementation of industrial policy.

Table 2.1 Industrial policy domains, instruments and rationales

Domain	Instruments	Rationales
Product Markets	Creating and promoting national champions Nationalisation/Privatization Output and export subsidies Public procurement Tariffs and Non-Tariff Trade Barriers (NTBs) Product and technological standard-setting	Increase scale of firms Invest in sectors that private capital is hesitant to enter Promote sectors that have significant externalities Provide demand for domestically-manufactured products Protect firms from foreign competition (on the condition that they invest rents in learning)
Human capital accumulation	Investments in education at all levels, often for targeted skills Training subsidies High wage policies (e.g. raising minimum wages, or imposing levies to firms that hire foreign unskilled workers)	Increase the availability of skilled workers Push firms to rely on high skills rather than low wages Induce firms to provide on-the-job training
Physical capital accumulation	Loan guarantees Corporate tax holidays and discounts Capital allowances for industrial investments Financial market regulation Strategic investment funds State owned banks	Subsidise finance for promoted industries Correct informational asymmetries in capital markets Make financing available for risky/uncertain technological development
Spatial agglomerations	Creation of special development zones Cluster infrastructure Special incentives for location in clusters/zones	Increase spatial agglomeration to capture benefits of proximity.
Technological Development	R&D tax credits and grants Appropriate IPR regime Public procurement for domestic high-tech products Establishment of R&D centres Output/export subsidies for high-tech products	Promote investment in technological capability building. Encourage firm-university-government linkages.
Information generation, collection and provision	Collective institutions of communication State export marketing agencies Government-sponsored market research institutes	To provide general overview To provide ‘focal points’ for action (including coordination between complementary actors’

Production of plans, white papers, “visions”	To provide information that individual firms/industries do not have

Source: Based on Warwick (2013).

2.2 The Case for Free Trade

The debate on whether development is best achieved by imposing tariffs or by maintaining free trade is as old as economics itself (see contributions in Jomo and Reinert, 2005). There are four main theoretical strands that we examine here: free trade as a way to encourage specialization in activities with comparative advantage (Section 2.2.1), free trade as a means to encourage accumulation and achieve dynamic comparative advantage (Section 2.2.2), new trade theories (Section 2.2.3).

2.2.1 The Theory of Comparative Advantage

One of the most influential defenses of free trade has come from the theories of comparative advantage. The first formulation was made by David Ricardo (1817). In an elegant exposition, Ricardo argued that in a model of two goods, two countries and one factor of production (labour), both countries would gain from trade if they specialised in producing the good in which they have higher relative productivity. A later version of comparative advantage was expressed in neoclassical terms by the Hecksher-Ohlin (H-O) model (Hecksher 1919; Ohlin, 1967 [1933]; Stolper and Samuelson, 1941), which relied on relative differences in factor endowments to make a similar point. In a model of two goods, two countries and two factors of production, it was argued that both countries would gain from trade if they specialised in producing the good that uses more intensively the factor that they possess in relative abundance.

In both cases, the message was powerful, as trade could be ‘win-win’ for both countries, even if one had the absolute advantage in producing both goods. In this context, industrial policy would distort the efficiency gains brought about by the pursuit of activities with comparative advantage, making countries worse-off compared to under free trade policy.

While a lot of research has been undertaken on extending these models, combining them, testing them under relaxed assumptions and proving their empirical validity, not much has changed in terms of the core propositions. Perhaps the most interesting addition is that of Wood (1995), who formalized the argument that skills should be considered a factor of production[1]. Wood showed that treating human capital as a separate factor could explain wage inequality in the global North as a result of international trade. A second extension that has been helpful, although not very different conceptually from standard models, is the reinterpretation of trade models to include trade in components or tasks that make up a final good (for example Grossman and Rossi-Hansberg, 2008; see also Milberg and Winkler, Chapter 3 for a critical review).

Unsurprisingly, the theories of comparative advantage have been the subject of fierce debate. A major problem lays in their unrealistic assumptions, such as perfect competition, international immobility and internal mobility of factors, constant returns to scale in production, no externalities and, most importantly, equal technological capabilities that allows all countries to make use of the same technologies. That is not to say that the models cannot be tweaked to incorporate these elements, but if they do, the results are at best weakened (Deardorff, 2005) and at worst countries could even be worse-off after free trade (Evans, 1989). Especially problematic is the assumption of labor mobility within countries and a lack of attention to asset specificity in economic activities. This implies that adjustment can happen fully and with no cost, while reality is starkly different (Lin and Chang, 2009). Additionally, if capital is mobile internationally, then we can easily imagine capital going to wherever labor is more productive, making absolute advantage the determining factor (Milberg and Winkler, 2013, chapter 3). Finally, a crucial problem is that when we allow for different economic activities to have different potentials in terms of economies of scale or technological learning, the static gains from specialisation might be overshadowed by dynamic problems of specialisation in low-potential activities (Reinert, 2009), a theme that is recurrent in this Chapter.

Empirically, the results are also difficult to interpret. The H-O is extremely simplified and thereby difficult to test with real world data (Deardorff, 1984), and performs poorly on predicting patterns of trade (Teffler, 1995; Baldwin, 2008). The evidence for the factor

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[1] Leontieff (1953) had first suggested that the reason that the U.S. exported more labour-intensive goods than predicted by the H-O model, must be that U.S. labour is more productive than foreign labour.

price equalization predicted by Stolper and Samuelson is also elusive (see for example Goldberg and Pavcnik, 2007). Additionally, the increase in intra-industry trade since the early 1980s among countries with similar factor endowments was left completely unexplained by theories of comparative advantage. Moreover, statistical results proving beneficial effects from trade is not enough to verify theories of comparative advantage, as gains from trade can be derived from multiple theories (Leamer and Levinsohn, 1995).

2.2.2 Dynamic Comparative Advantage

One of the criticisms levelled at the theory of comparative advantage is that it is static. Trade leads to specialisation, which yields static efficiency gains and that is the end of the story. However, this contrasts sharply with the historical evidence of structural transformation in advanced economies and with the dynamic experience of post-War development of the Newly Industrialised Countries (NICs) in East Asia and Latin America. The shifting export structure of the NICs, from primary products to increasingly capital-intensive and complex manufactures begged for an explanation.

This problem was dealt in the mainstream with the development of theories of 'dynamic comparative advantage', although a precise definition of the term remains elusive. Most works in this direction see comparative advantage as evolving through time, but the mechanism that leads to this evolution is not so much related to trade but to endogenous factors that draw on developments in new growth theory.

In one of the first formulations, Balassa (1979) looked at the changing 'revealed comparative advantage[2]' in manufacturing in a sample of 36 countries and argued that this changed progressively over time from labor-intensive to capital-intensive industries. This lent credence to a stage view of comparative advantage[3], where advantages change over

[2] The Revealed Comparative Advantage (RCA) was an index developed by Balassa, defined as the ratio of the share of exports of a product in a country's exports over the share of the world exports of this product in world exports.

[3] Akamatsu (1962) also saw the process of development as one of continuous shifts in comparative advantage (although not using that term) between developed and developing countries, as a result of colonialism, competition, and nationalism. As wages rose in the advanced country industries started to locate in less advanced countries, and then as these also faced increasing costs,

time, as countries accumulate physical and human capital. The specific mechanisms of accumulation were not explored much in Balassa, but he argued that export promotion, in the sense of providing an overall neutral, free trade regime, enabled the observed accumulation of factors of production in successful NICs, such as South Korea and Taiwan[4].

A very similar point was made more recently by Lin (2011), who discussed how factor endowment (to which he includes infrastructure) changes over time, continuously moving the optimal industrial structure towards more skill- and capital- intensive industries. The rationale is similar to that of Balsassa; when firms specialize in the industries in which a country has a comparative advantage, they can obtain a larger market share and maximize their economic surplus. This surplus can be (although it may not be) reinvested in physical and human capital. With a competitive price system, allocation will be optimal and the technology chosen appropriate for the level of the country's development. However, unlike Balassa, Lin advocates a very limited but important role in fixing the informational externalities that are created by pioneer firms (see also section 2.3.2) and in addressing coordination market failures that may arise for firms in undertaking complementary investments in assets, such as skills and hard infrastructure (see also section 2.4.2). The failure of governments to undertake this role prevents countries from upgrading their industrial structures and as a result they get stuck in the so-called "middle-income trap" (Lin, 2017).

Dynamic theories of comparative advantage shift the explanatory burden of development from trade to what causes growth, itself a hotly debated issue. Increasingly since the works of Lucas (1988) and Romer (1986), the mainstream has recognized that accumulated investments in human capital and R&D are characterized by increasing returns and can thereby accelerate growth, encouraging a closer look at innovation as the driver of growth. The 'technological capabilities' literature, drawing on Schumpeter's view

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industries developed in yet less advanced countries. This led to the formation of the famous 'flying geese' pattern, with Japan on its head, and Korea and Taiwan behind it.

[4] The thesis of a "neutral" trade regime in Taiwan and South Korea has been extensively criticized by Wade (1990). Essentially, what appeared as neutral regimes were industrial policies that used protection strategically to build capabilities in sectors with export potential.

of innovation as the driver of development (1962 [1934]), has strived to show that the use and development of technology requires extensive learning on the part of the firms (reviewed in Section 2.5). This effort is far from the automatic diffusion assumed in models of dynamic comparative advantage and opens the door for the consideration of government policy in making such learning possible (see also Lin and Chang, 2009). Simple learning-related market imperfections, such as learning-by-doing, can alter the results of dynamic comparative advantage models to show how government intervention can shift comparative advantage over time (Redding, 1999).

2.2.3 New Trade Theories, Same Advice

New trade theory models were developed mainly to explain the rise in intra-industry trade among advanced economies during the post-War period (Krugman, 1992). These models incorporate several market failures and structural dualities that had long been recognised in classical development economics but not formalised in a general equilibrium framework before, and show that comparative advantage does not determine intra-industry trade. In many cases, the solutions are not unique and there is a possibility of growth divergence between countries after trade, since trade could lead to specialisation in sectors with different potentials for increasing returns to scale or externalities. Even if these results could support government interventions, these models have been included in the section on free trade, because the main representatives of this school still support a free trade approach. On the one hand, they argue that comparative advantage still applies at the aggregate inter-industry level (Krugman, 1992). On the other hand, fears over government failure (see also Section 2.6.1) have made mainstream economists sceptical that the first-best policies according to the new trade theory models could work in practice, except perhaps for where production externalities are beyond doubt (Krugman, 1992; McCulloch, 1993).

It would be useful to review the main types of new trade theory models, as some of the concepts come up frequently in the literature on infant industry protection as well. Krugman (1985) has grouped them in three categories, summarised here.

The first set of models incorporate positive production externalities. These can arise because of the development of specialised skills or technological spillovers as an industry grows. New entrants do not need to invest as much as earlier entrants in developing skills or technology because they can benefit from the investments made by earlier entrants, bringing down their average costs of production. This leads to increasing returns to scale at the industry-level. Even though trade models had tried to incorporate these in the theory of comparative advantage since Graham (1923), it was only with the work of Ethier (1982) that a real step forward was made, according to Krugman. In these models, a larger industrial output implies lower unit costs, leading each country to specialise in the good in which its industry is larger. In such a setting, several equilibria can arise, even ones that make countries worse-off when trading, depending on the assumptions made regarding the respective size of industries and labor force.

A second set of models includes those that incorporate imperfectly competitive market structures. The basic approach taken (for example Helpman and Krugman, 1985), builds on the work of Dixit and Stiglitz (1977) and Spence (1976), who modeled product differentiation under monopolistic competition. Again, multiple equilibria are possible, as each country will specialize in different varieties of the same good, but which variety and in what proportions depends on specific assumptions. Trade will be beneficial if the varieties and the scale of output after trade are larger than in autarky. In Krugman's review, which country produces what variety does not matter from a global welfare point of view, but it is possible that different varieties display different potentials for future unit cost reductions and face different demand elasticities. This again shows that future divergence is possible.

Finally, the third type of models are based on oligopolistic competition, drawing from a variety of game theoretical set ups. Depending on the assumptions, any number of things could happen in such a setting. In a Cournot oligopoly, the removal of trade barriers could increase the total number of market players, increasing the perceived demand elasticity for each firm. This will lead all firms to expand output and reduce prices. However, it is also possible that increased competition may drive some firms out of the market, leading to a structure that is more concentrated after trade, characterized by the existence of larger firms that compete more than before trade (Dixit and Norman, 1980). In a much-cited contribution, Brander and Spencer (1985) argued that there could be some benefits from export subsidies in an oligopolistic setting, opening the door for considering strategic government intervention in trade.

Unlike with earlier trade models, no one-size-fits-all policy advice can be derived from new trade models, as even small changes in assumptions could give different results. However, it is also clear that intervention is not necessarily welfare-reducing as in earlier trade theories.

2.3 Infant Industry and Externalities

As explained in Section 2.2, in the context of market imperfections at the firm level or the industry level, specialisation under free trade might not be optimal. In this section, the reasons for this are further explored. Section 2.3.1 briefly discusses the infant industry argument and describes a range of externalities that could prevent an industry to emerge and achieve cost competitiveness. Some of the critiques made to the infant industry argument are critically evaluated in Section 2.3.2.

2.3.1 Infant Industry Arguments: From the Firm to the Industry

Infant industry arguments emerged as a critique to the dominant 'school' of Adam Smith. Smith's support of free trade as the road to development was criticised most notably by Hamilton (1791) and List (1983 [1885]), who argued that a domestic industry in a developing economy might not become immediately as competitive as foreign imports (Chang, 2002; Bairoch, 1995). Domestic firms need to gain experience and skills in production, and make investments to raise their productivity, in order to drive their production costs below those of their competitors. A period of temporary support[5], either in the form of a tariff to raise import prices or in the form of a subsidy to match the price gap, would make the domestic producer able to compete. Support can gradually decrease as unit costs fall down over time, until eventually it is removed when the industry becomes globally competitive. For protection to be the optimal choice, the total costs of protection

[5] It should be noted that both Hamilton and List did not only mention tariffs but had in mind a more holistic package of support (see Ho, 2005; Irwin, 2004). Nevertheless tariff protection emerged as the key concept from this debate, perhaps because notable economists such as Mill (1996 [1848]) and Torrens (1841) singled out tariffs for infant-industry as the only acceptable exception to the optimality of free trade.

should also be outweighed by the discounted future benefits of protection, according to the so-called Mill-Bastable criterion (Kemp, 1960).

While the infant industry argument found support even among mainstream economists, it was not easy to square the logic of learning-by-doing with the perfectly competitive equilibrium universe. A solution was given by Marshall, who focused on external economies of scale at the level of the industry, while assuming that firms operate under constant returns to scale (see Hart, 1996). Marshall focused on production externalities that induce the industry-level long-run average costs to fall with output due to a variety of spillover effects, especially prevalent in skill- and capital- intensive industries, such as the development of specialized skills and the diffusion of knowledge. Firms cannot fully internalize the benefits of, for example, developing skills by training their labor or developing knowledge that is diffused, as other firms do not get charged for using these inputs. As firms cannot internalize the spillovers arising from their activities, there is a possibility that they underinvest in the generation of skills and knowledge. Without a subsidy to raise the private return in line with the social return and without shielding the industry until costs have gone down compared to competition, a country could fail to specialize in industries that feature such spillovers. We look more closely into some of these externalities below.

2.3.2 Learning By Doing

Arrow (1962), in his seminal contribution, was one of the first economists to emphasize the external returns to scale arising from an increasing stock of knowledge as production experience accumulates[6]. Such learning-by-doing has been incorporated in trade models, formalizing the infant industry argument within a general equilibrium framework. In these models, there are usually two sectors considered, one featuring learning-by-doing and one with no such learning, with one of the countries (the developed one) already producing in the former sector. With its early start, the developed country has achieved learning by doing, and under trade it has a comparative advantage in that good and specializes in its

[6] Arrow's work was also an inspiration for later endogenous growth theories (Lucas, 1988; Romer, 1987).

production. Under these conditions some form of protection (tariffs or subsidies) would make it possible for the developing country to achieve the required production quantity for learning to take place, eventually being able to specialize in that good (Bardhan, 1971; Clemhout and Wan, 1970; Young, 1991; Greenwald and Stiglitz, 2006).

Informational Externalities

Another production externality that has gained some attention relates to the informational externalities generated by pioneer entrepreneurs (Rodrik, 2004). The act of searching for activities that can be profitable under local conditions carries significant costs, but if pioneers succeed, then others can emulate them, thus presenting a significant informational externality (see also Hausmann and Rodrik, 2003). A subsidy to the initial investor subject to performance requirements can help compensate for that externality. On the other hand, first movers can reap significant benefits as they enjoy a temporary monopoly, which is a strong incentive for firms to compete to innovate (see Schumpeter, 1911 [1934]). Whether a pioneer is discouraged or not to innovate may then depend on the extent of barriers to entry to that market and the capabilities of competitors.

Apart from production-related informational externalities there are also consumption-related ones. For example, Grossman and Horn (1988) considered the case where consumers do not have enough information for the domestic product. In this case, protection might be able to induce consumers to purchase the product and thereby learn its qualities[7]. Bagwell and Staiger (1989) similarly considered that an export promotion subsidy to high-quality firms who cannot signal their quality to foreign consumers, because foreign consumers are unaware of their brands and the only way for them to learn of the quality of these firms is to consume their products. In this setting, an export subsidy can raise national welfare.

[7] In that specific model Grossman and Horn found that protection exacerbates the quality problem, as marginal firms enter the industry, dragging quality down. However, as it happens with many such models, the result is very specific to the assumptions of the model on firm entry.

Knowledge Spillovers

Knowledge spillovers between firms and industries can also be a significant externality (see Greenwald and Stiglitz, 2006). Protecting the industry that generates the spillovers can increase the productivity of the rest of the economy, making it possible for all firms that receive the positive spillover to be able to compete better in the future. There are two policies related to this that have received more policy attention in developing countries, subsidizing Foreign Direct Investment (FDI) and promoting geographical clusters in sectors with potential for spillovers.

While support for attracting FDI is based on a long list of empirical and theoretical arguments (UNCTAD, 1999), one that has particular relevance here is the local knowledge spillovers from FDI operations (Lall, 2004). Foreign firms can be the source of superior managerial skills and technological knowledge related to production, organization, marketing and research to the local economy, especially if there are linkages developed between foreign and domestic firms. However, given that these benefits cannot be internalized fully by foreign firms, the latter might not be adequately incentivized to undertake activities that could lead to knowledge spillovers. In this case, government regulations could use 'a carrot and stick' strategy to increase knowledge diffusion by attracting FDI that would otherwise not have been made. On the one hand, fiscal incentives can attract relevant MNCs to produce locally. These incentives can be targeted to particular sectors or activities (for example if they depend on a certain amount of R&D or ratio of technical personnel). On the other hand, government regulations can also accelerate some of this diffusion by stipulating local content requirements, encouraging supplier-buyer linkages by offering match-making services or handing out tax incentives to firms that engage in MNC-local firm linkages and restricting the employment of foreign managerial personnel to encourage localization of management.

Additionally, there is a spatial dimension to technological spillovers. The booming literature on clusters and industrial districts has revived Marshall's original insight into the importance of geographical proximity for technological spillovers[8] (Porter, 1990; Piore and

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[8] Clusters also offer potential for other production externalities, such as the development of specialized skills and suppliers and reductions in transaction costs.

Sabel, 1984; Best, 1990; Schmitz, 1995; Markusen, 1996; Morrison et al, 2013; Balland et al, 2015). Promoting clustering in sectors that benefit from such spillovers can improve collective efficiency and make an industry globally competitive. Policy support can include measures such as investment in relevant infrastructure (e.g. airport, port and rail infrastructure to increase connectivity, or shared facilities for treatment of waste from a particular economic activity prevalent in the cluster, the establishment of institutional channels of communication and networking between firms, the creation of specialized R&D and local training centes (Humphrey and Schmitz, 1996; Ketels and Memedovic, 2008).

Critiques of the Infant Industry Argument

The infant industry argument has been the subject of various criticisms. First, it has been argued that, related to the firm-level learning-by-doing, the initial period of losses could be covered by the firm, as firms can recover this cost with their future profits and the return is private. Second, at the industry-level externalities, protection might not actually eliminate the incentive problem. For example, if a subsidy is given to a firm for engaging in productivity increasing activities so as to catch-up with foreign competitors but the benefits of that can spread freely among later entrants that can capture market share, then the incumbent might still not be incentivized to do so (see Kemp, 1960; Baldwin; Krugman and Horn, 1988; Grubel, 1966). In other words, if the externality can be internalized, then the state should not intervene, and if it cannot be internalized, then intervention instead of altering incentives, will just make marginal firms enter an industry.

The above critiques force us to look closer at the infant industry argument, but they do not provide a credible basis on which to dismiss it. First, the subsidy should be just enough to compensate the firm that generates the externality, even knowing that spillovers will happen. In any case, incumbent firms can still gain significant advantages even in the case of partial non-appropriability, as there is a strong tacit element to knowledge. Second, we are very often talking about developing economies with pervasive market failures, not least in the financial sector (Stiglitz, 1987), which makes it difficult for firms to raise equity or borrow funds to undertake these costs, even if they wanted. For example, finance for long-term investments might not be available or there could be need for complementary investments to make investments profitable (see section 2.4.2 on coordination failures).

Other critiques have been mostly empirical, trying to see if protected sectors have indeed displayed total factor productivity growth (see a review for East Asia in Noland and Pack, 2003), or if there is a relationship between tariffs and sectoral growth (Nunn and Trefler, 2007), pointing out that there is no general correlation between protection and growth. However, these studies, especially cross-national ones, suffer from methodological and conceptual problems (Rodriguez and Rodrik, 2000; Chang, 2011). How can one find a consistent pattern, when institutional and policy quality has varied tremendously among countries that have protected their infant industries in the past? While free trade is an easy option that can be applied anywhere, industrial policy is highly context specific and can succeed only under certain conditions. Yet, if it is not applied at all, the chances for catch-up are very slim. Finally, looking at protection is only half the story of successful development. Detailed studies of the East Asian NIC experience show that protection needs to go hand in hand with compulsion for technological learning (Amsden, 1989; 2001).

2.4 Industrial Policy and Production Structures

The shock of the Great Depression in the 1930's was accompanied by a wave of criticism of the dominant classical liberal paradigm in economics[9]. Keynes (1936) provided a powerful critique of the theory of self-equilibrating markets, showing that investment, either stimulated by monetary policy or by means of fiscal policy, can increase aggregate demand and alleviate unemployment, thereby smoothing cyclical problems. The path-breaking works on imperfect competition by Sraffa (1926), Robinson (1932) and Chamberlin (1933) also provided a critique of classical supply-side microeconomics. In this context, not only was there doubt that the economics of perfect competition could deal successfully with economic phenomena in developed countries, but these also came to be seen as irrelevant in developing countries, where markets did not exist or where secular unemployment was rife.

[9] The dominance of liberalism in the economics discipline did not stop the now advanced countries from systematically using tariffs to develop manufacturing though (Chang, 2002).

The development economics discipline that was born around that time considered the structural transformation of countries as of paramount importance. The development of industry represented a structural change that was not only about changing the mix of economic activities from agriculture to manufacturing but also about progressing from a backwards, subsistence economy to a modern, capitalist one that obeyed the laws of markets. The role of the state was to hasten and guide this transformation where markets could not deliver, by using a vast array of industrial policy instruments at its disposal.

In this section we consider three different issues related to this. Section 2.4.1 discusses the role of the state as raising the capital necessary for investment. Section 2.4.2 discusses the problem of structural transformation with coordination failures. Section 2.4.3 puts the structural problem in its international dimension by considering Latin American structuralist and dependentist theories.

2.4.1 State-Led Resource Mobilisation and Investment

Following Keynes's influential critique of neoclassical economics (1936), attention shifted from supply-side issues to the impact of investment on aggregate demand. Economists Harrod (1939) and Domar (1946) also developed the highly influential Harrod-Domar model, where the growth of real GDP was proportional to the share of investment in GDP. The higher the savings and the lower the capital to output ratio, the higher the growth rate would be. This simple but powerful prescription meant that growth was a problem of increasing savings.

The question of where the capital stock would come from to provide the necessary investment was also present in models that dealt with the structural dualities in the developing world (Lewis, 1954; Ranis and Fei, 1961; Johnson, 1971). The subsistence sector by definition did not really produce a surplus, and industrial workers were deemed unable to save as they consumed most of their income on necessities. This left the capitalist class as the most likely source of investment capital (Lewis, 1954).

However, in the cases where such a class did not exist, was not able to save enough or spend the surplus that it appropriated on imported luxuries instead, the state could act as a surrogate capitalist by using its power to tax, borrow and spend in order to concentrate capital resources and invest. Therefore, in addition to using policy measures to guide private investments, the state was also to become an investor, especially in sectors with high capital requirements for entry (for example energy and heavy industries), sectors in which it is politically unfeasible for private investors to operate in (for example defence) or in sectors deemed strategic but with no private investments forthcoming[10].

The early post-War period was sympathetic to an increased role for state ownership in the economy, not only in the advanced world, as evidenced by the wave of nationalizations in Europe, but more so in developing countries, which were seen as lacking in private capital and entrepreneurship (Leff, 1979).

This trend was sharply reversed in the aftermath of the so-called neoliberal revolution. For developing countries, the heavy borrowing in the 1950's and 1960's to finance investments also turned sour. The widespread debt crises a couple of decades later led to the adoption of IMF/World Bank structural reform packages, which pushed for liberalisation and privatization (Palma, 1998). Nevertheless, SOEs in strategic sectors have remained a key pillar for industrial policy mainly in emerging countries like China (Nolan, 2014) and Brazil (Musacchio and Lazzarini, 2015) and less so in advanced countries, with the notable exception of Singapore (Chua, 2016), Taiwan, Norway and France to an extent (see Christiansen, 2011 for OECD countries).

2.4.2 Coordination Failures

Another important role for industrial policy has been to solve the pervasive coordination failures that can arise in the process of structural transformation. Coordination failures arise when there are interdependencies between economic sectors and their development fails to be coordinated on by market signals. This is not uncommon in the industrial sector, where there are complementarities between economic activities, in the sense that they are profitable when undertaken simultaneously; in other words, social and private returns diverge. These failures open the door for state intervention, either in coordinating or in undertaking some of these investments.

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[10] This is in addition to the classical argument that state ownership is preferable in cases of natural monopolies, such as utilities.

The earliest full account of the extent of such failures was by Paul Rosenstein-Rodan (1943) and was a big topic in early development economics, especially in the debate of balanced versus unbalanced growth (Nurkse, 1953; Scitovsky, 1954; Fleming, 1955; Hirschman, 1958).

Rosenstein-Rodan argued that due to externalities, a 'balanced' industrial strategy was needed, investing in multiple industries at once, otherwise known as the Big Push. The following points were important in this rationale:

1. There are economies of scale internal to the firm (the need to reach a minimum efficiency scale) and at the industry level as a growing industry allows for a finer division of labor across firms and this can increase productivity[11]. These cannot be exploited due to the small size of the domestic market.
2. There are complementarities of industries. Workers in a large industrial unit would earn more than subsistence wages and this surplus would create demand for more goods. By investing in several such industrial units, it is possible to create enough local demand to sustain an industrial system. However, without these complementary investments, a sole industrial unit may lack a large enough local market.

Rosenstein-Rodan argued that integrated state investments and the establishment of state-led coordinating units was necessary to implement a Big Push and solve the complementarity problem. Others, like Nurkse and Hirschman were more sceptical of state intervention and put emphasis in encouraging entrepreneurs. Hirschman (1958) even argued that an 'unbalanced' approach would provide more incentives for entrepreneurs to mobilise resources in order to solve identified bottlenecks, and thus a more effective strategy for development.

The idea of coordination failures resurfaced in economic literature at the end of the 1980's. Murphy et al. (1989) elaborated a formal model arguing that policy intervention can help an economy coordinate to reach a desirable equilibrium (industrialisation). Most

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[11] Adam Smith (1999 [1776]) with his now famous pin factory example had first posited that a larger market provides the opportunity to firms to specialize and raise productivity. Young (1928) and Kaldor (1961) also elaborated the dynamic linkages between demand and specialization: growth increases demand, which leads to more specialization, which in turn increases productivity and growth – a virtuous circle.

models in this direction see the coordination problem as arising because the intermediate goods sector is non-tradable and displays increasing returns and therefore does not get established in the absence of the final goods sector (Rodrik, 1996; Matsuyama, 1992; Ciccone and Matsuyama, 1996). The need for government intervention is evident in these models, either in the form of subsidies or in providing demand through procurement policies to the intermediate goods sector.

It has also been suggested that with free trade foreign markets can provide the necessary demand to intermediate goods sectors, thereby alleviating some coordination problems (Trindade, 2005). However, there are at least two problems with a free trade solution to coordination failures. First, in the presence of production externalities and imperfect market structures the allocation under free trade will not necessarily be optimal, as was discussed in Section 2.2. Second, coordination problems will exist even under free trade with respect to non-tradable factors like infrastructure, skills, and technological capabilities.

Finally, another way we can look at coordination is from a new institutionalist perspective. In game-theoretical terms, if the optimal outcome depends on many agents communicating and negotiating, then agents might incur significant transaction costs, especially if different players have a strong preference for different coordinated outcomes. The state can step in to reduce the transaction costs involved, either by encouraging large groupings of players so as to reduce the numbers of players negotiating, by for example stipulating the creation of business associations, or by providing a focal point to guide coordination, as it happens with indicative industrial plans (see Chang, 1994 Chapter 2). Arguably some of the institutionalized channels of communication between state and business in NICs had precisely this function.

2.5 The international dimension

2.5.1 Structuralism

The classical development economists saw a developing economy as qualitatively, structurally different from a developed country. Central to their ideas was the duality in the domestic productive sectors, namely traditional agriculture and handicrafts, and manufacturing. The move of resources from the former to the latter was considered key for growth (Lewis, 1954).

Structuralism, a 'school' associated with the Economic Commission for Latin America (ECLAC), retained this view, but argued that these dualities are an outcome of the developing countries' integration into the world capitalist system and there are strong socio-political dimensions to it (see Sanchez-Ancochea, 2007).

As the name indicates, structuralism was meant to convey that structures within the country and within the global system condition the type and the pace of development. In line with structuralist currents in other sciences, there was an effort to dig down and find these 'deep' structures, often represented as a binary (Jameson, 1986). Indicatively, the asymmetries between advanced countries (the core) and developing countries (the periphery) are summarized by Jameson (1986) below:

1. They produced different types of products. The core had a diversified productive structure, characterized by industries with increasing returns. The periphery was characterized by structural dualities, featuring export-oriented undiversified primary goods sectors with higher productivity but few linkages and other domestic-oriented sectors featuring low productivity and unemployment.
2. The industry in the core was characterized by oligopolistic structures both in its industry and in its factor markets (trade unions). This allowed the core to retain high prices during cyclical downturns and appropriate larger amounts of profit.
3. The core had better access to technology compared to the periphery.
4. The core used more protectionist measures than the periphery.
5. The center with its advanced capitalist structures was prone to cyclical instability that had a negative impact on demand for the periphery's products. The interruptions of the Great Depression and the Second World War were indicative of this.
6. The periphery was characterized by low savings, low rates of capital formation and high inflation.
7. There was a lower standard of living in the periphery.

Structuralism is a theory of development and as such it would be too broad to review it here. What is relevant for this research is the justification it brought for industrial policy.

As a result of points (1) and (2) above and given the fact that primary commodities have a lower income elasticity of demand (Engel's law), the leading structuralist economist Prebisch (ECLAC, 1950) argued that there was a secular decline in the terms of trade of primary commodities vis-à-vis manufactures. A similar trend was observed by Singer (1950) and this came to be known as the Prebisch-Singer hypothesis.

In this context of non-beneficial mutual trade relationships with the rest of the world, it was argued that development via primary commodity exports would not lead to growth and development. What was needed was industrialization and, since the existing domestic institutions were unable to spur it, the state was meant to take an active role in pursuing import-substituting industrialization.

Another important dimension of the structuralist contribution to the industrial policy debate is the inclusion of political variables. Structuralism used historical-institutional analysis to understand the contemporary problems of development and offer solutions within this context. In this sense, the protracted inward orientation of ISI in Latin America, which has been the subject of much criticism, was not a theoretical necessity, but could also be interpreted as a pragmatic response to the prevailing international conditions at the time. According to Prebisch (1964), there was no lack of understanding that export markets could offer economies of scale for capital- and technology- intensive goods, but the high tariff walls of advanced countries until the late 1950s pushed Latin American countries to adopt an industrialization path that relied on the domestic market. However, the emergence of industrial classes through ISI that captured the state (Kay 2002) made it difficult to change course when ISI had run its course.

As problems in applying ISI policies mounted and the international economic environment changed, ECLAC intellectuals adapted their thinking towards a more integrationist (and much less interventionist) approach, dubbed 'neostructuralism' (ECLAC, 1990; Fajnzylber, 1990; Katz, 2000a, 2000b; Ocampo 2002, 2005). This approach combines structuralism with the neo-Schumpeterian school and is discussed in Section 2.6.

2.5.2 *Dependency Theory*

Dependency theory emerged partly due to the frustration with the lack of further progress in industrialisation, despite a couple of decades of ISI policies, in Latin America and partly due to the inspiration of the Cuban socialist revolution (Palma, 1978). While dependency theory was generally rather pessimistic about development in general and about the role of the state in industrialisation in particular, it is included here because it forms the background for the emergence of the Global Value Chains (GVCs) literature, explored further in Chapter 2.

The basis for dependency analysis was the previous Marxist theories of imperialism (reviewed in detail in Palma, 1978). While in orthodox Marxism the development of capitalism in developing countries was seen as inevitable, dependency theory questioned whether such capitalist development was feasible at all. They argued that a continued situation of underdevelopment might be in the interest of local elites and large capital in the advanced countries, whose alliance would work to suppress development. Three different views emerged with respect to the role of the state in dependency theory (see Lall, 1975).

The first view and the more widely criticized was the strong position of Andre Gunder Frank (1967), arguing that dependency not only precluded development but would also lead to 'immiserization'. The solution was to initiate a revolution and install a socialist regime. The second view was more moderate and was associated with Furtado (1964), Sunkel (1973) and dos Santos (1970), who argued that stagnation was the logical outcome. Similarly, Frobel (1981) in his thesis on the new international division of labor (NIDL) that emerged in the late 1960's was pessimistic about the prospects of industrialization for developing countries. While in the NIDL Multinational Corporations (MNCs) started to locate manufactures in developing countries, this was only limited to enclaves. In this analytical universe the states were accommodating to market conditions and simply facilitated the status quo (Wallerstein, 2000).

The third view is associated with Cardoso (Cardoso and Faletto, 1979) and with the early work of Evans (1979). The argument here is that development in the periphery is possible but this will be of the 'dependent' type, meaning always subservient to developments in advanced countries. Notwithstanding the ambiguousness of the concepts of autonomy and dependency in a world of interdependent economics systems, this dependentist branch made some interesting points on the political economy of development, similar to structuralism. Evans (1979), for example, argued that development is shaped by an alliance of interests, comprising the domestic political and economic elites, as well as foreign elites, through their interests in the domestic subsidiaries of foreign firms. This alliance of interests did not necessarily prevent development altogether, but would result in reduced autonomy for the state in pursuing industrialization. Such an analysis opens the door for considering industrial policy, not strictly in the context of the nation state, but extending research to the study of global interests. This becomes more important when the domestic industrial sector depends to a large extent on FDI or when domestic firms insert themselves in GVCs, as is the case with many developing countries nowadays.

2.6 Industrial Development and Technological Capabilities Accumulation

The importance of technological development for growth had been articulated by Schumpeter (1911; 1934) and by prominent economic historians such as Gerschenkron (1962) and Abramovitz (1986). However, the issue of technological development in developing countries had been somewhat ignored or unexplored until the late 1970's, partly because innovation and technical change were considered to be the purview of developed country firms that engaged in formal R&D efforts. Neoclassical economics assumed that technologies existed in some metaphorical 'shelf' and that firms could choose the technology that is most appropriate for their countries' factor endowments and then costlessly apply it. Classical development economists also portrayed developing countries as the passive recipients of technological diffusion, often embodied in blueprints, manuals and capital goods or argued, like Gershenkron (1962), that the use of advanced technologies in developing countries was being prevented by lack of capital rather than of capabilities to use them. In this context, technological mastery was just an outcome of capital accumulation and production, as 'learning by doing' often implied. Developing industries, and especially capital goods sectors, would be the fastest way to productivity growth and technological development.

A series of works emerged in the 1980's and the early 1990's that strongly questioned the above assumptions, based on empirical work in technological development in NICs such as Korea, Taiwan, Brazil, Mexico and Argentina (see Lall, 1992, 1993; Katz, 1984; Katz [ed], 1987; Pack and Westphal, 1986; Amsden, 1989; Kim, 1997). It was shown that contrary to what had been assumed, developing country firms engaged in significant learning in order to develop technological capabilities, a necessary precondition not only for effectively absorbing technology from abroad but also for engaging in minor innovations (see also Ernst et al, 1998).

This new approach to technological development in developing countries was driven to a large extent by the nature of firm behaviour and competition as perceived in the evolutionary economics literature (Nelson and Winter, 1982; Dosi et al, 1990). In this paradigm, firms neither try to optimize a profit function rationally nor do they have a well-defined choice set. They focus instead on developing 'routines', to carry out functions, to make decisions, and to guide them in their search for new solutions. Routines are embedded in the institutions (firms) and the people within them, are historically determined and usually change when there is an expected positive impact on profitability.

The efficacy of these routines depend on the skills within the organisation and are an important building block of an organisation's capacity to respond to competitive pressure by innovating in the broad sense (developing new technological capabilities). Firms with routines that lead them to make on average choices with a positive on average impact on profitability are able to survive the competition and those that do not die out. In this context, growth comes from firms that compete with each other not on the basis of prices but on the basis of innovations (Lazonick, 1993). However, firms can only develop these capabilities gradually and cumulatively, progressing from simple, less risky areas to increasingly more complex tasks. In other words, firms develop capabilities in an evolutionary manner (Katz, 1984).

Additionally, technology markets do not work in the way it has been portrayed in the neoclassical paradigm. Technology has aspects of a public good but is also partly appropriable and it displays increasing returns to use. Moreover, there is significant uncertainty in the distribution of the results of technological search efforts, so that full sets of insurance markets are difficult (or impossible) to emerge (Katz, 1984). Additionally, one cannot just simply buy or copy a technology and immediately acquire the technological capabilities; there is a strong element of tacitness in knowledge, meaning that the right skills to use it effectively need to be developed over time. For firms, the task of developing technological capabilities can be hard and requires deliberate firm effort (Nelson, 1987).

Firm-level learning is also highly influenced by the institutional fabric in which firms operate. This has been most notably studied in the context of the 'Innovation System' literature (Lundvall 1992; Nelson 1993; Freeman, 1995), which aims to capture the relationship between important actors in an economy with respect to innovation, their interactions, and their impact on the direction and rate of the economy's technological learning. Institutions, by shaping the incentives firms face, as well as by determining the density, quality and type of interactions between firms, academic institutes and the governments that significantly affect the development of technological capabilities. While in advanced countries these systems focus largely on science and technology institutions that encourage radical innovation, in developing countries such systems include the productive sphere, where major learning in production takes place (Lundvall et al, 2011). Arguably, the productive structure should also be a concern for developed countries as well, as the recent re-emergence of industrial policy shows (Aiginger, 2007).

Industrial Policy for Technological Development

The difference in technological maturity between developing and developed countries means that different kind of interventions are required. In advanced countries, where the emphasis is on radical innovations and on launching new sectors, industrial policy has been mostly about government funding of basic research and defence-related projects as well as fiscal support of R&D efforts (Mazzucato, 2014), areas where there would be underinvestment by private actors due to the inappropriability of returns. Other interventions mostly focus on subsidizing the accumulation of human capital, providing relevant infrastructure, encouraging interaction between relevant agents, and providing access to risk capital and long-term financing (see also Block and Keller [eds], 2015 for industrial policy in the US).

In developing countries, the focus of interventions should be on developing basic capabilities in production first and then gradually progressing to capabilities for more medium and advanced innovation, as defined by Lall (1992). As Lall (1992, 1993 and 2004) has argued, the government needs to pay attention to: shaping the incentive structure firms face (macroeconomic and trade policies) so that firms find it more attractive to invest in new technology and learning; increasing the availability and quality of factors of production (skills and capital) by spending on higher education and subsidising capital investments; and increasing the availability of technical information and support services. Many of these interventions are not dissimilar to measures for infant industry ones and some could be considered general in nature as opposed to selective. However, Lall's suggestions focus on supporting innovation and on counterbalancing protection with competition.

Learning and Productive Structures

As was mentioned at the start of this chapter, industrial policy is essentially selective, based on the rationale that certain economic activities offer better potential for long-term development. While standard economic literature cites the differences in increasing returns and externalities, evolutionary economics stresses different potentials of different activities for technological learning.

This rationale is most readily seen in neostructuralist contributions that have emerged as an analytical merger between the technological capabilities approach and structuralism (see Section 5.4.1) (Fajnzylber, 1990; Katz, 2000, 20001; Ocampo 2002 and 2005). In these works, both the type of productive structure present in developing countries and the international environment still play important roles, as in earlier structuralist approaches, but now the emphasis has shifted to the impact of these two factors on further technological transformation. For neostructuralists, the specialisation of Latin American countries in activities with low technological density and lack of linkages, such as primary commodity production and assembly activities, mean that there is little productivity growth, making convergence with core countries difficult (Bielschowsky, 2008).

Typically manufacturing has been suggested as an economic activity that offers potential for steep learning curves (Lall, 2000; Chang, 2010), although other capital- or technology- intensive sectors could also be encouraged, such as agro-industry with biotechnology applications or capital-intensive processing of primary commodities. The tacit knowledge that builds up over time in the workers and entrepreneurs involved in such ventures can in turn create the conditions for investing in even more complex activities. Such a process of cumulative causation could probably also explain wider statistical patterns, correlating certain exports with higher productivity growth (Hausmann et al, 2007). Additionally, the potential for learning in a sector is also influenced by the specific technological and regulatory institutions that operate in the sector (Malerba and Orsenigo, 1996; Malerba and Nelson, 2010) or the specific global value chain governance structures that national firms engage with (Pietrobelli and Rabellotti, 2011).

In conclusion, the relationship between technological capabilities and production displays a kind of circular causation. Capabilities determine what a firm can produce, but what it produces has impact on its capabilities (Nübler, 2014). Government policy can help by both encouraging firms to develop their capabilities and steering them into products with higher potential for learning.

2.7 The Institutional Basis for Industrial Policy

While the previous discussion was reviewed mostly in terms of theoretical arguments for industrial policy, it is worth spending some time to have a closer look at the institutional basis of a successful industrial policy. While in theory the reasons for intervening are multiple, one would expect that the success of such interventions would depend at least on the vision of the government and its capacity to successfully implement policy.

It is not our intention here to review the large literatures on neoclassical political economy or institutionalist approaches that explore the nature of government and the state. We will only briefly review two relevant discussions on industrial policy, the mainstream neoclassical arguments for government failure (Section 2.7.1) and the theory of the developmental state (Section 2.7.2). While the former adopts a cynical view on the ability of the state to successfully implement industrial policy, the latter has strived to analyse the conditions that have allowed states in the past to succeed in this task, especially in the East Asian NICs.

2.7.1 Government Failure

It is not only markets that fail, but governments, too. This is not a surprise. Governments, like other organizations, might suffer from lack of relevant capacity, inadequate funds and inter-agency coordination and monitoring problems (Stiglitz and Heertje, 1989). Given that solutions to these issues could be plausibly found, as it happens in other organisations (see for example Chang, 1994 chapter 2), the mainstream posits two further problems that require more thought; the informational burden of the government in designing policy and the problem of rent-seeking. These are described below.

Informational Problems

As we saw in previous sections, industrial policy can be an optimal solution in a neoclassical setting, but this optimality rests on the assumption that the subsidy will be just adequate to correct the market failure that exists. It has been argued that this would require an impossibly large amount of information on the part of the government as well as great capacity to collect and process it in order to make decisions. Thus, even though it would be technically possible in the world of models to design optimal subsidies and tariffs, the informational burden in reality is prohibitive. Pack and Saggi (2006) include a long list of the information that would need to be collected, such as which firms and industries exhibit knowledge spillovers, which ones benefit from dynamic scale economies, the sectors with long-term comparative advantage, what is the potential competitiveness of firms, the nature and extent of market failures, the magnitude and direction of inter-industry spillovers and so on. They argue that it is unrealistic to expect the government to know these issues better than firms or investors, so non-intervention might work better than the ideal first-best policy solution.

However, this criticism relies purely on assumptions of agent behaviour that are only found in models. In reality, no one behaves in the way neoclassical economics wants us to. For example, when a firm conducts R&D it does not have a precise distribution of R&D outcomes, as many models assume. When a firm tries to find a supplier, it most definitely does not look at a global supplier list and judge every single offering on a comparative cost/quality basis. The way market agents behave is with 'bounded rationality' (Simon, 1979; see also discussion in Chang, 1994 chapter 2). We follow rules to guide us in decision-making that require much less informational input, than what is required by idealized neoclassical models.

In this sense, the government does not need to go out and measure spillovers in every single sector of the economy; it can rely on information gathered through government-business channels or it could simply chose sectors that have been proven to have some such potential elsewhere. It is also not unimaginable that in a small developing country the government can have good information on the capacity of firms and their interaction. If researchers are able to discern this with a few months of fieldwork, governments (and more so local governments) could have the information needed to make good decisions. Moreover, the optimality of real policy needs to be measured against the optimality of actual agent behaviour. It is not unthinkable that firms, especially developing country SMEs, could have a lot less information than specialised government departments (see for example, Humphrey and Shmitz, 1996).

However, as in most cases, a thoughtful criticism like this is a good springboard to understand to what extent the lack of information could be a problem and how it could be solved. Generally, institutional channels that allow governments to discuss and develop policy with the private sector and other key agents would be a good way to collect and disseminate relevant information. In Japan and Taiwan Deliberation councils and business associations have been used as a way to deal with this informational barrier (Evans, 1995) and in the European Union, public private partnerships (PPP) are driving strategy and funding decisions in the development of advanced digital technologies (European Commission, 2017). During my fieldwork in Malaysia, some firms also reported that the relevant government departments often visit them to discuss how they can help them grow or hold public forums to gather stakeholders together.

Rent-Seeking

Another problem surrounding the implementation of industrial policy frequently mentioned is that of rent-seeking. Rent-seeking is often used synonymously with corruption but it is defined as the ‘expenditure of resources and effort in creating, maintaining or transferring rents’ (Khan, 2000, p. 70). The size of the rent is not part of the rent-seeking cost (if agents value it in the same way, it does not matter who receives it), but the cost is only about the resources spent in order to acquire the rent. Corruption can be defined "as behavior which deviates from the formal rules of conduct governing the actions of someone in a position of public authority because of private-regarding motives such as wealth, power or status" (Khan, 1996, p.12). Even though the two concepts are distinct, they can also occur together. For example, the bribe that a firm offers the government in return for a rent is not only part of the rent-seeking cost, but it is also corrupt.

The first models on rent-seeking (Krueger, 1974; Posner, 1975; Buchanan, 1980) showed that the cost of creating and maintaining a monopoly did not only encompass the small deadweight losses of monopoly rents, but also included the much larger cost of the resources spent bidding for the rent. In this sense, industrial policy, by creating and re-distributing rents (which would be bid upon), thus investing resources in resource transfer rather, than resource creation, could be incredibly wasteful from a welfare point of view. However, the costs of rent-seeking can vary significantly depending on assumptions about the nature of the bidding process and the number of agents bidding (Murphy et al, 1993). Indeed, if the original distribution of rents is inefficient, then rent-seeking could (implausibly but potentially) even lead to a more efficient outcome (see discussion in Khan, 2000).

Khan (2000) offers a more holistic approach. He argues that, to fully understand the impact of rent seeking we need to take into account both the rent-seeking costs and the rent outcomes. If for example, a rent has the ability to induce learning in a firm and the rent-seeking cost is low, then industrial policy, can have an overall positive net outcome. This view is corroborated by looking at successful and unsuccessful developers, where the types of rents distributed and rent-seeking costs are similar, but the outcomes are very different. The successful cases, like Japan or Korea have managed to discipline rent-recipients so that rents are used for learning, contributing to future competitiveness (also in Amsden, 1989).

The answer then to the problem of rent-seeking is not to wholesale liberalise and privatise to eliminate rents, but for the government to devise institutional configurations that will allow it to discipline rent recipients and reduce rent-seeking costs.

2.7.2 The Developmental State

The Developmental State can be seen as the antithesis of the pessimistic view of the corrupt, information-constrained state that the mainstream has put forward. As a theoretical construct, it was derived by looking at the nature of state interventions in the successful industrialised countries of Northeast Asia (Japan, Korea, Taiwan), so much that the two have almost become synonymous (Johnson, 1999; Hayashi, 2010). The impressive development of these countries, especially in contrast to the disappointing economic performance of Latin American and Sub-Saharan African countries since the mid-1970's, called for a theoretical explanation.

While the mainstream posited that the so-called 'East Asian miracle' was the outcome of a free-market approach to development (Balassa, 1991; World Bank, 1993), a wealth of evidence showed that all these countries had intervened extensively in the economy and that these interventions were plausibly connected to economic success (Deyo, 1987; Haggard and Moon, 1983; Lim, 1983; Amsden, 1989; Wade, 1990). This raised an obvious question; why, when industrial policy had been implemented in several countries around the world, had it succeeded to that extent only in East Asia? The answer for a group of researchers lied in the nature of the state.

The definition of the developmental state varies, so it is hard to come up with a list of definite characteristics (see Stubbs, 2009; Öniş et al, 1991). Nevertheless a few features have stood out:

1. *There is a transformative goal*: While this is somewhat obvious, it is worth stressing. The state should perceive economic development as a top priority (Hayashi, 2010; Weiss, 2000; Leftwich, 1995). This often arises because the governing elites need to legitimise themselves or even protect the sovereignty of their countries by ensuring national economic development.
2. *There is a cohesive set of institutions*: In the Northeast Asian examples, authors have identified key agencies that pursued the stated objectives, and these were able to implement their policies.
3. *The bureaucracy is highly skilled and experienced*: The 'Weberian' ideal has often been projected into the bureaucracies of the successful industrialized states. However, while

certainly good capacity to understand the problems of industrialization as well as to design and implement policies are important, it should be noted that this is a capacity that can be built over time (Chang et al., 2002).

4. *There is state autonomy*: Due to various historical and institutional circumstances, the state can enjoy a degree of autonomy from other social groups, and thus is able to act on its own interests and discipline rent recipients. This quality has often been associated with authoritarianism, which characterised all three countries at the time of their high growth [12] (Haggard, 1990), but there is no general relationship between authoritarianism and developmentalism (Haggard, 2015). Some work has tried to show how developmentalism can thrive under democratic conditions (White, 1995).
5. *Leadership is embedded*: The 'embededness' of the state in business and other networks, formal or informal, meant that the policy design was relevant and that the targets of policy shared the same transformative goals (Evans, 1995).

However, the theory does not come without problems. First, the version of the state-society relationship put forward is often highly idealized and does not easily square with high incidences of corruption (although in less critical sectors for economic development, such as defense and construction) and the political squabbles that have plagued the NICs (Kang, 1995). Second, other countries in Southeast Asia and China grew fast for certain periods despite not featuring the same state-business relationships and without having the same bureaucratic quality (Hayashi, 2010). It seems that there is a danger of identifying the particular institutional structures that prevailed in Northeast Asia as the only ones conducive to industrial development, when we should be looking for attributes that could be replicated with other institutional forms. For example, Chang (1999) argues that the state needs to be able to carry out the following functions: coordination of investment for systemic change, provision of a vision to serve as a focal point, institutional building through adaptation and innovation and conflict management over resource allocation. These broad considerations both describe many of the attributes of the developmental state

[12] Indicatively, South Korea was under military rule from 1961 to 1987, Taiwan from 1949 to 1996, and in Japan the Liberal Democratic Party (LDP) was continuously in charge from 1955 to 1993.

and can serve as guides for other institutional solutions that might be more suitable to prevailing conditions.

2.8 Contemporary Challenges

While there are tens of countries that have partially industrialised and could comfortably be described as 'middle income', there are no countries that have reached the technological frontier after Korea, Taiwan and Singapore did, and even among these countries there is significant variation in terms of income per capita [13]. This means that discussions on successful industrial policy often draw from the same group of countries. One of the bigger problems with this is that policy advice could risk becoming outmoded as the global economy evolves. A key question that has emerged in the literature, and one which this thesis is attempting to answer, is to what extent the lessons that have been distilled from the theory and practice of industrial policy can be applied within the current global economic context. Two central issues have attracted attention, the question of policy space and that of global value chains (GVCs). Given that the latter is the central question of this research and the focus of our next chapter, the discussion here will be kept simple aiming to provide a summary for the purposes of this broad review of industrial policy.

2.8.1 Policy Space

The issue of policy space relates to the evolving global governance and what this means for domestic policy options. It has been defined by UNCTAD (2014) as "the combination of de jure policy sovereignty, which is the formal authority of policymakers over their national policy goals and instruments, and de facto national policy control, which involves the ability of national policymakers to set priorities, influence specific targets and weigh possible trade-offs" (p. VII). Starting from the broad conditionalities on macroeconomic and governance reforms attached to IMF/World Bank structural adjustment loans in the 1980's, policy space has been continuously shrinking, particularly in the area of trade and industrial policies (Chang, 2006).

[13] For example in 2015, GDP per capita in 2005 constant US$ was US$37,950 in Japan and US$37,923 in Singapore against US$25,272 in South Korea and US$22,454 in Taiwan (UNCTAD, 2017).

The launch of WTO in 1995 marked a watershed in this direction, by enshrining into its agreements the curtailment or prohibition of certain practices that had previously been staple instruments of industrial policies, including some of those that have been found to be most effective. Not only have tariffs been reduced substantially across the world, but also specific subsidies are banned (the SCM agreement), as are measures to promote local content in FDI (the TRIMS agreement). Intellectual property regulations are also severely tightened (the TRIPS agreement). Signatories to the Procurement Agreement also cannot use government procurement selectively to promote domestic production. More recently, the wave of US and EU bilateral Free Trade Agreements (FTAs) and Bilateral Investment Treaties (BITs) have produced an even more restrictive environment (Gallagher, 2008).

Of course some flexibility remains under WTO, although much less under bilateral FTAs, for developing countries. The least developed ones are subject to Special and Differential Treatment (SDT), which means that they are allowed to not reciprocate fully some measures, although eventually they are expected to comply. Some countries have also bound their tariffs at relatively high rates (Akyüz, 2009), although few of them make full use of this limit, even after the financial crisis of 2008-2009. Additionally, a number of important measures are still available; some production subsidies might be actionable but not prohibited outright and those for environmental and research reasons are allowed. Preferential export credits and some entry conditions on foreign investors are also allowed. Finally, adopting a more pragmatic approach, some countries that have international clout, such as China, often circumvent the WTO rules and protect their industries anyway; after all, it can take years before a ruling is reached and in the meantime the subsidy has already been in place for a while.

It has been suggested that the willingness with which many developing countries sign on to WTO agreements and the FTAs is not simply an outcome of pressure by developed countries. It has taken place mainly because countries are offering policy and regulatory commitments in order to entice FDI flows and join global value chains (GVCs) (Baldwin et al, 2014; Orefice and Rocha, 2014). However, as will be explained further in Chapter 2, this quick recipe for basic foreign-led enclave industrialization cannot substitute for sustainable indigenous industrial development, which will be harder if not impossible to come by without industrial policy.

2.8.2 Global Value Chains

The second development that requires a rethinking of industrial policy is the expansion of GVCs. These can be defined as the "full range of activities which are required to bring a product or service from conception, through the different phases of production (involving a combination of physical transformation and the input of various producer services), delivery to final consumers, and final disposal after use" (Kaplinsky and Morris 2001, p.4). This range of activities is organized according to a global or at least regional division of labour, spanning multiple production sites, where different production and post-production activities take place, which are usually coordinated by lead firms based in developed countries.

The question of industrial policy within the context of GVCs has been raised only in the last few years (Gereffi and Sturgeon, 2013; Milberg et al, 2013; Yeung, 2016). Some of the more important issues that have been put forward are the fact that tariffs could be inconsistent with a strategy of attracting export-oriented FDI (Baldwin, 2014), that it is even more difficult now for developing country firms to become global leaders given the global market concentration in lead firms (Nolan, 2014) and that sectoral measures do not make sense in the current pattern of specialization in tasks rather than products (Grossman and Rossi-Hansberg, 2006). Due to the above, it has been suggested that industrial policy instruments might not be effective enough or they might hurt industrialization efforts.

However, as we will see in the next chapter there are no strong theoretical arguments against supporting a domestic industrial base while pursuing a GVC-led development strategy, although the lack of policy space could be more of a hindrance to such efforts.

In addition, when we take GVC expansion into account, more rationales for industrial policy also appear. First, in a more structuralist interpretation, industrial policy can improve bargaining power of low-end suppliers in developing countries against the more oligopolistic lead firms, even if such help has limits. Second, the locational decisions of GVCs and their historical evolution lend even more credence to critiques of theories of comparative advantage. Factors like capacity for conducting R&D and specialized infrastructure, affect the geographical pattern of GVCs and the competitiveness of suppliers in them. In such a world, competitive advantage is created rather than given, and industrial policy can still play a role in delivering that.

Nevertheless, a detailed theoretical exploration of these issues is missing from the literature and few case studies have been put forward to show how industrial policy has been implemented while pursuing GVC-led development. This research aims to fill precisely this gap by undertaking a theoretical review on the subject in Chapter 3 and then presenting two relevant case studies in Chapters 4-5.

2.9 Conclusion

This chapter reviewed various rationales for implementing industrial policy. The key conclusions that emerge are that industrial policy is needed mainly for three reasons:

1. To prevent specialization in sectors with low economic potential by correcting for market failures, such as the existence of learning-by-doing, informational asymmetries and externalities and technological spillovers, which might lead to underinvestment in sectors with greater positive social welfare.
2. To take an active role in structural transformation by investing in sectors that show potential for learning, productivity growth and spillovers and by coordinating investments, directing financing, granting subsidies, employing protection measures to promote domestic manufacturing.
3. To help firms engage in technological capability development by making rents conditional on learning, investing in science and education and innovation-related infrastructure (e.g. research institutes, testing and certification centres).

This thesis takes the view that a focus on technological capability development is both inclusive of other rationales that have appeared in the literature and also more appropriate for the study of industrial upgrading, which has an evolutionary character.

The last two sections highlighted that the success of industrial policy will depend on the capacity of the state to implement it and the overall nature of domestic institutions, as well as the policy space afforded by the international governance structures.

3 Industrial Policy, Innovation and Global Value Chains – an Integrated Framework

3.1 Introduction

The central thesis of this research is that traditional industrial policy instruments remain necessary, even in the context of GVC-led development. The perceived tension between the goals and instruments of industrial policy and those of development in a GVC context dissipates once we incorporate the insights of the evolutionary economics school (see Chapter 2, Section 6). A firm's effort to accumulate technological capabilities is greatly influenced not only by its engagement with other firms within the GVCs it participates in, but also by the structure of incentives created by industrial policy. The interaction of these factors, which are not independent of each other, will shape the conditions for the accumulation of technological capabilities and subsequent upgrading.

To the author's knowledge, the only other approaches that try to consider GVCs, evolutionary economics and industrial policy together are those of Ernst (2002) and Breznitz (2007). However, while Ernst was eager to show that the international leg of the equation is important, our aim is a mirror opposite, trying to meaningfully integrate industrial policy in discussions of GVCs and innovation. This research also goes further beyond Breznitz by offering a more integrated and systematic framework, building on work that has been published since.

The Chapter begins with Section 2, giving a brief overview of the emergence of GVCs. Section 3 goes on to discuss the different frameworks that have emerged to analyse transnational production networks, spending more time on the concepts of governance and industrial upgrading found in the GVC literature. Section 4 critically evaluates the analysis so far regarding the intersection of GVCs and industrial policy. Finally, Section 5 presents the framework used in this research.

3.2 The Emergence of Global Value Chains

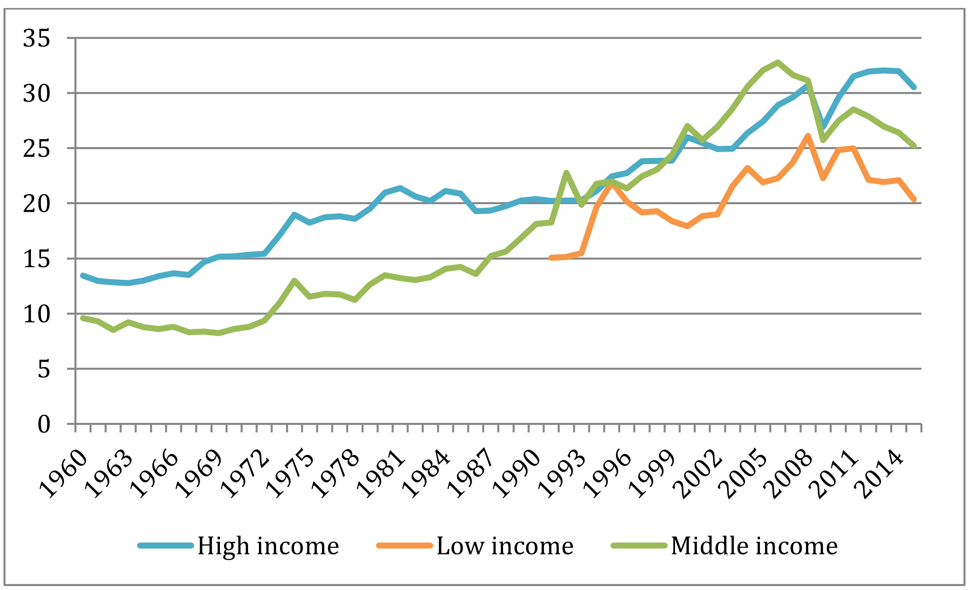
The emergence of transnational production networks is linked to the growing deverticalization of firms during the post-war era. The large integrated and diversified corporations that characterised industrial development in the US from the 19th century until the 1970's (Chandler, 1977, 1990), were products of an era of mass production, leveraging economies of scope and scale within the firm. Backward and forward integration allowed firms to have high capacity utilization rates, dominating the large domestic markets of the US and Europe.

However, the opening up of global markets, further advances in information technology (IT), the emergence of modular components and the formidable challenge of the Japanese lean system of manufacturing, have changed the landscape (Langlois 2002; Sturgeon, 2003; Baldwin and Clark, 2000). Increasingly since the mid-1980's corporations started to focus on their core competences (Prahalad and Hamel, 1990), by outsourcing and/or offshoring their non-core functions. In certain sectors like electronics, textiles or footwear, lead firms have shed production activities entirely, becoming 'fab-less' (Sturgeon, 2002). Simple assembly and production tasks have been largely offshored to developing country locations, while firms in developed countries have focused on high value-added activities, such as design, R&D, branding and marketing. That said, increasingly a number of traditionally knowledge-intensive tasks (such as design and certain kinds of R&D) are also being commoditised and offshored (Howells, 2002; Ernst, 2009). At the same time, an explosive increase in M&As since the 1980's has led to unprecedented degrees in global concentration in the narrower fields of activity of lead firms (Nolan, 2001, 2014).

The large scale restructuring that took place primarily in the US and to a lesser extent in Europe and East Asia, led to sharp increases in the demand for independent suppliers that could offer substantial cost reductions or cost-efficient export platforms for relocation of production activities. East Asian and Central American locations emerged as top destinations for such investments, giving rise to GVCs. The latter have signified a qualitative shift in the nature of the globalisation of production; from establishing subsidiaries that produced similar products but for different markets, the goal for lead firms has shifted to coordinating dispersed production activities, mainly for export to advanced markets (Baldwin, 2014). Moreover, it has been observed that even in cases when these productive activities are not undertaken by subsidiaries owned by lead firms, but by other suppliers, there is a significant degree of coordination undertaken by the lead firm, who influence heavily the business operations of their suppliers (Nolan, 2001). The combination of a global dispersion of fragmented productive activities, coupled with the role of real firms in orchestrating production by suppliers, is what differentiates GVCs from simple transnational investments.

The phenomenon of GVCs, although micro-economic in nature, is detectable on aggregate indicators. The share of exports in GDP for most countries has been rising rapidly in the past few decades, especially since the mid 1980's. The share of exports in GDP of middle-income countries rose faster than that of high-income countries, from 8.4% in 1967 to a peak of 33% in 2006, falling gradually to 25.3% in 2015 (Figure 3.1). However, the rise in exports masks a growing reliance on imported goods to export. It is common for products to cross borders several times, with only a portion of the final value added in each stage. Globally, about 57% of world exports were part of a multi-stage trade process[14] between 2005-2010 (UNCTAD, 2013a).

Figure 3.1 Share of exports in GDP (%) by country group, 1960-2015



Source: World Bank Development Indicators, 2017

Figure 3.2 Share of foreign value added in exports, selected countries and years

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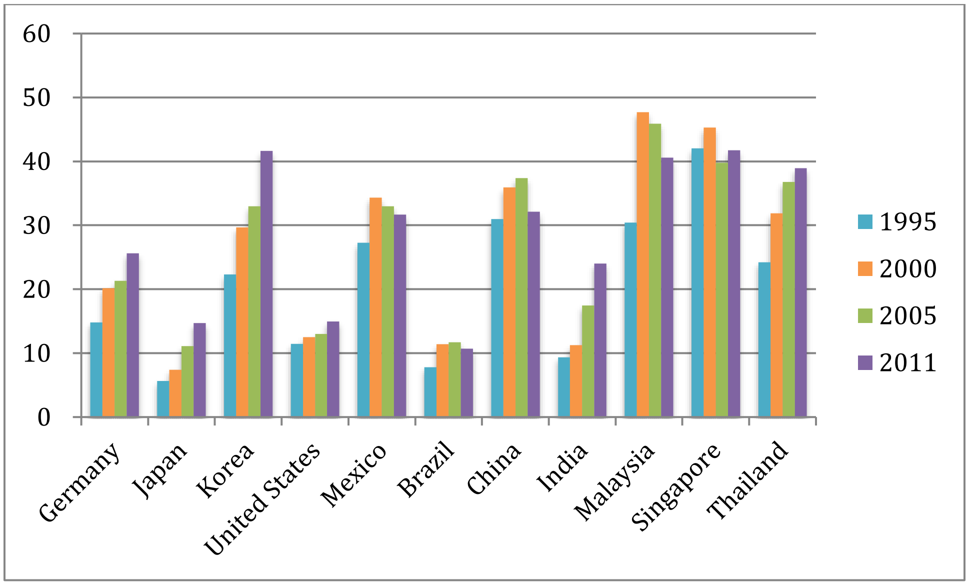
[14] This percentage is calculated by adding the foreign value added used in a country's exports (upstream perspective) plus the value added supplied to other countries' exports (downstream perspective) and dividing by total exports (UNCTAD, 2013a, p. 11).

Share (%)



Source: OECD – TIVA database, 2017

Not all countries participate in GVCs to the same extent and their level of participation varies over time (Figure 3.2). For Germany, Japan, Korea, the United States, India and Thailand, the extent of their participation in GVCs has increased between 1995-2011. For China, Mexico, Malaysia and Singapore, the share of foreign value added in exports increased at first and subsequently declined. The reasons for this decline could be that some countries build their own capabilities over time in exported products (as in China and Brazil in Lee et al., 2017) or that countries lose their status as preferred export-oriented hubs for Trans-national Corporations (TNCs).

Finally, in terms of sectors, the electronics, electrical equipment and transport equipment sectors have featured some of the highest shares of foreign value added, mostly organized along regional chains, in East and Southeast Asia, North America and Europe (Baldwin and Lopez-Gonzalez, 2013; Sturgeon and Memedovic, 2011).

3.3 A Review of Global Value Chains

3.3.1 Competing Frameworks

Until now we have used the term GVC to mean a transnational production network in general. However, as we see in this chapter, the term is also associated with a particular theoretical framework. A number of other frameworks have also been developed to study the same phenomenon and their definitions are given in Box 1.

Each framework speaks to the particular discipline it came out of. Global Commodity Chains (GCC) has sprung up from sociology, Global Production Networks (GPN) from critical geography, Fragmented Production is found mainly in economics, while the Global Business Revolution is mostly associated with studies of the firm. The more wide-ranging GVC framework emerged in an effort to develop a common concept to unify the research strands above, although significant differences remain.

Box 3.1: Definitions of key frameworks

Global Business Revolution
'Through the hugely increased planning function undertaken by systems integrators, facilitated by recent developments in IT, the boundaries of the large corporation have become significantly blurred. The core systems integrators across a wide range of sectors have become the co-ordinators of a vast array of business activity outside the boundaries of the legal entity in terms of ownership. The relationship extends far beyond the price relationship. In order to develop and maintain their competitive advantage, the systems integrators deeply penetrate the value chain both upstream and downstream, becoming closely involved in business activities that range from long-term planning to meticulous control of day-to-day production and delivery schedules. Competitive advantage for the systems integrator requires that it must consider the interests of the whole value chain in order to minimize costs across the whole system'
Nolan, 2001, p. 44

Global Value Chains
'[The] full range of activities which are required to bring a product or service from conception, through the different phases of production (involving a combination of physical transformation and the input of various producer services), delivery to final consumers, and final disposal after use'
Kaplinsky and Morris 2001, p.4

Global Production Networks
'[An] organizational arrangement, comprising interconnected economic and non-economic actors, coordinated by a global lead firm, and producing goods or services across multiple geographical locations for worldwide markets"
Coe and Yeung, 2015, pp.1-2

'[An] organizational innovation that enables network flagships to combine concentrated dispersion with *systemic* forms of *integration*. These networks *integrate* the dispersed supply and customer bases of a *network flagship*, i.e. its subsidiaries, affiliates and joint ventures, its suppliers and subcontractors, its distribution channels and value-added resellers, as well as its R&D alliances and a variety of cooperative agreements, such as standards consortia.'

Ernst, 2002, p.508

Fragmented Production
'The term, "fragmentation", refers to a splitting up of a previously integrated production process into two or more components, or "fragments"…made possible by utilizing activities from the "service" sector.'
Jones and Kierzkowski, 2001, p.18

Commodity Chains
'A network of labor and production processes whose end result is a finished commodity'
Hopkins and Wallerstein, 2000 [1986], p.159

Global Commodity Chains
'Global commodity chains have three main dimensions: (1) an input-output structure (i.e., a set of products and services linked together in a sequence of value-adding economic activities); (2) a territoriality (i.e., spatial dispersion or concentration of production and distribution networks, comprised of enterprises of different sizes and types); and (3) a governance structure (i.e., authority and power relationships that determine how financial, material, and human resources are allocated and flow within a chain)'
Gereffi, 1994, p.96

In general, this research will use the GVC framework as the *lingua franca* of this literature, since it is more widely used in policy circles and academia, although we will take an eclectic approach, drawing from all the frameworks mentioned above. It is not our aim to reproduce here an in-depth genealogy of these concepts, so the reader is referred to Bair (2005; 2009), Kaplinsky and Morris (2001) and Henderson et al (2002) for detailed discussions. What follows is a short critical evaluation, focusing on the concepts of governance and of upgrading in the GVC and GPN literatures.

3.3.2 From Dependency Theory to Global Commodity Chains

The first attempt to conceptualize the phenomenon of transnational, export-oriented, production networks was within dependency theory. Fröbel et al (1981) in *The New International Division of Labour* explored the emerging tendency for the establishment of foreign-owned manufacturing facilities in developing countries, to service exports markets. For the authors, this represented another form of dependency, where labour worked for low compensation in export enclaves with few linkages to the domestic economy, fully dependent on external technology, and without any security, as firms were footloose. In this context, sustained development of the host country would not be feasible.

Hopkins and Wallerstein (2000 [1986]), who were the first to talk in terms of production 'chains' in a global context, also took this pessimistic view. Their commodity chain concept aimed to show that capitalism was not a national but an international phenomenon. Throughout the history of capitalism, products have required inputs that linked together seemingly different production systems in a global market exchange. The division of labor between countries in the context of GVCs continued to prop up this unitary 'world system', with oligopolistic core firms, supported by strong states, being able to appropriate more surplus compared to firms in developing countries.

However, the successful development of some East Asian economies showed that it was possible for the periphery to develop, thereby putting a dent on the dependency thesis. More importantly, the state in those places emerged as an autonomous agent that could impose its own goals for industrialization on dominant class interests. In this sense, government action was not purely determined by the market logic as Wallerstein had suggested (see Skocpol, 1977; Evans et al, 1985).

The concept of GCCs, developed later by Gereffi (Gereffi and Korzeniewicz [eds], 1994), built on Wallerstein, but also marked a clear departure. Gereffi (1995), although a student of Wallerstein, was much more optimistic on the implications of such production chains for development. For example, the demand created by large retailers and other fab-less brands in advanced markets was seen as instrumental in spurring the development of independent suppliers in the successful East Asian NICs (see also Hamilton and Gereffi, 2009). At the same time, the role of the state was also seen in a more positive light compared to the dependency formulations, arguing that domestic industrial policies could improve supplier competitiveness, although these were not examined in detail (Bair, 2005).

The main analytical innovation of GCCs was the introduction of a binary typology of chain governance, namely the distinction between buyer-driven and producer-driven chains (Gereffi, 1994). Producer-driven chains featured large industrial enterprises that controlled the production system through forward and backward linkages, typically found in capital-intensive industries such as automobiles. Buyer-driven chains were instead governed by large retailers, brand-name merchandisers and trading companies that purchased finished products from producers in various exporting countries. By identifying these two distinct types, Gereffi was able to capture not only the typical FDI-led global integration that had been the focus of earlier studies, but also the increasing integration without equity investments, based largely on global sourcing networks. The studies on the triangular textile and footwear trade in East Asia were representative of these efforts (Gereffi, 1994; Chen, 1994; Bair and Gereffi, 2001).

However, despite these advances, the typology remained largely descriptive in nature, and was unable to accommodate the increasingly diverse outsourcing arrangements that were coming to light. The GVC framework that was developed later identified a larger number of types of chain governance as well as key variables that determined their emergence. The GCC continues to be the focus of sociologists that are interested in the macro, world historical processes and the role of labor, compared to the inter-firm relationships that became the focus of GVCs (Bair, 2009).

3.3.3 The Multinational Corporation and the Global Business Revolution

Another strand of literature that is important for understanding production networks is that regarding the multinational corporation (MNC), although this intellectual lineage is not widely acknowledged in the GVC literatures.

The question of why a firm would choose to become a multinational and invest abroad has been explored at great depths in business literature, with notable contributions by Penrose (1959 [1956]), Caves (1971), Hymer (1976), Rowthorn (1992), Dunning (1984), Dunning and Lundan (2008). The GVCs and GPN literatures clearly have been influenced by the more nuanced analysis of lead firm strategy in MNC/FDI works. However, the focus had usually been on low production and transaction costs as determinants for overseas investment, at least until Gereffi et al. (2005) and Coe and Yeung (2015) also explored supplier capabilities more seriously. Moreover, the empirical work by GVC and GPN scholars has focused on the upgrading of developing country suppliers, rather than lead firm strategy. In contrast, the Global Business Revolution framework, developed by Nolan (2001; Nolan et al, 2008), shares a focus with business literature on the global large lead firm.

Nolan's framework examines more closely the evolution of the large firm from an integrated entity investing in its own subsidiaries to becoming a system integrator and coordinating its 'external firm'. Nolan observes that lead firms have shed their non-core competences but have increased their global market dominance in the narrower scope of core business. These global lead firms (termed 'core system integrators') normally have some superior attributes compared to their suppliers or to lower-end competitors, such as better access to financial resources, higher R&D spending, better branding or the ability to attract better human capital. These firms also closely coordinate the activities of their first-tier suppliers, with whom they develop strategic partnerships. Key business decisions of strategic suppliers, such as where to locate production or activities like R&D and product development are made in close cooperation with lead firms who monitor these processes. This 'planning' of business activities beyond what is legally the boundary of the firm is conveyed by the concept of the 'external firm'. Moreover, this phenomenon is cascading down the value chain; the most important first-tier suppliers also specialize, outsource and closely coordinate with their own suppliers and so on.

The Global Business Revolution framework describes aptly the logic that pushes global lead firms to pursue strategies of outsourcing and coordinate dispersed production activities. However, its emphasis is on the competitive position of large global lead firms and not on the perspective of their suppliers, especially in the lower tiers. Moreover, while it offers a rich understanding of governance when lead firms have much more bargaining power than their suppliers, it does not focus much on situations where greater inter-dependence between suppliers and lead firms exists. In this sense, this framework does not provide a framework to study individual lower-tier suppliers in a developing country, which is better analysed through the GVC and GPN frameworks. However, the insights from the Global Business Revolution framework are highly relevant for this study, so we will be revisiting them throughout this work.

3.3.4 Global Value Chains and Global Production Networks

The GVC and GPN frameworks are the most fully developed so far, at least in terms of sketching out some causal principles. The two literatures may come from different theoretical perspectives, but empirically case study work in the two traditions has tended to be quite similar (Bair, 2005), so they are considered here together. Before we go on to describe the theories of governance and upgrading in these literatures, it is worth spending some time to problematize the definitions of GVCs and GPNs first, as their fuzzy boundaries are indeed a source of confusion.

First, which product is the starting point of the analysis and how much forward or backward should one go? For example, some case studies in the electronics sector take telecommunication devices as the final products, but when they analyze inputs into the production, they do not really go backwards all the way to the raw materials that make up the hardware, which would be quite cumbersome. Other studies focus instead on some key functions of the firms involved (design, assembly, key component manufacturing) or on individual components (semiconductors, LCD screens, software) that might actually feature in more than one chain. The opposite starting point is usually encountered in agricultural commodities, starting from the raw material and going forward to downstream processing, marketing and use, when one could go backwards into agricultural machinery, fertilizer and water pumps. In this sense, the boundaries of the GVC/GPN are simply a matter of perspective, rather than a sharply delineated object of inquiry that exists independently of the viewpoint of the researcher.

Second, what is the role of extra-firm actors? The GVC theory has strived to abstract from complexity to uncover causal relationships in governance and upgrading. To do this, it has largely focused on the inter-firm arena, with other key institutions like the state being peripheral to the analysis and rarely conceptualizes as having their own (potentially conflicting) goals. The GPN framework has acknowledged that firms are anchored in a certain geographical space and institutional matrix, which creates historical specificities in the way GPNs become embedded in local production structures. However, this approach has led to a rather complex and descriptive framework, especially when it comes to the role of the extra-firm actors, such as the state, trade unions and international institutions.

There are no hard and fast answers to the questions above, but we simply point out that any analysis of transnational production networks should explain clearly what boundaries have been adopted. In this dissertation, it is argued that a focus on the product and its immediate components is the most fruitful approach to study the electronics value chain, going further backwards only if there are significant elements of governance between lower-tier suppliers. Nevertheless, we acknowledge that few studies, not excluding this one, can tackle such detail, especially given the sensitivity of information involved. In terms of the extra-firm actors, while we acknowledge the multitude of actors involved, we are only concerned with the role of the state as it is expressed in industrial policy objectives. The narrow focus enables a more in-depth analysis and an exploration of the different configurations possible.

Governance

As mentioned in Section 3.2, the binary governance structures of GCCs were not able to capture a large spectrum of transactions that stood in between the buyer-led and producer-led types. Gereffi et al (2005) dealt with this problem by incorporating insights from transaction cost economics and theories of the firm to make governance a more analytically useful concept.

Three key elements appeared to influence governance: the complexity of information and knowledge transfer that is needed for a particular transaction to take place, the extent to which these elements can be codified and the capabilities of actual and potential suppliers to meet these requirements. These characteristics determine governance into market-based, modular, relational, captive and hierarchies (see Table 3.1 for definitions). Governance modes can change over time, leading to dynamic organizational changes in the GVCs concerned.

Table 3.1 Governance Modes

Table 3.1 redacted, pending permission

The above modes are highly dependent on supply side characteristics. However, the organization of the chain can also depend on institutional variables, as highlighted by the varieties of capitalism approach (Hall and Soskice, 2001) or on final market characteristics as the original GCC typology strived to show. Coe and Yeung (2015) try to integrate some of these issues in the GPN framework. They argue that governance modes are organizational outcomes of how firms deal with the following factors: optimizing their own cost-capability ratios, sustaining market development, working with financial discipline and dealing with risk. Part of their summary table is reproduced here (Table 3.2) but some of the terminology has been changed to match the terms used in the GVC literature to facilitate comparison.

Table 3.2 Firm-specific strategies and organizational outcomes in global production networks

Table 3.2 redacted, pending permission

There are some new elements here. The optimization of cost-capability ratios is a more complex way to understand capabilities, as the incentive to outsource does not only depend on suppliers, but also on how high the capabilities of the lead firm are compared to its production cost. In any case, this is the variable the GVC framework has largely dealt with. The market imperative refers mainly to whether a firm is operating in a saturated market or in one that is growing. Both will increase incentives to externalize production, but a firm operating in a saturated market will focus more on cost cutting by engaging with low cost suppliers, rather than on building strategic partnerships. Finally, the issue of risk is more problematic, as it encompasses many diverse issues, from potential leakages of intellectual property when outsourcing to rapid technological shifts. This makes it unlikely that all types of risk would have the same impact on the incentive to outsource, as the authors seem to suggest.

The issue of financial discipline is a welcome addition. This has not been explored enough in the GVC literature, except perhaps by Milberg and Winkler (2013) and Nolan (2001). Firms that are more financialized will make more efforts to cut costs by outsourcing non-core competences. This also has implications on future growth, as higher stock market capitalisations could improve the ability of firms to conduct M&As and increase in scale (Nolan, 2001). At the other extreme are state-owned firms that may have different goals, such as employment expansion or strategic technology acquisition, rather than shareholder value maximization. The issue of financial discipline ties into the wider discussion of varieties of capitalism (Hall and Soskice, 2001) and could also shed light on the observed governance variations in production networks not only according to sectors, but also according to the national origin of the lead firm or the type of ownership.

However, the above typologies of governance are not without problems. First, they refer to transactions between only two firms and it is not clear if a certain kind of coordination at the 'top' impacts the 'bottom' or not. In other words, does it matter for a low-end plastic material supplier if Foxconn is a strategic partner to Apple or a captive supplier? It is possible, for example, that supplying to a strategic partner could offer more long-term potential as these are less easily replaced by lead firms compared to captive suppliers. However, this is not something that is explored in the literature. This is important because if we perceive the value chain or the network as the totality of these inter-firm relationships, a theory of governance should have something to say about the set of these relationships, rather than only about the binary relationships at the top.

Second, it has been mentioned that modes of governance are not static and can change over time, but the mechanisms are not explored systematically within the frameworks. Many of the dynamic changes considered take place due to developments external to the networks or chains. For example, supplier capability can be shaped by industrial policy as explained in Chapter 2, while codification in the form of global standards is a process that frequently involves the state and multi-stakeholder bodies that can use standards to erect barriers or promote specific technologies (see for example Kennedy, 2006 on the case of wi-max in China). Other changes could be endogenous; for example, as suppliers engage in GVCs they increase their capabilities or lead firms increase codification over time to promote outsourcing (Pietrobelli and Rabellotti, 2011). In any case, it is clear that exploring dynamic changes will require connecting GVCs to other theoretical bodies, and in this research these will be industrial policy and the development of technological capabilities.

Upgrading and Development

The GVC and GPN frameworks have tried to find ways to describe the new ways of organizing production globally and uncover the drivers of their governance patterns. If anything, it is clear that the boundaries of the firm keep changing and international trade has become increasingly complex. In this setting, far removed from the perfectly competitive models of economic theory and the theory of comparative advantage, how is development to be achieved?

Development in the GVC framework is perceived as an aggregation of firm level upgrading outcomes across a pre-defined space, such as the sector, the region or the national economy (Bair, 2005; Coe and Yeung, 2015). In this framework, upgrading can take four different forms. A firm could remain within the same chain 'link' but introduce a more efficient production system (process upgrading), it could introduce a new product (product upgrading), it could add more high value-added functions (functional upgrading) or it could change chains altogether (inter-chain upgrading) (Humphrey and Schmitz, 2002).

The reason that upgrading leads to development is that suppliers can capture more profits. Adding more functions could turn a firm from a supplier to a strategic partner and eventually to a lead firm, a situation that could land a firm into a position of more structural power, and hence the ability to reap more profit in the future. However, given the tough competition between lead firms, this strategy is risky and might not always pay the imagined rewards. For this reason, some researchers suggest to focus entirely on profitability as a measure of upgrading, rather than the firm's position on the value chain (Coe and Yeung, 2015; Ponte and Ewert, 2009; Tokatli, 2013). However, in this way we would not be able to differentiate between strategies of increasing profit through innovation and productivity growth, and strategies that rely on skirting regulations or repressing labor. A way around these issues would be to follow Morisson, Pietrobelli and Rabellotti (2008) and define upgrading 'as innovation producing an increase in the value added' (p.45), shifting the focus back onto firm capabilities for upgrading.

However, there are two problems with the concept of upgrading as development in the GVC framework.

First, upgrading captures a change relative to the original situation of the firm but not relative to the firm's competition and the other chain links. What this means is that there is no way of understanding if there is an improvement in the bargaining position of the firm following the upgrading vis-à-vis the buyer. If supplier firms constantly upgrade in order to keep up with technological developments but remain at the lower end of the value chain, then, even though technological capabilities will be improving somewhat, the relative distribution of value added will be stable. This highlights the need to study firms in context, rather than as stand-alone case studies.

Second, upgrading does not take into account empirical evidence on lead firms that came to that position not by gradually upgrading from being suppliers, but by starting their own brands from the start. For example, Hyundai Motors accumulated capabilities by a combination of reverse engineering capital goods, sending engineers abroad for training and technology licensing (Westphal et al, 1981). As explained later in Chapter 4, many of Guangdong's leading firms in electronics and telecommunications developed on the basis of a mixed strategy, acting both as a supplier to foreign brands, and also as a lead firm for the domestic market.

Assuming that upgrading in GVCs is desirable, the next point of inquiry would be what causes it. In general, there seems to be an assumption in the GVC literature that integration into GVCs is a prerequisite for upgrading, as it encourages learning-by-doing and firms gain knowledge from dealing with sophisticated buyers and markets. However, despite this superficial link, there have been little efforts to incorporate more seriously the economics of technological change. Moreover, not many works have looked at the social and environmental aspects of upgrading. The few examples that exist show that insertion in GVCs does not actually guarantee upgrading, especially since suppliers are often discouraged from functionally upgrading and competing with lead firms on certain business segments[15] (Schmitz and Knorringa 2000, Giuliani, Pietrobelli and Rabellotti, 2005). This is in sharp contrast to the more critical tradition of looking at FDI, where both benefits and costs have been repeatedly reviewed (for a summary see UNCTAD, 1999).

In arguing that integration into GVCs is the main conduit for knowledge transfer and market development for firms in developing countries, and by not problematizing this process further, the GVC line of research has failed to come up with a credible theory of development beyond the firm-level.

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[15] Of course discouragement does not mean that it is impossible. Several developing country firms developed brands successfully, often buying the firms that had supplied them with OEM (original equipment manufacturing) business before, in order to gain market access and technology. For example, the South Korean electronics manufacturer LG acquired the U.S. based TV maker Zenith in 1999.

For example, Gereffi (1995) used the earlier framework of GCCs to discuss industrialization strategies pursued in East Asia and Latin America from 1950 to 1990. Gereffi argued that the export orientation of many East Asian suppliers was feasible because of the sharp rise at the time of buyer-driven GCCs in light consumer goods, such as electronics and textiles. In contrast, heavy industries continued to be characterized by producer-driven chains that had a more inward orientation. However, what his argument missed is that the demand generated by the lead firms needed to be matched by supply from firms that had already developed significant capabilities, and this depended on the implementation of industrial policies.

A similar problem exists in the GPN literature. Coe and Yeung (2015) describe three different modes of 'plugging into' networks for regions: (i) regions integrate by creating local indigenous firms that rely on innovation and could become lead firms; (ii) regions act as export platforms for MNCs; and (iii) regions integrate by being hosts to (indigenous or foreign) specialized suppliers and strategic partners[16]. This typology is an effort to differentiate regional modes of integration based on the average function of firms within the GPNs that develop in each region. There is a clear hierarchy of development outcomes according to the technological capabilities of firms, but how firms develop these is not discussed.

In contrast to those who are advocating integration into GVCs as the only (or at least the main) path to economic development, my view is that we should understand economic development as a process of accumulation of capabilities, whether these are enhanced by integration or not.

3.4 Global Value Chains and Industrial Policy

Given the diverse approaches to the study of transnational production networks, it is not surprising that opinions in this literature on the role of industrial policy in fostering

[16] The terms Coe and Yeung (2015) choose to refer to the three modes are indigenous, structural and functional. It is worth noting that the three types of integration described above are also similar to other characterisations development trajectories in East Asia. For example Keller and Samuels (2003) talked about technologlobalists, technonationalists and technohybrids and Amsden (2001) who discussed the independents and the integrationists.

economic development vary widely. These views do not depend only on what the perceived impact of GVCs is on the implementation of industrial policy but also on whether the author is convinced that industrial policies bring about industrial development, regardless of how production is organized.

This Section discusses three distinct views on the issue. Section 3.4.1 discusses the view that selective industrial policy is not feasible under fragmented production. Section 3.4.2 evaluates the view that industrial policy is desired but its impact on creating global lead firms in developing countries might be limited. Section 4.3 discusses the view supported by recent GVC scholarship that industrial policy is necessary to increase supplier capability but it should not be interventionist in trade and investment.

3.4.1 Industrial Policy is a No-Go

Traditionally market-oriented institutions have seen the expansion of GVCs as further justifying a hands-off approach to the economy. For example, a joint publication by the OECD, the WTO and the World Bank (2014) insisted that the role of governments in regards to GVCs is only to provide a facilitating environment, focusing only on horizontal measures such as infrastructure and education.

This view is largely based on two observations that have weak foundations. The first is that even if selective instruments were successful in the past (which in any case mainstream authors do not agree with, as discussed in Chapter 2), such instruments are not relevant any more due to the fact that GVCs are organized according to tasks, not sectors. The second is that tariffs cannot be used since trade is essential for value chains and tariffs will disrupt them.

Selectivity

The trade in tasks literature (Grossman and Rossi-Hansberg, 2008) argues that countries do not trade in products or components, but in tasks (for example, R&D, design, production of components, assembly, sales), which are horizontally similar across sectors. Countries then specialize in tasks rather than products or components, prompting some to declare sectoral industrial policy incompatible with GVCs (De Backer and Miroudot, 2014).

This view seems rather extreme. First of all, it implies that all products have the same processing steps and that no particular asset specificity is needed (in skills or capital equipment) for different sectors. This is clearly not true. Assembly for semiconductors is not the same as assembly for toys even if in abstract terms they mean something similar. This becomes even harder to fathom as we move into more capital- and skill-intensive tasks that feature even higher asset specificity. For example both South Korea and Taiwan have specialized in semiconductors (among other products), but South Korea leads on memory chips while Taiwan on ASICs[17]. The production of memory chips relies on large economies of scale (mass production) and is characterized by vertical integration, where firms both design and produce chips (e.g. Samsung and Intel). In contrast, ASICs require flexible production methods, while design and production do not necessarily take place within the same firm. Firms producing ASICs (e.g. TSMC) need to adapt their products to their clients' designs and produce at a smaller scale for each design compared to memory chips (Hobday, 1991). Both governance in GVCs (Gereffi et al, 2005) and systems of innovation (Malerba and Nelson, 2011) differ greatly by sector. This means that even if firms undertook the same tasks in different sectors, they would still face distinct opportunities and constraints to upgrading, arising from these unique sectoral characteristics.

However, there are at least two ways in which industrial policy should adapt to GVCs. First, it has become evident that increased production and exports in what would have been considered a high-tech sector in the past (for example electronics or automotive) does not necessarily mean the undertaking of high-tech activities anymore, if firms are engaged only in labor-intensive, low-tech assembly. One should not just look at the sector then, but also at the functions performed within that sector. Second, the rise of GVCs puts focus on the entire spectrum of activities that is required to bring a product to market, beyond manufacturing. For example, for suppliers to become competitive in the production of electronic components it is necessary that they have access to reliable, fast and cheap logistic services. Industrial policies for the electronics industry then should take into

[17] Application Specific Integrated Circuits (ASICs) are custom designed for specific applications.

account not only the capabilities of electronics suppliers, but also the logistics infrastructure they have access to.

In conclusion, the rationale for industrial policy in targeting specific sectors has not changed, but what GVCs imply is that *within* sectors of interest, targeting could be done at the component or task level at the *entire value chain* and not just manufacturing.

The Use of Tariffs

The ineffectiveness of tariffs in the context of GVCs is perhaps the most widely cited impact of GVCs on industrial policy. The main rationale is that within GVCs products cross borders several times to get processed further and therefore tariffs would make this process highly uneconomical, thereby hurting efforts to industrialize (De Backer and Miroudot, 2014, Hummels et al, 2001). For example, if a country has tariffs on a certain component for mobile phones, then a global mobile phone manufacturer/assembler like Samsung or Foxconn, will not locate there at all, and in this case the developing country will not have the chance to integrate into GVCs at all.

However, this argument needs some unpacking. First, the import-intensity of production is not new. For example, during the implementation of ISI policies in Latin America, it was observed that imports rose sharply as imported capital equipment was needed to localize production and assembly, thereby actually worsening the balance of payments (Prebisch, 1964). Second, tariffs are not normally implemented as an across-the-board measure, but as a highly differentiated policy tool.

There should be a distinction between imports for the domestic market and imports for exports. The latter have been encouraged by implementing measures that reduce or eliminate tariffs on imported components for exports, such as the duty-drawback system on imported inputs used for exports, tariff exemptions for certain components or free trade zones. These can co-exist with tariffs for goods, for which import substitution could take place. The challenge is to ensure that domestic producers that have developed on the basis of import substitution invest in building capabilities, so that they eventually become globally competitive when the tariffs are removed.

Furthermore, there could be differentiation according to the stage of production. In many cases, even in export-oriented countries such as China and Malaysia, there are higher tariffs on final goods that target the domestic market and lower or no tariffs on intermediate goods. This encourages local processing of final goods with cheap imports of intermediate goods. Tariffs can be extended gradually to intermediate goods if localization of those is desired, although this should take into account the size of the domestic market for such goods. In any case, the structure of tariffs can change over time to match the industrial structure of the economy (Akyüz, 2009).

Of course, this discussion does not imply that tariffs will always be successful. In Chapter 2 we saw that successful use of tariffs requires that industrial policies should discipline rent recipients into investing in capabilities building, e.g. with conditions on exports as it happened in Korea (Chang, 1994; Amsden, 1989). Moreover it is possible for export-oriented production to be encouraged side by side with producers for the domestic market, using highly differentiated tariff structures to match an evolving strategic vision for industrial development, as it happened in Taiwan and Korea (Wade, 1990).

3.4.2 Industrial policy has new limits due to the rise of GVCs

The second line of critique against industrial policy in a GVC context is that grooming national champions is less likely to be effective nowadays, given the tight race at the top of the chain. However, as this section shows, without industrial policy the chances for upgrading to the top are even dimmer than before.

Some authors in the GVC literature argue that the main problem with industrial policy is that national champions have traditionally been vertically integrated firms, a business form that cannot be competitive given the trend of vertical disintegration (Gereffi and Sturgeon, 2013). However, a firm could be promoted to reach Minimum Effective Scale (MES) in a specific stage of the chain, so the 'extreme' vertical integration is not a necessary feature of firms supported by industrial policies. Moreover, industrial policy does not imply insularity from the global economy. Establishing joint ventures with foreign firms, licensing technologies and engaging in international M&As have all been strategies employed by national champions at least in South Korea and China, in order to access foreign knowledge networks.

The most convincing argument on the contemporary problems of promoting national champions is that of Nolan (2001), who has shown that there is an ongoing unprecedented struggle for market dominance between the top global lead firms in almost all sectors[18]. These firms keep on growing by conducting M&As, which are feasible, given their superior access to financial resources and high market capitalizations. They then invest in enormous R&D expenditures to sustain their technological dominance, branding power and state-of-the-art IT infrastructure, erecting formidable barriers to entry.

In this context of highly oligopolized and ever-concentrating market structures, a developing country firm starting its catch-up now would be even more disadvantaged than before. It would have far fewer resources to spend on R&D, branding and M&As (even with industrial policy measures) and it would not be able to compete on price since cheaper production sites are also available to lead firms through outsourcing. Of course, the development of few but powerful brands from South Korea and Taiwan in electronics, automobiles and ships (LG, Samsung, HTC, Hyundai) shows that it might be difficult but not impossible. Below in Table 3.4 we show the slow growth of global firms from developing countries. In 2015 these accounted for a quarter of all global companies and revenue, the majority of growth since 1995 is due to the development of Chinese firms.

Table 3.4 Fortune 500 companies from developing countries

Country	No of F500			Share of firms in 2015
	1995	2005	2015	Total global revenues (%)
Developing Countries	10	30	123	25.00
Brazil	4	3	7	1.31
China	2	15	97	20.43
India	1	4	7	0.96
Indonesia			1	0.15
Mexico	1	2	2	0.47
Malaysia		1	1	0.23
Russia		3	5	1.15
Thailand		1	1	0.21
Turkey	1	1	1	0.09
Venezuela	1			

Note: China does not include Hong Kong firms
Source: Fortune.com/global500

[18] According to data from the US Census Bureau analyzed by the Economist, between 1997 and 2012 the weighted-average share of the top four firms' revenues in the US has risen from 26% to 32% of the total. Almost a tenth of the industrial activity took place in industries in which the top four firms control two thirds or more of sales (The Economist, March 24 2016).

We agree that becoming a global leader today is indeed much harder than it was before the 'Global Business Revolution'. However, there are three further considerations one should take into account.

First, technological leadership often changes not in 'head-to-head' battles over established business, but when there is a new technological 'window of opportunity' (Lee, and Malerba, 2016). For example, Nokia toppled Motorola when the GSM standard was implemented and then Samsung and Apple toppled Nokia with the emergence of the smart phone. This requires the existence of firms that have already built considerable expertise and are ready to recognize opportunities in new technologies and reap them. Industrial policy can help with developing such capabilities in the first place.

Second, in some ways becoming a lead firm has also become easier, since firms can access large networks of suppliers, bypassing the cumbersome task of building advanced manufacturing capabilities in-house (Sturgeon and Lester, 2004). For example, Xiaomi, a Chinese mobile phone company outsources product assembly to Foxconn and Inventec, among others, to produce its phones, the same suppliers used by Apple.

Third, becoming a global lead firm is one measure of success of many. Taiwan has secured a high standard of industrial performance not by having lead firms, but by being home to the top first-tier suppliers in the electronics industry.

Fourth, the problem of high entry barriers to lead firm status should actually be further cause for concern and would serve to justify (rather than nullify) the rationale for industrial policy, despite the lower likelihood of developing country firms reaching lead firm status. China, a country that has used industrial policies aggressively, managed to create large (mostly state-owned) firms, making up a quarter of Fortune 500 companies in 2015. Their innovative capacity is another story (see Nolan, 2014), but at least they have amassed the required resources, should they want to invest with a view to competing globally.

Let's take this argument further. We saw in Chapter 2 that the structural differences between developed and developing countries had been cited as a key reason for implementing industrial policy (ECLAC, 1950). While at that time the framework was conceived largely in terms of industry versus commodity production, later works have differentiated between industrial sectors in terms of productivity growth. In a nutshell, core countries specialize in industrial sectors that have more potential for productivity growth than developing countries do.

The GVC can be thought of as a microcosm of how these structural differences are encouraged and sustained at the global level (Schwartz, 2007). Lead firms face oligopolistic market structures, while competition increases as one goes down the value chain and profits similarly decrease. This is not only an outcome of technological or market characteristics, but it is a structure sustained actively by lead firms. Strategies of grooming alternative suppliers, squeezing suppliers by offloading to them the risk of maintaining inventories, and restricting their access to key technologies are some of the ways in which lead firms can sustain the gap with suppliers. In other words, there is an endogenous incentive for lead firms to keep externalizing selected aspects of their production and then keep costs down by squeezing suppliers, thereby increasing their own profits even in the face of sharp product market competition (Milberg and Winkler, 2013).

Since lead firms predominantly reside in advanced countries and lower-tier suppliers in developing countries, on aggregate something like a core-periphery relationship can be created through GVC operations. On the one hand, the expansion of GVCs makes it ever harder for suppliers to reach lead firm status, and, on the other hand, supportive industrial policy is even more necessary for them to improve their bargaining power, even if they do not aspire to become lead firms. Almost all industrial policy measures can be of help, but particularly helpful are those that increase the scale of suppliers (e.g. promoting national champions) and those that increase technological capabilities beyond those of competitors, such as the promotion of specialized clusters (Pietrobelli and Rabellotti, 2006), public-private partnerships in developing high-tech products (Weiss, 1998), university-industry collaborations, worker training and R&D subsidies and grants.

3.4.3 Yes to industrial policy, but no to selectivity

During its first decade at least, GVC scholarship did not engage much with industrial policy, focusing instead on insertion into GVCs as the main tool for knowledge transfer and consequently for development. However, given the success of the GVC framework with policymaking (Neilson, 2014), more questions started emerging about the role of the state in this context.

The vision of industrial policy that was articulated by the GVC literature, as represented by Gereffi and Sturgeon (2013), Coe and Yeung (2015) and UNCTAD (2013b) is one that envisions a role for industrial policy in developing local supplier capabilities but in a way that aligns with the interests of lead firms and buyers so that integration is encouraged. This view is based on both a reluctance to acknowledge that trade policy could play role (as in 3.4.1) and also on the understanding that national champions could be too vertically integrated and insulated from global knowledge flows (Section 3.4.2). Below we summarize some of the basic recommendations:

- Attention to horizontal non-selective measures such as infrastructure, human capital and R&D support, to both indigenous and foreign firms.
- Support for compliance to ISO and other production standards.
- Creation of clusters and promotion of inter-firm linkages.
- Intellectual property protection policies.
- Liberalized trade and investment environment.
- Environmental and social standards.

While these works highlight an important part of the contemporary development experience, they do not go far enough in problematizing the creation of firm capabilities, especially beyond the supplier-buyer relationship. A key criticism of the neoclassical literature was that it assumed that firms can be competitive from the get-go or that they can themselves fully bear the cost of learning and experimentation. In line with our discussion in Chapter 2, we argue that this is an unrealistic assumption. Successful building-up of technological capabilities often needs bold action. More importantly, it is crucial to consider the role of industrial policy in areas where a conflict exists between the needs of lead firms and national economic development. For example, while the emergence of technologically advanced lead firms is an objective of economic development, lead firms may want to stifle their growth to prevent future competition. (UNCTAD, 1999; Christopherson and Clark, 2007; Evans, 1995).

This work is a departure from other works that consider GVCs and industrial policy in three ways. First, selective industrial policy measures are not considered incompatible with development in the face of GVC expansion but necessary. Second, the constraints to development from global integration are considered in greater depth, especially as they relate to indigenous firm development. Third, a more integrated framework is presented that attempts to connect the three literatures of concern here, (industrial policy, GVCs and development of technological capabilities), not only nominally, but also analytically. We present this in Section 3.5 below.

3.5 An Integrated Framework

Since three different theoretical strands are considered, we specify three 'pairs' of relationships that make up the building blocks. First is the relationship between industrial policy and the building of technological capabilities. This has been explored at length in Section 2.6. Second, there is the relationship between industrial policy and GVCs, which was explored in depth in Section 3.3. We discuss these two briefly (3.5.1 and 3.5.2). Third, there is the connection between technological capabilities and upgrading in GVCs, presented below, in Section 3.5.3. In section 3.5.4, we bring all these elements together and give some broad examples of the diversity of industrial trajectories possible.

3.5.1 Pair One: Industrial policy and Technological Capabilities

For a detailed view on industrial policy and technological capabilities the reader is referred to Chapter 2, Section 6, but to re-cap briefly:

Evolutionary economics has argued that firm technological capabilities, spanning from basic assembly to launching cutting-edge product and process innovations, are accumulated gradually and require significant effort by the firms (Nelson and Winter, 1982; Dosi et al [eds], 1988; Lazonick, 1993; Cimoli, Dosi and Stiglitz, 2009; Nübler, 2014). Industrial policy should complement the endogenous incentives firms have for investing in innovation by shaping the environment faced by them, through changing relative prices, reducing uncertainty by providing markets, and encouraging cooperation between firms. These factors significantly influence the choice of a firm regarding what to produce and whether and exactly in which areas to invest in technological capability accumulation (for a detailed exposition of the types of capabilities see Lall, 1992 and Pack and Westphal, 1986).

3.5.2 Pair Two: Industrial Policy and GVCs

My analysis so far agrees with several previous works on strategic industrial policy (Amsden, 1989; Wade, 1990; Chang, 1994; Lall, 2004). Industrial policy affects domestic firm engagement with GVCs in two ways. The first is direct, encompassing policies to attract FDI or any other policies that promote domestic firms' integration into GVCs. The second way is indirect and it involves changing any of the determinants of governance modes and are in the purview of industrial policy, such as standard-making, financial discipline, financial risk, and more importantly the capabilities of suppliers.

3.5.3 Pair Three: Technological Capabilities and GVCs

The notion of technological capability development and its relationship with industrial upgrading is something that is frequently mentioned in the GVC literature (Hobday, 2001; Ernst, 2002; UNCTAD, 2013). Moreover, concepts that are important to the innovation literature, such as the complexity and the codifiability of knowledge, have already been used to classify GVC governance modes (Gereffi et al, 2005).

Despite these superficial links, the efforts to analytically combine these two literatures further have been sparse. This could be due to the difference in the objects of investigation. The GVC literature looks at transnational inter-firm relationships, with the state usually treated as exogenous. In contrast, evolutionary economics has produced concepts like the innovation system that explicitly take into account the role of the state and other institutions (e.g. universities) for firm innovation capacity development. Another reason for the sparse integration between the two literature is that the main object of the study of innovation economics has been frontier innovation in industrialized countries, for which insertion into GVCs would not be a significant determinant (Enrst and Kim, 2002).

The two literatures can be fruitfully combined, if one views transnational inter-firm relationships as a central source of technological learning for firms directly engaged in transnational production networks, additional to the sources found in the domestic economy, which is traditionally the focus of the innovation literature. Conversely, for the GVC scholars, focusing on technological capabilities can provide a better understanding of upgrading, beyond the buyer-supplier relationship.

We prefer to critically combine two already existing frameworks that complement each other. The first is that developed by Ernst and Kim (2002), who constructed a matrix describing the possibilities for knowledge transfer to local firms when they participate in GPNs, drawing on modular networks found in the electronics industry (Table 3.5). The process of knowledge transfer is complete when it has been internalized by the local supplier. The more common mechanism that can takes place even outside of GVCs is where the supplier acquires knowledge embodied in capital equipment bought on the market. However, within GVCs, provided that increasing supplier capacity is in the interest of the lead firm, other arrangements could also take place, such as the lead firm training supplier employees or sending its own engineers to the supplier to help with production.

Table 3.5 Knowledge transfer matrix in GPNs

Table 3.5 redacted, pending permission

The second framework is that developed by Pietrobelli and Rabellotti (2011), who deepen the connection with the GVC literature, by pointing out that different GVC governance modes can encourage different kinds of learning mechanisms (Table 3.6).

Table 3.6 Governance and learning

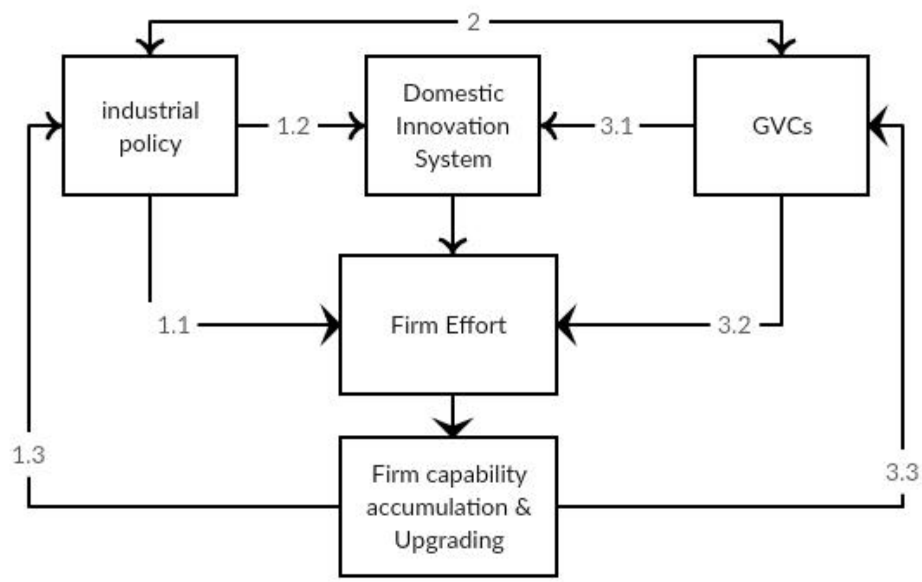
Table 3.6 redacted, pending permission

Pietrobelli and Rabellotti (2011) argue that a mature, complete and effective innovation system in the suppliers' country could help with increasing the suppliers' technological capabilities as well as their capacity to deal with complexity and codification. This in turn encourages chains that rely on increased supplier competence, complexity and codification and offer better opportunities for further learning than chains, which rely simply on low costs. This is similar to the argument this research is making, but our emphasis is on the impact of industrial policy over time on a wide range of technological capabilities, from production to innovation.

3.5.4 An Integrated Framework

The causal relationships discussed in 3.5.1, 3.5.2 and 3.5.3 are put into Figure 3.3 to provide a visual guide to what has been argued so far. The main goal is upgrading, understood as innovating to upgrade, in any of the four identified ways discussed previously. Upgrading requires the build up of technological capabilities and the success of such a build up in turn will also depend on how extensive and intense the firm effort is (Ernst and Kim, 2002; Lazonick, 1992). To mirror the flow of the chapter, Arrows 1.1 and 1.2 reflect the influence of industrial policy on firm effort. Some of it is direct through shaping prices, market structure and uncertainty, while some of the impact is indirect, through the impact on the domestic innovation system, with policies such as setting up research agencies, investing in infrastructure, encouraging linkages and so on. There is also a feedback loop from firm capability accumulation to industrial policy, to show that policy should adapt to a changing level of skills (Arrow 1.3). Then Arrow 2 reflects the direct relationship between industrial policy and GVCs. Arrows No 3.1 and 3.2 reflect the bidirectional relationship between knowledge transfer and GVCs.

Figure 3.3 Determinants of upgrading



The need to adapt policy in terms of the development stage of the country and the stage of maturity of a sector has been pointed out before[19] (Chang, 1994; Livesey, 2012). Infant industry policies (including subsidizing FDI) would be needed in the beginning to establish new sectors that are mature in the world stage. Then, as economy-wide technological capabilities evolve and suppliers can undertake more complex functions, the main goal of

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[19] The notion that policy needs to adapt to the stage of maturity of a sector is related to the industry life-cycle literature. Key works include Abernathy and Utterback (1978), Gort and Klepper (1982), Klepper (1990) and Utterback and Suarez (1993).

industrial policy would shift to maintaining competitiveness in the already existing segments and to promoting upgrading to higher value added segments.

Moreover, the institutional variation across countries, or even regions means that the design and implementation of policy, the responses of agents to it and the nature of interaction between agents can differ and that such differences can be sustained over time (Zysman, 1994; Hall and Soskice, 2001; Chaminade and Edquist, 2010). For example, it may be the case that a country selectively and strategically attracts foreign firms, like Singapore did, or puts more emphasis on building indigenous technology, like Korea and to a lesser extent Taiwan did, thereby shaping the direction of future policy choices in terms of climbing up the value chain (Amsden, 2001; Yeung, 2007; Thurbon and Weiss, 2006; Keller and Samuels, 2003). Others point out that, when policy aims to increase competitiveness, the necessary policy instruments should depend on the sector, too. Some sectors that usually feature small firm sizes, such as textiles, biotechnology, specialized equipment suppliers or software development, might require clustering in order to increase collective efficiency, while others, such as automobiles, chemicals, and other heavy industries, require achieving economies of scale in a single firm (Robertson and Langlois, 1995).

We now push the analysis a little bit further to add a three-stage perspective to this, building on the cumulative and evolutionary character of firm, sector and economy-wide technological capabilities (Table 3.7).

The three stages are: (i) when the industry concerned is emerging and the economy has low technological capabilities; (ii) when the industry is growing and the economy has intermediate technological capabilities; and (iii) when the industry is catching-up and the economy has advanced technological capabilities. This implicitly assumes that firms and economy are developing in tandem. This assumption is for simplicity, as it might not be the case, when one industry is developing much faster than others. The industry here is defined in terms of the broad category of the final product, for example textiles and garments or electronics, while recognizing that only a few stages of production or specific components will make up the sector in each economy. In modular chains there are often components that have their own complex chains, such as hard disks or semiconductors. In that case it might be possible to focus on a sub-industry, especially if the same component could find its way into different types of final products.

Table 3.7 Stages of industrial policy, GVCs and industrial upgrading

Industrial Policy Instruments		Impact of integration into GVCs	
General policies	Specific for Indigenous Firms	Knowledge Transfer	Constraints
Industry Emerging, Low Technological Capabilities in Economy			
Active attraction of FDI Selective instruments to promote specific industries (e.g. tariffs and subsidies) Infrastructure development Investments in education, esp. vocational	Creation of SOEs or subsidize entry of POEs Establishment of local institutes to help with technology transfer and adaptation Policies to encourage JVs and firm linkages in general	Lead firm actively transfers knowledge to subsidiary JV partners and promoted domestic suppliers become captive suppliers to MNCs that have invested in the economy and enjoy spillovers Spillovers to local economy from turnover of skilled workers	Limited subsidiary autonomy implies limited demand for local subcontracting
Industry Becoming Competitive, Intermediate Technological Capabilities in Economy			
Clustering policies Subsidies to encourage R&D Establishment of applied research institutes Encouraging government – industry – academia linkages	Infant industry policies to encourage economies of scale and learning in domestic firms Subsidization of standards compliance	Lead firm transfers more or higher value-added products/functions to subsidiaries Greater autonomy for subsidiaries Subcontracting demands from lead firms for lower-end tasks	Low-end foreign subsidiaries might feel competitive pinch from domestic firms and leave Lead firms encourage price competition among subcontractors to keep costs down
Industry Catching-Up, Advanced Technological Capabilities in Economy			
Selective protection of strategic firms/sectors High-tech-specific subsidies Incentives for talent to return from studies/work abroad	Selective subsidies and protection to leading firms, with conditionalities on competitiveness Enhanced competition for previously protected firms with sufficient capabilities (e.g. by	More chances of relational and modular supply links, which improve technology transfer further	Lobbying from lead firms to limit development of potential competitors (e.g. citing security concerns of their products or unfair trading practices)

Investments in high-end skills Promotion of basic research Venture capital promotion	liberalizing or putting in place anti-trust strategies) Encouragement of international M&As and technology licensing		Unlikely that MNE subsidiaries will reach this stage because advanced tasks are undertaken in headquarters

Notes: POE: Private-owned enterprise (indigenous), from Amsden (2009)
Source: Author's classification

One will notice that in Table 3.7 we have divided policies into general -pertaining to all firms in the domestic economy whether foreign or indigenous- and into policies specifically to encourage indigenous firms. This is to highlight the fact that discussion of integration into GVCs often does not make it clear whether the firm that is doing the upgrading is foreign or not, a distinction that has implications both on the ability of the firm in question to upgrade and on the impact of upgrading on local development (UNCTAD, 1999). It is also tied to discussions of path dependencies, with reliance on FDI being a major determinant of future industrial trajectories (Amsden, 2001, 2009). It is after all difficult to expect a country to develop indigenous innovation capabilities without first spending years encouraging and promoting local learning, a strategy that would usually conflict with lead firm interests.

In reality, the possibilities for different paths arising out of the interaction of industrial policy, integration into GVCs and firm strategy are endless, given the evolutionary character of development. However, we hope that some of the empirical regularities that are highlighted by the stage approach will prove a useful guide for future thinking on industrial policy.

The first stage is about the emergence in a developing country of an industry that is already mature in advanced industrialized countries. Assuming a low level of industrialization, which was the case in many emerging export platforms in the 1960's and 1970's, such as South Korea and Taiwan, the most basic production and innovation capabilities had to be created and nurtured. Two strategies have been followed to encourage the development of an emerging industry: (i) relying on attracting FDI, and; (ii) promoting indigenous capital. These strategies can be pursued simultaneously in different industries, as it happened in South Korea and Taiwan (see Wade, 1990).

Attracting FDI aims to leverage on the demand for offshoring and subcontracting to build domestic capabilities. Common policy tools include tax incentives, specialized infrastructure in the form of export processing zones or other industrial zones, duty-free imports for certain inputs, relaxed rules on labor protection, and so on. The aim is to reduce transaction and production costs so as to make offshoring in the economy more attractive for MNCs. Some examples of this include the efforts of China with special economic zones (Zeng, 2010) or Malaysia with free trade zones (Johansson and Nilsson, 1997). In this FDI-led stage, there are knowledge transfers taking place between the headquarters and the subsidiaries established in the developing economies, with the former having an interest in developing the capabilities of its subsidiaries. The benefits of FDI then could spill over into the local economy (UNCTAD, 1999). In the simplest case, this spillover would be only the knowledge acquired by workers and managers and some minimal local sourcing. However, even this case does not necessarily imply a hands-off attitude from the state. For example, in Penang in Malaysia the local state was active in attracting selected firms for FDI and tried to encourage their linkages with local suppliers by connecting firms with each other and set up a private-public vocational skills center to improve local human capital (Hutchinson, 2008).

Actively promoting indigenous firms to enter an emerging industry in a country at a low level development requires tackling several market failures that may prevent firms from doing so. Capital might be scarce in the country or financial markets might be unable to provide finance for long-term investments. Basic skills might also be lacking, including at the managerial level, to handle basic investment and production activities and so on. The state could help by offering fiscal incentives, by establishing its own firms, or by setting up state-owned financial intermediaries to provide long-term and/or specialized finance, to encourage entry into the industry. Indigenous firms can also link-up to value chains as subcontractors to local MNC subsidiaries or foreign buyers and benefit from knowledge transfers within GVCs. It could be argued that this is the strategy followed in China, and Korea and Taiwan before it, where domestic firms mushroomed next to foreign-invested firms and were able to provide simple components or perform basic assembly.

Upgrading to the next stage requires different type of interventions than those for simple industrial emergence. For upgrading to happen, firms (either local or foreign subsidiaries) have to progress from performing basic tasks to acquiring more advanced innovation capabilities, although these will still be considered intermediate by global standards, such as adaptation of technology, training of skilled workers and forging of linkages with other agents in the innovation system (Lall, 1992).

Again, industrial policy can be instrumental in encouraging the shift from industrial emergence to upgrading. Given that these innovation capabilities require investments in capital (including R&D) equipment, skilled staff, marketing and so on, tax incentives and other ways to subsidize particular types of investments could be crucial. This can be directed at both indigenous firms and at foreign firms, to induce them to make larger investments in their subsidiaries. Promoting scale economies in indigenous firms through building national champions is also a strategy followed in countries like Korea (Amsden, 1989) and China (Nolan, 2014). Initiatives to promote clustering and coordination could also fall under this category, as they also encourage economies of scale in R&D and marketing on top of cross-fertilization of ideas and increased labor mobility (Robertson and Langlois, 1995; Humphrey and Schmitz, 1996). Investments in human capital become increasingly important at this stage, as do investments in building supporting institutions, such as the establishment of research agencies and technical institutes and investments in telecommunication and IT infrastructure.

Even without industrial policy measures, it is possible that some upgrading would take place anyway, because of the inter-firm knowledge transfer within GVCs, as has been discussed previously. In Malaysia, for example, electronics MNC subsidiaries nurtured local subcontractors, while some lead firms, such as Intel, increased the functions performed by their own subsidiaries considerably over time (Rasiah, 1999).

However, as mentioned before, there are also limitations to upgrading at this stage. First, some foreign investors that look for lower costs might not appreciate the higher factor costs that come with a growing industry and simply relocate. Second, lead firms may try to increase competition among suppliers in order to reduce costs and diversify their supply sources, thereby reducing profits for suppliers (Milberg and Winkler, 2013). Third, some of the measures that had been traditionally used to promote the emergence and upgrading of an industry are not available due to a restriction in the policy space of developing countries nowadays (Gallagher, 2008).

The last stage is that of a mature industry that is about to catch-up with industry leaders. Here industrial policy should stimulate advanced innovation capabilities, which has often been the focus of innovation economics. Relevant measures include selective protection, promotion of industry-government-academia research consortia and provision of risk capital.

At this stage, the limits to and the opportunities from integration into GVCs change considerably compared to the previous two stages. It is difficult to even find one example of a country that has managed to reach a mature stage based mainly on foreign-led enterprises. Even in Singapore, SOEs are active in key sectors, such as shipbuilding and semiconductors. For indigenous firms, barriers to entry into the most sophisticated parts of the value chain can prove impossible to overcome (Nolan et al, 2008) and efforts to reach lead firm status are often frustrated (Sturgeon and Lester, 2004). Industrial policy would need to deal with these issues, by focusing on the specific problems faced by firms with potentials to become lead firm. The recent controversial moves by China to impose restrictions on foreign firms in the IT sector and the support it provides to its lead electronics firms by battling security concerns raised by the US and the EU, are an example of such a strategy.

3.6 Conclusions

This Chapter has shown that it is possible to analytically combine the theories of industrial policy, the evolutionary perspective of technology capabilities accumulation, and the GVCs literature.

The GVC literature has highlighted the importance of governance in production and trade that takes place outside the limits of intra-firm coordination. By inserting themselves in such networks, developing country suppliers have the opportunity to be exposed to higher technology and production standards, engage with more sophisticated markets and become more motivated to invest in capability accumulation. The positive impact of integration, notwithstanding fears of social and environmental downgrading, has led to policy advice that prioritizes the needs of lead firms over the creation of indigenous global firms.

However, as the previous Chapter has shown, bold action to build up technological capabilities is necessary for successful upgrading, even if it conflicts with the objectives of lead firms. First, a period of protected learning, balanced with incentives to encourage investment in capabilities, is still of great importance. Second, lead firms have incentives to sustain their leadership and these can diminish opportunities to upgrade further, especially as developing country firms move up the GVCs. This means that at the intermediate and final stages of industrial development, developing countries need to use more, not less industrial policy.

Finally, the framework developed in this Chapter has highlighted that there are not hard and fast rules. From encouraging certain modes of knowledge transfer and responding to developmental constraints arising from integration to adapting to a changing industrial structure, it becomes evident that industrial policy needs to be responsive to many different factors that shape technological capability accumulation. The creation of a strong vision supported by institutional mechanisms that bring stakeholders together can help provide the cooperation, flexibility and knowledge needed to implement successful industrial strategies.

4 Borrowing the Ladder to Climb Up: The Experience of Guangdong in the Electronics Industry

4.1 Introduction

The theoretical framework conceptualized in Chapter 2 posited that successful integration into and upgrading within Global Value Chains (GVCs) are contingent on industrial policies that accelerate technological capability accumulation. The evolutionary character of the process of capability accumulation also implied that interventions should change over time, from encouraging integration and the accumulation of basic capabilities to increasing scale and eventually to catching-up with the frontier. While integration into GVCs offers opportunities for technological learning for firms, industrial policy can offer additional channels via investments in the local innovation system together with incentives for firms to invest in capability accumulation. Industrial policy interventions can therefore be compatible with a strategy of integration and upgrading within GVCs, contrary to common perception.

This Chapter explores the validity of this study's theoretical framework by examining the experience of Guangdong province of China in promoting integration, upgrading and catch-up in the electronics sector. Guangdong has successfully integrated into electronics GVCs and more recently there is evidence that upgrading has taken place. By critically and extensively reviewing the experience of Guangdong province in the past four decades, this study provides empirical evidence that contemporary industrial policies can harness integration of domestic producers into GVCs to advance industrial upgrading.

Guangdong's development is a story of an impressive transformation[20]. On the eve of reforms, Guangdong had a relatively underdeveloped industrial base, compared to Beijing, Shanghai and parts of the Northeast region, such as Liaoning, Jilin and Heilongjiang

[20] Comprehensive works on the post-reform development of Guangdong province include Vogel (1989), Cheng [ed] (2003), Yeung and Chu [eds.] (1998), Cartier (2001) and Di Tommaso, Rubini and Barbieri (2013). A collection of the most important policy documents in the post-reform period is provided in the volumes of Guangdong Archives (2008).

provinces. In 1978, the province accounted for only 4.6% of Chinese Gross Domestic Product (GDP). By 2015 Guangdong accounted for 10.8% of Chinese GDP and had the 7th highest GDP per capita in the country (China Bureau of Statistics or CBS, various years, a).

Guangdong's economic success owes in large part to the fact that it hosted the earliest Special Economic Zones (SEZs) in China, attracting foreign investment and following a growth path intimately linked to integration into GVCs. Guangdong was chosen to pioneer market-oriented reforms because of two main reasons. First, Guangdong's relative lack of industrial assets meant that if reforms failed, China's industrial powerhouses would not be in danger. Second, the province borders Hong Kong, which was expected to prove vital as a source of foreign investments and linkages to foreign markets (Vogel, 1989).

The electronics industry has been an important driver of Guangdong's growth. The province, and specifically the Pearl River Delta (PRD)[21] within its borders, is one of the main industrial bases for electronics manufacturing and assembly in China. The industry has also become very important for the provincial economy, accounting for almost 22% of provincial industrial value added (Guangdong Bureau of Statistics or GBSa, 2015). The province has successfully integrated into the electronics GVCs. Every large first-tier supplier in electronics has facilities Guangdong and numerous clusters of foreign-owned and domestic SMEs have formed undertaking assembly, predominantly in telecommunications equipment and computer peripherals. The emergence of a few domestic firms with brand-power from Shenzhen, the largest electronics production base in the province, and some recent investments by foreign firms in sophisticated components and R&D, indicate that upgrading has taken place successfully.

Scholarship on the Guangdong electronics industry has focused largely on the formation of Foreign Direct Investment (FDI)-led clusters in the province. This Chapter widens the lens by also taking the development of domestic firms into account, making this

[21] The PRD is an economic region within Guangdong encompassing some of the most prosperous cities there such as Guangzhou, Shenzhen, Zhuhai, Foshan, Jiangmen, Dongguan, Zhongshan, Huizhou and Zhaoqing.

research better able to account for the diversity in the industry in terms of ownership, size and position in the value chain.

Section 2 discusses the existing research on Guangdong and the ways in which this study adds a fresh perspective.

Section 3 begins the analysis by offering a review of the evidence regarding the extent of upgrading in the electronics industry in Guangdong. The industry is diverse featuring: (i) large, innovative domestic firms with brand-power; (ii) smaller, often foreign-invested, unsophisticated assembly and processing firms; and (iii) large foreign operations that are more advanced in terms of product portfolio and processing techniques.

Before proceeding to a review of the industry's development, Section 4 discusses policy-making by the central and provincial governments in relation to the electronics industry and offers a brief discussion on the particularities of studying provincial policies in China in the context of ongoing reforms.

Finally, Sections 5, 6, 7 and 8 discuss the successive policy regimes in the Guangdong electronics industry that reflect respectively: (i) the Maoist era (1949-1978); (ii) the first attempt to integrate into GVCs (1979-1992); (iii) efforts to increase scale of firms and the industry as a whole (1993-2005); and (iv) recent attempts to encourage innovation (2006-now). The Sections discuss the main thrusts of industrial policies and policies that have encouraged integration and upgrading within GVCs, and offer insights on how these have complemented each other (or not) in each phase.

This Chapter will show that industrial policy interventions have been critical in creating the capabilities necessary to achieve upgrading in Guangdong's electronics industry. The provincial government supported domestic firms (mostly state-owned in the beginning) by providing subsidies and by taking advantage of central-level protectionist policies. At the same time, large domestic firms were explicitly encouraged to be export-oriented, enabling them to integrate into GVCs early in the reform period. Many of these firms ended up building successful brands in recent years. Integrating at the low-end of the value chain by attracting FDI and encouraging processing and assembly provided an easy way for domestic firms to engage with GVCs. In turn, the emergence of these FDI-led manufacturing clusters has turned into an important asset for both foreign and domestic firms, who are now becoming strong in hardware innovation. However, despite the successes, ongoing weaknesses in the innovation system point to further issues that need to be addressed by public policy in the future.

4.2 Literature Review

There is no complete account of the development of the electronics industry in the province of Guangdong. First, there are works that explore a province-wide mode of development, known as the ‘Pearl River Delta (PRD) model’, but these do not focus on the electronics industry and they emphasize the province’s low value-added FDI-led exports, which is an outdated perspective, given the industry’s recent upgrading and strong domestic firm presence. Second, there are works that touch on the role of city governments in Guangdong province in developing the electronics industry, but only in specific cities (e.g. in Shenzhen or Dongguan). Third, there are works that focus on the development of industry in China and discuss large domestic firms that are based in the province (e.g. telecommunication equipment conglomerates Huawei and ZTE). Finally, there are works on the Guangdong electronics industry from the GVC perspective, which focus on the operations of foreign firms, neglecting the role of domestic ones. This research is able to effectively synthesize these different perspectives by employing the framework laid out in Chapter 2. Before doing that this Section will examine the main strands of the literature.

The first strand of literature focuses on the provincial political economic structures that have shaped patterns of industrial growth in Guangdong (Eng, 1997; Cheng [ed.], 2003; Yeung and Chu [eds.], 1998). According to this literature, Guangdong has pursued an export-oriented strategy. On the one hand, the central government used the Delta to implement its ‘Open Door Policy’, aiming to tap into foreign trade and investment flows to advance the country’s technological capabilities (Tzeng, 1991). Rapid export-oriented industrialization has also been sustained by migration flows from inland provinces, again controlled by the center. On the other hand, the industry evolved with a great deal of experimentation, made possible by the autonomy enjoyed by the provincial government vis-à-vis the center and that of sub-provincial governments vis-à-vis the province. Provincial leaders, such as Ren Zhongyi and Lin Ruo were instrumental in securing this autonomy for the province in the 1980s and in passing it down to sub-provincial governments (Vogel, 1989; Cheung, 1998).

However, these works do not make mention of any of the strategic industrial policy initiatives that have been important in the development of the electronics industry in Guangdong. As will be explained in this Chapter, attracting FDI and promoting exports by Transnational Corporations (TNCs) was an important tool for integrating into GVCs, but complementary industrial policy initiatives launched by the central government and elaborated on by the provincial government, were also important in encouraging upgrading in the industry. Moreover, no works have examined the development of the electronics industry at the provincial level in Guangdong in the context of the 'PRD model' (or otherwise). As industrial policies, governance structures and innovation systems can differ across industries, zeroing in on one industry can better capture the evolutionary dynamics of industrial policy and its relationship with GVCs. Additionally, the interest in the 'PRD model' peaked in the late 1990s, and only a few works have examined the evolution of provincial-level institutional structures and their impact on industrial upgrading in the last fifteen years (Lim, 2016; Yang, 2014). Offering an updated account is particularly important because in 2008,of Guangdong in labor-intensive assembly, issued the 'Outline for the Development of the PRD' (hereafter referred to as 'PRD Outline'), encouraging upgrading into higher value added activities. In response, the provincial governor at the time, Wang Yang, implemented the 'double relocation' policy, aiming to shift low value-added activities and low-skilled labor towards inland areas. Considering this latest period, which has been neglected, is extremely important, given that many of the positive upgrading outcomes, such as the emergence of innovative domestic firms, have taken place during this time.

A second strand of literature looks at the 'PRD model' as pursued by sub-provincial governments. Under the province, there are three levels of government, often collectively referred to as local governments: (1) the prefecture and prefecture-level cities; (2) counties or county-level cities; and (3) towns, townships or districts (Saich, 2004). As of 2014, Guangdong had 21 prefecture-level cities[22], 35 counties, 3 autonomous counties, 61

[22] These are Shenzhen, Guangzhou, Shaoguan, Dongguan, Heyuan, Meizhou, Chaozhou, Shantou, Jieyang, Shanwei, Huizhou, Zhuhai, Zhongshan, Jiangmen, Yangjiang, Zhanjiang, Maoming, Yunfu, Zhaoqing, Foshan, Qingyuan.

municipal districts, 4 townships, 7 ethnic minority townships and 1128 towns. In Guangdong, towns, township and district governments are important when it comes to administrative and local infrastructure issues, but policy-making powers are concentrated primarily in prefecture-level cities and to a lesser extent in counties and county-level cities.

The ability of prefecture-level city (hereafter referred to as city) governments to pursue their growth objectives means that industrial strategies have differed somewhat across the province. Among the different cities commonly studied in terms of the electronics industry, Shenzhen emerges as the one that has pursued upgrading more vigorously, discouraging lower-end FDI projects since the early 1990s, offering incentives for innovation and upgrading, and paying greater attention to hard and soft infrastructure (Ng and Tuan, 2001; Wang and Meng, 2004; Chen, 2014; Segal, 2003). In contrast, Dongguan, despite the important role of the city government there in building infrastructure and pursuing industrial upgrading (Yeung, 2001), is seen as overall weak in terms of nurturing industry towards upgrading (Wang, Luo and Tong; Yang, 2007). Guangzhou is seen as somewhere in between, attracting better FDI than Dongguan, but not adequately supporting innovation as in the case of Shenzhen (Segal, 2003; Schiller, 2011).

However, the focus on city governments in the existing literature omits certain dynamics that are important in a contemporary analysis of industrial development in the province. First, the provincial government has always been an important driver of policy-making and implementation, adapting policies decided by the central government and passing them down to sub-provincial governments, as well as in providing funds and other kinds of support directly to firms. Second, the role of the provincial government has increased following the implementation of the PRD Outline, which requires coordination at the provincial level. Third, over time value chains have formed at the level of the province, making it difficult to discuss isolated city-level dynamics.

A third line of work centers on the role of the central government in terms of supporting ‘national champions’ in the electronics and telecommunications industries, with measures such as preferential government procurement, tariffs, subsidized loans, restriction of foreign competition and funding. These works conclude that industrial policy interventions by the Chinese government fostered large-scale indigenous conglomerates (Harwit, 2007;

Fan 2006a,b), but that these are not globally competitive (Ning, 2009; Ernst, 2014; 2016; Fuller, 2016).

However, the China-wide lens of the studies mentioned above does not adequately capture the regional specificities in pursuing industrial policy or in integrating into GVCs. Understanding these at the provincial level can help shed light on why certain firms emerged in Guangdong and how these built their capabilities over time. Moreover, by focusing on large firms this literature does not account for the vast supply clusters that have emerged in the province, formed by thousands of small-sized factories and service firms and which are important for the industry's overall competitiveness.

The fourth line of work that is relevant for this research, focuses on the emergence and upgrading of provincial electronics clusters within GVCs. The emphasis of this literature has been on the foreign-invested firms in the province, their positions within GVCs and the process of their upgrading (or lack thereof). This literature explores the global dynamics that have led to the emergence of TNC-led supply clusters in the province, noting the relocation of manufacturing activities from Taiwan and Hong Kong to Shenzhen, Dongguan and other locations in the PRD (Yang, 2007; Chen, 2007) or the increasingly wide-ranging and sophisticated activities of large contract manufacturers (Lüthje, 2004). However, the role of industrial policy interventions in encouraging upgrading, especially in regards to domestic firms, has been underexplored in this literature, with some notable exceptions (e.g. Yang, 2014 on the Shenzhen Light Emitting Diodes industry).

Understanding the development of the electronics sector in Guangdong requires drawing on all the above perspectives. On the one hand, it is impossible to leave out the role of the provincial government in pursuing industrial upgrading. The provincial government has set the broad developmental directions for the entire province, and has developed its own industrial upgrading initiatives, especially since 2008. On the other hand, a full account needs to take into account the role of GVCs and the avenues they have provided for upgrading for firms in the province. By integrating and furthering the different perspectives found in the literature, it is possible to build an account of Guangdong's industrial development in the electronics sector that coherently takes into account the impact of industrial policy and integration into GVCs and explores their dynamic evolution over time.

4.3 Growth, Integration and Upgrading in the Guangdong Electronics Industry

Just how much has the Guangdong electronics industry upgraded over time? This section will examine the performance of the industry since integration into global trade and investment flows in 1978, drawing on data published by the national and provincial statistical agencies and ministries. The data presents several challenges, the most important of which is the change in the size of firms (in terms of minimum annual revenues) that are part of the annual industrial surveys over time, which was raised from RMB 5 million during 1998-2010 to over RMB 20 million in 2011 and the fact that statistical variables are not consistently available over time, which makes compiling time-series challenging. However, despite their limitations, the comprehensiveness of Chinese industrial statistics presents a rich source of data that can be mined for the purposes of this research.

4.3.1 Output and Value Added

The growth of output and value added in the electronics industry has been very rapid. Table 4.1 lists the absolute numbers in the two variables and their share in the province's total industry.

Table 4.1 Key statistics in the Guangdong electronics industry, 1995-2014

	Industrial Output (RMB billions)	Share in Provincial Total Industrial Output	Industrial Value Added (RMB billions)	Share in Provincial Total Value Added	Value Added /Output
1985	3.7	8.0%	0.67	4.7%	18.4%
1986	3.6	7.0%	0.57	3.6%	15.6%
1987	5.7	8.7%	0.86	4.3%	15.0%
1988	9.1	10.3%	1.44	5.2%	15.7%
1989	9.9	9.7%	1.85	5.4%	18.7%
1990	13.8	11.5%	2.68	6.8%	19.5%
1991	21.6	11.0%	3.57	6.8%	16.5%
1992	30.4	11.0%	5.09	7.3%	16.8%
1993	41.2	11.1%			
1994	61.2	13.9%			
1995	84.8	13.4%	17.9	11.6%	21.1%
1996	99.5	13.6%	21.1	11.1%	21.3%
1997	128.1	15.6%	28.4	13.6%	22.2%
1998	159.9	16.4%	34.7	14.2%	21.7%
1999	195.0	18.5%	43.6	15.6%	22.3%
2000	241.8	19.4%	58.1	17.0%	24.0%
2001	311.0	22.2%	65.5	17.5%	21.1%
2002	416.4	25.4%	88.1	20.2%	21.2%
2003	593.2	27.6%	134.1	23.5%	22.6%
2004	746.6	27.9%	148.3	20.9%	19.9%
2005	983.1	27.4%	209.5	22.3%	21.3%
2006	1,189.1	26.6%	252.0	21.4%	21.2%
2007	1,337.7	24.2%	252.1	17.9%	18.8%
2008	1,537.4	23.5%	322.8	18.3%	21.0%
2009	1,572.2	23.0%	342.9	18.8%	21.8%
2010	1,922.8	22.4%	430.6	18.7%	22.4%
2011	2,146.0	22.6%	420.1	19.4%	19.6%
2012	2,286.5	23.9%	483.9	21.3%	21.2%
2013	2,583.6	23.6%	574.3	21.6%	22.2%
2014	2,825.5	23.6%	612.5	21.7%	21.7%

Notes: 1980-1990 in constant 1980 prices; 1991-1994 in constant 1990 prices and 1995-2014 in current prices. Data for 2012-2014 is based on industrial sales revenue, which very closely approximates output value. Empty cell denotes data unavailability.

Source: Author's calculations on data from GBS (various years, a), GBS (various years, b) and CBS (various years, b).

The industry was still relatively small in the mid-1980's, accounting for only 8% of industrial output value and 4.7% of value added in the province, but growth accelerated in the late 1990's. In 2004 the industry accounted for almost 28% of the province's industrial output, declining since then and stabilizing at around 22% to 23% in recent years. However, the share of value added in total output, an indicator of upgrading, has not changed much since 1995. Table 4.2 shows the compound annual growth rates for the two variables, over five year intervals.

Table 4.2 Compound annual growth rates in output and value added, Guangdong

	Output	Value Added
1985-1990	30%	32%
1991-1994	42%	
1995-2000	23%	27%
2001-2005	33%	34%
2006-2010	13%	14%
2011-2014	10%	13%

Source: Author's calculations on data from GBS (various years, a) and GBS (various years, b).

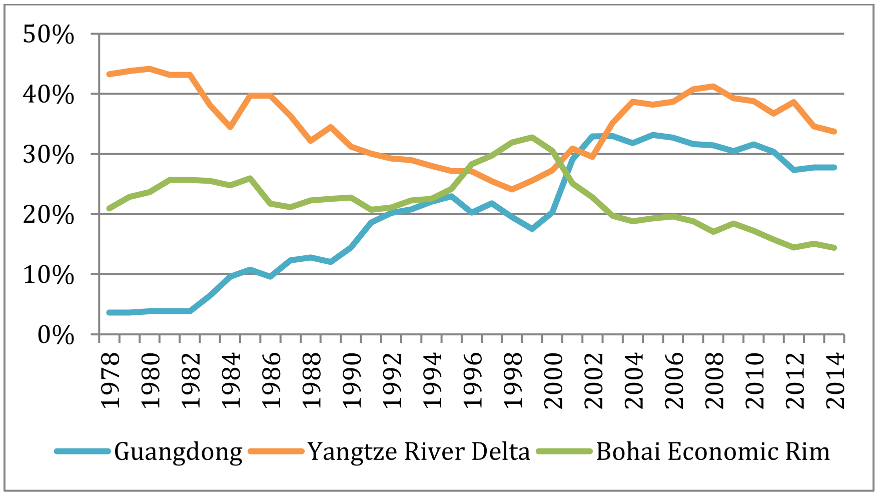
Growth was fastest during 1991-1994 and 2001-2005. These are both related to liberalization episodes: after 1992, following Deng Xiaoping's Southern Tour to Shanghai, Guangzhou, Shenzhen and Zhuhai, market-oriented reforms increased in scope and scale (Zhao, 1993) and in 2001, China entered the World Trade Organization (WTO).

4.3.2 Geographic Distribution

Guangdong accounts for a large share of the electronics industry in China, second only to the Yangtze River Delta (YRD). The province accounted for only 3.6% of the industry's total revenue[23] in 1978, but it quickly increased its share, accounting for 33% of total revenue by 2001, dropping slightly ever since. The YRD accounted for 34% of industrial revenue in electronics in 2014 (Figure 4.1).

[23] Business revenue as reported by industrial firms is the only consistent variable reported in the Electronics Information Industry Yearbooks (MIIT, various years, a) that allows for a comparison of the industry's size across time and regions. It refers to the revenue from the sales of products (or commodities) and from rendering of industrial services by industrial enterprises.

Figure 4.1 Share of key economic zones in China's total electronics revenue, 1978-2014, %



Notes: Yangtze River Delta here includes Shanghai, Jiangsu and Zhejiang provinces and Bohai Economic Rim includes Beijing, Tianjin, Hebei, Liaoning and Shandong provinces.
Source: Author's calculations on data from Ministry of Industry and Information Technology (MIIT) (various years, a).

Within the province, the sector's development in the early 1980s concentrated in the old industrial centers of Guangzhou, Foshan and Shantou and the newly established Shenzhen SEZ. The latter remains the major base for electronics manufacturing in Guangdong today, accounting for 49% of total electronics output and 58% of the value added in 2014 (Table 4.3). At the same time, the share of other locations in Guangdong, such as Dongguan and Huizhou, which also drew in FDI, has increased rapidly.

Table 4.3 Share of cities in the Guangdong electronics industry

	Shenzhen	Guangzhou	Dongguan	Foshan	Huizhou	Others
Output Value as a Share of Total						
1985	37.6%	24.4%	0%	14.2%	0%	23.8%
1995	49.3%	5.6%	5%	3.7%	13.7%	22.6%
2005	58.3%	7.2%	12%	2.4%	7.9%	12.2%
2014	48.5%	7.6%	17.3%	3.4%	10.9%	12.3%
Value Added as a Share of Total						
2014	57.8%	6.3%	12%	3.5%	9.5%	10.9%

Source: Author's calculations on data from GBS (various years, a).

4.3.3 Performance by Types of Ownership

The industrial sector data that this chapter looks at is split into the following ownership categories:

- State-Owned Enterprises (SOEs). This category was split into SOEs and State-Holding Enterprises (SOSHEs) after 1998. The latter category includes both the ‘pure’ SOEs and those corporatized companies in which the state has a large share.
- Foreign Invested Enterprises (FIEs). This includes wholly foreign owned subsidiaries, joint ventures and enterprises from Hong Kong, Macau and Taiwan (HKMT).
- Collective Enterprises
- Shareholding Cooperative Enterprises. This includes stock companies in which the shares are owned by employees. These used to be part of the collective economy until 1998.
- Shareholding Enterprises. This includes mostly private firms since those with majority state ownership are under SOSHEs.
- Private Enterprises, which is a category that has been added in the data since 2006. This can also include private shareholding enterprises.

The categories listed above are not based on the firms’ registration status and are not mutually exclusive, leading to double counting (see Holz and Lin, 2001; Holz, 2013). Moreover, a large number of FIEs are actually domestic Chinese investments, but they have registered as foreign (usually coming via Hong Kong) mainly to take advantage of preferential tax rates for foreign investment in China. The true volume of this phenomenon is difficult to establish, especially in Guangdong where access to Hong Kong has been much more convenient (Yeung, 2002).

During the 1980’s and early 1990’s, many foreign investments in the province were in the form of Joint Ventures (JVs) with SOEs. These, together with the SOEs, were part of the planning system and, as such, were managed by the provincial-level authorities. As wholly foreign-owned (WFOEs) and private domestic investments started increasing towards the end of the 1980s, the share of state controlled production in the province’s total decreased steadily (Table 4.4).

Table 4.4 Share of SOE sector in output, Guangdong

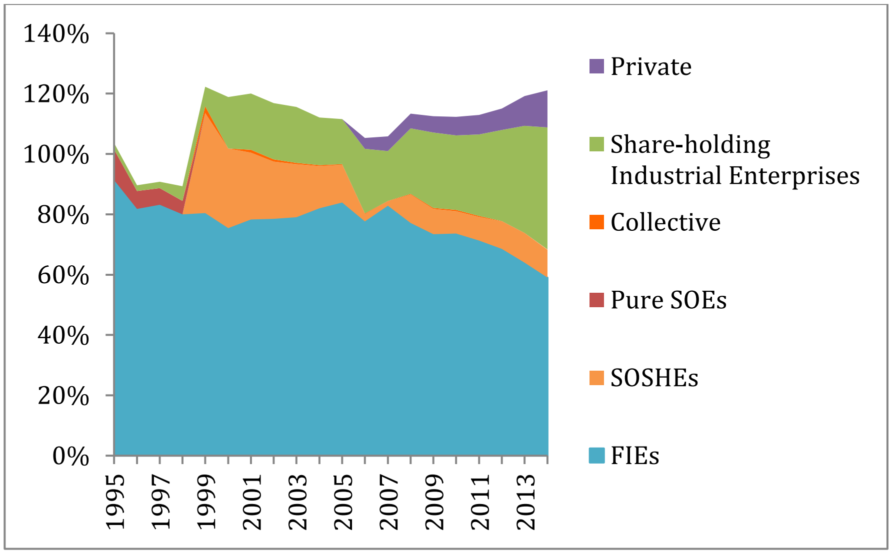
RMB billions, Constant Prices

	Total Sector	State Sector	Share of State Sector in Total
1985	3.7	2.5	68.3%
1986	3.6	2.9	78.5%
1987	5.7	5.2	90.6%
1988	9.1	7.6	83.6%
1989	9.9	7.8	78.3%
1990	14.8	10.7	72.6%
1991	21.6	18.7	86.4%
1992	30.4	23.9	78.6%
1993	41.2	29.6	71.9%
1994	61.2	38.7	63.3%
1995	96.3	53.9	55.9%

Source: Author's calculation on data from Guangdong Electronics Industry Annals (GEIA) (2002) and GBS (various years, a).

Data after 1995 shows a different picture, as JVs between foreign investors and SOEs started to be reported under FIEs. In 1995, 91.3% of the industrial output was produced by FIEs, either wholly owned or in some form of JV, while pure SOEs accounted for only 10% of the total (Figure 4.2). Since then, the share of FIEs in total output has been steadily declining, accounting for below 60% in 2014. The share of SOSHEs in production has also experienced a decline (from 33% of total output in 1999 to less than 10% in 2014), indicating a continued process of restructuring in the state-owned sector. Meanwhile, the share of the private sector has been increasing rapidly. This indicates a decreasing reliance on foreign capital and the dynamic emergence of a domestic private sector.

Figure 4.2 Electronics output value by ownership categories, Guangdong, 1995-2014, %



Note: The shares exceed 100% because of double counting across categories. The share is also below 100% for some years because the private economy was not fully captured prior to 1999.

Source: Author's calculation on data from GBS (various years, a).

4.3.4 Performance By Types of Products

The province has specialized in low- to mid-tech products, compared to other provinces in China, such as in audio-visual equipment, consumer electronics and peripherals. Nevertheless, the share of the province's production in China's integrated circuits (ICs) – a sophisticated component - increased markedly between 1995 and 2013 (Table 4.5).

Most of the province's value added in electronics is concentrated in the telecommunications equipment segment (Figure 4.3). This is most likely related to the rise of large telecommunications equipment manufacturers such as Huawei and ZTE, and the mobile phone production cluster that has developed in and around Shenzhen. Value added produced by the segment represented 20.5% of total value added in the industry in 1996, increasing to 45.3% by 2014.

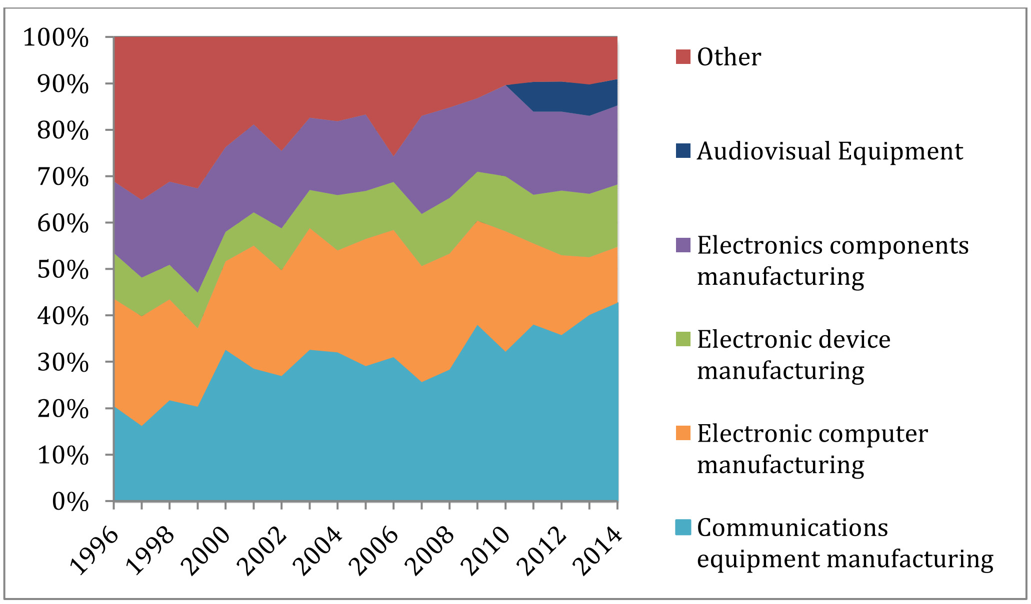
Table 4.5 Share of Guangdong's production in China's total (% of number of units)

	1995	2000	2005	2010	2013
Microcomputers	26.3	17.6	20.6	14.6	6.0
Laptops	3.4	0	13.8	5.9	3.5

Printers	16.9	14.5	47.8	73.1	54.2
Laser Disc Players	54.5	24.3	72.5	92.1	95.2
Colour TVs	25.9	33.5	49.4	38.0	49.8
Digital Cameras			57.9	40.5	55.2
Mobile Phones	0.1	18.0	13.8	48.7	50.6
Phones	70.6	69.8	88.8	88.8	86.6
PBX (switches)	16.8*	51.3^	34.3	51.2	58.5
Colour Picture Tubes	27*	21.3^	28.5	26.2	100.0
Screens	13.4*	8.1^	8.9	33.5	12.0
Discrete Semiconductor devices	15.9	10.7	30.1	36.7	27.0
Integrated Circuits	1.6	19.6	21.2	24.7	21.0

Notes: * denotes data for year 1994 and ^ data for year 1999.
Source: Author's calculations on data from MIIT (various years, a), Zhou [ed] (2011) and GYCC (1995, 2000).

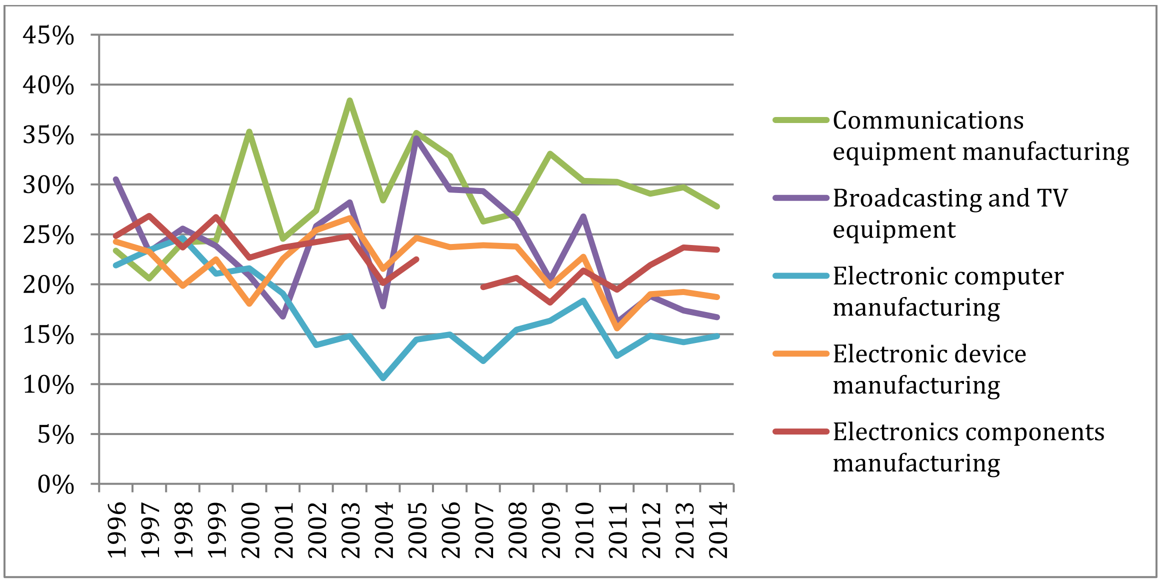
Figure 4.3 Share of electronics segments in Guangdong electronics value added, 1996-2014, %



Notes: The category 'electronics components' refers to passive devices, such as resistors, capacitors and inductors. The category 'electronic devices' refers to active devices, such as transistors, vacuum tubes and integrated circuits.
Source: Author's calculations based on data from GBS (various years, b).

While there are wide annual fluctuations, the share of value added in output for the telecommunications equipment segment increased from under 25% to over 30% for most years since 2000, indicating upgrading (Figure 4.4). By contrast, the computer manufacturing segment shows a marked decline from 23.5% in 1996 to 15% in 2014, suggesting 'downgrading'. These indicate that the process of upgrading has not been uniform across the industry. Moreover, during 1998-2003 spikes in the share of value added in output in Guangdong's electronics industry, as domestic telecommunications equipment manufacturers benefitted from import-substitution policies by the central government.

Figure 4.4 Value added in output by electronics segments, Guangdong, 1996-2014, %



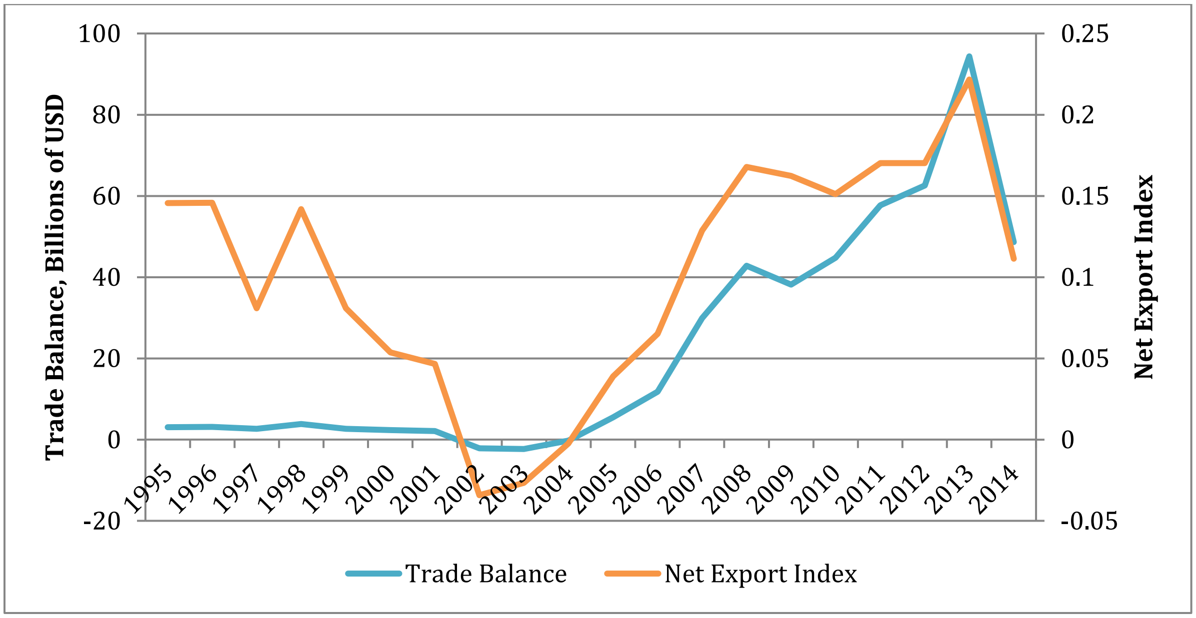
Source: Author's calculation on data from GBS (various years, b).

4.3.5 Trade

China ran a trade deficit in electronics during the first decade of reforms (Zeng, 1990) and the SEZs also run a deficit during their first few years (Wong, 1987). However, consistent data on exports at the provincial level is available only after 1995 on electric and electronic goods combined and by that time the sectoral trade balance was positive (Figure 4.5). Gross exports have skyrocketed since, increasing from USD 12 billion in 1995 to USD 242 billion in 2014. Figure 4.5 shows the trade balance and the net export index, which is the trade balance divided by the total value of trade. During the second half of the 1990s the province was running a diminishing surplus in the industry, which turned into a deficit around the time China entered the WTO. Since 2005, there has been a large surplus in the sector, which, given the largely liberalized trading regime in the sector (China is signatory to the International Technology Agreement in WTO), points to increased competitiveness.

Figure 4.5 Trade balance and Net Export Index in Guangdong electronics, 1995-2014

Left: USD billion, current prices. Right: Net Export Index

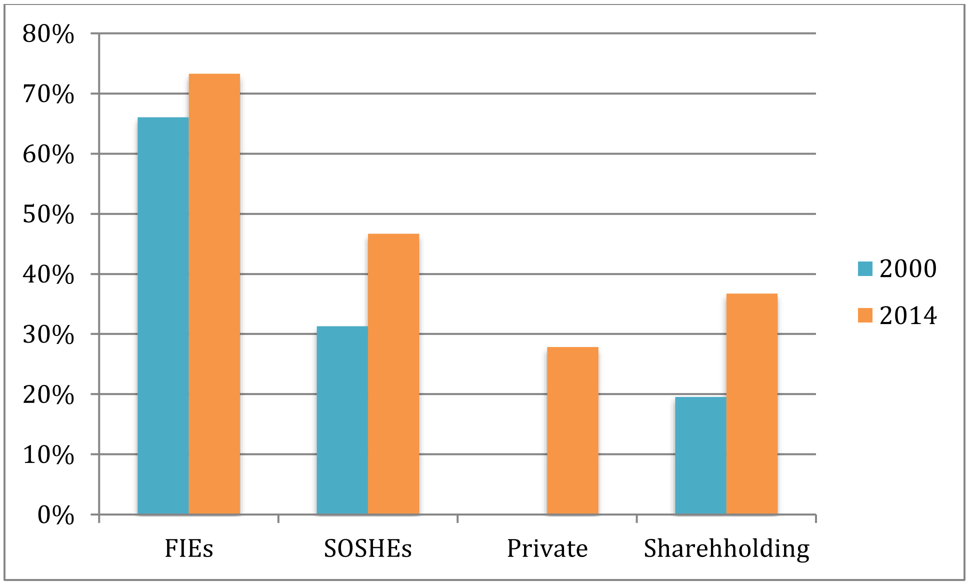


Notes: The net export index divides the trade balance by the total amount of trade. It gives an indication of the trade surplus that is independent of the level of trade. If there are no exports it takes the value of -1 and if there are no imports the value of 1.

Source: Author's calculation on data from Guangdong Statistical Yearbook (various years, a).

The export-intensity of firms, measured by the share of exports in total sales, has increased over time as well, further highlighting the increasing competitiveness of the industry (Figure 4.6). As expected, FIEs display higher levels of integration into global trade, while private firms are more oriented towards the domestic market. Between 1995 and 2014, FIEs also accounted for at least 60%-70% of total exports in the industry (GBS, various years, b)

Figure 4.6 Share of exports in sales by ownership category, Guangdong electronics industry



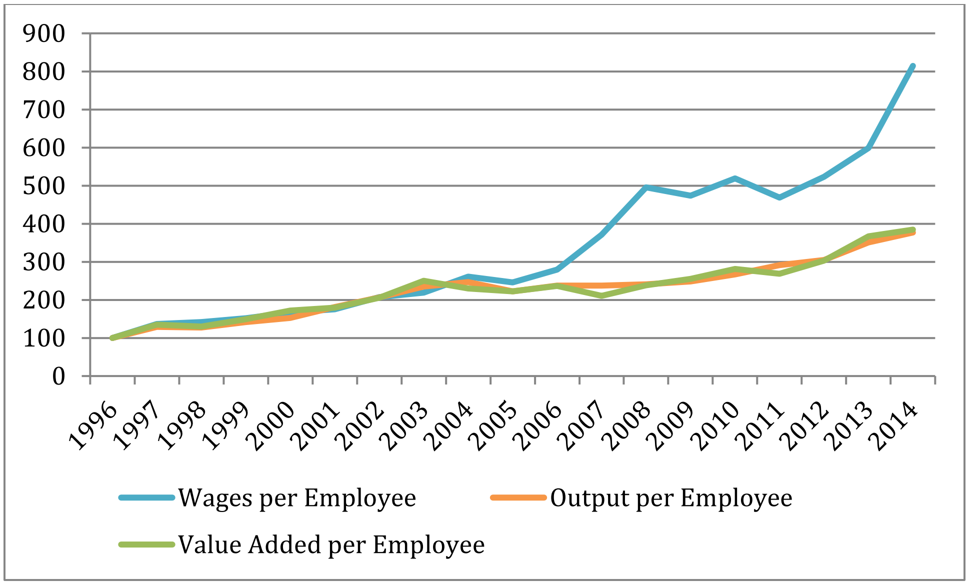
Notes: Private firms were recorded as a separate category since 2006. The value of exports is not derived from customs data, but from a variable called "Exports Delivery Value" in the industrial accounts. It records the value of the products that an industrial enterprise has delivered to export units or directly exported, as well as the value of the products from processing and compensation trade.

Source: Author's calculation on data from GBS (various years, b).

4.3.6 Productivity

Value added and output per employee has increased by four times during the period 1996 to 2014. However, it should be noted that the data is nominal, rather than real, so it most likely overestimates the real rate of growth. The data also reflects the rapid increase in wages that has taken place since the mid-2000s, far outstripping the increase in productivity (Figure 4.7). The large increases in labor productivity indicate that upgrading is in place, either due to increased skill levels or due to the increased capital intensity of production.

Figure 4.7 Growth in wages, output and value added per employee, Guangdong electronics industry, 1996=100

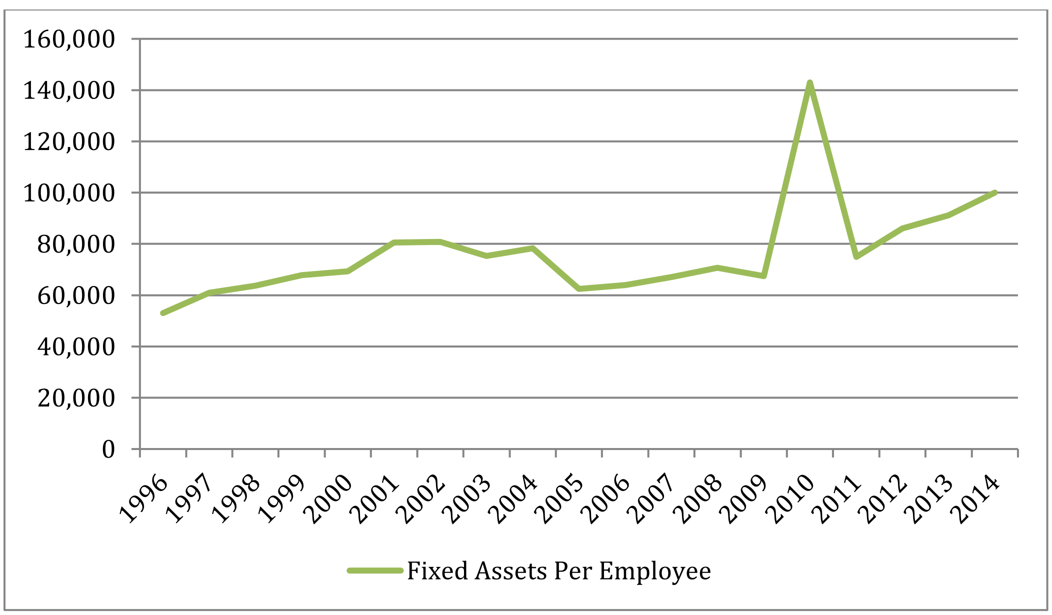


Notes: Wages include reported wages and benefits paid. The separate categories of wages and benefits are not reported in all years, so wages may be underreported.

Source: Authors calculations on data from GBS (various years, b).

Figure 4.8 Fixed assets per employee, Guangdong electronics industry, 1996-2014

RMB, current prices



Source: Authors calculations on data from GBS (various years, b).

Fixed assets per employee have been increasing, almost doubling in terms of value between 1996 and 2014 (Figure 4.8). Figures are not adjusted for inflation, so the increase may be overestimated. There is a peak in 2010, but it is not clear what caused this, implying that it may be an error or adjustment in the statistics. In the first half of the 2000s, there was a gradual fall in fixed assets per employee, rising again after 2010. This is consistent with a post-WTO expansion of low capital-intensity production and then a restructuring towards more capital-intensive activities, following rising factor costs and changes in policies in 2008.

4.3.7 Innovation

More than any of the previous measures, Guangdong's increased innovation capacity in the industry points to upgrading. The total R&D spending from the industry's large and medium firms has increased fast, almost doubling every five years. In 2014 the industry spent RMB 58.6 billion (USD 9.5 billion) in R&D, accounting for almost half the spending in the total industry in China (Table 4.6).

Table 4.6 Innovation indicators in large and medium enterprises, electronics, Guangdong

	R&D[1] (Million RMB)	R&D as share of revenue	Share in total provincial R&D	Patent applications (PCT[2])	Share in China's total R&D in electronics
2000	4,180		43.90%	1,304	29.79%
2005	11,478	1.37%	63.63%	7,780	41.48%
2006	14,981	1.38%	60.63%	14,271	43.00%
2007	22,677	1.85%	67.42%	19,665	56.11%
2008	21,518	1.54%	52.36%	19,760	41.36%
2009	27,349	1.74%	49.51%	28,289	45.50%
2010	35,561	1.86%	50.54%	27,623	51.82%
2011	44,019	2.05%	48.94%	36,978	46.73%
2012	51,098	2.24%	47.41%	38,568	47.99%
2013	58,610	2.75%	47.36%	41,540	46.79%

Notes: 1. All R&D refers to intramural R&D expenditures. 2. PCT: Patent Cooperation Treaty.

Source: Author's calculations on data from GBS (various years, c), GDST (2000), CSB (various years b) and GBS (2013).

The industry has also become more R&D-intensive, almost doubling the share of R&D in output between 2005 and 2013, while patent applications have increased by a factor of 32 between 2000 and 2013 (Table 4.6).

In electronics, the overwhelming majority of R&D takes place within large firms. According to the Guangdong 2013 census (GBSd, 2013), 85.5% of R&D in the industry took place in large firms (453 firms) and a further 10.8% took place in middle-sized firms (1,513 firms). Large firms are those that employ over 1000 persons and have an annual turnover of over RMB 400 million (approx. USD 60 million), medium firms those that employ between 300 and 1000 people and have an annual turnover of RMB 200 to 400 million (approx. USD 30 to 60 million) and small firm those that employ between 20 and 300 people and have an annual turnover of RMB 3 to 20 million (approx. USD 4.5 to 30 million). The funds for R&D in the industry came mostly from the enterprises' own resources, with only 3% of funds coming from government between 2009 and 2012. The dominance of enterprises in R&D explains the largely commercial nature of R&D activities. In 2012, almost no funds went to basic research, about 7% of expenditures went to applied research (an original investigation aimed at a specific practical aim or objective), and 93% went to experimental R&D (which is not original investigation but draws on existing knowledge gained from research or practical experience) (GBSc, 2013).

FIEs accounted for 47.7% of firms in the 2013 census, but for only 28.4% of total R&D expenditures. Combining this fact with the distribution of R&D according to firm size noted above, we could assume that the majority of R&D takes place in large domestic firms[24].

4.3.8 Lead Firms & First Tier Suppliers

A final indicator of upgrading is whether the sector features first-tier suppliers and lead firms. Here Guangdong performs particularly well, as it is a host both to some of the largest

[24] A survey of electronics firms in Dongguan and Guangzhou showed that in the absence of such large local players, the innovation capabilities of domestic firms are on average lower than those of foreign ones (Schiller, 2011). However, the survey did not include Shenzhen, which is the 'hub' for innovative domestic firms in Guangdong and the data is from 2008, predating the large-scale efforts of the province to shift its development model.

lead firms and first-tier suppliers in the world and even boasts a few lead firms based in the province.

First-tier suppliers started locating their subsidiaries in Guangdong in the 1990's. It is not possible to estimate exactly their contribution to output, but some figures can be gleaned from the annual Guangdong top 50 industrial firm list, which was unfortunately discontinued since 2010. In 2010 Foxconn accounted for 15.3% of total provincial output in electronics (17.2% in 2007), while Flex contributed for an additional 2.3% and 4.1% of between 2002 and 2010. Subsidiaries of Jabil and Wistron have also made the list but their contributions have been small (below 1%). So whereas before 2000 no subsidiary of large first-tiers suppliers was large enough to make the top 50 list, by 2010 at least 19% of the industry's output came from such first tier suppliers.

The large-scale operations of first-tier suppliers and product mix, often combining automated and labor-intensive production methods, led Lüthje (2004) to proclaim their presence as a sign of upgrading, especially compared to the more low-end processing operations performed by informal assembly firms. However, their capacity for further upgrading and innovation should also be taken into account. Indeed, some R&D is also taking place in such firms, especially in Foxconn, followed by Flex and Jabil[25]. Foxconn undertakes significant R&D activities in Shenzhen and Flex in Zhuhai has set up a Production Innovation Centre. Nevertheless, such firms do not have high investments overall in R&D. Foxconn spent about 1.17% of its total revenue in R&D in 2015 globally and Flex respectively 1.4%, whereas Cisco spent 12.6% and Apple 3.4% (company annual reports).

The most interesting development in the Guangdong electronics industry has been the rise of domestic brands, particularly in telecommunications equipment (ZTE and Huawei) and in consumer electronics (TCL, Konka, Oppo, DJI). These brands are becoming increasingly well known even beyond China. Firms like Huawei and ZTE are still relying on importing some key components[26] (Li, 2012), but they are undertaking great efforts to

[25] Interview with engineers at first tier suppliers, F07, Foshan, 29 November 2015.

[26] For example central processing units, GPS modules, CPU, GPS, the AMOLED screen and memory chips.

vertically integrate. Huawei especially has invested in designing its own chipsets, used in Huawei phones since 2012. It has also developed patented technology in 4G-LTE and is a major force behind the development of 5G technology[27]. TCL on the other hand has attempted to expand via international acquisitions; it purchased French TV manufacturer Thomson's Cathode Ray Tube (CRT) business in 2004 and established a joint venture with Alcatel, although both of these struggled financially initially[28]. Nevertheless, the company recovered and is now the fastest growing television brand in the United States[29]. The large indigenous brands also perform a great amount of R&D, although it is unknown what share of this may be carried out outside Guangdong. Huawei, ZTE and TCL had high ratios of R&D in sales, reaching 15%, 10% and 6% respectively in 2015, which compared favorably with foreign lead firms such as Cisco (12.6%) and Apple (3.4%) in relevant segments of the industry (company annual reports).

4.4 Policy-making in the Guangdong Electronics Industry

4.4.1 Studying industrial policy in the Chinese context

To outsiders, China is often seen as a unitary, monolithic one-party state, where top-to-bottom directions dictate its politics and economics. Scholars of Chinese political economy have a somewhat different view, commenting that it is characterized by 'fragmented' or 'regionally decentralised' authoritarianism (Lieberthal and Oksenberg, 1988; Xu, 2011) as policy needs to accommodate the interests of different power centers across the Party, the bureaucracy, the state-owned sector and the different levels of government.

The principal agency for advancing industrial competitiveness in the electronics industry has been the Ministry of Industry and Information Technology (MIIT) and its predecessors. The Ministry of Science and Technology (MOST) is also important in advancing Science and Technology (S&T) capabilities in industrial firms, with responsibilities that are increasingly overlapping with MIIT. In the past, other agencies

[27] Lucas, Louise and Fildes, Nic 'Huawei aims to help set 5G standards', *Financial Times*, 29 November 2017.

[28] Lau, Justine 'TCL to close most European operations', *Financial Times*, October 31 2006.

[29] TCL Explosive Growth Continues in North America, *PR Newswire*, 25 July 2017.

such as the Ministry of Post and Telecommunications (MPT) (now part of MIIT), the Ministry of Railways, Chinese Academy of Sciences (CAS) and the military, used to be significant buyers of electronics products and produced an estimated 10% of the total output (Zeng, 1990), making them important stakeholders in policy-making.

The need for consensus has been met in several ways. First, 'Small Leading Groups' with participating officials from different agencies have been used to forge consensus at the central, provincial and sub-provincial levels for important agendas. Second, the process of policy-making has been regularized, especially in the past 15 years, ensuring that different agencies have the option to comment on policy drafts relevant to them. Third, institutional reform has helped to put different agencies under one roof. For example, in the end of the 1990s the Ministry of Post and Telecommunications was merged with the Ministry of Electronics and in 2008 the Ministry of Industry and Information Technology was created by absorbing other industrial ministries. The changes in leadership at the central and provincial are shown in Table 4.7.

The relationship of provincial governments to the center, and of the provincial government to the sub-provincial ones, adds further complexity to policy-making. The broad (and vague) development directions are forged at the top and their detailed implementation is up to the provincial and sub-provincial governments to determine. Guangdong, like other provinces, has implemented in one way or another all of the big initiatives launched by the central government, including the more interventionist ones, such as the 'national champion' initiative of the mid-1990s. At the same time, there is also significant room for maneuver in the adaptation of policies at lower levels, especially in initiatives that are not deemed as important by them. In some cases, provinces can simply chose to delay implementation or choose not to implement them at all, if they perceive them to go against their interests[30].

Table 4.7 Leadership in the electronics industry at central and provincial level

Relevant Institution	Name of Minister	Period	Relevant Institution	Name of Director	Period

[30] Interview with government-affiliated consultant, BJ01, Beijing 1 April 2015.

Ministry of Electronics	Zhang Ting Jiang Zemin Li Tieying	05 1982 – 06/1983 06/1983-06/1985 06/1985-051948	Guangdong Electronics Industry Joint Company	Xu Zhiliang	05/1983-10/1983
			Guangdong Electronics Industry General Company	Xu Zhiliang	10/1983-05/1986
Ministry of Machinery and Electronics Industries	Zou Jiahua He Guanyuan	04/1988 – 1989 1989 - 04/1993	Guangdong Bureau of Electronics Industry	Xu Zhiliang	05/1986 - 01/1995
Ministry of Electronics	Hu Qili	03 1993 - 03 1998	Guangdong Department of Electronics and Machinery Industry	Xi Zhiwei Luo Jiansheng	01/1995-03/1998 03/1998 – 02/2000
Ministry of Information Industry	Wu Jichuan Wang Xudong	03/1998-03/ 2003 03/2003-03/2008	Guangdong Department of Information Industry *	Xu Zhibiao Wen Guohui	02/2000-09/2007 09/2007-09/2009
Ministry of Industry and Information Technology	Miao Wei	12/2010 until today	Guangdong Economic and Information Commission	Yang Jianchu Lai Tiansheng Tu Gaokun	09/2009-03/2013 03/2013-02/2017 01/2017 until now

Notes: *Part of the responsibilities of the defunct Guangdong Department of Electronics and Machinery Industry went to the Guangdong Economic and Trade Commission (GETC). The GEIC combined the GETC and the Guangdong Department of Information Industry.

The central-provincial dimension is certainly important in Guangdong, given that it was the place that first forged an autonomous space for provinces, during the 1980s. The province has always displayed a strong local identity that has its roots in historical and cultural traits, accentuated by the role of Guangdong as a protagonist in the reform process (Vogel, 1969, 1989). Provincial leadership encouraged this autonomy by convincing the

Party to build the SEZs in Guangdong[31] and by boldly encouraging experimentation in localities, under the leadership of Ren Zhongyi[32] (Party Secretary, 1980-1985) and later under Lin Ruo (Party Secretary, 1985-1991) and Ye Xuanping (Governor, 1985-1991). Particularly important in securing autonomy have been the fiscal relationships between the centre and Guangdong, which progressively allowed the province to retain a larger share of its fiscal revenue for provincial-level investment (Cheung, 1998).

The inheritance of a liberal attitude towards trade, investment and institutional reforms, has been important in the way the province has adapted central level policy in the electronics industry. In interviews, the Guangdong government was often described as adapting policies in a way that emphasizes cooperation with foreign firms and encourages overseas investments. It has also kept its pioneering spirit, by being one of the first provinces to apply new policies in the electronics sector (e.g. setting up government funds that offer financial support to firms not only with grants but also by taking equity in supported projects since 2012)[33]. However, provincial autonomy also has its limits and this was signaled by the implementation of the PRD Outline in 2008, published by the State Council, which pushed strongly for more attention to higher value-added activities in the province.

Finally, policy-making in the electronics industry has been deeply affected by the long reform process of the Chinese economy, from a Marxist-Leninist centrally planned

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[31] This has been attributed to Xi Zhongxun, First Party Secretary during 1978-1980 and father current Chinese President and Party Secretary Xi Jinping. According to Cheung (1998) Xi even suggested at one point that the province should form a federal union with China, but his proposal was shot down.

[32] Ren Zhongyi was particularly bold in encouraging experimentation, commenting in 1980 that “if something is not explicitly prohibited..then move ahead [and] if something is allowed, then use it to the hilt” (Vogel, 1989:81). He also did not waiver even when corruption scandals involving smuggling of consumer goods in Shenzhen drew in much criticism. In a meeting in Guangzhou in 1982, Ren promised to shoulder responsibility for any mistakes in the implementation of reforms, gaining the admiration of cadres (Choi, Chi-yuk, ‘One man’s triumph over foes of reform: Guangdong leader who blazed new trail’ *SCMP*, 21 November 2008)

[33] Interview BJ01, footnote 11. Also interview with government-affiliated research centre, GZ07, 25 March 2015.

economy, to what is now called ‘socialism with Chinese characteristics’[34]. This has meant that the institutional context has been in a constant flux, both in terms of the agencies involved in policy design and implementation and in terms of the boundaries between regulatory and entrepreneurial functions of those agencies. The issue of reforms in the Guangdong electronics industry is taken up further in Sections 4.5 and 4.6.

4.4.2 The policy-making process and the governance structure

The multi-stakeholder, multi-scalar governance in the industry has led to the emergence of a complex process of policy-making. The general developmental direction is set by the socio-economic five-year plans (FYPs), which are now under the purview of the National Development and Reform Commission (NDRC). The FYPs are made with input from many different actors (including ministries and provinces), who provide suggestions and feedback during the formulation phase, ensuring that a consensus is formed. The NDRC is also responsible for drafting macro policy initiatives that can include the electronics industry, such as the Strategic Emerging Industries (SEI) Plan that was announced during the 12th FYP period (2011-2015). Regarding initiatives for specific industries, the primary agency at the national level remains the MIIT. The latter can independently draft its own plans, as long as they are broadly within the aims of the FYPs, but for issues of particular national importance, it might be necessary to get the approval of NDRC[35].

Plans drafted by the NDRC and the ministries should, in principle, be interpreted, adapted and adopted by lower level governments and their units, replicating to an extent the coordination structure of the centre. The large policy initiatives are drafted by the Guangdong Development and Reform Commission (GDRC), which is in charge of overall planning, the management of investments in large projects, and interagency cooperation. Industry-specific policies are drafted by the Guangdong Economic and Information Commission (GEIC), in charge of improving the development of all enterprises, and the Guangdong Department of Science and Technology (GDST), in charge of promoting science, technology and innovation. There are some overlaps between the activities of

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[34] Notable works on the Chinese economic reforms include: Naughton (1995), White (1993), Fewsmith (1994), Nolan (1995), Shirk (1993), Vogel (2011), Wang (1998) and Steinfeld (1998).

[35] Interview BJ01, footnote 30.

GDST and GEIC, although firms do not seem to consider this a problem[36]. The Guangdong Department of Education is also of some importance, as it is responsible for funding research projects at universities with long time horizons (over 10 years)[37]. In some circumstances where broad coordination is needed, there are also provincial 'Small Leading Groups', which bring important provincial-level leaders together to oversee the implementation of important initiatives.

Provincial plan drafts follow the spirit of central-level documents while also looking at the key industries and tasks that are more relevant for the province and introduce specific policy measures for them. Drafting in some cases might be done by specialized agencies affiliated to the government, such as CCID (China Centre for Information Industry Development) consulting[38]. Government-affiliated think tanks, such as the Guangdong Academy of Social Sciences or the Guangdong Development Research Centre, also provide important inputs to drafting[39].

The draft is then sent to other relevant agencies for comments, as well as to experts, who are consulted increasingly frequently since the mid-2000s. Experts are called upon according to their seniority. More senior experts will be invited to give comment to provincial-level policies, while less senior ones will go to city-level meetings and so on[40]. Business opinion is mainly solicited through inviting provincial-level industry associations (such as the Guangdong Electronics Association) to provide comments and through expert consulting groups. Input will be absorbed and usually sent out for a second round of comments before the final draft is approved[41]. The implementation and monitoring of the plan is then divided according to the mandate of the different agencies.

Figure 4.9 shows the multitude of vertical (red lines) and horizontal (blue lines) relationships that shape the content and implementation of policy.

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[36] Interview with business association, F04, Foshan 11 March 2015.

[37] Interview with expert academic, GZ08, Guangzhou 13 April 2015.

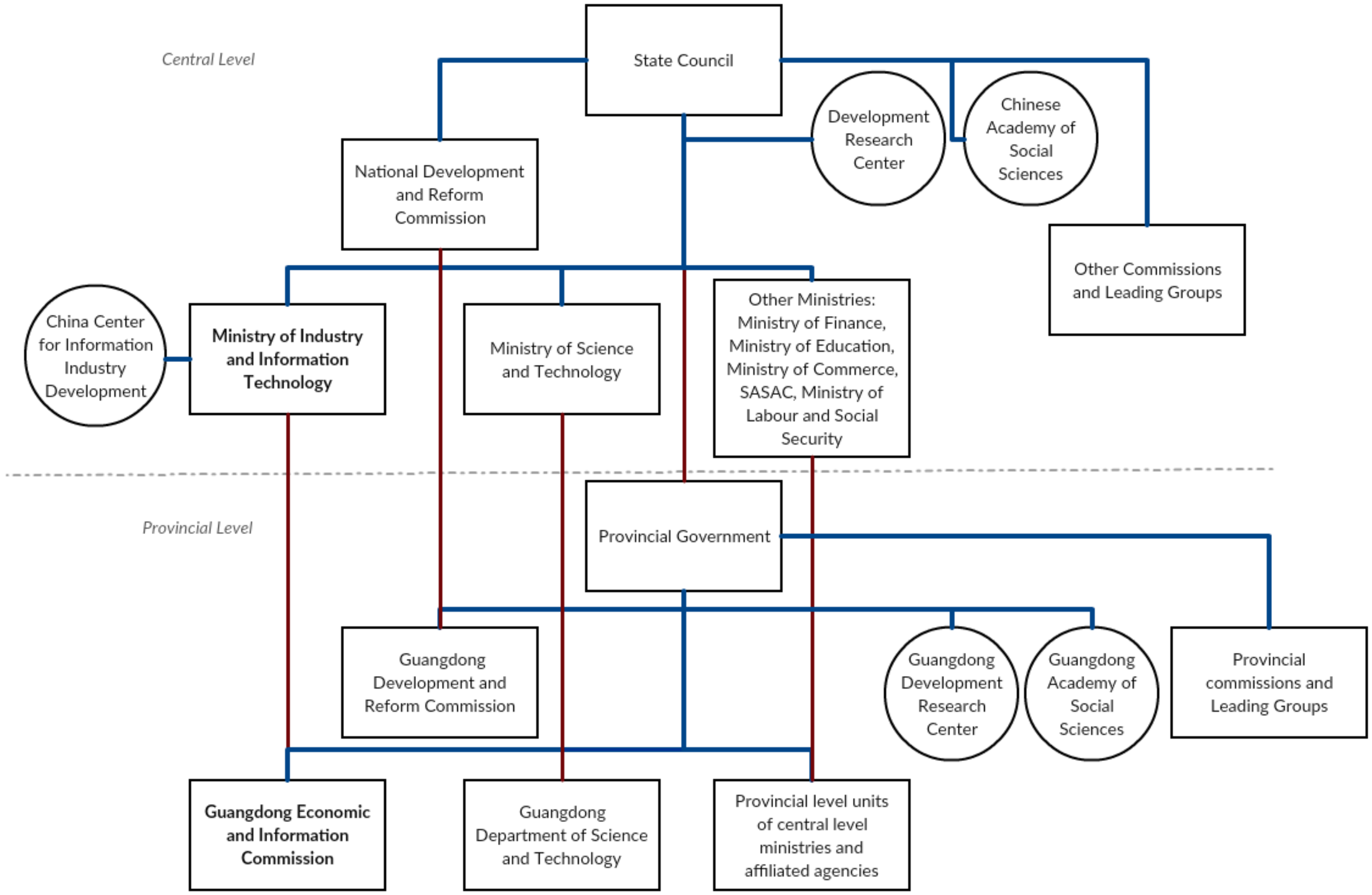
[38] Ibid.

[39] Interview GZ07, footnote 33. Also, Written communication with government-affiliated think tank, GZ09, Guangzhou 12 April 2015.

[40] Interview GZ08, footnote 37.

[41] Interview GZ07, footnote 33.

Figure 4.9 Governance structure in the Guangdong electronics industry



Source: Authors elaboration.

4.5 1949-1978: An Emerging Industry, Mark I

During the pre-reform era, China's industrial development mostly took place behind closed borders, with the exception of Soviet help and the occasional imports of technology and capital equipment[42]. The importance of electronics (mainly computers and ICs) for improving the capacity of the military meant that R&D and production were intimately tied to the defense industries (see Zhou [ed.], 2011). Guangdong was not at the frontline of industrial development, but owing to the Maoist principles of self-reliance and decentralization, the province developed some basic production and technology development skills in the industry.

The Chinese electronics industry, led by the Fourth Ministry of Machinery Industries, started developing in the 1950s (Ning, 2009, Chapter 3). The first Chinese computer was made in 1958 at the Institute of Military Engineering at the University of Harbin, based on technology transferred from the Soviet Union (Pecht and Liu, 2006). China developed transistors in the late 1950s and was able to manufacture ICs since the late 1960s (Maier, 1980; He, 1990). Given the few resources that China possessed at the time, the majority of R&D and production in the industry took place in advanced institutes and in military bases. By 1978, 24% of business revenue in the industry was created in Shanghai, 16% in nearby Jiangsu, 11% in Beijing, 6% in Liaoning, and only 3.6% in Guangdong (Zhou [ed.], 2011).

The level of China's technological development advanced considerably after 1949, but remained low by Western or even Soviet standards. This may not be surprising given China's stage of development at the time, the turbulent periods of the Great Leap Forward and the Cultural Revolution, and the preoccupation with moving industries to remote places to protect against a possible nuclear war. Additionally, the transferred Soviet technology was already lagging behind the global technological frontier and the Sino-Soviet split in 1960 led to the abrupt withdrawal of Soviet experts. By the time of reforms, some estimates put the technology gap with the United States (US) in computers and semiconductors at 15

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[42] Accounts of China's economic development in the Maoist period can be found in Riskin (1987), Meisner (1999), MacFarquhar and Fairbank [eds.] (1987, 1991). An overview of Guangdong's development during the same period – with a focus on Guangzhou - can be found in Vogel (1969).

years (Maier, 1980). The acquisition of technology from Western sources became feasible, following the normalization of diplomatic relations with the US in 1972 and a cautiously open attitude after the end of the Cultural Revolution in 1976. However, technology exports to China remained hindered by the Coordinating Committee for Multilateral Export Controls (COCOM) regulations and the US Export Administration Act (ibid.).

In Guangdong, before the establishment of the People's Republic of China, the only electronics-related firms were some privately-owned repair shops for radios and other electrical goods, which were gradually nationalized in the 1950s. The expansion of a broadcasting station, which had been built earlier by the Kuomintang, created some local demand for small components and repairs for wireless communications. The first large SOEs were established in the urban centres of the time, namely Guangzhou, Foshan and Shantou, and produced small batches of radio components and assembled simple goods such as radios, loudspeakers, magnetic telephones and transformers. In a reform effort in 1962, the more technologically backwards firms were turned into collectives and the rest were brought under the management of the provincial department of machinery industries (GDEIA, 2000; Yu [ed.], 1988).

Research in electronics was conducted at the Sun Yat-sen University that had been established in Guangzhou in 1924 and in new research institutes that were established to help develop the industry, such as the South China University of Technology, the Guangzhou Wireless Research Institute and the Guangzhou Electric Apparatus Research Institute. These undertook research in transistors, semiconductor technology and to a lesser extent computing (Yu [ed.], 1988). By the mid-1960s, SOEs in Guangdong could produce TVs, electronic measurement instruments and communication equipment for the military. Even some modest successes by China's standards were achieved. The Guangzhou Zhujiang Radio Equipment Factory produced a transistor radio (model SB3-1 under the brand name 'Zhujiang') that received the first prize in the country's first radio quality appraisal (GDEIA, 2000).

During the Cultural Revolution the number of enterprises in the industry was reduced from 38 in 1968 to 25 in 1969 and a large amount of resources was invested in moving a large factory from Guangzhou to the northern mountainous regions of Guangdong and establishing two more factories there. The goal was to develop the local peasant economy and shield the industry from potential foreign attacks on China from the coast, but the cost was enormous and the factories were deprived of access to the urban industrial and research system (GDEIA, 2000). In the early 1970's, the situation begun to normalize and by 1977 there were 159 firms, employing 3,220,000 people and producing about 3 million RMB (USD 1.6 million) annually (Table 4.8).

Table 4.8 Key statistics for the Guangdong electronics industry, 1965-1978

Year	No of Firms	No of Employees	Output Value (Million RMB)	Productivity (RMB/employee)
1965	31	4,169	12.9	4,580
1966	34	5,265	28.8	8,020
1967	36	6,635	28.8	5,540
1968	38	7,084	24.6	4,890
1969	25	9,026	38.9	6,630
1970	146	15,245	80.3	5,700
1971	201	21,779	116.3	5,580
1972	178	22,971	125.9	5,790
1973	147	22,095	120.2	5,646
1974	140	24,150	150.8	6,360
1975	143	26,102	254.0	10,240
1976	145	30,841	321.6	11,085
1977	159	32,209	365.0	11,706
1978	165	36,872	390.6	11,228

Source: GDEIA, 2000.

Between 1969 and 1976, the province joined two China-wide campaigns to develop the industry, the 'Go in For Electronics in Big Way' (*daban dianzi*) and the 'Great Battle for Colour Television' (*caise dianshi dahuizhan*). These entailed a large effort to build capacity in cathode ray tubes (CRT), camera tubes and semiconductor components. Some twenty units were involved, including factories and research institutes, coordinated by the Guangdong Broadcasting TV Small Leading Group and headed by the provincial leader at the time, Lin Liming. Among the technological achievements of this period mentioned in the official history of the sector are a 16-inch black and white TV, a mainframe computer and an ultrasound wave detection equipment (GDEIA, 2000; Yu [ed.], 1988). However, the effort to develop the industry in almost every locality was matched by falling productivity (Table 4.8).

On the eve of reforms, Guangdong's experience with the planned economy had produced some indigenous capacity in the electronics industry. The industry accounted for only 2% of Guangdong's industrial output value, was of low quality and technologically weak, but the units involved had at least developed basic capabilities in production, assembly and even research. These allowed Guangdong to integrate into GVCs after reforms, not only by attracting foreign capital, but also by turning its domestic enterprises into suppliers to foreign firms.

4.6 1978-1992: An Emerging Industry, Mark II

During the first fifteen years of reforms, the Guangdong government and many of the province's city governments had a pioneering role in implementing experimental institutional reforms and in opening-up to world trade and investment (Vogel, 1989). This encouraged a 're-birth' of the electronics industry, which expanded rapidly on the basis of foreign investment. At the same time, several of the large domestic firms that operate in the province today can trace their origins to the SOEs that were established during this period. On the one hand, the favorable policy environment and the purpose-built infrastructure attracted foreign investment, and on the other hand, government efforts encouraged SOEs to reform, improve their capabilities and produce for foreign markets. These two strategies created the basic structure of the industry: a nucleus of domestic firms, some with SOE origins, which developed with state support and by integrating into GVCs, and clusters of FDI-led small-scale labor-intensive suppliers, mainly of Hong Kong and later of Taiwanese origin.

4.6.1 China's Renewed Modernization Effort

In 1978, Deng Xiaoping, China's new Paramount Leader, lost no time in announcing the Four Modernizations programme, aiming to bring the country back on track after the turbulent period of the Cultural Revolution (Vogel, 2011). Deng placed the formerly neglected S&T sector at the center of the modernization effort. Technological development was supported by a wide restructuring of the S&T system to better service industry and by encouraging access to foreign technology (Saich, 1986).

Under this general direction, the electronics industry became a priority area. The Ministry of Electronic Industry (MEI) was established in 1982 and was briefly headed by Li Tieying. However, it was Jiang Zemin[43], Minister from 1983 to 1985, who first laid down a strategic vision for the electronics industry in China. Jiang put emphasis on centralizing resources in the industry, focusing on key advanced technological projects that would enable the country to close the technological gap. Catch-up would be further enabled by encouraging foreign trade and investment, especially in provinces that implemented the Open Door Policy, and by pursuing reforms that separated regulatory from business management functions in the state-owned sector (Jiang, 1984a).

China progressed from transistors to ICs, but was struggling to develop Very Large Scale Integration (VLSI), putting the technological gap with the US at 5-10 years by the mid-1980s (Central Intelligence Agency or CIA, 12 March 1985). In computer hardware and software, the picture was not much better either (Jiang, 1983). However, at the time China faced many other severe problems, including an antiquated infrastructure, frequent energy shortages and macroeconomic disturbances, which featured as the main areas of concern in the 6FYP (1981-1985) and 7FYP (1986-1990). This meant that resources for spending on electronics were limited[44]. At the same time, forging a coherent development plan in the industry was a challenge, given the multiple actors involved (see Section 4.4.1). Nevertheless, the development of domestic capabilities in the industry was supported with a variety of measures. These included (drawing on Jiang, 1985a):

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[43] Jiang Zemin would later become the General Secretary of the Communist Party of China from 1989 to 2002.

[44] Jiang (1984b: 145): "We need to effectively solve the problem of placing the electronics industry on a strategic footing and formulate corresponding policies and measures [..]. I believe that when considering economic development, we should accord the same importance to the electronics industry as we do to energy and transportation". Li Megwei (1990:45), Former Director of the Ministry of Electronics' Quality Company noted: "Our country has difficulties, it cannot invest like advanced countries do [but].. a lot of people think the investment during the 6FYP and 7FYP in the entire electronics industry was small, not even that of one Baosteel" (*author's translation*).

- The establishment of special funds for key state projects granted to firms and other institutions with public bidding,
- Preferential policies to support the development of key products. Enterprises producing these would be entitled to low-interest loans, tax reductions and exemptions, and special depreciation considerations.
- The leading enterprises and institutions that undertook key state projects were given more decision-making power over foreign exchange, finances and pricing.
- The establishment of an incentive fund for units that make outstanding contributions to developing and applying electronic technology.
- Imports of foreign electronic products that can already be produced domestically were limited or restricted with tariffs. For example, in early 1985 China reduced prices on domestically produced microcomputers, cut tariffs on components and doubled tariffs on imported machines. The government also centralized import licensing for over 15 key commodities and re-imposed foreign exchange controls (CIA, February 1986).
- Soft loans or other support were given for the diffusion and use of electronic products and services.

Industrial policies implemented in Japan (Fifth Generation Computer Programe), the US (Star Wars) and the European Union (Eureka plan) were inspirations for the measures above (He, 1990). The experience of South Korea and Taiwan were also frequently cited as an example to follow for policy in China (Li, 1990), including in Guangdong (Xu, 1992). As explained later in this section, Guangdong firms not only benefitted from the above measures, through import protection and funding, but were also encouraged to have an outwards orientation, which enabled them to access additional channels for learning.

4.6.2 Electronics Becomes a Pillar Industry in Guangdong

The electronics industry in Guangdong expanded rapidly on the basis of foreign investment during the first few years of reform. By 1986, at least 80 FIEs (most of them JVs) and more than 700 other businesses that engaged in processing and assembly trade had been established, with foreign capital utilization of USD 60 million (Luo, 1988). The industry's rapid development, together with its potential to contribute to technological advances, led the provincial government to proclaim electronics a ‘pillar’ industry in Guangdong in 1983, gaining the support of both Ren Zhongyi and Lin Ruo, the provincial leaders during the 1980s (GDEIA, 2000). However, instead of only attracting FDI, the initiatives launched during this time aimed to leverage integration into the global economy to encourage domestic firms, which were mainly SOEs at the time, to enhance their capabilities and upgrade.

The declaration of the industry as ‘pillar’ was followed by the ‘Policy to Accelerate the Preferential Discounts to the Electronics Industry’ and other specific plans drawn up during the 6FYP and 7FYP[45]. The policy packages were meant to emulate those adopted by Asia’s ‘Four Little Dragons’, by supporting firms through subsidies and a protected domestic market, while at the same time encouraging an outwards orientation. This strategy also became known as building an ‘Electronics Industry with Guangdong characteristics’ (Luo, 1988; Xu, 1992). The policy support included the following measures, summarized by Kuang (1988):

- Income from new products was tax-free
- Firms were allowed to use 1% of sales of new products (that have been approved by the provincial government) to upgrade their technology
- Interest-free or subsidized loans were given to important enterprises
- Subsidies were given to certain units
- Priority for support was given to enterprises with advanced technology, low cost and high quality.

During the first half of the 1980s the main products that were supported were the ‘three machines’, namely TVs, tape recorders and radios. However, the increasing attention to technological catch-up by the MEI, led to a shift in emphasis for the province as well,

[45] According to the annals of the industry there were several plans published between 1981 and 1987, such as the ‘Plan concerning the development of large scale ICs’, ‘Draft long term plan for the development of the provincial electronics industry’, ‘7FYP Plan for the Guangdong Electronics Industry’, ‘Plan for the development of the Guangdong Province Computer Industry’, ‘Designated Enterprises and 6FYP Plan for the Guangdong Province Wireless Electronic Enterprises Backbone Enterprises’ (GDEIA, 2000, author’s translation). Unfortunately the author has not been able to access these documents.

prioritizing, large scale ICs and investment goods in the latter half of the 1980s (Yu [ed.], 1988). Between 1987 and 1992, at least 18 companies (from the provincially managed ones) received preferential policies in the areas of ICs, electronic computers, software and program-controlled switches (GDEIA, 2000).

Efforts were also made to revamp the technological capabilities of firms. During the 6FYP (1986-1990), USD 240 million was used for this purpose, mainly through importing equipment, with the provincial government covering 52% of expenditures, while the rest was covered by sub-provincial governments and enterprise own funds (GDEIA, 2000). Importing foreign technology[46] could save steps in industrial development, saving time and money on developing indigenous technology. However, the end goal of policy was to eventually absorb the technology and achieve self-reliance in the future (Jiang, 1984b).

Additionally, efforts were made by the provincial government to educate the technical and managerial staff of SOEs. Education was generally provided at Electronics Technology Secondary Schools and four Technical Schools, while courses were also organized for workers after work, within firms and sometimes with instruction from large specialist schools. For example, the Guangzhou Baiyun Wireless Factory organized after-work classes with Jinan University and the South China Engineering School for engineering, management and wireless electronic technology for its technical staff and cadres. For line staff, on-the-job training was normally provided (Yu, [ed.] 1988).

The electronics industry also benefitted from China-wide S&T programs launched in the 1980s, namely: (a) the State High-Tech R&D Program (863 Program), launched in 1986 to promote high-tech industries, including electronics; (b) the Spark Program, launched in 1986 to promote the use of S&T to modernize the rural economy; (c) the Torch Program for high-tech industrialization, launched in 1988 to develop High and New Technology Enterprises (HNTEs) that could commercialize technologies. Beyond

[46] Another way to acquire technology was to leverage the domestic market to force foreign vendors to share technology. This strategy was used extensively in the telecommunications sector, managed by the MPT, who undertook large infrastructural projects, but was also used in the electronics sector. Jiang (1985b) commented: "[we] need to use our domestic market as a bargaining chip for importing more advanced technology in accordance with the principles of equality and mutual benefit and of opening portions of our market to the outside world in return for foreign technology". However, it is not clear to what extent this applied in Guangdong.

providing funding for high-tech electronics, these programmes encouraged the construction of specialized industrial parks. The Shenzhen High-Tech Industrial Park was established under the 863 programme in 1985 and in the 1990's tens of High-Tech Development Zones (HTDZs) were set up in Guangdong under the Torch programme[47] (Arvanitis and Jastrabsky, 2006). The parks and zones, which were larger than parks in size and included parts of urban areas, encouraged clustering and were important avenues for firm-level interaction and learning (Breznitz and Murphree, 2011; Di Tomasso, Rubini and Barbieri, 2013).

Despite the support to the industry described above, the electronics industry in Guangdong continued to be constrained by the lack of quality universities, especially beyond the provincial capital, Guangzhou. This made the supply of local talent difficult[48] and shaped an innovation system in the province that is still heavily reliant on firm-level training and research efforts (Kroll and Tagscherer, 2009).

4.6.3 Restructuring and Institutional Reforms

With MEI leaders being staunch supporters of reforms[49], the ministry encouraged bureaus to grant more management autonomy to SOEs. However, reforms proceeded in varying degrees. Some firms felt uncomfortable trying out their new responsibilities, while many bureaus continued to exercise power despite their pronouncements (Jiang, 1985c).

When it came to reforms, the Ministry put the focus not on Guangdong but on other provinces, where production units were larger and more advanced, not only in electronics, but also in other industries, too. Companies that had a good track record in terms of technological capabilities could be trusted to follow newer production standards and

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[47] The development of High-Tech zones were also supported by the Decision to Rely on Technology to Promote Economic Development in 1991 and the Preliminary Regulation to Support the Development of High Tech Enterprises in 1993.

[48] Shen Yili, a Director at the Guangdong Science and Technology Commission claimed that FDI could help with this. He is quoted as saying: "[Guangdong does not] have the educational facilities that exist in Shanghai, so we will have to concentrate on technical training and exchange programmes with foreign investors (Crothall, Geoff 'Guangdong aiming to be centre for hi-tech'. *SCMP*, 11 June 1990).

[49] See also Ning (2009), especially Chapter 4.

perform better under marketization (Jiang, 1984a). However, given that Guangdong was a pioneer in economic reforms, it hosted some of the enterprises that participated in the first autonomy and management experiments. In 1980 the Foshan Wireless Electronics First Factory was one of the first eight factories in the province to receive experimentally expanded management rights. The Shenzhen Electronics Group was also one of the first four horizontally integrated groups in electronics in the country (GDEIA, 2000).

Another aspect of reforms had to do with rationalizing the industry, expanding the scale of production by merging facilities and improving coordination of imports among production units[50]. Partly due to lack of experience and partly due to lack of foresight, production lines for final products were often imported without production lines for their components, or were imported incomplete. For example, a firm in Guangzhou imported in the beginning of the 1980s a production line for black and white TVs, but did not import testing equipment and know-how, so the products were unreliable, working only 2,000 to 3,000 hours without malfunctioning. This was increased to 8,000 hours after the necessary equipment was imported (Yu [ed.], 1988).

For Guangdong, another problem was that some of its old industrial assets had been moved to the mountainous areas during the Cultural Revolution. After reforms, these factories were transferred to Shenzhen, Guangzhou and Zhuhai and formed large SOEs, such as the Shenzhen Huaqiang Group, the Guangdong Semiconductor Factory, the Guangdong Huayue Factory, the Guangdong Yuebao Joint Company and others (GDEIA, 2000). The relocation created the ‘seeds’ of a domestic industry in Shenzhen, together with firms that were established by other provinces and Ministries. In the beginning of reforms there was only one electronics factory in Shenzhen, the Shenzhen Wireless Factory in Baoan. By 1981 there were eleven companies, six of which were SOEs including the ones

[50] The problem of duplication and lack of coordination in imports was acute. For example, during the 6FYP 113 assembly lines for colour TVs were imported in China but only 10 companies could produce 300,000 to 400,000 units a year, only a tenth of what a factory by Samsung or LG (then Gold Star) could manage at the time. Moreover, the lines imported were from so many different companies that it was difficult to reach scale in component production. For such reasons, TV production remained expensive by global standards (by about 70% to 80%) (Lu, 1990).

mentioned above. The rest were set up as joint ventures between ministerial agencies and the local government (Wei, 2010).

Finally, institutional experimentation implied changes in ownership and management patterns. Many of the firms established during this period were SOEs, under state or collective ownership, but were run effectively as private sector enterprises. For example, TCL, a large TV maker, was established by the Huizhou city government under the leadership of a government employee, Li Dongsheng, with the government - reportedly at least - having little interference in day-to-day affairs[51]. The private sector started to be 'tolerated' in the end of the 1980s, especially in Shenzhen (Segal, 2003).

4.6.4 Guangdong Integrates into GVCs

Guangdong hosted three of the first SEZs in 1980: Shenzhen, Shantou, and Zhuhai (the fourth was Xiamen in Fujian province). Even though FDI was allowed in other parts of China as well, the SEZs, which were inspired by the experience of Singapore, Korea and Taiwan (Sit, 1985), were the first to offer generous fiscal incentives for foreign investors (OECD, 2003). Incentives included "a 15% corporate tax rate, 1-3 years tax holidays in general but 5 years for investment over US$5 million, repatriation of corporate profit, personal income after tax, and repatriation of investment capital after completion of contract" Chu (1998: 491). There were also duty free imports on raw materials and intermediate goods, while sales to inland areas were restricted. Moreover, wholly foreign-owned enterprises (WFOEs) were welcome in Shenzhen and other SEZs much earlier than in the rest of the country, especially those established by overseas Chinese. High-tech enterprises could also get an extension of their tax holiday (Wu, 1998).

The early SEZ experience was highly contentious within the Party leadership, with the more conservative factions likening them to treaty ports, a humiliating spot in China's history. The profiteering, real estate boom, incidences of corruption and smuggling were considered scandalous for many, and SEZs were eventually surrounded by physical borders in 1984 to limit the illegal flow of goods to the rest of the country (Vogel, 1989). The

[51] 'Huizhou – new breed of state enterprises leads economic race', *SCMP*, 11 April 1996.

supervision from cadres from Beijing was therefore intense, and difficulties mounted with the growing macroeconomic imbalances of the mid-1980s.

However, the experiment was eventually deemed a success and similar policies were rapidly extended elsewhere. First, fourteen coastal cities were granted the ‘open city’ status, which was similar to an SEZ, in 1984. Then in 1985, the entire Pearl River Delta was granted the status of Open Economic Region, together with the Yangtze River Delta, which centred on Shanghai, and other coastal areas. The new regions, although not as free to experiment with economic policies as the SEZs, also offered incentive packages for FDI.

A lot of resources were spent on infrastructure provision, as Shenzhen and Zhuhai were essentially built from scratch. During the first few years, the SEZs spent close to RMB 7.6 billion (USD 3.7 billion) in developing adequate infrastructure (Wong, 1987). Moreover, particularly in Guangdong, infrastructure had suffered from neglect by the provincial government during the previous decades. Vogel (1989) noted that the lack of energy infrastructure meant that factories frequently ran just three days a week. The provincial 6FYP and 7FYP were heavily focused on developing energy, transport, telecommunications and raw materials (Ye, 1986).

The amount of infrastructure spending, the high ratio of goods sold locally (exports were a key goal for SEZs to earn foreign currency) and the deteriorating macroeconomic environment led to a curtailment of capital construction in the province towards the second half of the 1980s (Ye, 1986). To bridge the financing gap, the Shenzhen government experimented with a system of using state-owned land as collateral to raise funds for infrastructural development, a variation of which was later adopted by other local governments. Despite these efforts, problems of insufficient transportation and telecommunications infrastructure, and erratic electricity and water supplies persisted during the 1980s (Wong, 1987). Additionally, both domestic and foreign firms were encouraged to be more export-oriented, so as to increase their foreign exchange earnings.

The infrastructure and incentives handed out by the SEZs and later by the entire Pearl River Delta were important in achieving integration into GVCs. The success of these measures can be seen from the amount of foreign investment that came in. Wu (1998, pp.36-37) provides some data from Shenzhen between 1979 and 1990. During that period, Hong Kong firms invested cumulatively USD 1.9 billion in Shenzhen, more than 10 times the amount of Japanese or US firms, and 8.7% of their investments (USD 165 million) were in electronics. Japanese firms invested USD 77 million in electronics and this made up 52 % of total Japanese investments. US firms invested USD 15 million or 13% of their total investments in computers and electronic systems. Hong Kong, Japan and the US accounted for 92% of investments in the electronics industry in Shenzhen. Many of these investments took place either in JVs or as more informal ventures engaged in compensation trade,

Establishing Joint Ventures

A key way for integration into GVCs in the electronics industry has been the creation of JVs with foreign investors accompanied by a stipulation for high technology transfer. In other regions of China these were particularly aimed at the domestic market. For example, in one of the earliest ventures, HP set up a JV in Beijing with the newly created China Electronics Import and Export Corporation under MEI to produce for the domestic market in 1984[52]. However, as foreign exchange started to become scarce in the end of the 1980s, following macroeconomic deterioration in China, most import-substituting projects faced problems, unless they were of very high priority[53].

Most of the early JVs were established in Guangdong, given its more favorable policies. The first JV in electronics was established in Shenzhen, between the Hong Kong Hua Electronics Company and the Guangdong Overseas Agricultural Management Office, and is now a large conglomerate named Konka (Wei, 2010). In 1990, almost 80% of the products produced by JVs were exported and in some product categories the percentage was even higher (91% of color TVs and 100% of telephones) (China Electronics Industry Yearbook Compilation Committee or CEIYCC, 1991).

Some of the JV projects were deemed strategic and entered the so-called “important” project lists in provincial annual and five-year plans and were prioritized in terms of

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[52] Taylor, Paul ‘World Trade News: US and China in electronics joint venture’, *Financial Times*, 24 April 1984.

[53] Dodwell, David ‘Survey of Shanghai: Deals delay in currency confusion’, *Financial Times*, 29 October 1985.

government support. One of these was the Shenzhen Electronics Group (SEG)-Hitachi Colour Display Device project, a JV between SEG, the (Shaanxi-based) Caihong group and Hitachi, established in 1989 for a total of RMB 156 million (USD 41 million). This project was also integrated vertically with a JV that produced glass bulbs in Shenzhen, set up also in 1989 by SEG, the China Electronic Industry Corporation (a central-level SOE) and a state-affiliated Hong Kong company (Hong Kong Kang Mao Ltd) (Liu, 1995).

There were high expectations that these JVs would lead to rapid technology transfer, but the reality was that many of these firms used low technology production methods and relied on labor-intensive techniques for exports[54]. Nevertheless, some of them were quite successful in the electronics sector. The top two industrial exporters in China in the early 1990's in the electronics industry were the Huaqiang - Sanyo JV and Konka, a JV with a Hong-Kong firm, both based in Shenzhen (CEIYCC, 1992). Many of the large domestic firms that emerged later had extensive experience in JV projects, indicating that the JV route was a major source of learning (see Annex).

Sanlaiyibu

Beyond the large SOEs and JVs, the electronics industry in China also features thousands of small firms (originally collectively-owned, now also private) engaged in export-oriented processing and assembly, referred to as *sanlaiyibu*[55]. These businesses do not have the legal status and privileges of FIEs and in some cases do not engage in foreign exchange payments at all. They are often 'signed as cooperative contracts with town or village level foreign economic and trade offices (*waijingban*) in the form of business entities and are registered in the name of the Chinese partners' (Yang, 2012: 142). The

[54] Vogel (1989, p.143) wrote humorously of all JVs in the province: "Considering the unrealistic hopes that Beijing had for attracting the latest technology at virtually no cost, the political pressures on Shenzhen not to make concessions to foreigners, and Chinese officials' low level of technical and international experience, it is perhaps surprising that any of these ventures worked at all"

[55] The term means 'three supplies and one compensation'. It denotes the existence of three different types of assembly and processing trade: processing trade with supplied materials, processing trade with imported materials and processing trade with supplied equipment.

Chinese party only charges processing fees or earns a fee from exports, if it has imported part of the materials.

The informal nature of *sanlaiyibu* attracted investors that could operate in this environment and engaged in labor-intensive activities. Hong Kong investors in particular were the largest takers, as they were more understanding of the Guangdong context and had significant familial connections with the province (Vogel, 1989). Guangdong was in very close proximity and offered considerable savings in production costs. A company could afford for the same investment value 10 times the land space and 5 times the workers compared to Hong Kong[56]. A survey of members of the Hong Kong manufacturers association shows that 46.6% of Hong Kong operations (across industries) in Guangdong in 2008 were still engaged in this type of processing trade, some 30 years after reforms started (Chinese Manufacturing Association, 2013).

Jiang Zemin, the head of MEI, argued that *sanlaiyibu* was part of a 'reverse development model' for domestic firms engaged in it. Assembly would be followed by indigenous development of technical services, then by assimilation of the technology embodied in equipment and finally by innovation and own production (Jiang, 1985b). While on the whole such hopes have not been met, processing trade was indeed a useful learning experience for some firms.

First, processing trade provided learning opportunities in terms of markets. One SOE branch manager (Ge, 1988) described it as the "WHCW" model: the world gives orders to Hong Kong, which then sends them to China and then China exports to the world. At the time, this allowed Chinese firms to gain capabilities in exports without needing to build market knowledge. Second, for some firms (mostly SOEs at the time) it was an opportunity to gain production experience before developing their own products, which were mostly aimed at the domestic market. For example, Aihua Electronics, an SOE based in Shenzhen, engaged in processing trade on the side, while developing its own brand for the domestic market in consumer electronics. It later also set up a JV with a Japanese company to produce higher performance products. The company kept the processing business, even if it was small as a share of its overall business, as it could employ surplus labor and provide

[56] Grothall, Geoff 'HK electronics firms 'not abandoning China'', *SCMP*, December 5 1989.

training to workers and managers on top of the market and trade knowledge it gained (Wei, 2010). Finally, *sanlaiyibu* provided extra cash to squeezed SOEs. It is no surprise then that participation was extensive. In Guangdong, by the end of the 1980's, almost 90% of the provincially managed SOEs had engaged in such business (GDEIA, 2000).

Conclusion

Guangdong followed an outward oriented path towards developing the electronics industry. The better-known path of this story is the establishment of the SEZs, the fiscal incentives towards FDI and the encouragement of low-end, labor-intensive processing trade. However, government leaders also paid emphasis on harnessing openness for learning in the domestic sector, made up mostly of SOEs at the time. Domestic firms were not only the beneficiaries of import-substitution policies and support schemes enacted by the central and provincial governments, but were also integrated into global trade and investment flows. They were chosen as partners for large JV projects and were encouraged to export directly to buyers or in processing trade arrangements.

4.7 1993-2005: Pushing for Scale

Already from the early 1990s, Guangdong started facing the challenge of the Yangtze River Delta (YRD), the economic region centered on Shanghai[57], as the latter grabbed the attention of the central government. On the whole, the policies adopted during this phase by the central government allowed firms (and the industry as a whole) to increase in scale. Scale at both the firm- and the industry- level is necessary to improve technological capabilities, by allowing firms to apply sophisticated process technologies and source components locally. The 'champion' initiatives allowed selected firms to become larger, engage in the production of more sophisticated products, absorb technology and in some cases even export under their own brands. At the same time, the TNC-led clusters expanded considerably, creating a diverse base of suppliers and a specialized labour supply and intensifying linkages with electronics GVCs.

[57] Crothall, Geoff 'Pudong status starts internal economic war'. *SCMP,* 28 May 1990.

4.7.1 *The Reform Battlefield*

The 1990s witnessed an intensification of liberalization and marketization reforms in China that radically changed, among other things, the structure, ownership and management of SOEs (Steinfeld, 1998; Nolan and Wang, 1999). Under the slogan of ‘grab the big, let go of the small’, many small and underperforming SOEs were closed down or privatized, while the larger ones were grouped together and corporatized. The reformed SOEs became the centerpiece of China’s industrial policy, promoting catch-up through the support of SOEs in pillar industries. A number of industrial policy interventions promoted selected firms - the ‘champions’ - such as restriction of domestic competition, regulation of market structure, easy lending and subsidies (Nolan, 2001, 2014; Sutherland, 2003).

The electronics industry also implemented the champion initiative. In 1993 MEI became an independent unit again, under the direction of the rehabilitated reformist Hu Qili. Hu was a strong supporter of reforms, but at the same time he felt that the domestic industry had to be firmly supported by the government. He was quoted as saying “China will never be able to turn around if we always live on foreign left-over[s] and follow the tails of foreigners. [..] An industry that relies totally on foreign imports is a dead one, state enterprises must focus on research and development in building up our national (electronics) industry” (SCMP, 2 July 1994). Hu and his successor, Wu Jichuan, encouraged the growth of the domestic industry with a number of measures.

First, ‘champion’ firms were chosen in the electronics industry. In the semiconductor segment, the 909 project was promoted. This was centered on Shanghai Huahong NEC, a JV between Shanghai Huahong Microelectronics Co and the Japanese giant NEC, and the most advanced IC fabrication facility in China at the time. The project was led by Hu Qili and he became its chairman upon retirement (Mays, 2013). In the consumer electronics segment, six large companies were chosen as champions: Panda Electronic Group (Jiangsu province), Rainbow Group (Shaanxi province), Changhong Electronic Corporation (Sichuan province), Legend Group (Beijing and Hong Kong), China Hualu Corporation (Liaoning province)[58] (see also Sutherland, 2003). Panda, Changhong and Caihong were

[58] ‘Big Enterprises to Take Lead in Electronic Industry’, *Xinhua News Agency*, 24 January 1995.

established SOEs, particularly in the TV manufacturing segment. Legend was a non-governmental high-tech enterprise specialized in computers (later renamed Lenovo) and China Hualu had been recently established to promote the VCR segment that China was promoting at the time[59] (Linden, 2003). None of these companies came from Guangdong, but as discussed in the next section, the province chose its own champions to promote.

Second, the rapid build up of information infrastructure created a large domestic demand for electronics firms. The Gold Card (*jin ka*), Gold Passage (*jin guan*) and Gold Tax (*jin shui*) projects were promoted by MEI since 1993 as a way to promote modernization in banking, customs and taxation respectively through the application of information technologies[60]. These projects generated demand for relevant equipment and software across China. The emphasis on informatization as a way to promote industrialization also continued into the new century. In Guangdong, the 10FYP (2001-2005) included a special plan on the informatization of the economy, promoting the manufacturing of relevant equipment, establishment of infrastructure and attention to software development and services[61].

Third, the convergence of digital telecommunications, information and electronics technologies, gave a strong impetus to the industry's development, as firms involved in telecoms could use their expertise to develop consumer electronics products and vice versa. In 1994, MEI established China Unicom, the first telecommunications corporation to challenge the monopoly of China Telecom[62], which was run by the powerful MPT. The struggle between the two ministries over the mobile business was dealt by merging the two ministries (along with the Ministry of Radio, Film and Television) to form the Ministry of Information Industries (MII), during an institutional reform aiming to eliminate branch

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[59] 'Key VCR Plant Switches on', *China Daily*, 29 December 1993.

[60] 'Vice-Premier Zou Jiahua on role of information technology', *BBC Monitoring Service: Asia-Pacific*, 24 April 1997.

[61] Opinion Regarding the Promotion of the Informatization of the Economy and Society, yue fa [2001] No. 2 document.

[62] The company was established with the resources of several ministries, including the ministry of railways, the ministry of energy and the ministry of electric power (Pei, Jianfeng 'Unicom opens door for competition in telecom', *China Daily*, 20 July 1994).

ministries in 1998. MII was headed by the previous MPT minister, Wu Jichuan[63]. The reform of the telecommunication sector would continue for some time, culminating in the big three: China Mobile, China Unicom and China Telecom[64]. The large telecoms were encouraged to compete with each other, but have been protected from foreign competition. Wu Jichuan strongly resisted pressures by Zhu Rongji to open up the sector to foreign investment during China's negotiations to enter the WTO[65]. Eventually, a 49% stake in JVs in the telecoms sector was agreed, which could be increased to 50% after two years[66].

China's investments in a mobile telecommunications network implied a massive demand for network equipment and mobile phone handsets that was used by MII to support the development of an indigenous industry. For example, it was announced in 1998 that telecommunication companies should purchase locally made mobile phone telephony equipment. This was acknowledged as "good news" by then Huawei director Fu Jun[67]. Additionally, other measures were announced, such as investments of USD 400 million on

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[63] Kazer, William 'China taps telecoms boss for super agency', *Reuters News*, 18 March 1998.

[64] China Mobile was split from China Telecom in 2000 'Posts and telecommunications China sets up two giant groups in telecom sector', *Xinhua Agency*, 21 April 2000. In the beginning of reforms operators could either offer fixed line services or mobile services. The last round of restructuring in 2008 created three operators that could offer both. These were China Mobile, which was merged with China Tietong Telecommunications Corporation (the fixed line service of the Ministry of Railways), China Telecom, which acquired part of Unicom's mobile business, and Unicom, which was merged with China Netcom – a company established by Jiang Zemin's son, Jiang Mianhang and focused on fiber optic networks (Yeung, Frederick 'Telecoms regulators take aim at cut-throat rivalry', *SCMP*, 11 November 2008; Kynge, James 'News Corp enters China', *Financial Times*, 20 February 2001).

[65] The leadership tried to reduce the power of MII by establishing the State Informatization Leading Group in 2001, headed by Zhu Rongji himself and responsible for overall development planning in the sector (Batson, Andrew 'Officials jump ship as China's telecom ministry fades', *Dow Jones International News* 14 May 2002). Then the State Council Informatisation Office (SCIO) was also established in 2001, which was first headed by Zeng Peiyan. The SCIO would be responsible for executing the national policies of the Leading Group. However, the appointment of Wang Xudong, MII minister, as head of the SCIO the status of MII was once again increased (McGregor, Richard and Dickle, Mure. 'New chief for China's telecom regulator' *Financial Times*, 7 July 2003).

[66] Pottinger, Matt 'Internet, telecoms score big in China WTO deal', *Reuters*, 15 November, 1999.

[67] Kynge, James 'World Trade: Beijing gives 'buy local' order', *Financial Times*, 5 November 1998.

support for auxiliary projects, the control of imports of complete sets of mobile phones and restrictions on FDI in this segment[68]. Mobile phone licenses were given to only nine Chinese companies in order to restrict competition, including three Guangdong-based firms, namely TCL, Konka and ZTE[69].

The above policies highlight the pitfalls of discussing industrial policy in China without taking into account the multi-scalar governance. In this case, the central government offered protection and support to several firms that had emerged in Guangdong, giving them the necessary space to learn and a lever to encourage technology transfer from foreign vendors (Harwit, 2007; Hsueh, 2011; Fan, 2006). At the same time, policy in Guangdong gave a distinct outward orientation to the electronic industry in the province and encouraged vibrant supply clusters that also supported the competitiveness of such firms.

4.7.2 Guangdong names its champions

In the mid-1990s the Guangdong Department of Electronics and Machinery Industry (GDEMI), adopted the strategy of 'strategic shifts' (*zhanlue zhuanyi*), which continued pushing for the same two objectives that had become prominent since the mid-1980s. The first shift referred to the move from an inward to an outward orientation, with a view to improving the foreign exchange balance. The second shift referred to changing the mix of products from consumer electronics to components (Liu, 1995). The shifts would take place by encouraging key firms to undertake projects in promoted products.

In the electronics industry[70] the GDEMI chose 10 enterprise groups and 16 'backbone enterprises' to support (Table 4.9), most of them top brands already and state-owned (or JVs with state-owned firms), with the exception of privately owned Huawei (see Annex). The promoted companies were meant to become large enterprise groups in the industry, so as to take advantage of scale economies and acquire resources to invest in R&D (GYCC, 1997; Xu, 1992).

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[68] 'China Strives to Localize Manufacture of Mobile Telecommunications Products, *Xinhua News*, 25 October 1999.

[69] 'China allows nine firms to produce mobile phones' *Reuters News*, 30 October, 1999

[70] For Guangdong the pillars were car manufacturing, petrochemicals, machinery, ICT, light industry, textiles, building materials and construction, pharmaceuticals, metallurgical industry and forestry (Guangdong 9FYP).

The available statistics show that, when the 'champions' were chosen, they already accounted for the overwhelming percentage of the provincially managed (state-owned firms, including JVs) electronics industry, accounting for 72% of sales and almost 80% of output[71]. They also collectively had a large presence in the entire provincial electronics industry (including the non-state sector), accounting for 41% of total sales and 49% of total output in the industry in 1997. Most firms were quite large in size, with the exception of some small 'backbone' enterprises.

[71] These calculations exclude Huawei as it is a private firm.

Table 4.9 Provincial champions, revenue and output, 1997

Groups	Sales Revenue (1990 prices) Million RMB	Output Value (1990 Prices) Million RMB
Shenzhen Huaqiang Group	6,006.19	6,571.59
Konka Group	5,525.00	6,800.70
TCL Group	5,417.59	8,405.17
Shenzhen Electronics Group	2,679.19	3,507.90
Foshan Electronics Group[1]	2,333.13	3,138.70
Guangdong Colour Picture Tubes[2]	2,119.67	3,226.50
SED electronics group[3]	666.31	954.55
DESAY Group	4,571.62	6,038.44
Fenghua Advanced Technology	807.72	1,939.26
Guangzhou Electronics Group	1,684.80	1,964.48
Backbone Enterprises		
Shenzhen Primatronix (Nanho Brand)	455.72	480.12
Guangzhou Radio Group	189.27	134.73
Huawei Technologies Co. Ltd	3,906.25	4,757.00
China Great Wall Computer Shenzhen Co. Ltd	3,992.26	13,469.66
Shenzhen Kaifa Technology Co. Ltd	1,720.00	1,795.30
Shenzhen Yuebao Electronics Technology Co. Ltd.	2,048.42	3,282.81
Chaozhou Three Circle Group	1,791.77	1,802.64
Shinwa Industries (China) Ltd	124.90	257.97
Zhongshan Kawa Electronic Group	20.92	385.54
Dongguan Shengyi Futongban[4]	240.71	562.75
Guangdong GoWorld Co. Ltd	566.29	409.71
Guangdong Jiali Group[5]	187.94	294.18
Tianma Group	205.58	57.02
Shenzhen Jinghua Electronics Co. Ltd	506.44	422.24
Shenzhen Xianke Enterprise Group	992.61	1,317.95
AF Technology Co. Ltd	28.90	34.00
Total	48,789.20	72,010.91
as Share of Total Electronics Industry	41%	49.3%
as Share of Total Provincially Managed firms	72%	80%

Notes: [1]now part of Foshan Gongying Investment Holdings [2]now part of Dongguan Development Holdings [3]now China Electronics International Information Service Co. Ltd [4]now Shengyi Technology Co. Ltd [5] now Sanshui Liping.

Source: Data on sales and output from CEIYCC (1998). Percentages are author's calculations based on data from GBS (various yeats, a) and GDEIA (2000).

Since the provincial government could not directly spend large sums owing to budget constraints, support was disbursed by way of preferential policies and loans, with priority given to projects that boosted the industry's technological development (Guangdong Yearbook Compilation Committee or GYCC, 1997). The following policy measures were implemented:

- Champion firms received preferential financing from China Development Bank for capital construction and technology renovation projects.
- Some firms like Fenghua Advanced Technology and GoWorld were encouraged to list in the stock market, following the successful listing of Konka in 1992, the first firm to do so in the industry in Guangdong (Wei, 2010).
- Firms received subsidies for R&D. It is unclear how substantial these were, as in general firms were expected to cover most of their research costs, while government funding supported basic research (GDEIC, 2001).
- Firms with over-capacity or at risk of bankruptcy were encouraged to restructure or engage in Mergers and Acquisitions (M&As) (GYCC, 1997).

The champions were expected to invest on key projects of importance during this time, which were in general prioritized in terms of finance and land availability (Liu, 1995). These projects had varied success, but they created some assets that still remain in production. The Shenzhen Electronics Group (SEG), a state-owned horizontally-integrated conglomerate, was particularly active in this regard, taking part in multiple JVs aimed at vertically integrating the local electronics industry. One such project was its effort to form a JV with SGS-Thomson (now STmicroelectronics) to produce silicon wafers for ICs[72]. The project initially envisaged a wafer fab in Hong Kong and a packaging plant and chip design facility in Shenzhen. The first phase was to see the production of 10,000 6-inch wafers monthly by 1995 with a second phase adding another 15,000 wafer capacity and a facility for 0.5 to 0.35 micron technology[73]. However, SEG was unable to raise the USD

[72] At the time China's capabilities were 2 to 3 microns in 4 to 6 inch wafers ('Chinese lay submicron fab plans', *Electronic World News*, 7 October 1991).

[73] Gold, Martin and Rick Boyd-Merritt 'SGS, SEG fab deal on hold', *Electronic Engineering Times*, 21 December 1992.

300 million needed in funding for the wafer fab[74]. The packaging facility nevertheless went ahead and started producing fully in June 1998. The inability of SEG to fund the investment shows the limits to the financial support available to firms by the provincial government, and explains the need to engage in exporting activities to gain extra income.

Towards the end of the 1990s, the provincial champion initiative started to target enterprises beyond the original 26 ones. In 1999 the electronics bureau chose 14 enterprises to have a guiding role (from the earlier champions) and as many as 50 leading enterprises that would also receive help to develop and grow (GYCC, 2000). The effort to widen support reflected two concerns. First, there was a growing preoccupation with developing large enterprises that could withstand entry into WTO. Tariffs, already quite low (10% in the sector compared to 17% overall for China) would eventually drop to 0% with accession to the ITA (Guangdong Information Industries Department, 2001). Second, the ongoing restructuring of state-owned firms was accelerating, and many SOEs that had been supported found themselves bankrupt or amid restructuring efforts, as in the case of the Foshan Electronics Group and Guangdong Colour Picture Tubes. This pushed the provincial government to look for new firms with high potential to promote.

Entry into WTO encouraged more attention to smaller firms, to make sure they can survive foreign competition. The 'Implementation Plan for the Structural Adjustment of the Guangdong Information and Communications Technology (ICT) industry' (GEIC, 2001) aimed to address the technological weakness of the industry, by encouraging microelectronics and software, especially IC design, envisioning a leading role for large firms, while making Small and Medium Enterprises (SMEs) act as innovative, specialized, flexible suppliers. However, beyond listing encouraged products and technologies, the plan was not accompanied by policy levers, nor did it include the cooperation of other agencies.

4.7.3 Champions Remain Integrated

As mentioned in Section 4.7.2 above, one of the 'strategic shifts' during this time was the increase in export orientation. This did not exclude the 'champions' - even if some of

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[74] LaPedus, Mark 'China Exports Chips – Low-tech Trickle is Just the Beginning, *Electronic Buyers' News*, 8 November 1993.

them had a domestic market orientation - as these firms were not meant to develop insulated from global investment and trade flows.

The access of champions to the domestic market, both due to their connections to local and provincial governments and their established domestic sales networks, was a draw for foreign partners, even after entry into WTO liberalized distribution and other services. Such domestic-market-oriented JVs included the SEG project on ICs with STmicroelectornics, the JVs between the DESAY group with Siemens, Philips and others, the JV of Guangzhou Radio Group with Ericsson and those of China Great Wall Group with IBM, Hitachi and Kingston (see Annex). The more successful firms were able to leverage these to achieve technology transfer. For example, TCL built JVs with its partners Sumitomo, Panasonic and Philips, exchanging its sales networks for technology transfer (Li, 2010).

However, the champions also continued to engage in exports. Many of them had begun their lives as export-oriented JVs (e.g. Konka) and others set up export-oriented JVs with foreign partners, some of which ranked among the largest exporters in the country (e.g. Huaqiang-Sanyo). They also operated as Original Equipment Manufacturer (OEM) suppliers (e.g. TCL, Shenyi Technology and others). This trend continued in the 1990s. DESAY exported 30% of its DVD production to Europe[75] and TCL, by the mid-1990s was already exporting to Southeast Asia and Eastern Europe[76]. Thus, the strategies of OEM/export oriented JVs and import-substituting JVs were not mutually exclusive, as often firms engaged in both (Wei, 2010).

Moreover, during this time, the central government launched its initiative to push firms to invest abroad (*zou chuqu*). The Guangdong provincial government was an early adopter of this strategy, pushing firms to invest outside the bounds of the province, and later of the country, since the mid-1990s (Davies, 2013; GYCC, 1997) Internationalization took place by M&As and by establishing R&D and production bases abroad. TCL was a pioneer of this strategy; it purchased French TV manufacturer Thomson's CRT business and

[75] Yan, Dai 'EU block of China's DVD players causes dispute', *China Daily*, 7 March 2002.
[76] Footnote 28.

established a JV with Alcatel in 2004, although both of these struggled financially initially[77].

4.7.4 Quick Results and Bottlenecks

The champion initiative had some quick results. First, production in some of the promoted components increased quickly. In color picture tubes, production almost doubled from 3.9 million pieces in 1994 to 6.9 million pieces in 1999. In integrated circuits, the province accounted for only 1.6% of production in China in 1995, and by 2000 it accounted for almost 20%. In mobile phones, before 1997 there was virtually no production in the province, but by 2000 Guangdong accounted for 18% of all units, dropping slightly to 14% by 2005 (MIITa, various years).

There was also an impact in terms of increasing the scale of selected companies. Beyond the year of the policy announcement (1997), there is no comprehensive data on all the firms' financial results but their success can be gauged by whether they made the annual Top100 Electronic Firms (by sales revenue), a list published by MIIT (available on http://miit.ccidnet.com/) (Table 10). In 1992 only 9 of the chosen firms were in China's top 100, but by 1999 14 firms were on the list, such as TCL, Konka and Shenzhen Kaifa. The success, in these terms, was not long lasting, with many firms from the original champion group gradually closing down or becoming restructured by the end of the 1990s.

Table 4.10 Champion firms from Guangdong in China's Top100 electronics list, rankings for selected years

	1992	1999	2002	2009[1]	2015
Shenzhen Huaqiang Group	10	14	17	16	45
Konka Group	9	4		18	27

[77] ibid.

TCL Group	51	5	6	7	4
Shenzhen Electronics Group	6	15	46	36	
Guangdong Colour Picture Tubes		31			
SED Electronics Group	29	33	25	53	
DESAY Group		22	23	17	
Fenghua Advanced Technology		54	60		
Guangzhou Electronics Group			57	55	
Huawei Technologies		10	7	1	1
Great Wall Computers	13			12	
Shenzhen Kaifa Technology	33	25			
Shinwa Industries (China)	35				
Guangdong GoWorld		95	85	87	95
Shengyi Technology		74	89		
Tianma Group					49
Shenzhen Jinghua Electronics	41	80			
Shenzhen Xianke Enterprise Group		38	86		
Share of Champions in Top100[2] in provincial sales[3]	25.90%	27.50%	15.60%	16.30%	-
Share of non-Champion[4] firms in Top100 in provincial sales	11.10%	4.60%	9.60%	7.70%	-

Notes: [1] 2009 is the last year for which Chinese yearbooks and list contain firm-level output and sales data [2] The top100 lists are by revenue from sales and refer only to local firms or JVs with local firms. This is in contrast to top50 lists produced by the provincial statistics bureau, which refer to industrial output or sales by any enterprise in the province and where factories like Foxconn routinely top the charts. [3]Provincial sales in the electronics industry only [4]Notable firms that were not original champions from Guangdong include Skyworth-RGB, ZTE, BYD Group, Midea Group and Galanz

Source: Annual Top100 Electronic Lists (MIIT website) and data from the GBS (various years, a).

Additionally, it seems that the province, instead of setting its sights on a limited amount of firms and nurturing them with a strategic vision, adopted a "strategic followership" (Wade, 1990) stance, supporting firms that had a good track record. This pattern of support fits anecdotal evidence[78] and confirms previous work on industrial policy in Guangdong

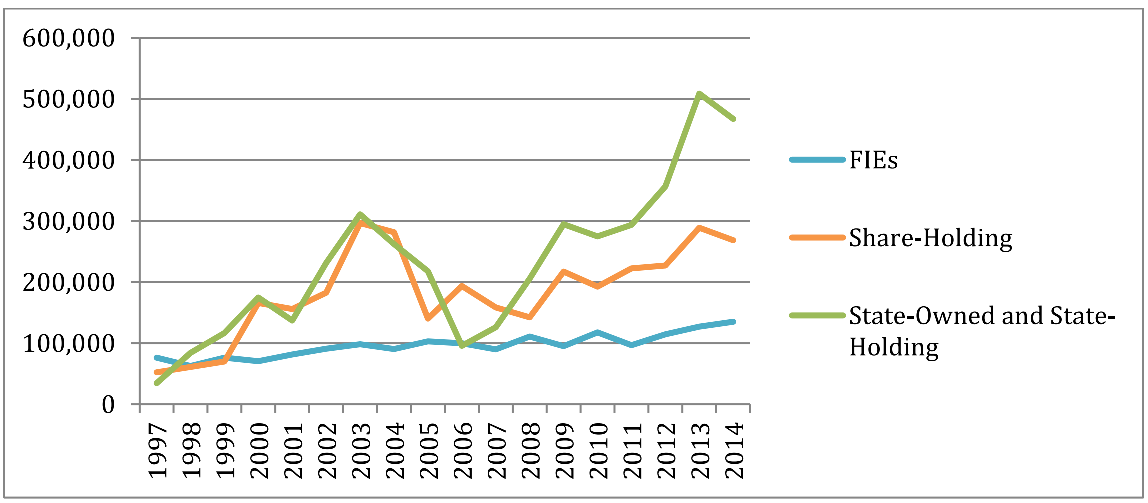
[78] An interviewee with long experience in the health electronics business pointed out that it was hard to get the attention of government when the enterprise was small, even though it was technologically sophisticated. When the firm grew larger, the government became more interested

(Thun, 2006; Segal, 2003). The provincial government supported firms that made the top 50 industrial firms in Guangdong, the top 100 electronics list in China or won China-wide technological awards and brand name recognition. For example, the official roundup of the industry in 2003 (GYCC, 2004) includes references to firms that were not part of the original champions, such as BKK electronics (now owner of Oppo and Vivo brands). The mention of firms in official documents usually implies these firms received support.

The efforts of the government during this time also coincide with the rapid growth in value added per employee in local firms in electronics (SOEs/SOCHEs & Share-holding corporations) (Figure 4.10). The visible slow-down in value added per employee towards the end of this phase is also consistent with the lack of strong industrial policy initiatives in the 10FYP (2001-2005). The rapid productivity growth post-2005 also foreshadows the emphasis on upgrading in the third phase (2005-now), discussed in the next section.

Figure 4.10 Value added per employee by ownership category, 1997-2014

RMB, current prices



Source: Author's calculations on data from GBSb (various years).

Finally, the emphasis of central and provincial policies on specific firms (rather than on creating a broader system of innovation), remained a constraining factor during this period.

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in supporting it to grow even bigger (Interview with firm investor, SZ05, Shenzhen 11 November 2015).

On the one hand, there were efforts to promote innovation. The provincial department in charge of industry promoted links between production, study and research (*chanxueyan jiehe*), by establishing engineering and technology development centers, encouraging the growth of High- and New- Technology Enterprises (HNTEs) and funding specific technology projects (Shanghai Microcomputers, 1997). The S&T system was under the purview of the Guangdong Department of Science and Technology (GDST), which was the agency responsible for policies on HNTEs, non-governmental technology enterprises (*minying*), high-tech zones and other types of S&T related clusters. Under the slogan of "Developing Guangdong Through Science and Technology" (*kejiao xingyue*), a series of support plans were released to further support HNTEs and non-governmental technology enterprises (GDST, 1998). These were complementary to champion initiatives, with some firms qualifying for both and taking advantage of the broad package of support available. Unlike the champion initiative, these measures were horizontal (mainly tax incentives applying to all qualifying firms) and place-based (e.g. specific zones).

On the other hand, the large-scale reform of the S&T system, starting in 1998, was disruptive. The reforms led by the GDST, were aimed to make public research institutes more commercial in nature, so as to better serve the needs of industry. Funding was cut drastically for the S&T system and only research of public nature was kept, with institutes pushed to reduce staff, spin off companies and charge fees for research (GDST, 2001).

While support was ample for large, especially state-owned firms, smaller innovative firms faced barriers to growth. Bank financing was mainly directed to the former, leaving the latter with few sources of capital available at a time of underdeveloped market-based financing (Segal, 2003).

4.7.5 Global Integration Intensified

Following Deng Xiaoping's Southern Tour[79], marketization and opening-up reforms were encouraged to expand in scope and depth (Qian, 2000). For Guangdong, this meant an increase in its integration into GVCs and some upgrading, through the diversification in

[79] For the political significance of the Southern Tour see Zhao (1993).

sources of FDI and the increasing investments by more sophisticated suppliers. In this section, the policy regime towards FDI is further examined.

Infrastructure Continues to Facilitate Integration

The beginning of the 1990's saw a sharp rise in infrastructure projects by the provincial and sub-provincial governments to match the speed of the growing economy and anticipate future needs. Planned targets for infrastructure in the province were routinely raised and projects that would have been undertaken towards the end of the decade were brought forward (Zhu, 1993). Large infrastructure projects planned in the beginning of the decade for Shenzhen and Guangzhou started taking shape in the mid-1990s, including the Yantian port and a super highway between Shenzhen and Guangzhou[80]. The rapid build-up of telecommunications, transport and energy infrastructure in the decade can be seen in Table 4.11.

Infrastructure serviced the economy at large and not specifically the electronics industry. However, its impact on the industry was substantial and it was a key factor in the decision of large foreign first-tier suppliers to locate facilities in the province, export costs were driven down substantially[81]. An official from the Dongguan city government pointed out that the rapid infrastructure construction also facilitated the functional integration of subsidiaries in different locations within the province[82]. An old joke went "when there is a traffic jam from Dogguan to Shenzhen, the prices of electronics go up!".

Table 4.11 Infrastructure indicators, Guangdong, selected years

Items	1985	1992	1995	2000	2005
Popularization rate of Main Lines of Local Telephones (line/100 persons)	0.48	1.8[1]	9	18	27
Capacity of Local Telephone Exchanges (10000 lines)		305	1,007	1,939	4,617

[80] Shenzhen unveils $74b project. *SCMP*, 28 November 1990.
[81] Interview with first tier supplier manager, SZ04, Shenzhen, 5 April 2015.
[82] Interview with official, DG02, Dongguan, 24 November 2015.

Capacity of Long-distance Telephone Exchanges (10000 lines)	0.17	10	45	70	206
Length of Long-distance Optical Cable Routes (km)				21,165	40,846
Capacity of Mobile Telephone Exchanges (10,000 lines)			145	1,825	7,925
Length of Highways (km)	51,288	55,883	84,563	102,606	115,337
Expressways (km)		42	358	1,186	3,140
Length of Railways in Operation (km)	1,026	1,426	1,861	1,942	1,924
No of Berths (unit)	1,219	2,030	2,285	3,191	2,926
Berths at 10,000 Ton class	34[2]	64	93	126	182
No of pipelines	9	17	26	45	63
Total length of pipelines	182	212	325	1,536	1,813

Notes: [1] refers to 1990. CAGR data for this variable starts from 1995. [2] refers to 1986
Source: Author's calculations based on data from GBSa (various years).

FDI Policy & the Zone Fever

The policy environment for FDI became more relaxed after Deng's Southern Tour. In preparation for entry into WTO, FDI was increasingly encouraged not just into infrastructure and high-tech industries but also in services such as finance, insurance, trade, tourism and real estate (GPG, 1996). The establishment of wholly foreign-owned enterprises (WFOEs) became increasingly commonplace compared to JVs and entry into WTO added to the ease of investing, by removing formal requirements on FIEs, such as export quotas and technology transfer requirements (OECD, 2003).

At the same time there were efforts to align FDI with local and national developmental objectives, particularly in Shenzhen. In the beginning of the 1990's, FDI approval in Shenzhen started to become more selective, moving away from simple processing into encouraging higher value-added and less energy-intensive or polluting activities (Ng and Tuan, 2001; Wang and Meng, 2004).

The publishing of the China-wide FDI catalogues also helped to meet these goals (Lu, 2002). Catalogues consist of three lists stipulating encouraged, restricted and prohibited industrial sectors for foreign investment. Whatever is not included in the catalogues is simply permitted. There have been several iterations of the catalogue, published in 1997, 2002, 2005, 2007, 2011 and 2015. The 2002 one liberalized entry into some industries, especially in services. Subsequently, there was little further liberalization but efforts have gone into stipulating higher process and product standards for investment. Encouraged projects were more likely to be approved and might have benefitted from lower income tax and value added tax (via rebates), duty free imports and easier finance (OECD, 2003). The catalogues were China-wide and did not change by province, but projects under certain total investment value could be approved by provincial and city governments.

The fact that export-oriented projects were considered encouraged, and the potential for export-oriented FDI to improve local growth and export figures, made them particularly welcome in the province. Incentives for FDI continued to be provided by city governments, who competed with each other to attract investments, often through exemption from local taxes or reimbursement of central-level taxes (OECD, 2003). In the end, many local governments ended up subsidizing export-oriented projects, even if they did not meet the objectives for upgrading at the time[83].

The creation of development zones also facilitated FDI attraction. Beyond the SEZs and the similar but smaller Economic and Technological Development Zones (ETDZs), the High-Tech Industrial Development Zones (HIDZs) and zones that encouraged processing trade, such as Free Trade Zones and Export Processing Zones (EPZs) (see Zeng, 2010 for a review). Zones offered specific incentives to investors, tailored to the type of business they were promoting. Di Tomasso et al. (2013) list some of the incentives for different zones in Guangdong province. They ranged from exemption of Value Added Tax (VAT) for own-use equipment and parts for all or selected industries, license-free inputs for all or selected activities, immediate or post-shipment VAT refunds and exemptions from real estate taxes.

Each zone or park promoted certain industries that fitted provincial or city development objectives. Since the electronics industry had become quite important for the provincial economy and it was considered a high-tech industry, many zones and parks in the province listed electronics as a desired industry to attract. However, there is little evidence that zone or park authorities consistently targeted firms in the electronics industry to locate activities in Guangdong during this phase.

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[83] Interview with business association, F03, Foshan, 29 January 2015.

Diversification & Higher Value-Added FDI

During 1978-1992, FDI in the industry was dominated by small Hong Kong operations and some high-profile JVs, but in the 1990s a diversification of investments was observed. Many foreign lead firms opted to set up assembly plants in the province, often in JVs with local SOEs. Their share of local production in some items was large. For example, almost 67% of mobile phones made in the province in 1999 came from Dongguan Nokia, a JV with a local firm (GYCC, 2000).

Moreover, some of the largest foreign first-tier suppliers such as Foxconn, Flex and Jabil (also known as electronics manufacturing service or EMS firms) located their operations in the province. These were drawn by the good infrastructure, as mentioned before, the availability of skilled labor and tax incentives, which allowed large-scale, low-cost but reliable operations. Such suppliers introduced relatively sophisticated product portfolios and process techniques compared to existing firms (Lüthje, 2004). However, their share of local procurement, beyond some plastic and metal components remained minimal, as facilities were vertically integrated, performing all stages of assembly, from board manufacturing and metal cabinets to plastic injection moulding and final assembly[84]. The scale of operations of first-tier suppliers in the province increased sharply after 2000[85][86].

At the same time, Taiwanese investments started to increase. Investments from Taiwan had been limited in the beginning of reforms as they were blocked by the Taiwanese government, but then restrictions started to be lifted in the 1990's, more investments flowed in. In Guangdong, Taiwanese investments concentrated in Dongguan, forming an export-oriented cluster in computers and peripherals, Taiwan's mainstay industry. Given that the Taiwanese suppliers were themselves second or third-tier suppliers, most of these operations were only for assembly. However, Taiwanese firms unlike those from Hong

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[84] Flextronics at Thomas Partners 2008 Technology Internet Conference, *Voxant FD wire*, 4 February 2008.

[85] Flextronics to ramp up China production as demand soars', *Dow Jones International News*, 22 April 2004.

[86] 'Hon Hai expands operations in Shenzhen', *Taiwan Economic News,* 23 October 2002.

Kong, would later go through a process of upgrading that left room for more skill-intensive operations to be relocated to the province in the future (Ernst, 2013).

4.7.6 Conclusion

From the early 1990s until the mid-2000s, Guangdong favored a strategy of increasing exports and, at the same time, deepening the capacity of firms to produce more sophisticated products. The two strategies extended the policy direction taken since 1978, but the scale of efforts increased and became more focused. Additionally, central-level policies, particularly in telecommunications were instrumental in providing learning rents to the telecommunication segment. During this period, several large domestic firms expanded in scale and capabilities, producing more sophisticated components and launching their brands domestically and even exporting to emerging markets. Moreover, large-scale first tier suppliers and assembly factories of large lead firms started locating in the province and TNC-led clusters expanded considerably.

Industrial policies appear complementary with GVC expansion in this phase. Foreign lead firms exchanged technology and expertise for local sales networks and a cheap export platform. Domestic firms were able to use subcontracting to improve their financial positions and their capacity to compete in the domestic market. Meanwhile, the vibrant small-scale supply clusters started to benefit local and foreign large firms by constituting a readily available and cheap source of low-end components.

One of the reasons that Guangdong's industrial policy was complementary with GVC upgrading has to do with China's large domestic market. The size of the market meant that there was enough space for both foreign firms and domestic players to sell their wares and foreign firms were willing to enter into JVs to access it. Additionally, the threat of exposure to global competition after entry into WTO and the attention of the Guangdong government primarily to well-performing firms, may have acted as instruments of discipline for domestic firms that enjoyed rents. However, despite this 'harmony' of interests, there remained a large segment of the industry that remained out of the equation, the small-scale, domestic private sector.

4.8 2006-now: Emphasis on Innovation

4.8.1 Attention to Indigenous Innovation

At the start of the new century, China had become the 'factory of the world', deeply integrated into GVCs and even boasting some firms with advanced technological capabilities. However, the country was facing also facing environmental damages, a persistent technology gap in advanced components (CCID, 2013) and had yet to develop truly globally competitive firms (Nolan, 2014). Already since 2000, some policies had been announced to encourage structural adjustment, but it was after 2004 that industrial policies, aimed at the entire manufacturing sector, rather than a few selected firms, were announced. The establishment of the NDRC in 2003 as a supraministerial body, in charge of macro policy and broad development directions and the creation of MIIT, which absorbed industrial branch ministries, also enabled better coordination in central government (Heilmann and Shih, 2013).

A series of plans were released since the mid-2000s, which tried to address critical shortcomings in China's industrial capabilities. The so-called 'indigenous innovation' campaign was launched during the 11FYP (2006-2010), with the landmark "National Medium- and Long-Term Plan for the Development of Science and Technology" (known as MLP). Subsequent FYPs also feature similar emphases on developing the indigenous industry, with the 12FYP encouraging the development of selected Strategic and Emerging Industries (SEIs) and the Made in China 2025 that was launched in 2015 to foster advanced manufacturing. These plans have not been without controversy, especially as Chinese firms are engaging in high-profile international M&As and governments at all levels have increased financial support for targeted activities[87].

The plans described above were adapted and implemented in Guangdong, as detailed in the next sections. It should be noted that some of the firms that had emerged as strong players in the previous phase became important for the implementation of central-level initiatives by the mid-2000s. For example, Huawei and ZTE started to play an important role in the development of domestic standards in mobile telecommunications network

[87] See for example EU Chamber of Commerce (2017) on Made in China 2025.

technology, a goal strongly supported by MIIT[88]. The promotion of the home-grown standard for 3G by MIIT (TD-SDMA) gave a boost to local firms involved in the mobile phone value chain, as in addition to the technology itself, chipsets, handsets and other equipment compatible with the standard had to be developed (Chen et al, 2014; see also Sun et al, 2016). The companies involved in TD-SCDMA, such as Datang/CATT, China Mobile, Huawei and others (including foreign vendors) also collaborated on developing the more successful standard for 4G (TD-LTE), which was also adopted outside China. Huawei is now expected to be an important developer of 5G technologies[89]. In semiconductors, the National Integrated Circuit Industry Fund, managed by MIIT, was launched in 2014 with a size of RMB 120 billion (USD 19.5 billion), to advance China's semiconductor capabilities. The fund has been pumping money into China's IC manufacturing and design houses[90], including Huawei's HiSilicon and ZTE Microelectronics[91].

A Change of Tune for Guangdong

Guangdong, by the mid-2000s, faced similar problems in advancing the electronics industry as the rest of China. A report on the competitiveness of the industry in Guangdong, carried out by CCID, a MIIT-affiliated think-tank, offered a lukewarm conclusion (Xiong, 2004). Guangdong had a more or less complete component supply chain, high levels of clustering, low labor costs and a few large innovative firms, but the industry as a whole was characterized by low value added in manufacturing and a high dependency on foreign imports (especially in core technologies and advanced components). It also lagged behind Beijing and Shanghai in human capital, endangering its capacity to upgrade in the future.

The overall model of growth of the province came under increased criticism, culminating in a rare move by the central government to publish a regional development plan. The Outline of the Plan for the Reform and Development of the Pearl River Delta (PRD) (NDRC, 2008), issued by the State Council, enshrined a new vision for the

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[88] Interview with policy expert, HK01, Hong Kong, 16 March 2015.
[89] See footnote 27.
[90] Zhu, Shenshen 'More cash promised to China's IC fund', *Shanghai Daily*, 16 March 2016.
[91] 'China IC design industry growing', *ETMAG.com*, 21 March 2017.

development of Guangdong, away from the chaotic, liberal, experimental character of the early reforms and more firmly towards innovation, upgrading and regional coordination. The PRD Outline was particularly important in ushering more coordinated development at both the provincial level, encouraging the integration of cities in the Delta[92], and also greater cooperation with Macau and Hong Kong, which are seen as possessing financial and human capital. The connection with Hong Kong was more concretely articulated in the Framework Agreement on Hong Kong/Guangdong Co-operation, which outlined areas of work in infrastructure and cooperation in science, finance, logistics and other services.

The 'PRD model' also came under pressure with rising wages and the phasing out of tax incentives for foreign investors after 2008 (see Section 4.8.3), while the financial crisis of 2008 demonstrated the fragility of an economy with large exposure to low-tech exports. This constellation of factors culminated in a noticeable change in Guangdong's policy direction. On the one hand, attention shifted to increasing the innovative capacity of domestic firms, beyond the few large well-performing conglomerates, and on the other hand, there were efforts to upgrade the low-end FDI and export-oriented firms through relocation and automation. We look at each of these below.

Industrial Policy with an Emphasis on Innovation

The current policy phase (2006-now) has emphasized upgrading the industry and encouraging domestic production of core technologies and components. The initiatives are broader in nature, involving multiple agencies and expanding the measures of support available, making them accessible to a broader constituency of firms. The main development plans for the industry during the latest phase are listed below (Table 4.12).

Table 4.12. Main development plans in electronics industry, Guangdong, 2006-2015

Date of pub.	Title	Main Agency

[92] Economic integration with Hong Kong and Macau is part of a strategy for a Greater Pearl River Delta Area, and has been supported by other initiatives as well, such as the 'Regional Cooperation Plan on Building a Quality Living Area' launched in 2012.

2006	Guangdong 11th Five Year Plan for the Development of the Electronics Industry	GEIC
2006	Guangdong 11th Five Year Plan for the Development of the High-Tech Industries	GDST
2005	Guangdong Party and Government Decision Elevating Indigenous Innovation Capability to Raise Industrial Competitiveness	GDST
2005	Guangdong Medium and Long Term Science and Technology Development Outline	GDST
2010	Guangdong Action Plan for the Development of the High-Tech Electronics and Information Industry	GEIC
2011	Guangdong 12th Five Year Plan for the Development of the High-Tech Electronics and Information Industry	GEIC
2011	Guangdong 12th Five Year Plan for the Development of Strategic Emerging Industries	GEIC (?)
2011	Guangdong 12th Five Year Plan for the Development of the High-Tech Industries	GDST
2011	Guangdong 12th Five Year Plan for S&T Development	GDST
2015	Guangdong Industrial Upgrading Battle Three Year Action Plan (2015-2017)	GDEIC
2015	Guangdong Intelligent Manufacturing Development Plan (2015-2025)	GDEIC

Source: Author's elaboration.

During the 11FYP (2006-2010), the 'indigenous innovation' initiative became Guangdong's overarching policy goal, with the Guangdong Department of Science and Technology (GDST) being the main implementing agency. Given the importance of the electronics industry for the provincial economy, many of the S&T-related plans, focused on promoting industrial development in electronics, especially in high tech segments of home electronics, new generation broadband, wireless communication systems and core integrated circuit design. Promoted areas were supported by funding key projects and by undertaking measures to improve market financing for high-tech firms (GDST, 2006).

During the 12FYP (2011-2015), attention shifted to promoting the Strategic Emerging Industries (SEIs). The Guangdong SEI plan (launched by the Guangdong Economic and Information Commission - GEIC) announced a total investment of RMB 22 billion (USD 3.2 billion) over five years. Support would be given to three top priority sectors, namely high-end electronics and IT, semiconductor lighting (LEDs) and electric cars, and secondarily to another five industries: biotechnology, high-end manufacturing equipment, new energies, environmental protection equipment, and new materials. The funds were disbursed in a variety of ways, including grants, awards, loan guarantees, interest rate subsidies and equity investments. About 40% of those funds came from the Guangdong Department of Finance and the rest from the relevant implementation agencies like the GEIC, the Guangdong Development and Reform Commission (GDRC) and GDST[93].

The latest initiative of importance has been the 'Made in China 2025', which has been implemented so far in Guangdong with the 'Guangdong Upgrading Action Plan' and the 'Guangdong Intelligent Manufacturing Plan 2025', both launched by GEIC. The Action Plan is ambitious, aiming to push more than 50% of industrial firms to update their production equipment[94]. The Action Plan was backed by the establishment of an upgrading fund worth a total of RMB 51.6 billion (USD 7.8 billion), a much higher commitment than the SEI initiative of 2011-2015. This was disbursed in supporting advanced manufacturing, equipment upgrading, automation, upgrading in the semiconductor industry and raising the efficiency of industrial parks. The GEIC offered some funding through of Industrialisation and Informatisation Development Special Fund in 2015-2017. The total spending was approximately RMB 5.2 billion (USD 780 million) in 2016. The electronics industry still absorbed a high proportion of funding (according to author's calculations, 30% of the robotics applications fund went to electronics-related projects).

The transition from the SEI initiative to Made in China 2025 has not meant a change in the industries supported, with the electronics industry remaining a pillar one for the province (GPG, 2015). Moreover, the drive towards intelligent manufacturing and robotics that is envisioned in Made in China 2025 entails the application of Internet of Things technologies, cloud computing, big data and other smart technologies which rely on a number of electronics products such as integrated circuits, displays, terminals, sensors and others, thereby increasing their demand. The main areas of support currently include

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[93] Lu, Yi 'Guangdong's first round of 580 million RMB special fund to support strategic emerging industries' [in Chinese] 1 December 2010, accessed at http://www.gov.cn/gzdt/2010-12/01/content_1757228.htm on 7 August 2017.

[94] GDEIC 'Interview with GDEIC Director Lai Tiansheng: In 3 Years 900 billion RMB to Promote Technological Transformation in More than Half the Industrial Enterprises' [in Chinese] 29 October 2014, accessed at http://www.gdei.gov.cn/zwgk/mtbd/2014/201410/t20141029_113440.htm on 7 August 2017.

advanced screens, high-performance IC design and advanced semiconductor packaging, embedded systems, 4G TD-LTE & 5G network technology and compatible equipment, as well as areas to do with intelligent machines. With each new plan, the promoted technologies have been updated towards frontier technologies.

Policy Measures

One way in which the provincial government promotes the electronics industry is by choosing important projects undertaken by firms to prioritize in terms of licenses, land availability and financing. During the period 2005-2010, 37% of planned investment in the projects of the 11FYP High-Tech Plan concerned projects in the electronics industry. Among those, the largest was a single project for a 6th generation TFT-LCD liquid crystal panel display production line, one of the core technologies promoted during that period. During the period 2011-2015, 48% of planned investment in the important projects of the 12FYP High-Tech Plan and 20% of those in the Guangdong SEI plan were in the electronics industry, with some overlaps.

Additionally, instead of choosing firms and giving support primarily to these, the trend since the mid-2000s is to provide funding through designated funds on a competitive basis (see Table 4.13). The funds disburse a mix of grants, awards, interest rate subsidies, and increasingly, equity investments.

Table 4.13 Policy instruments during the 12th FYP (2011-2015)

Special Funds
Guangdong Strategic Emerging Industries Fund
Guangdong Venture Capital Guiding Fund
Technology renovation fund
Industrial technology R&D special fund
Provincial High-Tech Industry Development Zone Development Guiding Special Fund
Guangdong Strategic Emerging Industries Venture Capital Risk Investment Fund
Guangdong Technology Financial Group (for equity investments)
Instruments
R&D tax deduction
Indigenous innovation tax discount
15% tax rate reduction for HTEs
Duty free imports for equipment for technology renovation programs
Duty free imports of important technology equipment
Reduced duty for imported equipment

Software and IC value added tax reduction
Rapid depreciation for R&D equipment
Interest rate subsidies
Loan guarantees
Free grants
Prizes
Export credit insurance
Priority for land use
Priority for government procurement

Source: Author's elaboration

The criteria for choosing projects are announced in advance and applications are reviewed by a panel of experts[95]. For example, the Guangdong SEI Development Special Fund had a special stream just for the high-end electronics sector, worth at least RMB 1.35 billion (USD 200 million), not including Shenzhen[96]. From this fund, a total of RMB 308.5 million (USD 45 million) worth of interest rate subsidies were given to SEIs (about 2.6% of the total loan value), and approximately 25% of those subsidies went to the electronics industry[97].

The Guangdong government was one of the first provincial governments to start undertaking equity investments in private-sector projects, under the umbrella of special funds. The Guangdong SEI Development Special Fund supported equity investments of a total of RMB 395 million (USD 63 million) between 2013 and 2016, RMB 200 million of which (USD 32 million) went to a project by TCL to produce a 8.5 generation TFT-LCD screen project and at least another RMB 50 million (8 million) went to other electronics-related projects[98]. Equity investments have been used more extensively under the Guangdong Industrial Upgrading Action Plan, accounting for 69.3% of total funding in 2015[99]. However, it will take time for the industry at large to warm up to this approach.

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[95] Interview GZ08, footnote 37.

[96] Funds are also created at the city level. Provincial funds normally spend on firms throughout the province, but in this case Shenzhen was excluded. The funding number was derived by multiplying the annual fund of RMB 450 million over the three years for which calls were published (GEIC, 2010).

[97] Author's calculations on data derived from various announcements on GEIC website (www.gdei.gov.cn).

[98] ibid.

[99] See footnote 94.

An interviewee from a business association warned that there is no clear legal framework outlining what the role of the institutional investor would be and how much of a voice the government would have in the funded project[100].

Additionally, there are state-owned provincial- and city-level venture capital funds that are encouraged to invest in promoted industries. The Guangdong SEI Venture Capital Fund is one such case. It invests through its financial arm, the state-owned Guangdong Finance Group into the also state-owned venture capital fund Guangdong Technology Electronics Venture capital in Huizhou. The hope is that investments in these funds would be augmented with contributions from the private and the SOE sector. The provincial investment would then be in the region of RMB 50 million (USD 7.4 million) for funds of 5 to 10 times that in scale (GDRC 2013a,b,c).

The target of the measures above are all firms, regardless of their ownership status, although in practice few foreign-funded firms apply for these[101]. Additionally, even though policy support has widened, policy-makers are still keen on designating key enterprises. For example, during the 12FYP, there was an annual announcement of firms that were considered 'backbone' (about 50 firms, including 8 previous champions) and a longer list of firms that are being 'cultivated' to become backbone (close to 100 firms) and these are prioritized in provincial funding and received preferential access to county-level funds. To be a backbone firm during the SEI initiative, a firm needed a high percentage of staff with university degrees (over 30%) and of staff dedicated to R&D (over 10%) and to have assets worth over RMB 50 million (USD 7.4 million) and revenue over RMB 100 million (USD 14.8 million), out of which revenue from SEI-related products should make at least 70%. Over 3% of annual revenue should be spent on R&D and the companies should have patents and IP rights (GEIC, 2010).

Finally, government procurement in China has been used to encourage indigenous innovation (Liu et al, 2011). A product could achieve the Indigenous Innovation status, if it was provided by an enterprise that both created and registered its intellectual property (IP) in China or if it was provided by a Chinese enterprise that had obtained the relevant

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[100] Interview F04, footnote 36.

[101] Interview with business consultant, GZ06, Guangzhou 23 March 2015.

IP rights or licenses. The products should also have a certification from the National Certification Administration (or its provincial departments), embody a high degree of creativity and innovation and be of reliable quality. Local firms supplying such products were given preference in bidding for procurement (as they were given a chance to lower their price if their initial offer was higher than that of a foreign competitor). The evaluation measures circulated also implied a higher scoring for indigenous innovation produces in price and technical evaluation (Boumil, 2012). However, China came under pressure to cease this measure and the State Council issued a statement announcing the delinking of indigenous innovation and procurement (USBC, 2014).

Guangdong has discontinued its promotion of indigenous innovation products through procurement, but throughout the short time that it implemented the initiative, it had an effect particularly in the LED industry, as a large number was purchased for use on highways (GDST, 2011). By 2014, the province had installed more than 2 million LED lamps on streets to cover more than 40 km of streets an almost five fold increase since 2011 (GDST, 2014). However, Yang (2014) argues that in Shenzhen the combination of procurement and subsidies in LEDs led to rapid entry by domestic firms, but this was accompanied by overcapacity and little technological upgrading, indicating that in many cases firms are not disciplined into using rents for technological learning.

4.8.2 Aligning FDI with Development Objectives

A number of factors have come together since the mid-2000s to create an environment in which low value-added, labor-intensive manufacturing has become an increasingly untenable business. For Guangdong, the ‘bet’ is to be able to replace those investments with higher value added ones or to force existing operations to upgrade.

First, corporate income tax reductions for foreign firms have been phased out since 2008 in China and export-oriented projects are no longer listed as an encouraged category in the Guiding Catalogues for Foreign Investment. Incentives are given instead for high-tech projects or for moving inland. In Guangdong there is now a closer scrutiny of investment projects to ensure they fulfill developmental objectives[102] and tax incentives,

[102] Interview F04, footnote 36.

even if they concern county taxes, are not used as frequently as before to attract investments[103]. At the same time, the central government has attempted to centralize approvals for important projects so as to reduce competition between local authorities based on tax[104]. These developments have forced industrial parks to compete on the basis of service quality, proximity to supply chains, the extent of the local market and other business facilitating services, rather than tax incentives.

Second, the centralization of permits for important projects has also been used to leverage FDI for technology transfer. For example, in 2009 in the LCD display segment, the NDRC only approved projects that had a Multinational Corporation (MNC) partner[105], namely LG (in Guangzhou) and Samsung (in Suzhou), ostensibly because foreign partners agreed to share core technology (Chen and Ku, 2014). The pressure on TNCs to act as a technology provider is expected to increase as the Made in China 2025 unfolds, which explicitly promotes the transfer and the assimilation of foreign technology. The recent commitment of Apple to build an R&D center in Shenzhen may also be interpreted under this light. Such decisions also have cascade effects along the chain. In the case of Apple, Foxconn has considered building a new plant in Shenzhen to support Apple's facility on advanced products[106].

Third, the provincial government launched the initiative of 'double relocation', under the slogan of 'empty the cage for new birds to settle down' (*tenglong huanniao*)[107], coined by Wang Yang (Guangdong Party Secretary, 2007-2012). Low value added, labor-intensive and polluting factories have been transferred from PRD cities into industrial parks of more peripheral cities and counties. The initiative, which later spread to other coastal provinces like Zhejiang and Jiangsu, can be interpreted as a way to encourage upgrading in the region, not by forcing existing operations to upgrade, but by inviting new, higher-value added investments to take its place (Lim, 2016; see also Di Tommaso et al, 2013).

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[103] Interview GZ06, footnote 101.

[104] Interview with government official, F05, Foshan, 15 April 2015.

[105] Nevertheless, provincial projects without MNC partners also went ahead, as in the case of TCL in Guangdong, highlighting the lack of consistency encountered so often in Chinese policies.

[106] 'Foxconn to Build Shenzhen Plant for Apple', *Sinocast Computers and Electronics Beat*, 19 January 2017.

[107] Miller, Tom 'China's plan to empty the bird cade', *Financial Times*, June 10 2009

Fourth, wages and other factor costs have been increasing fast in the past few years, depressing margins even further, especially for small, labor-intensive operations. Migration flows of unskilled workers have ebbed, with fewer migrants making it to the coastal regions, as opportunities emerge inland. Even though wage increases are a welcome consequence of industrialization, they have also been encouraged by the government with its more stringent application of the Labour Law[108].

Fifth, the previous abundance of migrant labor has come to end. For example, Flex, a first tier supplier, cites lack of labor availability is one of its biggest problems. The firm's Chief Financial Officer was quoted as saying at Forum in 2010[109]:

"Labor as a percentage of sales is such a small number [that the wage increase] really doesn't impact margins significantly at all so we're not worried about it in that respect but it's certainly something that we have to be competitive [in]. In terms of labor availability, we've seen that there is less availability on the coastal regions compared to how it used to be. People are not migrating as much and so what you have to do is move inland and so we are moving inland with some of our facilities, or opening up new facilities inland to take some of the labor pressure away."

To respond to these developments firms have employed diverse strategies, some of which contribute to the sector's overall upgrading.

First, the erosion of margins in low-end projects has prompted many firms to sell in the domestic market instead, as revealed in chamber of commerce surveys (Amcham South China, 2014; CMA, 2013). This is a trend that is reflected in aggregate statistics as well. At their peak in 2008, FIEs in Guangdong exported 84% of their output, while in 2014 the percentage was 73% (GBSb, various years). A turn towards the domestic market may imply more back-end processes locating to China, as product design and adaptation tends to locate close to the market. For example, Flex established a Product Innovation Center in Zhuhai in 2013, whose main function is to adapt products for customers who want to sell in the region. The domestic brands have become increasingly important customers for such

[108] See footnote 82.
[109] 'Flextronics at CLSA AsiaUSA Forum', *CQ FD Disclosure*, 3 March 2010.

first-tier suppliers[110], so such trends may be accentuated in the future. Huawei is one of Flex's largest customers and the two firms are even working together on Huawei's sustainable supply chain standard[111].

Second, many firms are taking up the government's financial incentives to move labor-intensive facilities elsewhere, but keeping higher-end functions or headquarters in advanced regions, such as Shenzhen. The strategy of relocation has enjoyed varied success so far. One interviewed firm[112] described its experience in a positive light. The firm was a producer of Printed Circuit Boards (PCBs), a relatively low-tech component in electronics. It was established in Shenzhen but the rising land and labor costs,made the cost prohibitive. The company opted to relocate under the scheme to Meizhou, the hometown of one of the owners. There, the firm found the new park well designed and with good wastewater management. The biggest problem for the firm was getting qualified staff to move there. In contrast, a first tier supplier manager suggested that moving inland was not a sustainable option, as the wage differential with inland provinces is often not large enough to compensate for the productivity gaps. Once the generous incentives expire (free buildings, no income tax), firms often come back[113].

Third, the pressure to find workers also has pushed some firms to make themselves more attractive to workers. An interviewed PCB manufacturer in Dongguan[114] argued that he had to change his attitude towards attracting workers. In the past, the majority of workers were migrant females below 30 years old. Now, there are more men on the production line and older women. The firm has built flats for families and an experimental kindergarten to make it more attractive to workers and reduce turnover.

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[110] A manager working at an EMS factory in Guangzhou suggested that this is still not very widespread. The Chinese firms themselves are used to working with very low profit margins and sometimes – even the big brands – cannot afford to hire the large EMS firms and chose local, smaller scale suppliers. Interview GZ11, Guangzhou 19 November 2015.

[111] Huawei steps up standard to be the Chinese electronics industry's poster boy for sustainability, Bien Perez, *SCMP*, 18 September 2016.

[112] Interview SZ01, Shenzhen 23 January 2015.

[113] Interview SZ04, see footnote 62.

[114] Interview DG01, Dongguan 28 October 2015.

Finally, firms have the option to upgrade their processes, supported by policy incentives to adopt intelligent manufacturing under the umbrella of Made in China 2025, discussed previously. Foxconn drew attention when it announced plans to fully automate its factories. Originally, the company wanted to move production inland and transform the Shenzhen plants into R&D and quality testing centers[115], but in the end, some production facilities remained in Shenzhen and they were gradually automated, together with other facilities in China. The 'foxbots' as its robots are called, are developed and produced by Foxconn in China[116].

4.8.3 Indigenous Innovation for Upgrading

Some authors have questioned whether policies to encourage indigenous innovation are compatible with a strategy of upgrading in globalized industries.

For example, Chen and Ku (2014) posited that there might be a conflict between these two strategies if the incentives of upstream and downstream suppliers are not aligned. The authors suggest that TCL leapfrogged with heavy state support into advanced liquid crystal displays (LCDs) and the firm would suffer from high learning costs. However, TCL's multi-decade experience in TV assembly meant that it was able to absorb the technology quickly and is now one of the fastest growing TV brands in the US market[117], while getting ready to launch an even more advanced factory in Shenzhen. Moreover, it is a vertically integrated firm, able to absorb its own production. Similarly, Huawei and ZTE developed chipsets to be used in their own handsets, which are manufactured by TSMC, while they also make use of outsourced chips, notably by Qualcomm, thereby using both own-developed components and global sourcing.

Ernst (2014) also argues that the indigenous innovation initiative launched by the central government set targets for domestic R&D for firms in the semiconductor industry and encouraged firms to limit technology imports. Ernst argues that by doing this, the central government has constrained firms' abilities to create global partnerships and access

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[115] 'Hon Hai: To Transform Shenzhen Plants Into R&D, Quality Testing Centers', *Dow Jones International News*, 18 August 2010.

[116] 'Foxconn boosting automated production in China', *ETMAG.com*, 3 January 2017.

[117] See footnote 29.

the most advanced technologies in the semiconductor segment. In this context, insisting on indigenous content may perpetuate the gap between Chinese and US firms. However, it is not clear if firms supported by the Guangdong government were subject to quotas on R&D, as the author suggests, at the expense of technology imports or global partnerships. The industry did reduce technology imports, from 0.18% of output in 2005 to 0.04% in 2012 (GBSc, various years), but the total funds for technology imports are only between 1-13% of what is spent on R&D on any given year. There is not much evidence in the policy documents or the interviews to suggest that in Guangdong firms were compelled to turn their attention to domestic innovation. This may be because of the tendency of Guangdong policies to use market instruments rather than fiat[118], or due to the nature of consumer and telecommunication electronics, as opposed to semiconductors. In consumer electronics, it is possible to develop brands (at least in less mature markets) and still rely on imported high-tech components, but in semiconductors it is necessary to develop domestic capabilities to be able to design and fabricate the product.

Moreover, despite the clear policy support in favor of developing domestic capabilities, the big brands of Guangdong remain embedded in global networks of technology and maintained an export orientation. Huawei, ZTE and TCL, as the most sophisticated brands, regularly go into technology partnerships and engage in global acquisitions. In 2016 Huawei was ranked 50th in global brand BrandZ's top 100 and 13th as a technology brand. In 2016 ZTE, was the third-largest seller of Android smartphones in 2016 in the U.S[119]. Beyond the flagship firms, many more have emerged. Oppo and Vivo are currently the 4th and 5th largest smartphone producers in the world, with fast growth in emerging markets, especially Southeast Asia and India[120]. The two brands are owned by BBK Electronics, which is based in Dongguan, a firm established in 1995 to manufacture VCDs and DVDs. Oppo, which is expanding aggressively abroad, sourced technology for its camera, one of

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118 Interview with government-affiliated research centre, GZ05, 25 March 2017.

119 Clover, Charles, ZTE rings up success in US smartphone market, *Financial Times*, February 4 2016.

120 'TrendForce Reports Global Smartphone Production Volume Reached 324 Million Units This Second Quarter', *Business Wire*, 3 August 2017.

its key distinguishing features, from Corephotonics, an Israeli startup[121], and frequently uses Qualcomm chipsets[122]. Other brands include the Coolpad brand of smartphones and tablets, which are produced by Yulong Computer Telecommunication Scientific, a company founded in 1993 in Shenzhen, and Skyworth, a TV brand founded in Shenzhen in 1988.

In addition, the development of local firms has created a large source of demand for the components and subassemblies produced by foreign first-tier suppliers like Foxconn[123] and smaller second-tier suppliers. Far from being encouraged to try to develop technologies that cannot be absorbed locally as Chen and Ku (2014) and others have suggested, the firms that are promoted create downstream demands for the existing production base. The large manufacturing base that was created in the PRD, with its origins in the low-end foreign-led operations of the 1980s and 1990s, is now also a source of attraction, not only for attracting higher value added FDI but also for new, hardware-based Chinese start-ups. For example, the large, foreign-owned, end-to-end outsourcing services firm PCH Electronics, not only continues its presence in the province despite the higher costs but also has gone on to employ 200 engineers to work on product design[124]. The main reason put forward, is that in the PRD, suppliers are always three hours away, the supply chain is predictable and the local factories can work on small-batch and low-inventory ways, which increases flexibility[125]. A similar reason was put forward by an interviewed large consumer drone supplier[126]. The company identified its main strength against better-funded foreign

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[121] Low, Aloysius 'Oppo phones will soon have 5x loseless zoom', *CNETnews.com*, 27 February 2017.

[122] Li, Jane and Soo, Zen 'Glass maker Schott dials China smartphone brands', *SCMP,* 23 February 2017.

[123] Wu, Debby and Cheng, Ting-fang 'Exclusive: Foxconn to build new Huawei smartphone factory in western China', *Nikkei Report*, 22 May 2016.

[124] Murgia, Madhumita 'Meet Liam Casey: the man behind your Made in China tech', *The Telegraph Online*, 6 October 2015.

[125] Kassei, Matthew 'Manufacturing Guru Liam Casey Looks Back – and Ahead; The man known as 'Mr China' discusses the importance of selling and what China and the U.S. can learn from each other', *The Wall Street Journal Online*, 8 June 2016.

[126] Interview with Chinese brand in consumer electronics, SZ07, Shenzhen 30 March 2017.

competitors as its proximity – and its relationships - to suppliers, which allows the firm to make prototypes within one day and turn out updated products faster.

These developments highlight the positive synergies between industrial policy and upgrading within GVCs over time. Pursuing integration into the global economy through heavy reliance on FDI in the past allowed the emergence of large clusters of low-end suppliers, while industrial policies focused on developing stronger and more capable domestic firms with an outwards orientation. In the end, the former have acted as 'industrial commons', becoming a source of competitiveness for both foreign and domestic global players. Meanwhile the more advanced domestic firms have upgraded within GVCs, outsourcing their production and engaging in global innovation networks. Retaining the manufacturing competitiveness of supply clusters in the PRD will continue to feed these synergistic relationships and allow more firms to emerge and/or upgrade.

4.9 Conclusions

For years, Guangdong had a bad reputation when it came to innovation, being charged with imitation and copycat production. The weaknesses in core electronics components, such as semiconductors and the large swathes of low-end suppliers, have added to the perception that the PRD model was unsustainable.

The provincial trajectory had been studied by scholars mostly with regards to the low-end clusters in computer peripherals and mobile phones. However, these works have been unable to shed light on an increasingly diverse industry, featuring dynamic domestic firms alongside traditional foreign and domestic GVC suppliers. This chapter has shown that an account of Guangdong's electronics industry needs an integrated perspective, taking into account the multi-level government structure in China and the multiple policies that have shaped industrial growth and upgrading. What have seemed like 'separate universes' - the supported and at times protected domestic large firms and the almost unregulated mushrooming foreign-led clusters - in reality begun their post-reform journey together and have now become further integrated. What the aggregate numbers hide, is a diverse industry, with frontrunners and laggards, which nevertheless form part of the same production system.

Overall, industrial policy in the context of GVCs in the case of Guangdong has relied on some old and tried tools: using good infrastructure to attract foreign investments, using instruments such as JVs to increase spillovers, offering the domestic market as leverage for technology transfer, incentivizing localization of more sophisticated components and putting in place funding and incentives for R&D and commercial application of high-tech research. However, the supported firms in Guangdong did not only focus on the domestic market, but also adopted a mixed strategy, using their integration at the lower end of export-oriented global value chains to improve their technological capacity and compete in the domestic market. The champions, even as they grew and became vertically integrated, did not lose their connection to the global industry and relied on sourcing components and technologies from abroad to complement their production capabilities. As their capabilities have accumulated, they have been able to advance in vertical integration, tackling areas that are more sophisticated and capital-intensive, such as IC design and advanced display production.

Policy-makers always wanted to encourage the domestic firms to reach the technological frontier. However, this has only become possible in the latest decade, indicating that learning is a long evolutionary process. Many of the firms that emerged as brands in this current phase have been around for decades, working at the lower end of the chain or having limited success with their own brands. Ultimately, innovation policies in this latest phase had more chances of success with a group of industrial firms that was already mature in the manufacturing process and had engaged extensively in the global market. However, policies are still not addressing the deficiencies of the innovation system in a comprehensive way, leaving question marks about whether the Guangdong electronics industry can reach its full potential. Funding to the private sector (especially SMEs), is constrained, and there remains a lot to be done on building quality higher education and increasing research capabilities in the public sector.

5 A Long Voyage to Ithaca: The Experience of Malaysia in the Electronics Industry

5.1 Introduction

The efforts of the Malaysian government to promote the development of the electronics industry exemplify an approach that relies on integrating and upgrading within Global Value Chains (GVCs). Integration has been pursued mostly by attracting export-led Foreign Direct Investment (FDI), first in semiconductor assembly and after the mid-1980s also in consumer electronics, computers and peripherals. Upgrading has been encouraged by putting conditions on FDI regarding local contents (until this clashed with World Trade Organization or WTO rules), Research and Development (R&D) expenditures, and other criteria related to the sophistication of processes within the firm, such as tax incentives dependent on the ratio of engineering and science and technology (S&T) staff to total or on R&D as share of revenue. Government programmes also aimed to increase incentives and resources for Small and Medium Enterprises (SMEs) to participate in GVCs, by encouraging linkages with large firms by providing tax incentives to the latter.

The case of Malaysia demonstrates that, without industrial policy measures that provide incentives to firms to accumulate technological capabilities and an innovation system that can stimulate such behaviour, upgrading within GVCs is limited. As reviewed in Chapter 2, the dynamics that exist within GVCs can contribute to the accumulation of technological capabilities within firms in developing economies over time. Foreign subsidiaries can obtain technology and management expertise from their parents and gradually engage in the production of more sophisticated products and the use of more complex production techniques. Over time, sourcing linkages may also develop and labour turnover can also diffuse technological capabilities in the local economy. The developments in the Malaysian electronics industry show that such developments are indeed possible, with many firms gradually upgrading and some domestic firms emerging as suppliers of equipment and sub-contracting services. However, the Malaysian electronics industry, after nearly 50 years of development, does not feature any firms at the technological frontier, global brands or at least sophisticated first tier suppliers. The situation is worse when considering the diffusion of capabilities to the domestic economy, where few firms have emerged.

This Chapter argues that policy initiatives to promote the development of the industry in Malaysia have not been able to leverage the opportunities provided by integration into GVCs. The instruments used have not provided adequate incentives for learning, while manufacturing has often been overlooked as a source of innovation in favor of science-based SMEs. Prioritizing inter-ethnic redistribution over technological capability accumulation as well as conflicts between the objectives of state and federal governments have also hampered upgrading. Without access to a well-funded innovation system that reaches manufacturing firms and without adequate incentives for engaging in learning, firms have only upgraded incrementally, a process that has been too slow and has not enabled firms to engage in frontier activities.

Moreover, it is argued that the industry has evolved over four phases, each with its own opportunities and challenges for upgrading arising from the changing policy instruments, the changing dynamics of the electronics GVCs and the evolutionary character of capability accumulation within firms. During the first phase (1957-1967) Malaysia undertook some import substitution efforts to stimulate industry, and the first factories in the industry were set up. However, it was during the second phase (1968-1985) that the industry really emerged based largely on the attraction of labour-intensive, export-oriented foreign investments. During this time the government made no efforts to develop domestic firms that could link to the industry or to target electronics FDI as a source of technological capabilities. The third phase (1986-2005) saw the promotion of high-tech activities in foreign subsidiaries and the emergence of some domestic firms. However, the incentives used were not enough to push firms to engage in learning, while the innovation system remained disconnected from manufacturing firms. During the fourth phase (2005-now) the government has attempted to develop the capital-intensive parts of the value chain and paid more attention to the development of domestic firms. While the industry continues to operate far from the frontier, some of the recent initiatives are promising and may mark the beginning of a new phase in the development of the industry.

The Chapter is structured as following. Section 2 offers a review of the literature on the development of the electronics industry in Malaysia. Section 3 reviews the performance of the industry over time. Section 4 discusses three issues related to policy-making in the industry (the role of ethnic redistributive politics, the federal-state government relationship and the governance structure in the electronics industry). Section 5 discusses the dynamics of upgrading in each of the four distinct policy phases in the industry's development. Section 6 contains the conclusions of this Chapter.

5.2 Literature review

The development of the electronics industry in Malaysia has been the subject of several studies during the last four decades. Over time, a consensus has formed in the literature, arguing that the Malaysian electronics industry has undergone significant upgrading since the industry took roots in the 1970s, but with few firms, if any, breaking into frontier activities, becoming first-tier suppliers or developing their own brands.

The first studies on the Malaysian electronics industry used it as a case study to assess the contribution of FDI to local economic development. Influenced by dependency theory, these works set out to demonstrate the low-level of technological capabilities in foreign subsidiaries, the use of precarious, predominantly female labour to perform assembly tasks (Lim, 1978; Hui, 1975) and the relatively few opportunities for sourcing that materialized for Malaysian firms (Chee and Lee, 1979 on Japanese Multi-national Corporations (MNCs) including electronics; Anazawa, 1985).

A series of works in the 1990s demonstrated that MNC subsidiaries in the industry had been upgrading since the mid-1980s (O'Connor, 1993; Rasiah, 1996; Hobday, 1999; Ismail; 1999; Capannelli, 1999; Goh, 1999; Ariffin and Bell, 1999). These studies, grounded in the technological capabilities framework, argued that contrary to the predictions of dependency theory, FDI-led export-oriented assembly operations could, under the right circumstances, upgrade into more sophisticated operations and diffuse managerial and technological skills throughout the economy. Ismail (1999) and Hobday (1999), both relying on interviews with firms in the early 1990s, found that while product

R&D remained limited, apart from exceptions such as Intel that conducted R&D on mature products, several firms undertook process R&D, such as Motorola and Texas Instruments. Moreover, the complexity of products started increasing (Arrifin and Bell, 1999), sourcing linkages started developing between foreign subsidiaries and local firms, facilitating technology transfer (Ismail, 1999; Rasiah, 1994; Noor et al, 2002) and upgrading increased demand for high-skilled labour (Rasiah and Nrayathan, 1992).

The optimism of the 1990s about FDI-led industrial upgrading through labour turnover and linkages with local SMEs started to be replaced by fears of ‘stalled industrialization’ (Henderson and Phillips, 2007) as Malaysia’s manufacturing industries started ‘running out of steam’ (Tan, 2014). Adopting a GPN perspective, Ernst (2004) and Henderson and Phillips (2007) noted that local firms continued to occupy the lower-ends of the value chain, with few signs of upgrading. Recent surveys of firms in Penang (Rasiah, 2010) and Johor (Van Grunsven and Hutchinson, 2016) across local and foreign firms, confirm that upgrading “is not fast enough to help stimulate the catch-up process” (Rasiah, 2010 p. 316).

Most studies on the Malaysian electronics industry concentrate on a few key factors behind the modest upgrading witnessed so far. First, Malaysia had been experiencing fast wage growth and many subsidiaries found the need to adopt labour-saving techniques, which increased the need for local sourcing as well as for higher skilled managerial and shop floor staff (Rasiah and Narayathan, 1992; Rasiah, 1999). Second, industrial policy measures implemented by the Malaysian federal government and the Penang Development Corporation (PDC) were seen as critical in facilitating the development and upgrading of the industry. The instruments that have been singled out are the efforts of the Malaysian Investment Development Authority (MIDA) and PDC to attract specific firms with incentives, targeted infrastructure and the establishment of the Penang Skills Development Centre (Singh, 2011; Athukorala, 2014), the role of the PDC in linking local firms to foreign subsidiaries (Rasiah, 1994; Rasiah 1999) and the efforts of the Malaysian government to provide incentives for R&D and increase the density and quality of the innovation system (Rasiah, 1999; Lall, 1995; Jomo and Edwards, 2003; Felker and Jomo, 2007). The lack of sustained upgrading into high value added activities is mostly attributed to weaknesses in policy design and implementation, such as the lack of adequate monitoring and evaluation (Lim and Ong, 2007), badly designed instruments (O’Connor, 1993; Rasiah, 2015) and inadequacies in the support infrastructure for innovation (Best and Rasiah, 2003). The political economy of industrial policy in Malaysia has also put emphasis on ethnic redistribution often at the cost of promoting capability accumulation (Jomo and Gomez, 2000; Lee, 2007; Gomez, 2012; Henderson and Phillips, 2007).

Overall, the literature has examined two key issues that are relevant to the framework of this research (as explained in Chapter 2): the role of the state in encouraging integration in GVCs by attracting FDI (rather than developing local suppliers that can integrate into GVCs), and the accumulation of technological capabilities in –predominantly foreign - firms. However, two gaps remain in the literature that this Chapter aims to fill.

First, there is need to update the literature with more recent developments in policy. Much of the existing literature reviewed above, is based on the developments in the Penang cluster during the period 1985-2000, when automation and upgrading in several foreign subsidiaries took place and industrial policy became more strategic, compared to the previous decades (Lall, 1994). However, the literature has not examined the developments in policy after Mahathir stepped down in 2004. The brief retreat from strategic initiatives on manufacturing (2004-2009) during Prime Minister Badawi's term was followed by the launch of the Economic Transformation Programme (ETP) (2010-2020) by Prime Minister Najib. The ETP launched projects to diversify the industry and more funding became available to domestic investors.

Second, most works have focused on foreign subsidiaries and the few works that focus on domestic firms are limited to those in supporting activities (such as tooling and machinery) (Rasiah, 1994; 1999; Best and Rasiah). This means that most studies on industrial policy in the electronics industry explore its impact on upgrading in foreign subsidiaries and on creating linkages with equipment suppliers, but they do not explore the factors that have constrained the emergence and growth of domestic firms in core manufacturing activities in electronics (e.g. semiconductor design and fabrication, assembly of semiconductors and boards and final product assembly). In contrast, this Chapter analyses the lack of domestic firm involvement in core activities as the result of the GVC-led development model adopted by the Malaysian federal and regional governments.

5.3 What the data says about upgrading

As discussed in Section 5.2, the literature points to limited upgrading taking place in the Malaysian electronics industry, with technological capabilities developed in process and product R&D, but with no firms undertaking frontier innovations, or reaching lead firm status. This picture is also supported by the statistical data available for the industry that is reviewed in this section.

The data presented here are drawn from the annual industrial surveys (1973-1989) and from the annual surveys of manufacturing industries (1993-2015), conducted by the Department of Statistics Malaysia (DSM). Data on investments have been collected from MIDA annual reports (1967-2015). The electronics sector in this section encompasses (unless otherwise stated) three classes of goods: manufacture of office, computing and accounting machinery (e.g. computers and peripherals); manufacture of television and radio receivers, sound or video recording or reproducing apparatus and associated goods (consumer electronics) and; manufacture of semiconductors and other electronic components and communication equipment and apparatus (electronic components).

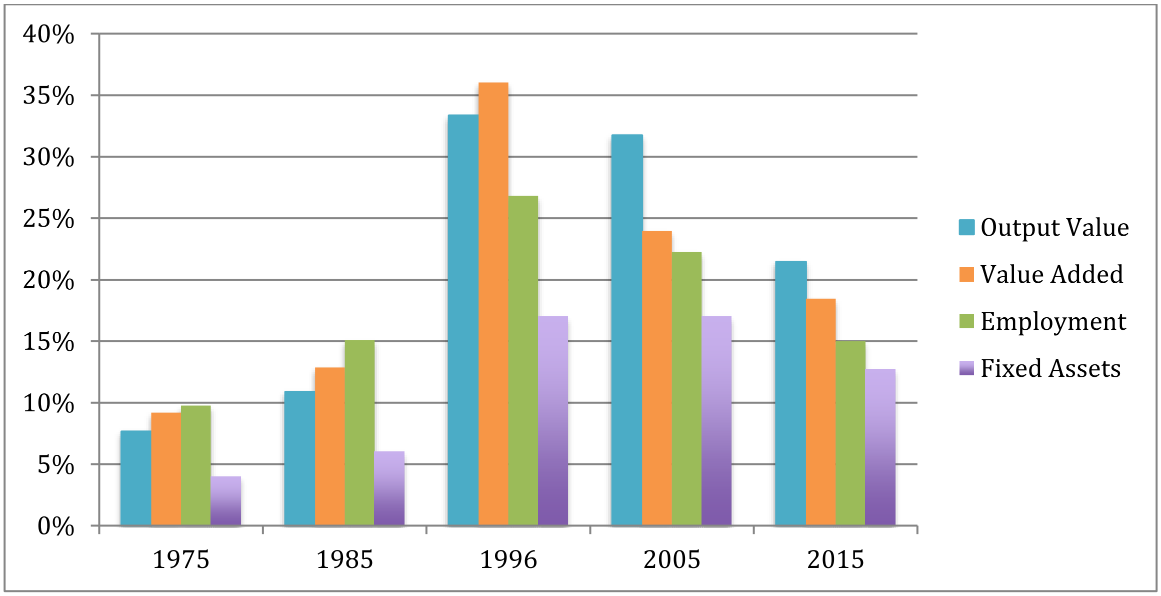
It should be noted that the data has several limitations:

- There are several missing years in the surveys. Instead of extrapolating values for missing years, data is presented only for the years available.
- Surveys have used the three different versions of the Malaysian Standard Industrial Classification (MSIC). There were efforts to match these over time by the by the author.
- Published survey data does not contain information on ownership.

There is no doubt that electronics has become one of the most important industries in the Malaysian economy since the first operations were established in the 1960s. Electronics accounted for a mere 8% of total manufacturing output value in 1975, but by 1999 it reached a peak of 41%. Since 2001 the importance of electronics in Malaysian manufacturing has been declining. In 2015 electronics accounted for 21% of output, 18%

of value added, 15% of employment and 13% of fixed assets in the total manufacturing sector (Figure 5.1).

Figure 5.1 Share of electronics industry in total manufacturing, Malaysia, selected variables and years

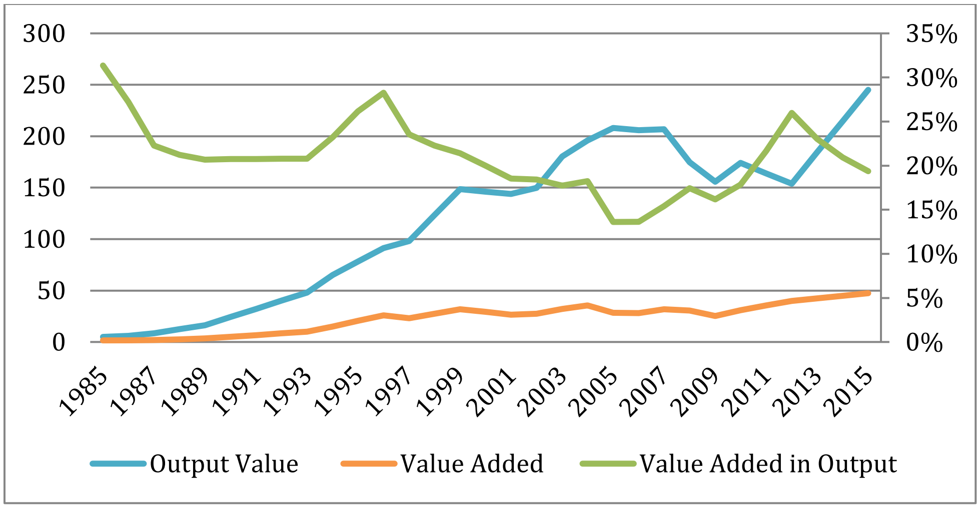


Source: Author's calculations on data from (DSM) (various years, a and b).

The output value and value added of the electronics industry declined between 2005 and 2012, although they recovered by 2015 (Figure 5.2). The organization of the electronics industry along GVCs implies a high share of intermediates in production, as each firm adds only a part to the final value added. In the Malaysian electronics industry the share of value added in output has varied widely over time. It was 31% in 1985, but started declining in the second half of the 1980s. In the mid-1990s it peaked again at 28% and then declined to a low of 14% in 2004-2005. It then recovered to 26% in 2012 and then dropped again to 19% by 2015. The big drops in the share of value added in output between 1985-1989 and 1996-2005 point to phases of 'downgrading'.

Figure 5.2 Output value, value added and share of value added in output, Malaysian electronics industry, 1985-2015

Left axis: Malaysian Ringgit (RM) Billion, current prices. Right axis: Share, %

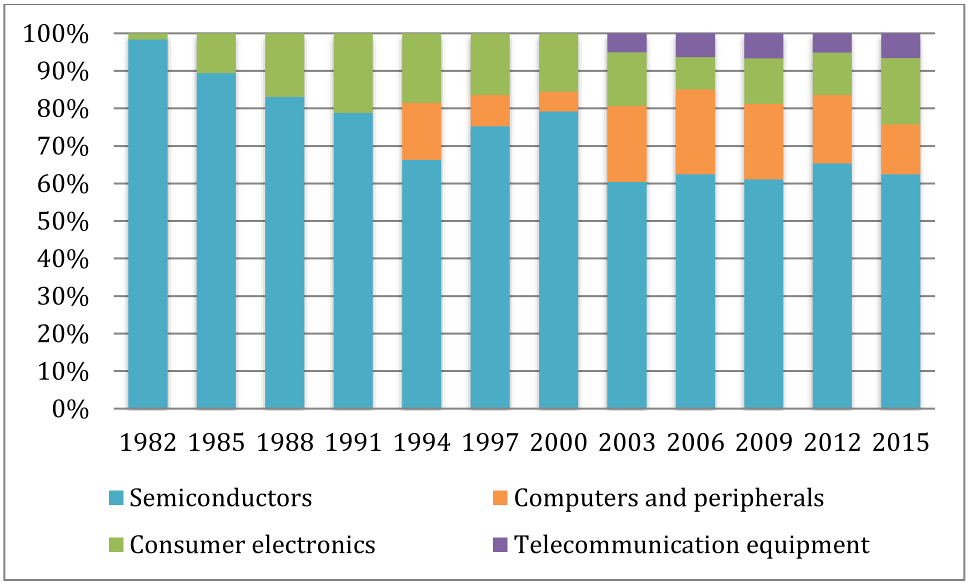


Notes: Values in current prices. Missing values have been extrapolated.
Source: Author's calculations on data from (DSM) (various years, a and b).

The semiconductors segment used to account for almost the entire industry until the 1980s, but the industry has diversified since then (Figure 5.3). The production of consumer electronics started increasing in the mid-1980s and that of computer and peripherals (primarily hard disks) in the mid-1990s. These two segments have accounted for 15% to 20% of the industry's value added since 2001.

Figure 5.3 Structure of the electronics industry in Malaysia, selected years

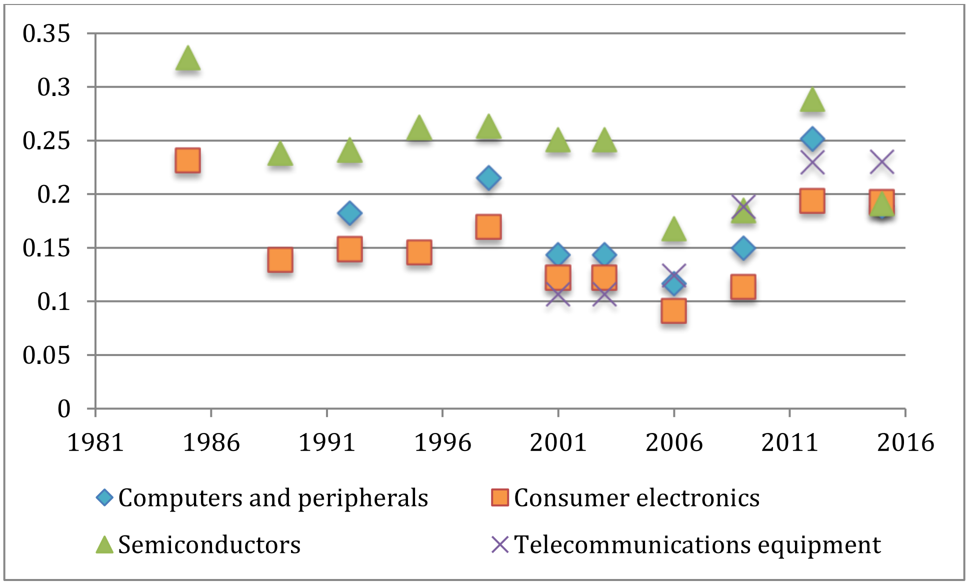
Share of electronics segments in total electronics value added, %



Notes: Telecommunication equipment was included in semiconductor segment before 2001.
Source: Author's calculations on data from (DSM) (various years, a and b).

The share of value added in output in semiconductors has been consistently higher than in other segments. This indicates relatively lower usage of intermediate inputs compared to the other electronics segments (Figure 5.4). However, in 2015 value added in output in the semiconductor segment dropped to 19%, the same level as the other major segments.

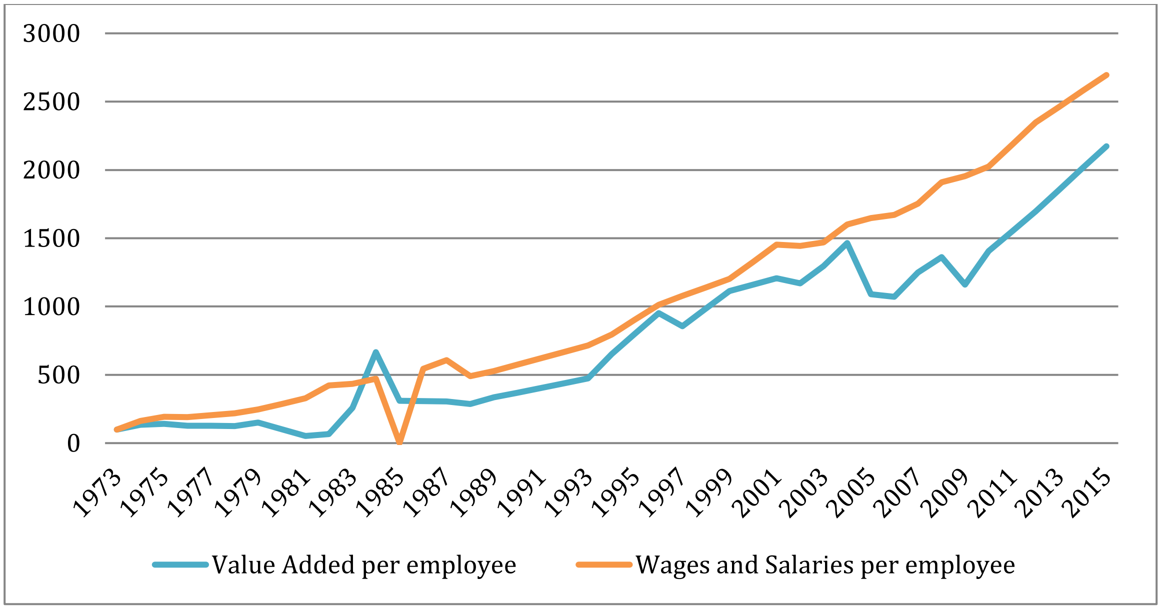
Figure 5.4 Share of value added in output for electronics segments, %, Malaysia, selected years



Notes: Telecommunication equipment was included in semiconductor segment before 2001.
Source: Author's calculations on data from (DSM) (various years, a and b).

Labour productivity in the electronics industry has been rising continuously since the 1970s, as measured by value added per employee. Between 1973 and 2015 value added per employee increased by 21 times (Figure 5.5), rising sharply since the mid-1990s. This trend is consistent with increases in installation of labour-saving, numerically-controlled machines in semiconductor assembly facilities during that period, as described by Rasiah (1994). Wages and salaries per employee have been growing more than value added per employee, especially during the late 1970s and early 1980s and after 2004.

Figure 5.5 Value added and wages per employee, Malaysian electronics industry, 1973-2015, 1973=100



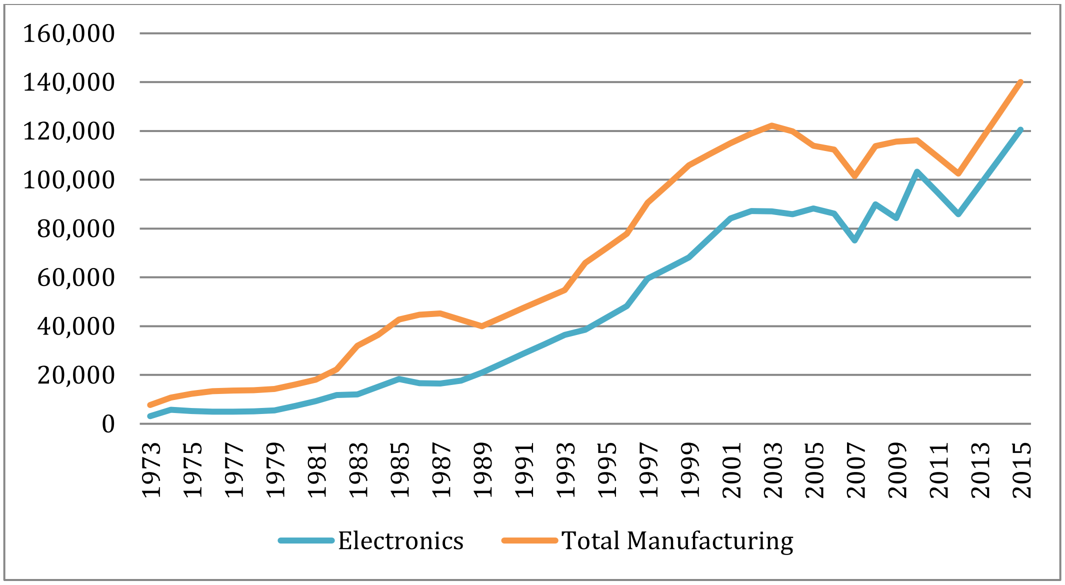
Note: Based on current prices. Missing values have been extrapolated.

Source: Author's calculations on data from (DSM) (various years, a and b).

Fixed assets per employee have increased by 38 times between 1973 and 2015 (Figure 5.6). A steep rise can be observed between 1993 and 2001, matching the observation of higher automation in semiconductor facilities taking place at the rime. However, growth in fixed assets per employee slowed down after 2001 (even turning negative for some years) with the exception of the more recent figures for 2015. It is also worth noting that fixed assets per employee are higher for the manufacturing sector as a whole than in the electronics industry, suggesting that the electronics industry continues to be more labor-intensive than other manufacturing industries in the country.

Figure 5.6 Fixed assets per employee, Malaysia, 1973-2015

RM, current prices

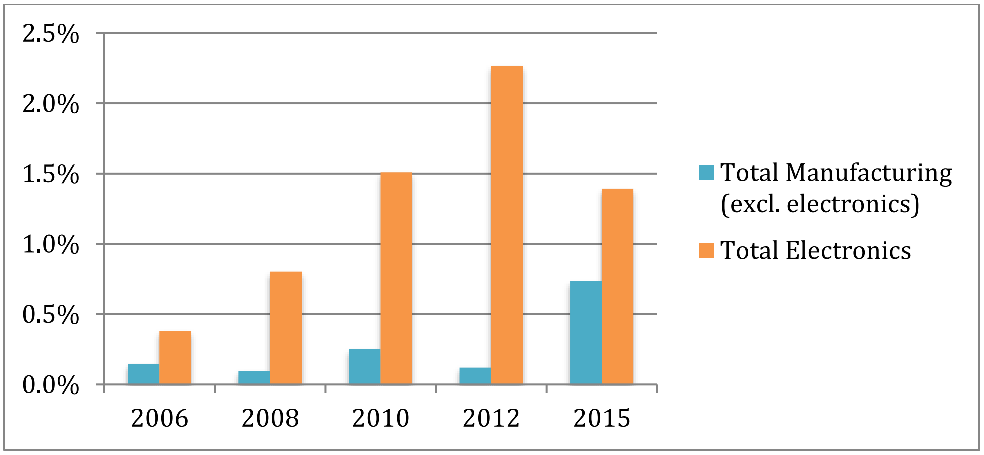


Note: Missing values have been extrapolated.

Source: Author's calculations on data from (DSM) (various years, a and b).

Unfortunately, there is no data on R&D as a share of sales or output in the industry before 2005. Data after 2005 shows a steep rise in R&D as a share of output in electronics from 0.5% in 2005 to 2.3% in 2012, and a drop to 1.4% in 2015. By comparison, the share for the total manufacturing sector (excluding electronics) has increased during the same period from 0.3% to 0.7% (Figure 5.7). On average, between 2005 and 2012, electronics accounted for 57% of total manufacturing R&D. Other sectors with high R&D expenditures included general-purpose machinery (5% of total) and automotive (4% of total). The rapid increases in R&D as a share of output for electronics points to upgrading since 2005 until 2012.

Figure 5.7 R&D as a share of output, Malaysia, %, selected years

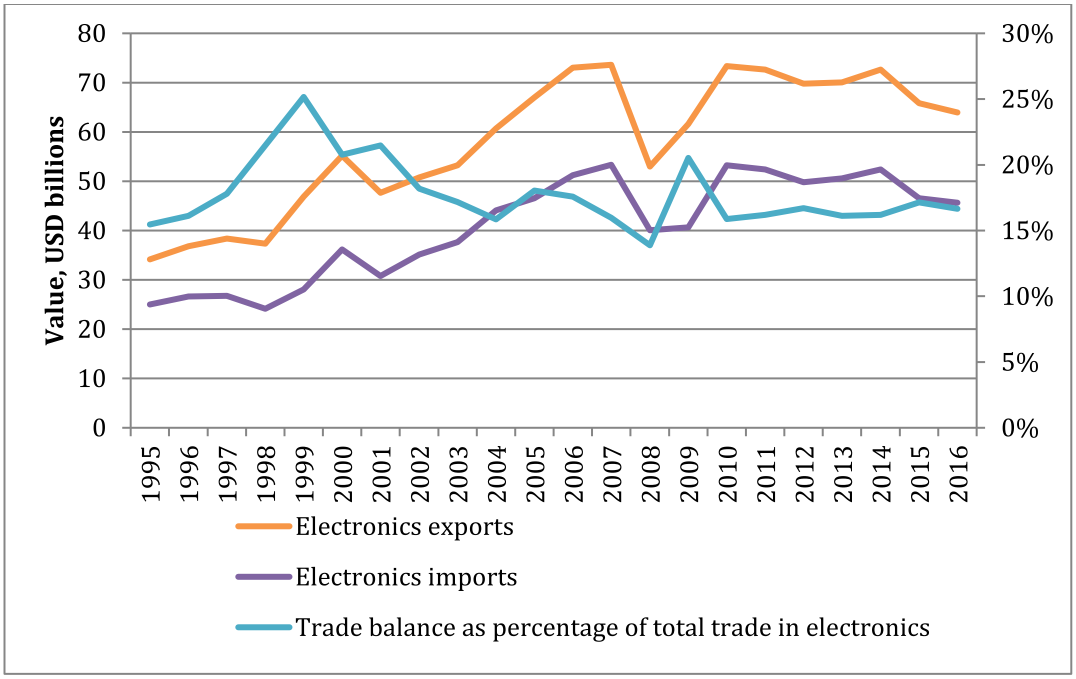


Source: Author's calculations on data from (DSM) (various years, a and b).

Exports and imports of electronics have been growing at the same rate since 1995, indicating that Malaysian electronics exports continue to be import-dependent (Figure 5.8). The trade balance has been positive, but it has been declining as a share of total trade since 1999, indicating that the trade surplus has not grown as fast as total trade. Data from the OECD Trade in Value Added (TiVA) database reveal that the share of domestic value added in gross exports has been declining, from 50.6% in 1995 to 33.2% in 2011 (Figure 5.9). This implies a higher reliance on imported intermediate inputs in the sector, and possibly 'downgrading'. While a lower share of domestic value added in output is expected when industries integrate into GVCs, the Malaysian electronics industry has its origins in export-oriented manufacturing, so this change may not be purely due to greater integration following trade and investment liberalisation. However, the share of domestic services value added in exports also declined between 1997 and 2004, but it started rising again in 2005 (Figure 5.9). A higher share of services in value added implies that higher value-added tasks take place beyond assembly, such as R&D and logistics.

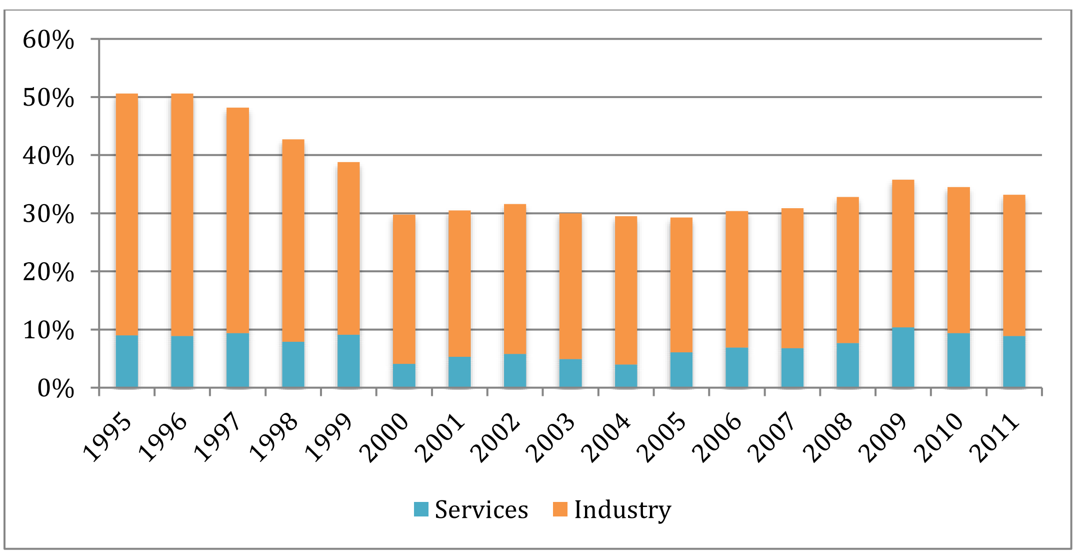
Figure 5.8 Electronics trade, Malaysia, 1995-2016

Left: Value in USD billion, current. Right: Share, %



Notes: Trade balance in secondary axis. Electronics are calculated from categories SITC 751, 752, 759, 761-764, 772, 775, 776.
Source: Author's calculation on data from UNCTADstat (2017).

Figure 5.9 Domestic value added as a share of gross exports in electronics, Malaysia, %, 1995-2011



Notes: Electronics is calculated based on SITC codes 30, 32 and 33.
Source: OECD TiVA (2016)

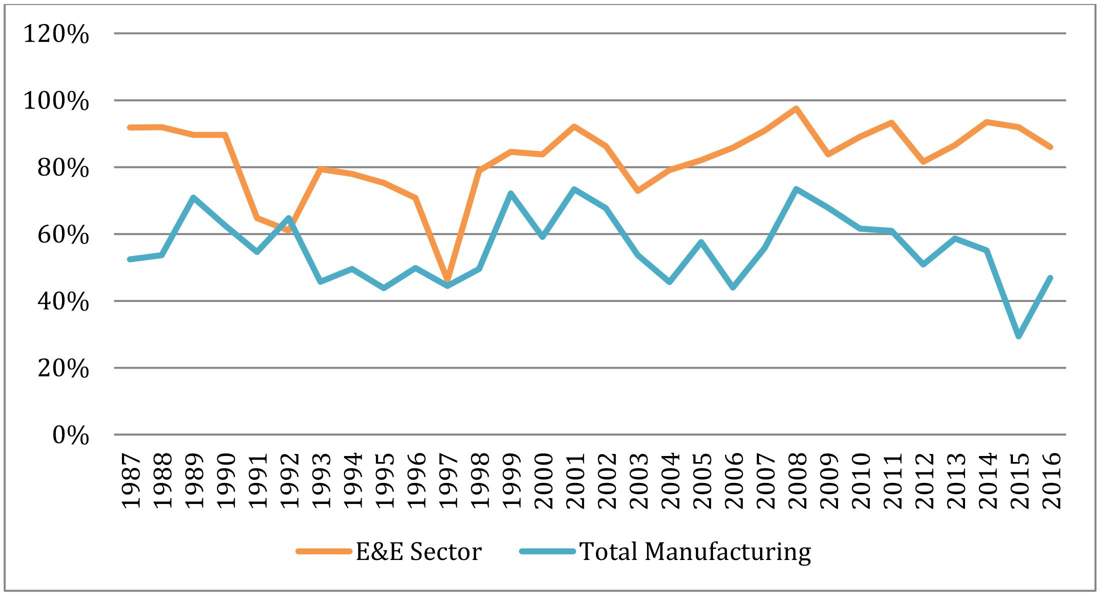
Unfortunately the public statistics provided by the DSM do not differentiate between foreign and domestic firms in the electronics industry. Tham and Loke (2011), based on unpublished DSM data note that in 2008 foreign-owned subsidiaries accounted for 38% of firms, but 74% of value added and 69% of employment. In 2000, these accounted for 52% of firms, 72% of value added and 70% of employment, which indicates the continued presence of large foreign subsidiaries. The latest foreign affiliates census includes data on at the broad industrial category of electrical and transport equipment (DSM, 2017). Foreign affiliates in the category were responsible for 82% of value added and 51% of employment[127].

Some indication of the extent of foreign involvement comes from investment data released by the MIDA. From 1987 onwards the share of foreign investment in the Electronics and Electrical (E&E) sector is consistently higher than in the total manufacturing sector as a whole, fluctuating between 80% and 98% of total annually. There is a noticeable drop in the share of foreign investment in the mid-1990s and another in the beginning of the previous decade (Figure 5.10). These seem to correlate with large Malaysian projects in 1997 and 2002-2003 (Figure 5.11), which probably represent the construction of two Malaysian-funded wafer fabs, Silterra and 1st Silicon.

Figure 5.10 Foreign investment in electrical and electronics (E&E) and total manufacturing, Malaysia, 1987-2016

Share of foreign investment in total, %

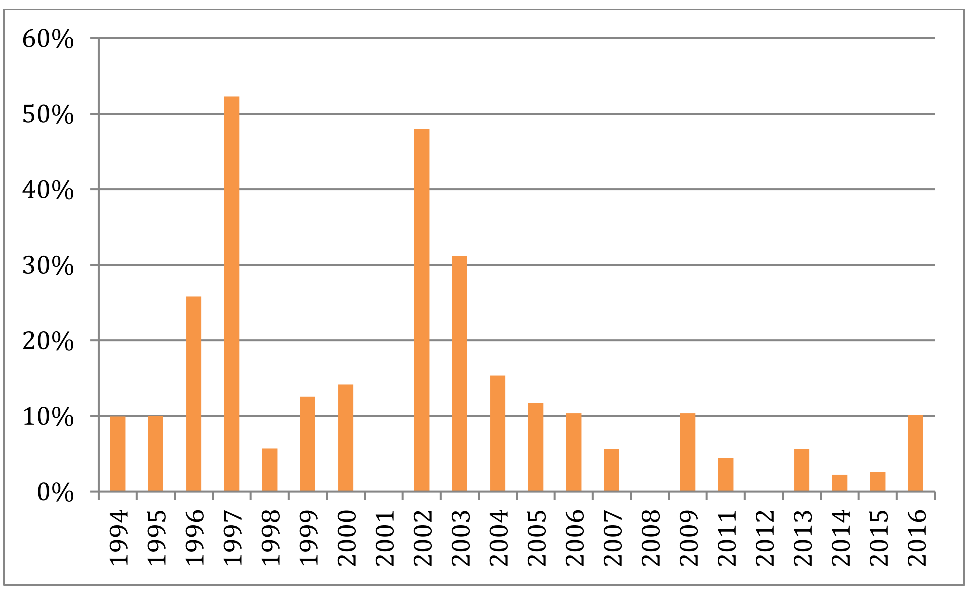
[127] Calculation by author based on data from foreign affiliate census and the latest manufacturing census.



Source: Author's calculations on data from MIDA (various years)

Figure 5.11. Domestic investment in projects over RM 100 million, electrical and electronics (E&E), Malaysia, 1994-2016

Share of domestic investment in total, %



Note: RM 100 million equals approximately USD 30 million.
Source: Author's calculations on data from MIDA (various years)

The overall picture emerging from a review of the available statistics is one of incremental upgrading, with phases of downgrading. On the one hand, there seems to be increasing value added per employee, a continued process of diversification and a rapid increase in R&D as a share of output in the industry. On the other hand, the value added as a share of output declined between 1996 and 2005, while capital intensity declined after 2005. Exports have been rising, but the trade surplus is of declining value compared to total trade. The share of domestic value added in gross exports has also declined between 1995 and 2011.

5.4 Policy-making in the Malaysian electronics industry

This section will briefly discuss three issues that have a profound impact on policy-making in the Malaysian electronics industry: (1) the role of ethnic redistributive politics (2) the federal-state government relationship and (3) the governance structure in the electronics industry.

5.4.1 The role of ethnic redistribution politics

Malaysia is a multi-racial society. The three major ethnic groups are the Malays, the Chinese and the Indians. In 1975, Malays and other indigenous people (known as *bumiputera*, meaning sons of the soil) made up 54.7% of the total population. The second largest ethnic group were the Chinese, comprising 34.2% of the total population, followed by Indians with 9% and other minorities with 2.1% (Ragayah, 2011). Malaysia's colonial history played a large part in creating an ethnically diverse society. The British imported Chinese and Indian labour to work in tin mines and rubber plantations. The colonial administration favoured British and other foreign capital, but they also maintained privileges for the Malays in paddy cultivation and gave coveted positions in the administration to the small, educated Malay elite (Jomo and Gomez, 2000).

Whereas the Malays were the most populous ethnicity, they were largely engaged in less lucrative activities, compared to the Chinese and the Indians. The Malays were concentrated in rural areas, engaging in low value-added rural economic activities, with a small middle class and a wealthy minority. By contrast, the Chinese found employment in mining, manufacturing and construction, earning higher incomes. Indian households tended to fall somewhere in between (Ragayah, 2011).

The post-independence government was led by the Alliance, a coalition comprising the United Malays National Organisation (UMNO), the anti-communist Malaysian Chinese

Association (MCA) and the Malaysian Indian Congress (MIC). In 1973 the Alliance became Barisan National (National Front), and included regional parties. The Alliance had been groomed by the colonial government to take power and facilitated British interests post-independence to avoid capital flight (Jomo and Gomez, 2000). It also concentrated efforts towards increasing rural incomes to benefit the Malays by spending on rural infrastructure and land development programmes to raise agricultural productivity. However, resentment over income inequality across ethnicities was brewing, culminating in the race riots of May 1969 (Ragayah, 2011).

Following the race riots, a new phase in Malaysian politics was initiated, with the overarching objective of creating a Malay capitalist class (Jomo and Gomez, 2000). The National Economic Policy (NEP) (1971-1990) was launched in 1971 with the twin objectives of poverty eradication and of altering the economic structure so as to eliminate the identification of race with economic functions. The policy had specific goals, such as that the employment structure would reflect racial composition and that Bumiputeras would own 30% of commercial and industrial activities.

The NEP goals were achieved by different instruments, such as by expanding rural industrialization programmes and by extending education opportunities specifically for Bumiputeras. More importantly, the government launched the Industrial Coordination Act (ICA) in 1975, which required manufacturing activities to be licensed and to provide a 30% share of Bumiputeras in employment and equity (Abidin, 2011). As Malays were considered new entrants in manufacturing, state-owned trusts and agencies were tasked with acquiring shares and reserving them for Bumiputeras. Such agencies included the Bumiputera Investment Fund, Majlis Amanah Rakyat (MARA), Perbadanan Nasional (PERNAS), the Urban Development Authority, the Bank Bumiputera Berhad, the Bank Pembangunan Malaysia Berhad (Malaysia Development Bank) and the State Economic Development Corporations (SEDCs) (Ragayah, 2011; Abidin, 2011).

Initiatives in the 1980s and the 1990s continued the promotion of Malay capital, albeit in a different form. The Heavy Industries Corporation of Malaysia (HICOM), which was established in 1980, did not only aim at increasing the scale and technological capabilities of heavy industries in Malaysia but also at creating Bumiputera enterprises that could enter these value chains. For example, PROTON, the national car project that was a joint venture with Mitsubishi, developed a vendor development scheme, but this was only open to Bumiputera-owned companies (Rock and Sheridan, 2007). In the 1990s the Privatization Master Plan was implemented, to encourage corporate ownership by Malays, by selling loss-making public enterprises (Abidin, 2011). Sapura, a Bumiputera-owned company in telecommunications equipment that has since diversified into oil and gas, was created with the privatization of the Telecommunications Department (see also Tan, 2008).

The emphasis on the development of Malay capital has had important implications for the choices made by the Malaysian federal and state governments in regards to the electronics industry. First, reducing rural Malay poverty was an important objective of the NEP (Ragayah, 2011). Export-oriented labour-intensive electronics assembly was a quick way to absorb rural unskilled Malay workers. Second, the decision by the Malaysian government to attract labour-intensive FDI was seen as a way to acquire capital and technology without supporting Chinese capital, a politically difficult choice (Jesudason, 1989). Third, since the decision of the Malaysian federal and state governments to actively attract FDI was mostly based on the political considerations described above rather than lack of fiscal resources, the government was able to offer credible incentives to multinationals and to put conditions on technology transfer (Khan and Blankenburg, 2009). Fourth, policies affected the structure of Chinese capital and its ability to engage in economies of scale. Many Chinese businesses restructured into small units to evade ICA rules (Rock and Sheridon, 2007) or found it more difficult to obtain financing[128]. This constrained the ability of Chinese firms to accumulate capital (Drabble, 2000). Some coping strategies included the strengthening of ethnic networks to pool resources together (Heng, 1997) and arrangements in which Bumiputeras simply got the license or award for a contract and business was mainly conducted by Chinese partners (the ali-baba arrangement).

Why didn’t the NEP lead to efforts to develop Bumiputera-owned electronics firms? Abidin (2011) argues that Malay businesses were not sophisticated at the time and that

[128] Interview with Malaysian semiconductor packaging firm in Penang, 22 February 2016, PN01.

foreign investors insisted on full-ownership, leaving little room for manoeuver. Since the industry developed with wholly foreign-owned operations in Free Trade Zones (FTZs), it may have been difficult then for the government to impose joint ventures (Henderson and Phillips, 2007). However, as it will be argued later in the Chapter, it seems that the government also did not consider the electronics industry as a significant source of technological development, at least until the mid-1980s (Athukorala, 2014). Following that, the privatization initiatives and the development of the stock market shifted incentives for the Malay middle class away from manufacturing into real estate and finance, reducing interest in investing in electronics manufacturing firms (Tan, 2014; Jomo and Wee, 2014).

The NEP and its successor policies failed to reach the stated target for Bumiputera policies. By 1990 Bumiputeras owned 20.3% of capital in the Malaysian economy, falling short of the 30% target. By 2008 the share of Bumiputera's in the country's capital had not changed much and remained at 21.9% (Abidin, 2011). Nevertheless, the NEP was considered a success, at least in easing ethnic tensions, allowing a peaceful, stable economy and creating Malay capital (Rock and Sheridan, 2007). Over time, the NEP requirements have been relaxed. The objective of 'growth with equity' continued in the National Development Policy (1991-2000) and the more recent Vision 2020, without specific targets.

5.4.2 The Federal-State relationship

An important dimension to consider in the political economy of industrial policy of the electronics industry in Malaysia is the role of the federal government vis-à-vis that of state governments.

Malaysia is a federal country, made up of thirteen states. Peninsular Malaysia (West Malaysia) has eleven of those states, Perlis, Kedah, Pulau Pinang (Penang Island), Perak, Kelantan, Terengganu, Pahang, Selangor, Negeri Sembilan, Melaka and Johor. East Malaysia is made up of two states on the island of Borneo, Sabah and Sarawak. There are also three Federal Territories, Kuala Lumpur, Labuan and Putrajaya. The states have their own governments, while the Federal Territories are governed directly by the federal government. The 11 states of Peninsular Malaysia formed the Federation of Malaya in 1948 – upon a proposal of the British to combine different territories into a union – that gained independence in 1957. In 1963, the federation of Malaya was established, and this included

Singapore, Sabah and Sarawak. However, Singapore left the federation in 1965 and became an independent and sovereign state (Wee, 1995, 2006, 2011).

There is a high degree of centralization in Malaysia, but states also have their own fiscal resources. The federal government collects almost 90% of total government revenue and redistributes resources to lagging states. The amount of transferred resources differs annually and depends on perceived priorities at the federal level and the specific bargains that have been struck between states and the federal government when they became members of the federation (Wee, 2011). The main source of revenue for the states are rents from state property, receipts from land sales, import and excise duties on petroleum, export duties on timber and other products (for Sabah and Sarawak), taxes on forests, lands and mines, entertainment duties and various service fees and royalties. However, state governments can only borrow from the federal government constraining their ability to raise independently funds for large projects.

While some aspects of industrial development (e.g. tariffs) are strictly within the purview of the federal government, states are responsible for local land development, local public services and state utilities, while social welfare, and some matters related to land, agriculture and forestry are shared functions (Wee, 2011). In addition to making direct investment by using their fiscal revenues, this division of responsibilities offers possibilities for states to be involved in industrial policy by developing industrial estates and offering related utilities and services. Such functions are mostly undertaken through SEDCs, which are tasked with promoting economic growth at the state level. The SEDCs are chaired by the Chief Ministers of state governments, highlighting their political role on top of economic objectives. While they had significant autonomy in the 1960s, SEDCs have been increasingly governed as federal government agencies since the 1980s, with employees being part of the civil service. In principle their resources are drawn from the state government and their own investments, although the federal government also provides grants and loans, especially to SEDCs of less developed states (Puthucheary, 2011).

The control of some fiscal resources, even if limited, by states and the SEDCs, opens the door for autonomy in terms of industrial policy at the state-level. In the electronics industry, researchers have pointed out that the government of Penang has been much more active in encouraging upgrading than the governments of Selangor and Johor, where the other two large electronics clusters are located. The Penang Development Corporation (PDC) actively courted foreign multinationals, initiated the Penang Skills Development Centre (PSDC) – a public-private initiative to support skills development in electronics – and took initiative in connecting local SMEs to foreign subsidiaries (Singh, 2011). Many researchers have therefore focused on the role of the Penang government in driving upgrading in the industry (Athukorala, 2014; Henderson and Phillips, 2007), even naming Penang a "developmental state" (Hutchinson, 2008). By contrast, the Selangor Development Corporation focused mostly on profit-making investments in real estate and services in nearby Kuala Lumpur (Puthucheary, 2011), while the efforts of the Johor Development Corporation were similarly underwhelming (van Grunsven and Hutchinson, 2016).

However, this Chapter focuses on the country level, rather than specific states, as after 1985 the federal government has become the main driver of strategic initiatives in the industry.

First, as mentioned earlier, the federal government has centralised power over SEDCs since the 1980s. It has also channeled funds to Regional Development Agencies (RDAs), which are controlled by the federal government, that often compete with SEDCs for funds. This means that, while SEDCs have been very important in spearheading industrial development, their power has somewhat declined in the last three decades.

Second, tax incentives and other facilitations that are part of the "package" that all investors in the manufacturing sector receive are given by the MIDA, a federal agency. Similarly, other incentives and financing related to science and technology and industrial upgrading are handed out by federal level institutions. State governments do not have the mandate to introduce tax incentives, significantly reducing the tools available to states to attract investments.

Third, many of the efforts to drive the industry towards higher value-added activities have been led by the federal government, such as the Malaysian Institute for Microelectronics Systems (MIMOS) and the state-owned wafer fabs. This has also changed the spatial concentration of industry, away from Penang into the nearby state of Kedah and the region around Kuala Lumpur.

Fourth, the antagonism that has existed between the federal government and state governments that are led by opposition parties has hampered upgrading. For example, Penang, which is Chinese-majority and led by an opposition party, has been starved of investment funds from the government, thereby constraining upgrading (Henderson and Phillips, 2007)[129].

This chapter acknowledges the regional dimension in the implementation of industrial policy and makes specific references to state-level initiatives where relevant. However, for the reasons listed above the lens of analysis remains the federal state.

5.4.3 The policy-making process and the governance structure

The Malaysian government formulates indicative five-year plans (FYPs) and long-term plans that give broad policy directions and goals[130] that are issued by the Economic Planning Unit (EPU), a department under the Prime Minister. Currently, the government is implementing the Eleventh Five-Year Plan (11FYP) (2016-2020). In 2010 the Malaysian government also launched the New Economic Model (2010-2020), under which two twin plans for transforming the government and the economy were issued: the Government Transformation Program (GTP) and the Economic Transformation Program (ETP). The latter contains actions to upgrade the country's economic structure, co-financed by the public and private sector (see also Section 5.4.1). The Ministry of Trade and Industry (MITI) has also issued three Industrial Master Plans since 1985, with the most recent one (Third Industrial Master Plan or 3IMP) formulated for the period 2005-2020. The Malaysian government does not issue policy plans specifically for the electronics industry, but as plans usually adopt a sectoral approach, they include dedicated sections for the industry[131].

State-level and regional (multi-state) development plans also include actions to support the industry. Malaysia has attempted since 2005 to formulate regional development policies with the creation of economic corridors, encompassing multiple states and regions. For the

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[129] Interview with think tank in Penang, 11 March 2016, PN11.

[130] For example, the New Economic Policy (1971-1990), the New Development Policy (1991-2000), Vision 2020 (1990-2020) and the New Economic Model (2010-2020).

[131] Most government documents list the electronics and electrical (E&E) industries together.

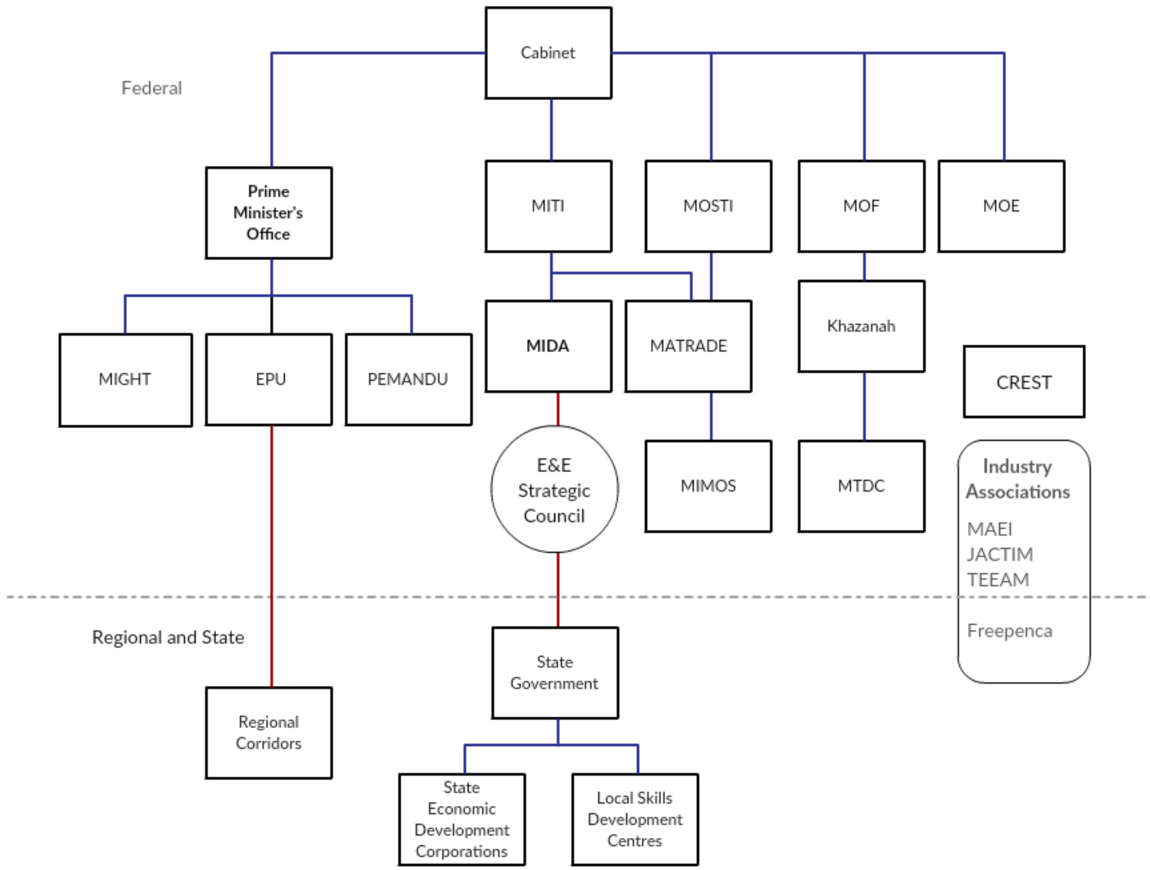
electronics industry, the Northern Economic Corridor (NCER), which includes Penang, Kedah, Perlis and Northern Perak is of particular importance, as it includes the Penang cluster and the Kulim high-tech park where several semiconductor wafer fabs are located. Iskandar Malaysia in Southern Johor (Iskandar Regional Development Authority or IRDA) is also important as it contains the electronics assembly cluster that is located on the border with Singapore. The Northern Corridor Implementation Authority (NCIA) launched the NCER Development Blueprint (2016-2025) in 2017, which includes priority projects in Batu Kawan (mainland Penang) and Kulim clusters that have a high concentration in electronics manufacturing. At the state-level the Penang government formulated its own strategy for developing the industry, the *Technology Roadmap for the Electrical and Electronics Industry of Penang* (PSDC, 2007; see Socio-economic and Environmental Research Institute, 2007 for summary), but this does not seem like a regular exercise.

The primary institution tasked with promoting the industry is the MIDA, an agency under the MITI (see Figure 5.12). A department within MIDA has more specific responsibilities for developing the electronics industry. Other key Ministries and agencies include the Ministry of Science, Technology and Innovation (MOSTI), the Ministry of Finance (MoF), the Ministry of Education (MoE) and the Malaysia External Trade Development Corporation (MATRADE) also under MITI. At the state level, the SEDCs are tasked with developing land for industry and their investment promotion functions are under separate investment agencies. The corridor implementation authorities also provide support services and provide grants to firms. Private-public and private-led institutions promoting multi-stakeholder dialogue and investments in high-technology are also important in voicing the vision of businesses and influencing policy. These include the Malaysian Industry-Government Group for High Technology (MIGHT), a multi-stakeholder group for promoting frontier technologies, the Malaysian American Electronics Industries (MAEI) under the American Chamber of Commerce (AmCham), the Electrical and Electronics Association of Malaysia (TEEAM) and the Free Industrial Zone Penang Companies' Association (Freepenca). The Semiconductor Fabricator Association of Malaysia was also established in December 2012 to spearhead the effort in promoting wafer fabrication during the ETP.

Plans touching upon industrial development in the country are made by consensus between MITI and MIDA and input is provided by other relevant agencies, business associations and private firms[132]. Plans, including the 2IMP and 3IMP usually offer vague calls for action without specific funding attached, but the ETP followed a different approach. The ETP organized ‘labs’, bringing many different stakeholders together, especially from the private sector, to chart specific projects and financing commitments. The leading institution for the ETP was the Performance Management & Delivery Unit (PEMANDU) a now-defunct unit under the Prime Minister’s Office (PMO).

[132] Interview with deputy Chief Executive Officer or CEO of government agency in Kuala Lumpur, 14 March 2016, KL08.

Figure 5.12 Governance structure for the Malaysian electronics industry



Source: Author's illustration

Despite the attention to electronics in the above-mentioned plans, there are several important gaps in the governance of the industry.

First, even though electronics is one of the priority industries, firms have difficulties in accessing financing (although not clear if this is more than firms in other manufacturing industries). In terms of bank financing, the Malaysian Industrial Development Finance Berhad is tasked with providing loans to all industries while several development finance institutions[133] provide preferential loans to Bumiputera and SME entrepreneurs. However, little financing goes into manufacturing, with firms often relying on their internal funds (Chin and Jomo, 2000; Tan, 2014). For example, out of the total gross loans and financing by Malaysia Industrial Finance (MIDF) in 2016, only 11.6% went into manufacturing, as opposed to 20% in financial, insurance and business services. At the same time, the government has provided capital grants to firms willing to undertake capital-intensive high-tech manufacturing investments only since 2005 (Rasiah, 2015). Khazanah, the government's sovereign wealth fund, invested in the country's first wafer fab (SilTerra), but it does not have much of a presence in the industry otherwise. Government schemes for venture capital and other equity/debt investments support high-growth firms and are not appropriate for manufacturing-oriented firms (that require patient capital). The Malaysian Technology Development Corporation (MTDC), now owned by Khazanah, started as a venture capital firm and invested in Globetronics in the 1990s. However, it quickly exited venture capital and switched to managing a mix of equity, grants and loans, on behalf of MOSTI. Now its focus is on biotechnology start-ups[134].

Second, there is a perception among interviewees that MIDA has an institutional bias towards attracting foreign investments, rather than developing domestic ones. The ETP

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[133] Development financial institutions that fall under the Development Financial Institutions Act 2002 (DFIA) include Bank Pembangunan Malaysia Berhad (Malaysia Development Bank), Bank Perusahaan Kecil & Sederhana Malaysia Berhad (SME Bank), Import-Export Bank of Malaysia Berhad (EXIM Bank), Bank Kerjasama Rakyat Malaysia Berhad, Bank Simpanan Nasional, Bank Pertanian Malaysia Berhad (Agrobank). Development financial institutions outside the DFIA include MIDF, Credit Guarantee Corporation Berhad, Lembaga Tabung Haji, Sabah Development Bank Berhad, Sabah Credit Corporation (http://www.bnm.gov.my/index.php?ch=fs&pg=fs_mfs_dfi&ac=162)

[134] Interview with CEO of government-owned fund management company in Kuala Lumpur, 24 March 2016, KL11.

clearly stated that MIDA should expand its efforts to promote domestic investment. The agency was responsible for disbursing RM 1 billion (approximately USD 300 million) as part of the Domestic Investment Strategic Fund, established in 2012. However MIDA has an incentive to focus on foreign investment, both because it has over time developed capabilities in doing so, and also because export and FDI growth remains a key government target that can be achieved with export oriented foreign investments[135].

Third, there is an institutional gap in terms of encouraging the accumulation of technological capabilities in industrial firms. Efforts by MIDA are mostly geared towards providing incentives to (largely foreign) firms conditional on local business spend and levels of R&D, while MOSTI's efforts are geared towards technology-intensive local SMEs. Developing the capabilities of existing Malaysian manufacturing firms by tools other than tax incentives remains a weak. The recent move by MIDA to provide grants during the ETP is a positive step (see Section 5.4.1). Moreover, there are no institutionalized spaces in which the industry and the government can come together to drive upgrading in the sector, with the industry often coming under other broader manufacturing-related initiatives (e.g. the ETP labs). This gap was to be filled by the E&E Strategic Council, established in 2015, but the Council has yet to publish a blueprint[136].

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[135] Interview with senior government official in Kuala Lumpur, 3 March 2016, KL04.
[136] Interview with chairman of business association in Penang, 23 February 2016, PN02.

The following Sections will analyse the development of the Malaysian electronics industry by looking at the evolution of industrial policies as well as policies for encouraging integration and upgrading within GVCs. It will be argued that, while Malaysia put in place policies to encourage integration and upgrading within its GVCs, industrial policies have failed to stimulate the accumulation of technological capabilities in firms, and therefore the process of upgrading has eventually stalled. The discussion is divided into four phases, highlighting the different policy approaches during different periods.

5.5 1955-1967: Stimulating industry after independence

5.5.1 Import Substitution

Malaya (later renamed Malaysia in 1963) gained independence from British rule in 1957. During the 19th century Malaya had been the most profitable British colony, owing to its rich mineral, forest and agricultural resources (Jomo and Rock, 1998). Transport, energy and telecommunication infrastructure was developed to serve the needs of the colonial export regime. The two main export commodities developed were tin and rubber, the former growing more popular following the decline of tin production in Cornwall after the mid-1850s and the rubber industry riding the wave of the motor industry boom in the first half of the twentieth century (ibid.). The two commodities accounted for 84% of total export earnings in 1947 (Alavi, 1996:28).

The British authorities had little interest in developing manufacturing capabilities in the country. Nevertheless, given the level of economic activity in a small local manufacturing sector had developed for local consumption, such as food processing and furniture, accounting for 8% of GDP in 1955 (Alavi, 1996:30). The need to expand industrial output and diversify exports was heightened as prices of rubber and tin started falling. The creation of synthetic rubber and the gradual depletion of tin deposits put pressure on the two staple Malaysian exports. The large share in their GDP and the fluctuation in export earnings meant that dips in revenue were substantial, reducing available funds for infrastructure development and other services in the decade preceding independence (Lim, 2011).

In 1955 a World Bank mission to Malaya argued that the country was in need of diversification into other export crops and manufacturing, which could be encouraged by import substitution. The report did not encourage large-scale industrialization, but advocated industries that could use local materials and could find a reasonable domestic market[137], such as furniture, ceramics, cement, pineapple canning, fish processing, and textile and garments (Wheelwright, 1963). Some of the recommendations of the report on industry found their way in the First Malaya plan (1956-1960), drafted by the colonial authorities and launched after independence. However, most of the emphasis was put on expanding commodity production to deal with falling revenue and low rural incomes. The top priorities for government expenditures were agricultural and rural development, transport infrastructure and electrification (Hutchinson, 2016).

Nevertheless, towards the end of the 1950s there was a consensus that industrial production needed to be stimulated, by way of tariffs, tax incentives for industries, infrastructural and financial support, as enshrined in the 1957 Interim Statement of Industrial Development Policy (MIDA, 1968). Tariff protection was encouraged with the establishment of Tariff Advisory Committee, that was established in 1961 and its successor, the Tariff Advisory Board of 1963. Both of these institutions suggested tariff levels to the Ministry of Commerce and Industry on an ad hoc basis and based on applications submitted to the board by producers and the private sector. The use of tariffs increased more with the Action Committee on Tariff and Industrial Development in 1965, which considered urgent applications for tariff and non-tariff protection. Tariffs as an instrument was supposed to be temporary, with the country hoping that protected industries would eventually contribute to exports[138].

According to data cited in the First Malaysia Plan (1MP) (1966-1970), 214 tariffs were raised at the time, but most researchers argue that the levels of protection were not high enough (Alavi, 1996; Wheelwright, 1963). According to Wheelwright (1963) the applied tariff rates were relatively low, between 15% and 25%, and in many cases there were zero.

[137] The Report did not advocate for the development of rubber-based products, as rubber was cheap to transport and processing could be done cheaply near home-markets (Wheelwright, 1963). Malaysia’s current market dominance in rubber-based products such as gloves and condoms serves as a reminder that such recommendations have often missed the mark.

[138] “In the long run import substitution and export promotion will become harmonising policies” (First Malaysia Plan, p.16).

Almost 25% of products from firms that received tax incentives did not receive any tariff protection (ibid.)

On top of the modest tariff support, incentives for establishing manufacturing operations were also provided by the Pioneer Industries Ordinance (PIO) in 1958. The Ordinance gave incentives to firms that engaged in activities that had not already reached large scale in the country, but whose development had favorable prospects and was in the public interest.

However, firms could apply for a 40% tax relief for two to five years depending on the level of investment. Losses could be carried over into the period after expiration of the Pioneer Status. Investments by pioneer firms, although they increased fast in the beginning, were not sustained for long. On the one hand, the level of qualifying investment was low, so many firms set up establishments only to profit from incentives, and on the other hand, the tax relief period was short, which penalised firms with long gestation periods (Lim, 2011).

Furthermore, investments in infrastructure and industrial estates were made. In the beginning, the most popular site was in Petaling Jaya, just outside Kuala Lumpur, where 112 Pioneer firms were already in production by the early 1960s (Wheelright, 1963).

Finally, institutional support to industry was provided by a dedicated government agency and a specialised banking institution. In 1965, the Federal Industrial Development Authority (FIDA) was established and took over several functions to centralise industrial development promotion. FIDA was responsible for organizing missions overseas, establishing a record of potential foreign and domestic investors to promote joint ventures, conducting research to identify new opportunities, providing advisory services and undertaking the functions of processing the pioneer applications (MIDA, 1967). The Malaysian Industrial Development Finance Berhad (MIDF) was also established in 1960 aiming to develop the manufacturing sector.

The results of this modest effort to stimulate industrial investment were encouraging. In 1960 manufacturing accounted for 8.5% of GDP and 6.4% of employment and in 1968 this had increased to 13% and 9.2% respectively (Lim, 2011:10). However, there were few large-scale investments, especially from domestic investors and in some areas there was overcapacity (Wheelright, 1963).

Various explanations have been put forward for the lukewarm ISI effort. Alavi (1996) argues that tariffs did not increase much because most interest groups with political influence would stand to lose from this. The Treasury would lose revenue from a potential fall in imports, importers would lose their business, and commodity producers would see input costs rise. At the same time, the segment that would be able to gain the most from import-substitution was the ethnic Chinese business, which were already running extensive commercial activities. However, the government did not want to be seen as openly supporting Chinese business, prioritizing rural Malay incomes instead (Alavi, 1986).

Moreover, the industrialisation effort during this time did not have a strategic focus. As mentioned above, tariffs were raised only upon application by interested parties, and the Pioneer Ordinance did not list specific areas that were of strategic support. The World Bank report had recommended feasibility studies to be undertaken to determine what industries should be developed, but by 1962, no such assessment had been made (Wheelright, 1963). Even if it had, it is not likely that electronics would have been high on the agenda. The priorities of Malaysia at the time were not to attain technological independence, but to address rural poverty and achieve diversification.

5.5.2 Openness to Foreign Capital

Without a strategic vision to build up indigenous industrial capital, Malaysia encouraged foreign capital to take advantage of the Pioneer incentives. Foreign investment was relied upon to modernize the industry as well as to undertake labour intensive projects to reduce unemployment. The incentives were not different for foreign investors, but Malaysia implemented few restrictions on foreign capital flows to make it an attractive destination for investment. The country offered unrestricted repatriation of capital, unrestricted remittance of profits and dividends within the Sterling area and nominal controls outside it, and it had bilateral investment guarantee agreements signed with the US and West Germany (First Malaysia Plan or 1MP, 1966).

In the end, foreign investments were the main driver of early industrialization efforts. Pioneer incentives were given to 110 firms between 1961-1965, and 61% of the project capital was foreign (1MP, 1966). This was true of the electronics industry as well, which emerged at the end of this period, largely thanks to Japanese firms (Capannelli, 1999).

Japanese firms were keen on setting up local assembly ventures to take advantage of the protected domestic market and were no strangers to Malaysia. Japanese investments into rubber and iron ore had flourished in the first half of the 20th century and political and economic relations between Britain and Japan were mended quickly after Second World War (Tomaru, 2000). Despite the bitter memories of occupation during the War, Japanese investments were welcome (Chee and Lee 1983).

Matsushita Electric, now Panasonic Manufacturing Malaysia, set up the first electrical products manufacturing operation in Malaysia in Shah Alam in 1965 (Rasiah, 2010). The firm was a Joint Venture (JV) between the Matsushita group (43%), Tabung Haji (a fund) and the Army Cooperatives. A 5% was also held by Hagemeyer, a German firm, which distributed the Matshushita products until the firm set up its own sales subsidiaries. Tabung Haji and the Army Cooperative have sold their shares since and the firm is now listed in the stock market (Chee and Lee, 1983). A 1968 census shows that by that year 37 enterprises had been set up in the manufacturing and repair of electronics and electrical goods. Even though foreign firms made up under one third of the total number, they accounted for 43% of value added, indicating their larger scale[139]. Approximately 34% of sales were from electric wires and cables, with the rest distributed between various appliances (DSM, 1969).

5.6 1968-1985: Emergence of Malaysian electronics industry

5.6.1 Stimulating domestic industry

Incentives to promote exports were put in place with the Investment Incentives Act (IIA) of 1968. The Act expanded and amended some of the previous incentives and included (Drawing on MIDA, 1968, 1979; Liew, 1969):

[139] As the category includes repairs, it is hard to know whether Malaysian firms were involved in manufacturing or not.

- Pioneer Status. This provided tax relief from 2 to 7 years, depending on the level of investment. An extra year of tax relief could be obtained if the factory was established in a declared development area or produced priority products.
- Investment Tax Credits. Granted to companies that did not qualify for Pioneer Status, amounting to 25% of the capital expenditure and an extra 5% if project fulfilled any of the conditions listed for Pioneer Status.
- Deductions for promotion of exports overseas. These could include expenses for advertising, providing samples, market research, preparing tenders, travel and others.
- Acceleration depreciation allowance for exporters that have not obtained Pioneer Status or Investment Tax Credits.
- Export Allowance.
- Duty exemption on imports of machinery and equipment and certain raw materials used for manufacturing
- Duty draw back on imported raw materials
- Tariff protection for certain domestic manufactures.
- Protection against dumping of foreign goods in local markets.

As it can be gleaned from the list of incentives above, the intention was not only to support exports, but also to continue import protection for selected products. The effective rate of protection (ERP) rose from 25% in 1962 to more than 65% by the end of the decade (Table 5.1). However, tariff support[140] was given primarily to agro-based industries. Out of the 21 products that received tariff support in 1970, only telephone equipment could be loosely connected to the electronics industry. The rest were drawn from food processing (MIDA, 1970:65). Moreover, even these tariffs were not connected to incentives for technological learning (Jomo and Edwards, 1993).

Table 5.1 Effective rate of protection in manufacturing, Malaysia, selected years

Year	ERP in manufacturing (% on value added)

[140] The Tariff Advisory Board was abolished in 1969 and FIDA took over additional functions in regard to applications for tariff protection.

1962	25
1966	50
1969	65
1972	70
1979	24
1982	23

Source: Jomo and Edwards, p. 19; 23

In May 1969, race riots erupted, prompting the government to launch the New Economic Policy (NEP) (see Section 4.1). The priorities for industrialization were more clearly defined under the NEP: increasing employment opportunities for surplus labour and expanding local content in certain industries (especially resource-based manufactures) and exports. Whereas since independence the government's role in industrialization was defined as one of providing assistance, incentives, and infrastructure (MIDA, 1968), under the NEP "the Government [would] take the initiative in industrialisation and [would] participate in the establishment of selected industries either by itself or in joint venture with the private sector" (MIDA, 1970:63).

The role of the government further expanded under Mahathir, who became the Prime Minister of Malaysia in 1981 and his drive into heavy industries. Priorities in import protection shifted from targeting primary commodity processing to the establishment of heavy industries. The latter was facilitated by the operations of the state-owned Heavy Industrial Corporation of Malaysia (HICOM), established in 1980 (Fourth Malaysia Plan or 4MP, 1981-1985). Proton, an automotive JV between HICOM and Mitsubishi, was one of the flagship projects of this initiative (see Jomo and Edwards, 1993).

Despite the trend towards heavier state involvement during this period, the electronics industry was not a target for it. Electronics was perceived as an industry that was export-oriented and labor-absorbing, rather than one that should be encouraged strategically for its technological potential. The industry was first explicitly encouraged in 1970, with the Labour Utilization Relief, an extra tax relief incentive for electronics and hotel and tourism industries to encourage employment. This is in contrast to the automotive industry, for example, that was targeted as a strategic industry with FIDA encouraging local content already since the mid-1970s. In 1975, a list of priority industries was circulated that included 65 electronic and electrical components and products (out of a total 124 products), under the condition that they were at least 90% exported (MIDA, 1975: 173). The exception to this was one capacitor and resistors joint venture with Bumiputera participation encouraged by FIDA in 1973 and some equity investments made by the PDC (Singh, 2011). By 1980 PDC had invested US$6.4 million in seventeen firms, although a small share of that was in electronics (Hutchinson, 2008; Singh, 2011).

5.6.2 Integration into export-oriented GVCs

Instruments For Integration into GVCs at the Federal Level

The investments of large MNC subsidiaries were actively solicited and were further facilitated by the provision of dedicated infrastructure in Foreign Trade Zones (FTZs). On the one hand, firms located in FTZs faced simplified custom procedures and duty-free imports of raw materials, components, parts and machinery used in the manufacturing process. One the other hand, in areas outside FTZs, Licensed Manufacturing Warehouses (LMWs) status could be given to firms, granting similar rights. The FTZs, pioneered in Penang, were popular and by 1973 out of 43 industrial estates in Malaysia, six had been designated as FTZs (MIDA, 1973). The export-oriented industries were also helped by amendments to the Employment Act of 1955 in the late 1960s and the enactment of the Industrial Relations Act of 1967. These prevented unionization in export-oriented factories in FTZs, allowed shift work for women for the first time and restricted the right to strike (Jomo and Edwards, 1993: 25).

The NEP requirements on Bumiputera corporate ownership were used to leverage the domestic market and encourage the creation of joint venture firms. For foreign firms that sold in the domestic market, equity requirements for Bumiputera ownership was at least 51%, held by institutional and private investors or through public issue in the Malaysian Stock Exchange (now the Kuala Lumpur Stock Exchange). Some flexibility in the application of these rules was allowed, depending on project-specific circumstances (Chee and Lee, 1983). An example from the telecommunications sector is the JV between Nippon Electric Co. Ltd. (NEC) and PERNAS, a state-owned company specifically designed to increase Bumiputera ownership in the economy, to produce multiplexing equipment for telecommunications. NEC expected that by setting up a JV with PERNAS, it would be view favourably in government procurement. However, the majority of foreign invested firms were wholly foreign owned subsidiaries as for 100% export-oriented projects, there were exemptions of equity requirements (ibid.).

Pursuit of Integration in Penang

The integration of Malaysia into export-oriented electronics GVCs is intimately linked with the efforts of the Penang state government to industrialize. Penang had developed as an entrepôt, profiting from trade in Southeast Asia and the boom in tin and rubber exports. However, after Independence in 1957, business declined with the development of Port Klang as the main port in Malaysia, the development of other ports in Southeast Asia and eventually with the removal of its ‘free port’ status in 1967. The declining economic prospects of Penang were first met with an ISI program on the industrial estate of Prai, with some state-managed factories, but with little success (Athukorala, 2014; Singh, 2011).

The Federal Government became concerned about the declining economic prospects of the island and commissioned the Penang Master Plan (PMP) in 1969 (Singh, 2011). Given the limited natural and agricultural resources of the state, the PMP recommended export-oriented industrialisation and indicated where infrastructure should be built to accommodate industrial development. Its implementation was enhanced by the establishment of the PDC, headed by the chief Minister of Penang, Dr Lim Chong Eu, at its head in 1969 (ibid.).

The PMP was also in line with the new priorities of industrialization in Malaysia, so there were few policy conflicts with the Federal government. Moreover, Lim, a long-time politician, negotiated the entry of his party Gerakan[141] into the ruling coalition to form Barisan Nasional, the leading party ever since. Penang had a Chinese ethnic majority until recently, and that created frictions with the local Bumiputera community that felt disadvantaged by the PMP’s attention to foreign investment. However, the relationships Lim had with senior politicians, including Prime Minister Tun Abdul Razak, ensured the sustainability of the federal government’s support (Singh, 2011; Athukorala, 2014;

[141] In 1969, Gerakan won the elections in Penang, ousting the local representative of the ruling Alliance Party. Gerakan was a social democratic, multi-racial party, that promised more independence vis-à-vis the federal government. Lim supported Razak in restoring order and peace following the May 1969 riots and Gerakan party joined the ruling coalition, to form Barisan Nasional (Hutchinson, 2008).

Hutchinson, 2008). FIDA was also actively supporting the efforts of the PDC, acting as a go-between the PDC and foreign investors in the beginning[142].

At the time, the efforts of the PDC were unique in terms of its attitude towards attracting investors in the electronics industry. It developed an investment guide and organized overseas missions to target specific companies, often headed by the Chief Minister himself. The relationships with existing investors were used to obtain intelligence on the industry and use that to draw more investors (Athukorala, 2014; Singh, 2011). Beyond, the PDC, the Penang government also paid attention to skills development. In 1970-1971, the Penang government, through the City Council of Georgetown, Penang's capital, initiated an on-the-job training scheme for school leavers. The scheme allowed participants to spend half a day working and half a day receiving technical education. Many of these graduates were employed at the electronics factories that sprung up (Singh, 2011).

5.6.3 Quick industrialisation and shallow integration

The incentives for export-oriented industrialization, enshrined in the IIA of 1968, and the creation of the FTZs gave a definite boost to integration into electronics GVCs, particularly in semiconductor assembly. National Semiconductor established the first export-oriented electronics facility in Penang in 1971 (Rasiah, 2010). By 1972, there were 17 electronics factories in Penang, employing some 12,000 workers. By 1980 this had increased to 25 firms employing almost 25,000 workers in Penang only (Hutchinson, 2008). In 1982, total sales of electronics firms in FTZs or with LMW status in Malaysia as a whole accounted for 88% of the value of sales in the electronics industry (MIDA/UNIDO, 1985). However, the linkages of export-oriented firms with the domestic economy were poor, with only 2.9% of raw materials and 10.6% of capital equipment sourced locally (Table 5.2).

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[142] FIDA brought a team to Penang by National Semiconductors to engage in talks with PDC and later featured Penang extensively in its promotional videos. National Semiconductors decided to locate in Penang, becoming the first semiconductor assembly facility in the island (Singh, 2011).

Table 5.2 Performance of export-oriented electronics firms, Malaysia, 1982

	FTZ Firms	LMW Firms	Total FTZ and LMW
Total Sales (USD 000)	1,433,231	198,302	1,631,534
Exports (USD 000)	1,431,809	187,160	1,618,969
Exports/Total Sales	99.9%	94.4%	99.2%
Local Raw Materials/Total Raw Materials	2.2%	8.9%	2.9%
Local capital equipment/total capital equipment	7.6%	22.4%	10.6%
Value Added/Sales	21.5%	42.6%	22.6%
Value Added/Employee (USD)	5,838	4,515	5,563

Notes: Original prices in RM, converted into USD by author.
Source: MIDA/UNIDO (1985: 63)

Nevertheless, in the late 1970s, some domestic SMEs started emerging as suppliers of tooling and simple equipment, predominantly in Penang. Such sourcing linkages were not easy to develop because most domestic suppliers were at the time small-scale and possessed low technological capabilities. Until the 1980s, almost all MNC subsidiaries undertook their own tooling, but demand for outsourcing precision engineering started to increase as local semiconductor assembly facilities begun automating their processing in the 1980s. The rapid change of pace in technology change meant that it was difficult to continuously import machinery and more economic to do in-house modifications or outsource locally. This demand was originally met by foreign suppliers, but it also created an opportunity for domestic firms to integrate into electronics GVCs. The efforts of the PDC were instrumental in fostering sourcing linkages with local SMEs. For example, Eng Teknologi, a large mould and die supplier, was connected to MNCs by PDC (Rasiah, 1998).

5.7 1986-2004: Promoting high-tech activities in foreign subsidiaries & the emergence of domestic firms

The attempt by the Malaysian government to pursue heavy industrialization in the beginning of the 1980s had been partly a response to the oil crisis of 1979. The sharp drop in export earnings (the trade deficit in 1982 reached 14.1% of GDP) prompted the search for alternative sources of growth (Bowie, 1991). However, the situation did not improve. In 1983 the collapse of commodity prices reduced the fiscal space of the government, making the heavy industrialisation initiative increasingly difficult to finance. In 1985-86, a cyclical downturn in the semiconductor industry reduced output and exports in the Malaysian electronics industry, which at the time accounted for 13% of total industrial value added. With this background, the development model pursued since the 1980s promoted technological deepening, while at the same time encouraging FDI and exports (Jomo and Edwards, 1993).

First, trade liberalization proceeded fast. Tariffs on IT goods were already low at an average of 11.1% in 1988, and were progressively cut in the run-up to WTO in 1995 and the Information Technology Agreement (ITA) in 1996. By 1997, tariffs in IT products were down to 4.4% and would reach zero by 2005. By contrast, Malaysia tried to secure higher tariffs for the automobile industry and some agriculture sub-sectors, while the former also benefited from import quotas on completely-built-up vehicles (WTO, 1997). For other (non-automotive) industries there was also an escalating tariff structure, with high tariffs for fully processed goods, lower for semi-processed and lowest for raw materials (see Gustafsson, 2007). The country also removed local content measures tied to incentives by 2000 and phased out export subsidies in the manufacturing sector by 2003 (Ariff and Nambiar, 2011).

Second, investment regulations were also liberalized and further encouraged export-orientation. Investment regulations were liberalized with the PIA in 1986, easing equity restrictions and putting in place incentives for exports (discussed in Section 5.3.2). Restrictions on export orientation and equity were abolished altogether in 2003 (Felker and Jomo, 2007). Additionally, incentives were extended to indirect exporters as well in 1986. This enhanced incentives for suppliers to relocate to Malaysia.

At the same time, electronics GVCs started expanding rapidly since the mid-1980s increasing investment outflows in developing economies. The re-evaluation of the yen and other East Asian currencies in the mid-1980s, led to a sharp increase in the offshoring of Japanese, Taiwanese and Korean investments to locations in Southeast Asia, including Malaysia. The rapid increases in labour costs in Singapore, also led to an exodus of labour-intensive consumer electronics and computer peripheral assembly (predominantly hard disk drives), into lower cost locations, such as Thailand and Malaysia (O'Connor, 1993; Salleh and Meyanathan, 1993). U.S. offshoring also started to increase during this time, and large contract manufacturers for U.S. lead firms concentrated in Malaysia during the 1990s, such as Flex and Jabil (Philips and Henderson, 2009).

The attention to attracting GVCs was complemented by strategic policies during 1986-2004 to leverage FDI for technology transfer and to develop domestic technological capabilities (Lall, 1995). This was witnessed by the following actions that are reviewed in more detail later in this Section:

- MITI started issuing Industrial Master Plans (IMPs), with the first one was launched in the mid-1980s (Section 5.3.1). The IMPs aimed to increase local industrial value added and encourage the development of more sophisticated economic activities beyond simple assembly and processing.
- Tax incentives were amended to encourage local value addition and R&D (Section 5.3.2).
- Efforts were made to increase the density and quality of the innovation system by establishing dedicated research and testing institutions, as well as cluster-related infrastructure and space for public-private dialogue. (Section 5.3.3).
- Schemes were introduced to link domestic SMEs to MNCs and foster outsourcing linkages (Section 5.3.4)
- The state channelled funds to build wafer fabs, the most capital-intensive part of the value chain (Section 5.3.5).

The combination of these policies exemplified an approach to industrial policy that attempted to leverage GVCs for industrial development. Instruments did not antagonize foreign investors but attempted to increase their incentives to source locally and upgrade their technology. The result was an expanded electronics cluster that showed some signs of upgrading and a few emerging domestic firms that grew in to service the upgraded foreign subsidiaries. However, weaknesses in the implementation of industrial policy, an innovation system that remained detached from the manufacturing heart of the industry, and the lack of adequate incentives for firms to engage in learning, inhibited the development of firms that could sustain upgrading into the frontier.

5.7.1 The First Industrial Master Plan (1IMP)

Already since 1978, MIDA had begun studies for an Industrial Plan to improve the outcomes of its industrialization process. The 1IMP (1986-1995)[143] was published in 1985 and targeted 12 subsectors, stretching the resources of the state: resource based (food processing, rubber, palm oil, wood-based, chemical and petrochemical, non-ferrous metal products and non-metallic mineral products), and non-resource-based (electrical and electronic, transport equipment, machinery and engineering, ferrous metal, textiles, apparel).

The 1IMP was a large, well-researched study with concrete proposals on how to develop strategically the industry in Malaysia. Regarding the electronics industry, three key challenges were identified: (1) the overreliance on semiconductor assembly; (2) the lack of indigenous firms in the industry; and (iii) the need to upgrade assembly operations. The following measures were recommended to address these (MIDA/UNIDO: 101-115):

1. Preferential treatment for a limited priority product group (including tax incentives, protection of domestic market with predetermined declining schedule, and discounted loans)
2. Incentives for export activities (including tax reductions on income earned from direct or indirect exports, exemptions from duties used in exports, export credit)
3. Incentives for small scale firms
4. Encouraging the government to be a catalyst for indigenous R&D capabilities, by fostering collaborative R&D efforts, by continuing the work of the Malaysian Institute of Microelectronic Systems (MIMOS) and with various tax incentives for R&D

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[143] There was also the Malaysian Industrial Policy Study (MIPS), also funded by the UNDP, but also by the World Ban and carried out by an Australian consultancy, IMG, published in 1984. Its recommendations were to reduce protection and increase competitiveness in the economy. The MIPS did not gain as much traction as the IMP (Edwards, 1993).

5. Establishing the Malaysian Technology Development Corporation (MTDC) to act as a venture capital unit and a technology supplier
6. Encouraging the development of engineering and technical manpower and incentivizing the training of employees
7. Rewarding firms with fiscal incentives for local content
8. Promoting the diffusion of microelectronics in the economy
9. Improving market intelligence
10. Strengthening the role of the industry associations

The 1MP also made two suggestions regarding the structure of the industry. The first was to develop consumer electronics further that had started to develop rapidly in the 1980s. By increasing production of that segment, in which local content was frequently as high as 30% to 40%, Malaysia could create downstream demand for the more sophisticated IC industry (MIDA/UNIDO, p.20). While developing backwards integration into semiconductor design and fabrication was also recommended, developing consumer electronics was seen as less technologically challenging (see also O'Connor, 1993). The second suggestion was to create 'national champions'. The 1IMP rightly noted that there was no local firm large enough to become a leader in the industry, while the small, local firms with some technological capacity were overlooked when handing out incentives. The study encouraged the government to take bolder actions, by encouraging the merger of smaller firms or entering into a joint venture to create a firm that can operate in economies of scale. Such a firm would have to be encouraged to export, with the aim to become globally competitive.

There were some efforts by MIDA to encourage consumer electronics by giving tax incentives, but the recommendations of the 1IMP that concerned protection of certain parts of the industry and the support of local champions were not implemented.

5.7.2 Incentives for boosting local participation and technological deepening

The Promotion of Investment Act (PIA) 1986 was introduced to widen incentives for export-oriented manufacturing. According to MIDA (1987) and KPMG (1987), these were:

1. Pioneer Status (exemption from income tax, development tax, excess profit tax for 5 years irrespective of capital investment, or for 10 years for some industries).
2. Investment Tax Allowance (this was the previously named investment tax credits, now for participating in promoted activities, up to 100% in respect of qualifying capital dependent on area of investment and local content, tenable for 5-10 years).
3. Abatement of Adjusted Income (5% for resident companies in designated promoted industrial areas, 5% for small companies since 1986, resident companies complying with NEP, up to 50% for FOB sales in relation to total sales plus 5% of the value of indigenous Malaysian materials used in the products which manufactures products for exports)
4. Double deduction for Promotion of Exports (for resident companies expenses to seek market opportunities for exports)
5. Reinvestment Allowance (up to 25% of capital expenditure between 1979-1988, not compatible with Pioneer or Investment Tax Allowance
6. Accelerated Depreciation Allowance (not compatible with Pioneer or Investment Tax Allowance)
7. Export Credit Refinancing by the Central Bank – provides exporters with preferential credit (currently charged at 5%, also for indirect exporters)

The change in (1) effectively shifted the emphasis of the Pioneer incentive from the protected capital-intensive industries to export-oriented industries. The export orientation was reinforced with (3), (4) and (7) and local content clauses were put in (2) and (3). Investors whose pioneer status expired, could continue to receive tax incentives with (5) and (6). Equity ownership rules were also relaxed, allowing 100% ownership to new applicants if they exported more than 50% of output in products that do not compete with Malaysian firms, or if they employed 350 Malaysians and more. If products were of high technology or priority, a majority foreign share (51%) could still be retained even if the project was domestic market-oriented.

The levels of tax incentives and their duration changed almost annually. Eventually total tax relief was reduced and it was announced that 100% tax exemptions would be given only on a case-by-case basis (MIDA, 1991). In 1995, MITI announced that to obtain

Pioneer Status, firms had to spend some RM 55,000 (USD 20,000) per employee (although it is not clear what expenditures qualified) or satisfy other criteria, such as value added of 30% or more, 15% of the workforce in managerial, technical or supervisory positions, or location in promoted areas or activities beneficial to Malaysia's progress (Felker and Jomo, 2007).

Under the PIA, 24 electronics products and parts were promoted, including computers and peripherals, consumer electronics, appliances and upstream components related to semiconductor assembly, as suggested by the 1IMP. In contrast to previous policies, these projects did not need to be export-oriented (MIDA, 1987). Local content in the industry was promoted by being tied to tax incentives. However, achieving a high percentage of local value added in semiconductors was difficult: even if all the materials, excluding the wafers, were sourced locally, total value added would rise by probably less than 10 percentage points (O'Connor, 1993: 216). Moreover, incentives for local content had to be phased out by 2003 as part of Malaysia's commitments to WTO. For this reason, government attention turned towards establishing wafer fabs in the mid-1990s.

More funding also started to become available for manufacturing industries. The New Investment Fund (NIF) was launched in 1987 to channel RM 1 billion (USD 400 million) of funds by the central bank to commercial banks for on-lending to investment projects in new productive capacity in the manufacturing, agricultural, tourism and mining sectors, at a maximum rate of 7.75%, which was below market prices (MIDA 1987). Loans were between RM 250,000 (USD 100 thousand) to RM 50 million (USD 20 million) (up to 75% of expenditure) for five years (KPMG, 1990). In 1989 the industrial Technical Assistance Fund for Small and Medium Scale Industry was established to provide grants, with an initial amount of RM 50 million (USD 20 million).

Incentives were also set up to encourage skills development. In 1993 the Human Resources Development Fund (HRDF) was set up for all industries above 50 workers and in 1996 extended to SMEs. Firms would put 1% of payrolls into a fund and could apply for reimbursement of a percentage of expenses on approved training programs (Felker and Jomo, 2007).

Incentives for R&D and training had been considered since 1980 (MIDA, 1980), but it was in the late 1980s that these started to be fleshed out. MIDA put in place generous tax incentives to encourage firms to conduct or contract R&D, including various tax exemptions and deductions for capital expenditures. During 1984-1994 the electronics/electrical industry received 61.6% of the approved R&D tax deductions. These were worth a total of RM 80.8 million (USD 31 million), and were spread among 21 firms (Rasiah, 1996). The effort to increase R&D in research institutes and the private sector was coordinated by the Action Plan for Industrial Technology Development (APITD), launched in 1990. The APITD identified electronics as a sector that needed support for technological improvement (along with ceramics, chemicals, machinery and engineering, plastics, wood, textiles, food and rubber). It was also a key technology to be supported by government R&D (together with automated manufacturing, advanced materials, biotechnology and IT). The sectoral goal for electronics was to support Integrated Circuit (IC) design, radio frequency engineering, an automated assembly process for electronics called Surface Mount Technology (SMT), digital signal processing and design for peripherals (Felker, 2003:143).

Government funding for R&D was coordinated by the Intensification of Research in Priority Areas (IRPA), a scheme launched in 1988 to link public R&D to strategic areas for development. Some RM 117.16 million (USD 45 million) was approved under the scheme, with RM 25.6 million (USD 9.8 million) going to the industrial sector. Joint research between private sector and research institutes was encouraged (MIDA, 1994). In practice, however, many of the allocations were driven by the interests of the government research institutes and not the private sector (Felker, 2003). The first direct subsidy for private R&D was given in 1997, with the Industry R&D Grant Scheme and the Technology Acquisition Fund (each with and allocation of RM 100 million or USD 36 million), managed by the MTDC (ibid.). There is no data on the share of these funds that were absorbed by the electronics industry.

The uptake of R&D-related incentives and funding by private firms was low, either due to lack of interest or because of the complexity of applications (Felker, 2003). The low capabilities in the electronics industry, particularly in domestic firms, made it difficult to design R&D projects, state their expected results and handle the complex applications system. In contrast, thanks to their higher capabilities, foreign subsidiaries made use of

R&D-related tax incentives, increasing their research in process R&D and product adaptation.

5.7.3 The creation of an innovation system

A number of institutions were established during this time to increase the ability of firms to innovate by providing capital, research and testing services, and specialized infrastructure. This section discusses the contributions of these institutions to the Malaysian electronics innovation system.

Malaysian Industry-Government Group for High Technology (MIGHT)

MIGHT is a consultative forum that was launched in February 1993 to bring together stakeholders for the development of high technology industry. It was set up by the Malaysian Business Council and the National Council for Scientific Research and Development. The direction came from a steering committee chaired by Datuk Dr. Omar Abdul Rahman, the PM's Science Advisor and Tan Sri Dato Hj Basir Ismail (former Chairman of Petronas), while a support unit was stationed at Dr Omar's office[144]. MIGHT was meant to engage in 'strategic foresight' to identify areas for investments and policy options to build competitiveness.

However, the institution was not involved in the electronics industry, focusing instead on aerospace, biotechnology, photonics, nanotechnology and advanced manufacturing[145]. As a consequence of MIGHT's focus, many of the manufacturing firms that were conducting R&D at the time in electronics (e.g. Intel) were not part of the group. Motorola was the only electronics MNC to join MIGHT by 1995[146]. The emphasis of MIGHT on R&D, ignoring the accumulation of technological capabilities that can take place during

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[144] NTIS Alert Foreign Technology US Department of Commerce 'Malaysian Government, Industry Collaborate on New Technologies', 1 April 1994.

[145] MIGHT suggested a Masterplan to develop the telecoms industry proposing a vendor supplier system focused on local SMEs This could have stimulated parts of the industry given the convergence of telecommunications and digital technologies in the 1990s and the role of the local telecommunications provider as a large buyer, but not much came of it. (Kaur, Lashvinder 'MIGHT's Masterplan to Develop Telecoms Industry', 17 September 1994, Business Times.)

[146] Hamid, Hamisah 'Shift to Technology-Intensive Industries', 12 August 1995, Business Times.

complex production, were highlighted by a controversial suggestion the group made that manufacturing licenses should be made conditional upon R&D expenditures to 'jolt' the economy into the high-tech era[147]. However, given its support for advanced manufacturing, MIGHT promoted the idea of establishing wafer fabs[148].

Malaysian Technology Development Corporation (MTDC)

The MTDC was a government-run venture capital fund established in 1992. Its original mandate was to find technologies developed by research Institutes and universities to commercialise by providing venture capital, but few such opportunities emerged (Felker, 2003). In the beginning, some of MTDC's activities were helpful in growing the domestic electronics sector. Within a couple of years, MTDC invested RM 6 million (USD 2.3 million) in eight firms that were operating in the sector (consumer electronics, computer peripherals and software) (Rasiah, 1996). The most notable example of these is Globetronics. However, after that there was scarcely any investment by MTDC in electronics projects (Rasiah, 1996).

Science parks and clusters

A major thrust of the post-1986 development policies in Malaysia was the promotion of clusters to encourage upgrading. This was done by providing specialized infrastructure and targeted incentives for firms locating in the parks/clusters. In the electronics industry, the science parks/clusters of importance were:

- Technology Park Malaysia (TPM), established in Bukit Jalil, near Kuala Lumpur in 1995. TPM housed MIMOS, the government-owned research agency in microelectronics.
- Kulim High Tech Park (KHTM), built in 1996 in the state of Kedah opposite Penang. Even though it is not in Penang, the KHTP has easy access to the island and has benefitted from proximity to it. The park was envisioned to be a modern science city, bringing together R&D, design and engineering in industries, such as

[147] FMM – Might suggestion unwise, 25 April 1997, Business Times, Sheares, Michelle.
[148] Bujang, Asiah 'Time to develop chip-designing industry – Omar', 6 November 1998, Business Times.

microelectronics, robotics and bio-technology[149]. KHTP developed appropriate infrastructure to attract wafer fabrications, and it housed the first large-scale such operation Malaysia, SilTerra.

- The Multimedia Super Corridor (MSC) established in 1996 as a large cluster, which encompassed Kuala Lumpur, nearby Putra Jaya and the Kuala Lumpur International Airport. A purpose-built city with specialist infrastructure, Cyber Jaya, was built in the area. The MSC encouraged ICT companies working on software and hardware in telecommunications, multimedia and other IT applications, leveraging the convergence of information technologies with telecommunications (Tham and Loke, 2011).
- In Johor there is the Technovation Park and the incubator UTM-MTDC Technology Centre hosted at University Technology Malaysia (UTM), established in 1995 and 1999 respectively (Malairaja and Zawdie, 2008).

The parks provided much-needed specialized infrastructure for firms engaged in software and science-base activities (e.g. biotech). However, the fact that these were not located in Penang, apart from KHTM that is at least in close proximity, has hindered linkages with the manufacturing industry[150] (Singh, 2011). Another issue has been that these initiatives were not able to bridge the institutional gap between promoting industry and promoting Science and Technology (S&T) capabilities. TPM came under the Ministry of Science, Technology and Innovation (MOSTI) and MSC and has been led by the Malaysia Digital Economy Corporation (MDEC), also under MOSTI. By contrast, KHTM, owned by the Kedah State Development Corporation, was set up by MITI for firms that received MIDA's high technology status (Felker and Jomo, 2007). The focus of MOSTI on non-manufacturing, science-oriented start-ups has meant that many of the initiatives led by the Ministry have not been established with the needs of the electronics industrial cluster in mind.

[149] Wooing MNCs to high-tech park, The New Straits Times, 19 March 1996.
[150] Interview PN11. Interview with senior government official in Kuala Lumpur,

Malaysian Institute for Microelectronics Systems

MIMOS was established in 1985 as a unit under the Prime Minister's Department. MIMOS was an R&D unit during 1985-1990, became an agency between 1991-1996 and a corporation in 1997. The Institute quickly diversified its main business from just conducting research to creating business ventures (in internet infrastructure, computer and peripherals manufacturing and wafer fabrication).

It was envisioned that MIMOS could take a similar role to that of ITRI in Taiwan, but the institute never managed to become a driving force in the industry. The wafer fabs created by MIMOS (more on that in Section 5.3.4), were small and with mature technology that was a few generations from the frontier.

Part of the reason lies with the way MIMOS was managed; the focus of MIMOS expanded too broadly and too quickly, with projects not getting enough resources, and management decisions became increasingly political[151]. More importantly, MIMOS was not only far from the ecosystem it meant to serve in Penang, but also it did not have enough firms to serve. The foreign firms in the cluster relied on their parent firms for designing and prototyping, and there were few domestic firms that had an interest in designing IC chips and use MIMOS' services. Without downstream demand for MIMOS, the agency attempted to diversify into business, as noted earlier[152].

It is also possible that the capital and human resources at MIMOS were not enough during this time for the kind of role it was asked to play. In 2004 MIMOS spent RM 34 million (USD 8.9 million) on R&D, almost half of what the Malaysian Palm Oil Board (MPOB), another Government Research Institute, spent on palm oil related research, while palm oil as a sector contributed six time less value added in the economy (Yusuf and Nabeshima, 2009:167). Moreover, in MIMOS only 4% of researchers had a Ph.D and 18% a Masters. By contrast in MPOB those percentages were 36% and 20% respectively and in

[151] Interview with government-owned research agency in Kuala Lumpur, 26 February 2016, KL02.

[152] Interview KL02, footnote 151. Also Interview with senior government official in Kuala Lumpur on 1 April 2016, KL12.

SIRIM (Scientific and Industrial Research Institute of Malaysia) 24% and 27% respectively (ibid: 168).

Nevertheless, MIMOS achieved a lot of firsts for Malaysia. It created the first IC wafer fab and it introduced the first locally designed IC in 1994, a 16-bit RISC microprocessor. The operations of MIMOS created relevant human talent[153] and government expertise that became useful. Setting up the wafer fan was a learning experience for Malaysia, highlighting the importance of infrastructure, the technology involved and the scale needed, which inspired the plans to build the dedicated Kulim High Tech Park[154] (see also Section 5.3.5).

5.7.4 MNC-SME linkage schemes

Efforts were made to provide more institutional support for linkages between foreign firms and domestic ones, going beyond matchmaking. Even though the Vendor Development Programme (VDP) is more widely known for the automotive sector, when it was launched in 1988 for Proton, there was also an electronics component scheme launched in 1992, with Sapura (a large domestic telecommunications supplier) and Sharp (a Japanese consumer electronics firm) as anchor firms (Rasiah, 1996). Little is known about the results in this segment, but Sapura reportedly made extensive use of the programme (Rasiah, 1996). The companies participating in the VDP met local content and linkage criteria for tax incentives[155]. More companies joined over time, with Sony subsidiaries, Motorola, SGS-Thomson Microelectronics (now ST Semiconductors), JVC electronics and Hitachi Electronics among the large corporations that signed VDP agreements in 1994[156]. Sapura and Sharp spent some RM 3 million (USD 1.1 million) in two years to develop 5 vendors each[157] and the government channelled RM 9 million (USD 3.4 million) to the two firms

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[153] Interview with Vice President of foreign-invested firm in Kulim High Tech Park, 22 March 2016, KH01.

[154] Interview KL02. Footnote 151.

[155] Jacobs, Jennifer, ‘Electronics Sector Spurred to Set Root’. 11 August 1993, Business Times.

[156] K’Zaman, ‘Bahaman, Firm Base of Support Industries by 2000’, 25 January 1994, Business Times. Yeow, Jimmy, ‘MITI picks 50 more firms to Join SMI Vendor Scheme’, 4 March 1994, Business Times.

[157] Mansor, Lokman, RM64M Allocated to Help Develop SMIs This Year’, 24 August 1994, Business Times.

for loans to vendors. Moreover, financial institutions, such as MIDF and Bank Pembangunan Malaysia also set aside RM 40 million (USD 15.2 million) together for Soft-Loan schemes aimed at SMEs that wanted to become vendors for large firms (MIDF on Modernisation and Automation, while the latter for Bumi engagement in Furniture and Food industries) [158].

Some firms developed from this scheme, such as Akamai Electronics, a Bumi firm in Ampang Jaya that provided precision stamped parts for automotive firms, mobile phone components for Motorola Semiconductor and computer board assembly for SharpRoxy[159]. However, several problems persisted. Some of the anchor companies that signed memoranda did not follow through with proposals, while in other cases the anchor companies did not provide the mentorship or prioritise the suppliers in their work plans. Sometimes, suppliers would receive unrealistic orders and did not have enough information on the financial facilities available[160]. At the same time, the low level of expertise among SMEs was noticeable. Sapura vice chairman Rameli Musa commented that "[Sapura] had to practically station [its] engineers in these factories to teach them everything, from stock control, quality control and production control to sourcing of equipment"[161].

5.7.5 Backward linkages: establishing wafer fabs

Integrating backwards into higher value added functions in the semiconductor value chain had been a goal since the 1IMP, but the Second Industrial Malaysia Plan (2IMP, 1996-2005) was even more ambitious in this regard. It advocated the establishment of at least three wafer fabs, one for each type of wafer: DRAM (Dynamic Random Access Memory), ASICs (Application Specific Integrated Circuits) and Microprocessors, possibly with joint ventures. The wafer fabs were described in 2IMP as the 'missing link' of the

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[158] Laur, Lashvinder, 'SMI Development Gets Further Boost of RM10.6M', 14 February 1994, Business Times.

[159] Sulaima, Siti Hajjar, 'Couple Turns Electronics Firm into Success Story', 18 June 1994, Business Times.

[160] 'More vendor companies wanted under development programme', the New Straits Times, 10 April 1996.

[161] Jacobs, Jennifer, 'Local Participation in Electronics Industry Wanting', Business Times, 12 August 1993.

value chain, putting pressure on the trade balance, as the expensive silicon wafers had to be imported. While assembly accounted for only 8% of the value of the semiconductor, fabrication accounted for 35% (2IMP: 70). The establishment of wafer fabs was also seen as a way to draw in other upstream activities, such as R&D and design, and provide an anchor for smaller firms in the semiconductor value chain.

In the beginning, Malaysia's only fab was a small 4-inch facility by Motorola in Seremban producing discrete semiconductors. Another local effort and the first wafer fab for ICs to operate in Malaysia was MIMOS in 1996. The fab would produce 6-inch wafers at 1.5 micron[162], with a possibility to upgrade to sub-micron processes in the future[163]. MIMOS also built an 8-inch facility in 2002. The process technology has since improved to 0.35 microns for IC and 0.8 microns for discrete devices (ibid). The technology was not advanced and the capacity was small, not really aiming to be a commercial fab, but a learning project that suits prototyping and small-scale mature needs of local players.

Other planned projects by foreign investors prior to the launch of the 2IMP never got off the ground. First, Taiwan's Hualon Microelectronics Corp was considering a USD 260 million joint venture with local Malaysian firm Carsem Malaysia since 1990 to be located in Kulim and assistance would be provided by MIMOS for ASIC design[164]. However, first the government decided to build the KHTP in the area, delaying the project for a couple of years[165] and then the Hualon's chairman was embroiled in a financial scandal[166]. The project, which had received USD 112 million in local loans and a 10-year tax-free treatment[167], never got off the ground. Second, Hitachi was also considering building a fab for DRAMs in Malaysia in 1991, even sending 15 engineers from its assembly facility in

[162] At the time the frontier was at 8 inches and already at sub-micron level.

[163] Dennis, William ' Malaysia OKs Fab Funding', Electronic Buyers' News, 12 August 1991.

[164] Dennis, William 'Hualon to Locate Fab – Taiwan Electronics Maker Investing in Malaysian Semiconductor Joint Venture', Electronic World News, 9 April 1990.

[165] See footnote 164.

[166] Taiwan's Hualon in Big Malaysia Investment – Report, Reuters, 22 March 1992.

[167] Hualon to set up eight-inch silicon wafer plant in Malaysia, Taiwan Economic News, 2 July 1994

Penang to Japan for training[168]. In 1996, LG jointed the project[169]. Hitachi first delayed the project to invest in Munich instead[170] and then the project was put on hold in 1996 by the Malaysian government reportedly because it was worried the terms were too favorable to foreign investors. The terms had included 100% foreign ownership, an RM 600 million (USD 238 million) loan at a 4.2% rate (around half the prevailing market rate) and a 10-year tax holiday (twice the normal rate)[171]. Eventually, sharp drops in the prices of chips by 1996 and the Asian Financial Crisis led to the Hitachi-LG project to be cancelled altogether.

The government soon stepped in to shoulder some of the direct investment costs and support wafer fabrication by using its investment arm, Khazanah Holdings. Khazanah was under the purview of the Ministry of Finance and was chaired by Mahathir, by establishing SilTerra in 1997[172]. Khazanah eventually held 70% of SilTerra's shares, with LSI and Seiko Investments also holding small shares[173]. SilTerra ended up operating at a modest

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[168] Hitachi's plan to build chip plant adds to country's electronics industry, Electronics Times, 26 September 1991.

[169] Report: Malaysia Puts Hitachi $1.2B wafer plant on hold, Dow Jones, 13 March 1996.

[170] See footnote 168.

[171] See footnote 169.

[172] Khazanah, together with Bank Industri Malaysia and BI-Walden Ventures set up a joint venture named Wafer Technology Bhd. It the mid-1990s the venture had two projects. The first was a planned investment with US-based VLSI Technology group for a US 1.2 billion wafer fab in Kulim, with VLSI owning 20%, Khazanah 25% and three foreign semiconductor makers 5% each. The rest of the shares would be offered to local companies (Nordin, Fairuz Mona 'Plan to ste up RM3n wafer fabrication plant in Kulim', the New Straits Times, 28 October 1996). The plant would manufacture complex logic circuits in 8-inch 0.35 micron technology The plan was delaying and Khazanah agreed to increase its share to 55% for the project to go ahead (Lien, Jennifer 'Wafer fab plans hit by suspended project', Business Times Singapore, 6 November 1997).. Eventually, VLSI pulled out and LSI replaced it as a technology partner. Wafer Technology was then renamed to SilTerra in 1997. A second project was an announced US$830 million JV with Atmel for 8-inch wafers, with Khazanah holding 40% and Atmel the remaining 60%. As part of the agreement Atmel would buy back 100% of the production for 10 years (Malaysia: Khazanah, U.S. Atmel in Pact for $850M Plant, Dow Jones, 14 October 1997). However, the venture never took off, as local banks pulled out of the project in the middle of the Asian Financial Crisis (Lien, Jennifer 'US chipmaker Atmel's Malaysian venture delayed', Business Times Singapore, 13 May 1998).

[173] Hamid, Jialil 'Malaysia to offer incentives to foreign wafer investors', Reuters News, 26 July 2001

profit, focusing on mature technologies and fabrication of advanced logic, mixed signal, radio frequency and high voltage ICs. It commercial production in 2001 at 0.18 micron, upgrading to 0.13 micron in 2004[174]. While SilTerra had potential, the company also operated as a political project, with leadership at the helm that was inexperienced to drive the commercial fab forward[175]. Khazanah also made some other investments in the semiconductor value chain to complement its fabrication facility[176].

Another project financed by the state, was "InterConnect Technology". It was backed by the state of Sarawak, but was also suspended in 1997. This was supposed to be a foundry built by the Sarwak Economic Development Corporation, Malaysian and foreign investors and chaired by Penang's chief Minister Lim Chong Eu,[177] who eventually resigned amid financial difficulties and disagreements. The fab was later finished by the Sarawak Economic Development Corporation and operated as a wholly owned venture named 1st Silicon and started with a 0.25 micron processing line. Sharp provided technology for the project and was the major client[178]. However, the company quickly became loss making since it started operations in 2001 and by 2004 it had amassed some USD 640 million in losses[179].

By 2001, following the Asian Financial Crisis, the mood in the government had changed, and Mahathir promised sweeteners to foreign investors in fabs, such as tax incentives and 100 percent ownership[180]. However, the protracted semiconductor downturn did not help.

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[174] SilTerra demos new SRAM technology, New Straits Times, 23 December 2005.

[175] Interview with Malaysian consulting firm in Kuala Lumpur, 1 March 2016, KL03.

[176] For example, it had a 25% stake in MEMC Kulim Electronic Materials that produced silicon ingots and wafers (the materials that go into wafer fabs) ('MEMC Elec. Malaysian Firm to Form Wafer Joint Venture', Dow Jones, 20 March 1996). The company also bought a US-based proto-line manufacturing facility to conduct R&D on wafer fabrication for the CMOS process technology (Kasim, Sharifah 'WTM buys US wafer fabrication plant', the New Straits Times, 20 October, 1997).

[177] See Lien (1997), footnote 172.

[178] Bickers, Charles 'Technology – Sarawak Surprise: Malaysian newcomers aim to challenge Taiwan foundries' lead', Far Eastern Economic Review, 14 October 1999.

[179] Jayasankaran, S. 'Malaysia Bets on a Global Chip Boom', The Wall Street Journal, 14 April 2004

[180] See footnote 173.

As mentioned above 1st Silicon had accumulated losses and there was not much interest for new fabs as significant capacity existed globally at the time.

5.7.6 Few local firms and some upgrading

The result of the policy mix adopted during this time was limited upgrading in the electronics industry, diversification of the products assembled and the emergence of a handful of local electronics firms.

Foreign subsidiaries between the mid-1980s and end of 1990s diversified and upgraded their product range, increased the complexity of their process and invested in automation (Arrifin and Bell, 1999). The inflows of foreign investors from Japan and Taiwan led to increases in the share of consumer electronics in total output and exports. In 1984 consumer electronics accounted for 4% of total value added in the electronics industry; by 1995 its share had jumped to 30%.

However, there was little product development taking place (Ismail, 1999). The exceptions were a handful of large subsidiaries, such as Intel, Motorola, Sharp-Roxy and Matsushita, which conducted R&D on mature products (Ismail, 1999). Sharp-Roxy introduced a locally developed mini CD stereo in 1995 and developed processing machinery (an assembly machine for turn-tables)[181]. According to surveyed subsidiaries, firms did not locate product R&D in Malaysia due to the lack of trained personnel, markets and production experience in the country and fears over intellectual property leakages (Rasiah, 1996). In contrast, process R&D was much more common. All firms interviewed by Ismail (1999) engaged in some form of R&D on production methods and processes, with Texas Instruments, Motorola, Harris and Quality Technologies the most advanced in this respect. Frontier R&D activities were always retained at parent sites (Rasiah, 1996). Even so, the innovation activities of foreign subsidiaries were advanced compared to what local firms were doing. Sony was the top holder of Malaysian patents (among private firms) between 1989-2006, with a total of 7 patents, followed by Motorola Semiconductor with 5 (Yusuf and Nebeshima, 2009). Rasiah's survey (1996) suggests that government incentives

[181] Mokhtar, Nor Asmah 'Sharp-Roxy to Launch Locally Made Audio Products in Aug.', 17 April 1995, Business Times.

caused the shift towards more technology-intensive activities in foreign subsidiaries. Foreign subsidiaries claimed 91% of all R&D expenses in 1993 (Rasiah 1996) and firms reported that the R&D incentives were important in their locational decisions for 're-designing' activities (ibid).

There is also some evidence that backward linkages increased for the industry during this time. Tham and Loke (2011), using input/output analysis note that backward linkages from the E&E sector to the rest of the economy increased significantly between 1987 and 1991, but subsequently fell somewhat until 2005. The relocation of foreign suppliers from Japan to Malaysia following the yen devaluation of the mid-1980s and from the United States to Malaysia, following the emergence of fist-tier manufacturing contractors, the development of local sub-contractors and the SME linkage programmes helped to increase local sourcing. However, it seems that despite the formal requirements for local content in place, the government was hesitant to enforce them (Yusuf and Nabeshima, 2009).

Moreover, some of the domestic firms that had emerged during the previous phase (e.g. Eng Teknologi) to provide tooling and other machining services and components to MNC subsidiaries started to become more sophisticated. The Promotion of Investment Act in 1986 contained incentives for indirect exports and extended them for smaller-sized firms, thereby encouraging domestic SMEs to supply foreign subsidiaries. These sourcing linkages proved decisive in helping local firms grow. For example, Intel supplied Eng, LKT, Prodelcon and Metfab with capital to upgrade its equipment, technical expertise, prototypes and bilateral staff visits (Rasiah, 1999).

Additionally, as MNC subsidiaries focused on more complex products and automated their manufacturing processes, demand increased for subcontracting by local firms in labor-intensive tasks such as simple semiconductor assembly. Several domestic firms emerged during this time to absorb this demand including Globetronics, Unisem, Carsem, Inari and AIC semiconductor. Many firms were set up by former MNC employees, who set up their own firms to provide subcontracting services to their former employers. Globetronics was established by a former Intel engineer, Pentamaster by a former employee of National Semiconductor, Vitrox by a former HP employee and Aemulus by a former Alterra one. In some cases, government helped with expansion or with initial capital. MTDC took a 30% stake in Globetronics a couple of years after its establishment and helped with its expansion.

AIC benefited from loans from Bank Industri Malaysia to expand operations. However, there were no systematic efforts by the government to encourage the growth of spin-offs.

5.8 2005-now: Promoting capital-intensive and high-tech activities in the entire industry

Even though the broad policy approach towards the electronics industry did not change radically during the last decade, the industry seems to be at an inflection point. First, the Malaysian government started offering capital grants on top of tax incentives in 2005. This attracted companies in the more capital- intensive parts of the value chain. Second a dedicated fund was set up by MIDA to fund domestic firms. Third, the global developments in the electronics industry have encouraged the Malaysian electronics industry to diversify into new value chains. The Global Financial Crisis (GFC) reduced foreign investments in electronics and put pressure on the margins of labour-intensive manufactures. Additionally, the emergence of China as a large consumption and production hub has led GVCs to consolidate in China, rather than expand in Southeast Asia.

5.8.1 Industrial Policy: frequent changes and some promising initiatives

Mahathir stepped down in 2004 and was succeeded by Prime Minister Abdullah Ahmad Badawi. During Badawi's brief tenure (2005-2009), there was a retreat from strategic initiatives, as pressures mounted to reform government finances. Malaysia recovered quickly from the Asian Financial Crisis (AFC) of 1997-1998, but that was largely due to expansionary government spending and a ballooning government deficit. Private investment was growing 15% per annum between 1991-1997, but declined by -0.6% on average during 1998-2012 (Jomo and Wee, 2014).

As part of the State-Owned Enterprise (SOE) restructuring, there were efforts to sell the wafer fabs that had struggled to become profitable[182]. Khazanah has been seeking to sell SilTerra since 2008[183], with no success so far. The company, after a brief period of positive

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[182] Burton, John, 3 June 2005, Khazanah chief defends his record at driving change, The Financial Times.

[183] Leong, Doreen, 19 April 2010, Corporate: Silterra up for sale again?, The Edge Malaysia

profit racked up RM 1 billion (USD 290 million) in losses in 2007[184]. 1st Silicon in Sarawak was sold to Germany-based X-fab in 2006. Khazanah made no other investments in the electronics industry until 2015, when it invested in Aemulus, a semiconductor testing equipment firm. Nevertheless, during Badawi's tenure the government (via wholly-owned subsidiary Cyberview) established Fabtronic. Its aim was not as ambitious as that of SilTerra, pointing instead to develop advanced semiconductor packaging and to offer outsourcing services to MNCs located in Penang. The venture has been modestly successful[185]. It is essentially a "factory within factory", located in the facilities of AMD in Penang[186].

Moreover, many of the previous initiatives that aimed to build local capabilities lost their dynamism during Badawi's tenure. In an effort to streamline the various initiatives, the Multimedia Development Corporation (MDeC), MIGHT and MTDC that used to be under the Prime Minister's office, came under the purview of the MOSTI in 2004. It therefore became more difficult for businesses to participate in the elaboration of industrial policy objectives and initiatives, as industrial policy for the electronics industry continued to be shaped by the Prime Minister's office[187]. Second, the move implied that these initiatives ceased to be considered of strategic priority for the government[188]. MIGHT was transferred back to the Prime Minister department under the Science Advisor again in 2011 and then in 2014 under a minister in the same department.

Despite a lack of strategic vision for manufacturing, in 2005 government support switched to offering a mix of tax cuts and grants (spurring capital-intensive investments). The grants, inspired by the Singaporean model of support, were administered by MIDA[189]. Specific funds were set up for this purpose, such as the Strategic Investment Fund and the Automation Fund. Foreign investments responded and set up wafer fabrication plants (e.g. Infineon, Fuji, ON Semiconductor, Osram) and chip design facilities (e.g. Alterra) (Rasiah,

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[184]Puah, Pauline, 4 November 2008, MPs question Khazanah's investment in Silterra, The Edge Financial Daily.

[185] Interview KL02, footnote 151.

[186] Karamjit Singh, 24 August 2009, Net Value: Transforming Cyberjaya, The Edge Malaysia

[187] Hassan, Nezrin, 12 April 2004, My Bit: Keep a few doors open, The Edge Malaysia

[188] Interview with CEO of government-business group in Kuala Lumpur, 17 March 2016, KL10.

[189] Interview with Chairman of tax advisory firm in Kuala Lumpur, 14 March 2016, KL07.

2015; Rasiah and Shan, 2016). MIDA was also given a Domestic Investment Strategic Fund (DISF) to disburse among domestic investors. According to an announcement by MIDA, between July 2012 and September 2017, RM 1.3 billion (USD 350 million) was disbursed to support 264 projects. The majority of the projects were in Penang (76), followed by Kedah (13)[190].

In 2009 Najib became the new Prime Minister and launched the Economic Transformation Programme (ETP) (2010-2020). The ETP reflected a turn towards a more targeted approach to industrial policy. The Ninth Malaysia Plan (2005-2009) and the 3IMP (2006-2020) had advocated clustering, promoting higher value-added activities, improving skills in the workforce and increasing the service content of production, but were short on concrete measures. In contrast, the ETP focused on twelve New Key Economic Areas (NKEAs) and proposed specific projects to achieve the stated goals. The goals and projects were developed through large workshops with key stakeholders. The NKEAs that relied on public support for a significant portion of total investment were the infrastructure projects in Kuala Lumpur and the Greater Klang Valley, Agriculture and Education. The total planned investment for the ETP was RM 795.2 billion (USD 247 billion) out of which 14% would come from the public sector. Among NKEAs regarding industries, electronics featured the highest planned investment from the public sector, with 8.7% of the total (see Table 5.3).

Within the E&E industry, four segments were chosen to be promoted: (1) semiconductors; (2) Light Emitting Diodes (LEDs); (3) solar; (4) industrial electronics & home appliances. Previous areas of growth such as passive components (e.g. resistors, capacitors, inductors), Personal Computers (PCs), computer peripherals and consumer electronics were not promoted any more under the ETP, indicating an intention to diversify and upgrade. For each segment 15 key projects were identified (later extended to 18).

[190] Rosnani Saad, 14 September 2017, MIDA approves RM 1.3 bln DISF Grant Till July 2017, Bernama Daily Malaysian News.

Table 5.3 Planned investment in New Key Economic Areas, RM billion

NKEAs	Private Investment	Public Investment	Public invest. as share of Total	Share of total public invest.
1. Greater KL/Klang Valley	114.1	57.8	33.6%	58.8%
2. Oil & Gas	113.3	0.6	0.5%	0.6%
3. Financial Services	64.6	0.6	0.9%	0.6%
4. Wholesale and Retail Trade	66.7	0.4	0.6%	0.4%
5. Palm Oil	56.8	2.9	4.9%	3.0%
6. Tourism	132	4.6	3.4%	4.7%
7. Electronic & Electrical	58.2	8.5	12.7%	8.7%
8. Business Services	30	3.1	9.4%	3.2%
9. Communications Content and Infrastructure	29.3	1	3.3%	1.0%
10. Education	9.58	10.27	51.7%	10.5%
11. Agriculture	10.7	8.2	43.4%	8.3%
12. Healthcare	11.6	0.3	2.5%	0.3%
Total	696.9	98.27	14.10%	100%

Source: Author's summary based on the ETP (PMO, 2010)

The mix of instruments to support the ETP is similar to what was used in previous periods, but became more targeted to specific areas of interest.

- Tax credits and holidays for silicon producers and solar wafer and cell producers.
- Investment tax allowances for scaling up advanced semiconductor packaging plants
- Grants and loans prioritizing R&D and training in the LED sector

- Creating local champions in solar (namely IntaMAS and DSEM), by disbursing loans through the SME Corporation and offering technical support by MOSTI.
- Targeting MNCs to relocate to Malaysia to build wafer fabs in mature technologies and to engage in IC design
- Encouraging MNCs to outsource IC design to Malaysian firms
- Facilitating infrastructure for IC design (e.g. electronic design automation tools, prototyping lab and certification testing lab).
- Improving power quality in the Kulim high-tech park
- Developing vendor development programs (e.g. Agilent as an anchor firm in Penang)
- Conditions on FDI made stricter, encouraging technology transfer measured by key performance indicators and reviewed every three to five years
- Incentives given to firms willing to establish local R&D centres

The specific incentives that firms receive are not standard and are part of a 'package' that is negotiated on a case-by-case basis. Incentives include corporate tax exemptions, import tax exemptions, withholding tax, corporate tax exemptions and permits for hiring expatriate staff[191]. Requirements for getting incentives have increased, with MIDA looking closely at the share of engineers and technicians in production or the type of equipment used in production, and the level of local business spending[192]. Some of these conditions are putting pressure on firms to upgrade[193]. However, it should be mentioned that there are still weaknesses in monitoring of these requirements and a general unwillingness to cease incentives once these have been granted (Lim and Ong, 2007). Moreover, even though incentives are not given anymore to small labor-intensive firms[194], they are still disbursed

[191] Interview KL07, footnote 189.

[192] This is a condition inspired by the Singaporean authorities. Since making tax incentives conditional on local content is not allowed under WTO, the condition has changed on local business spending, but there is no restriction (at least in publically available information) on what this spending entails.

[193] Interview with senior manager in electronics manufacturing service firm in Penang, 30 March 2016, PN15.

[194] Interview with CEO of contract manufacturer in Penang, 9 March 2016, PN08.

to firms that are large employers and have a long history, even if they still engage in low value-added assembly activities[195].

A positive outcome of the ETP has been the renewed attention to MIMOS as a body that can provide valuable services to the local electronics clusters. First, in 2006 MIMOS changed its mandate, shedding all its business units and focusing again on R&D in semiconductors, industrial electronics and ICT and on offering supporting services to firms in the sector, especially in IC design and failure testing, at below market rates. The fab facilities of MIMOS focus on niche products, but companies can use them for prototyping. Under the ETP, MIMOS received funding (RM 224 million or USD 75.6 million) to build specialized shared facilities for the industry, namely the Centres of Excellence for Board and Systems, Test Development and Material Science and Packing and Testing Labs for Wafers, a Contactless Testing Lab and a Failure Analysis Lab. MIMOS also conducted skills development courses for university students and graduates. Between 2012 and 2015 MIMOS trained 186 engineers and offered support services to 145 companies (PMO, 2015).

There have also been some recent efforts to increase the technology-intensity of the industry by creating institutions that bring actors together to chart strategic initiatives. The Collaborative Research in Engineering Science and Technology (CREST) was created in 2012 to bring together industry (mainly the large MNCs but also SilTerra), academia (University of Malaya and University of Science Malaysia) and the government (e.g. NCIA and Khazanah) to enable collaborative research. CREST provides R&D grants for collaborative research between academia and businesses, covering at least 50% of project costs or more for targeted projects that will benefit the whole ecosystem. When it covers more than 50% of project costs, CREST owns the intellectual property and engages in revenue sharing with the company and university involved. CREST's budget was RM 900 million (USD 291 million) for ten years. RM 100 million (USD 33 million) was provided by the government, with the balance coming from the private sector[196]. The efforts of CREST have concentrated on the diversification of the electronics industry in line with the

[195] Interview PN15, footnote 193.

[196] CREST to Receive RM 800 mln for E&E R&D, 10 June 2012, Bernama Daily Malaysian News

ETP. In 2014, it was announced that it would spend RM 170 million (USD 52 million) over five years to set up two laboratories and conduct R&D on LEDs[197]. While it was envisioned that CREST could enable collaborations between firms, this has not materialized as firms involved have found it difficult to agree on how to share the intellectual property[198].

Additionally, the E&E Strategic Council was established in 2015, an initiative driven by Dato' Wong Siew Hai, Chairman of MAEI and a former Intel Malaysia director. The aim of the Council is to bring together the key stakeholders in the industry and elaborate strategic initiatives to upgrade the industry in Malaysia. However, government stakeholders have been reluctant to operationalize the Council[199] and there have no strategies coming out of the Council so far.

5.8.2 Towards diversified GVC linkages

Attracting foreign investments in capital- and technology-intensive parts of the electronics value chain was the primary mode of integrating and upgrading into global value chains since 2005. As can be gleaned from Table 5.4, the level of foreign investments in the industry increased sharply in the mid-1990s and again after 2005, reflecting most likely the large capital investments needed for wafer fabrication. They have accounted for more than 90% of all investments during the last ten years.

However, the last five years have seen a drop in the level of foreign investments. This is most likely related to a cyclical downturn in the semiconductor industry, with profitability dropping between 2008-2009 and in 2011-2012 (Bauer et al, 2016). While measures were taken to improve infrastructure and the business environment in Kulim High Tech Park (e.g. fixing power quality issues and providing waste management), it has become more difficult to attract investments to the park. Policy shifted towards increasing capacity in existing plants instead (not in upgrading) (PMO, 2014).

Table 5.4 Foreign investments, Malaysia, 2010 RM constant prices

Period	Foreign investments	Share of foreign investments in total

[197] CREST allocates RM170 mln to set up labs, conducts R&D on LED, 18 December 2014, Bernama Daily Malaysian News.

[198] Interview KH01, footnote 153.

[199] Interview PN02, footnote 136.

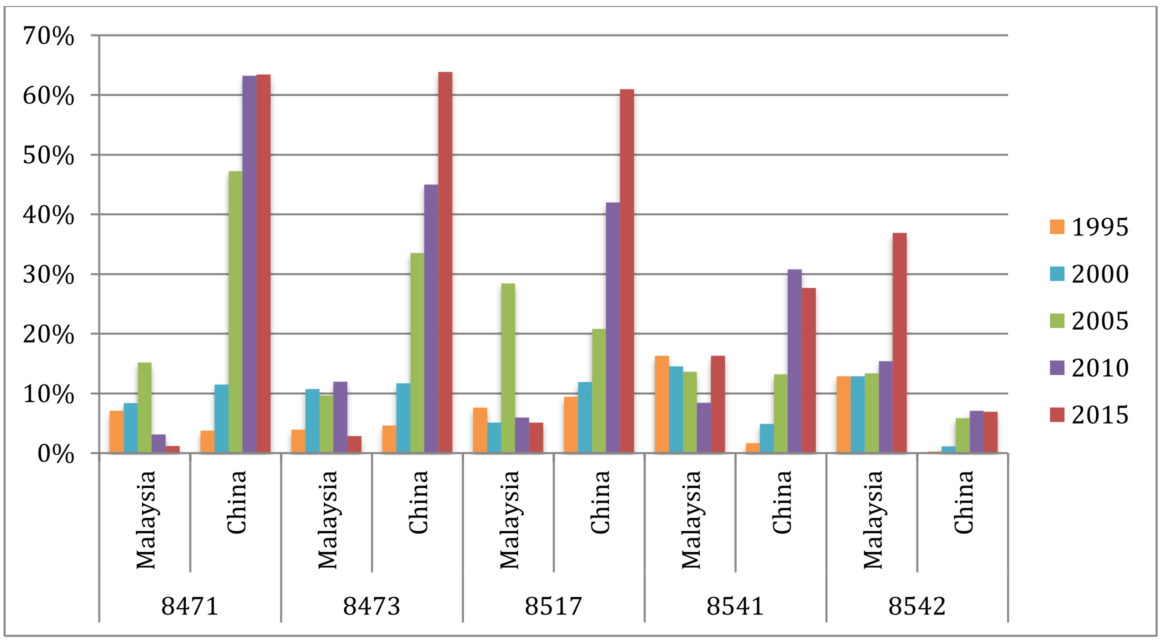
1987-1990	14,126.1	90%
1991-1995	17,728.1	73%
1996-2000	41,847.5	73%
2001-2005	46,339.8	84%
2006-2010	58,229.1	91%
2011-2015	47,319.6	91%

Notes: Data for 1986 are not available so period contains only four years. The investment figures have been deflated using the Producer Price Index provided by DSM.
Source: Author's analysis based on MIDA (various years)

In the low-end assembly segments, the country's industry also suffers stiff competition from China. For example, in many of Malaysia's top exports, the country's market share in the U.S has declined over time, while that of China's has skyrocketed (Figure 13). However, in the more sophisticated segments (e.g HS code 8542: electronics integrated circuits), Malaysia has actually gained market shares rapidly. Malaysia accounted for 37% of U.S imports in electronics integrated circuits in 2015, up from 13% in 1995. By contrast, U.S imports from China have remained stable for the past 15 years at 7% of total. Given the cost and market advantages that China provides, the Malaysian government is encouraging a "China plus one" strategy, pushing for subsidiaries to remain in Malaysia by retaining high-value added services, such as design, prototyping and ramp-up[200]. Malaysian firms such as Qdos (flexible Printed Circuit Board or PCB manufacturer) and UNISEM (semiconductor assembly) are following this strategy, expanding their production in China, while keeping more sophisticated R&D and manufacturing at home. Intel is also expanding operations in Vietnam and China but retaining its facilities in Malaysia to conduct mature product R&D.

[200] Interview PN02 (footnote 136) and interview with Penang senior government agency official, 10 March 2016, PN10.

Figure 5.13 Shares of Malaysia and China in total US imports, %, key commodities and years



Notes: All codes in Harmonized System (HS) as reported, four-digit level. 8471: Automatic data processing machines and units thereof; 8473: Parts and accessories for use with machines of heading 84.69 to 84.72; HS code 8517: Electrical apparatus for line telephony or line telegraphy; 8541: Diodes, transistors and similar semiconductor devices; 8542: Electronics Integrated Circuits
Source: Author's elaboration based UN Comtrade database, https://comtrade.un.org/data/

Moreover, the global market has also experienced turbulence as demand has been shifting away from desktops and laptops towards mobile phones, servers and components related to the Internet of Things (IoT). In this context, many of Malaysia's leading MNCs have been trying to find new markets and are changing their product lines towards components that are needed in these new industries[201]. Looking at the change in markets and the increased competition from China on mature products, the ETP has encouraged diversification away from standard semiconductor packaging towards development of IoT components, sensors, LEDs and Radio-Frequency Identifications (RFIDs). For example, Globetronics, a Malaysian firm based in Penang, shifted from semiconductor assembly and packaging to developing sensors, benefitting from a R&D grant from MIDA (company annual reports).

Not only is the Malaysian electronics industry diversifying in terms of products, but the industry is also diversifying in terms of actors with more domestic firms entering the value chain. Firms that were established in the 1970s-1990s (Globetronics, Carsem, UNISEM, Eng Teknologi, Pentamaster, Salutica) have increased their capabilities. For example, Eng has expanded production in overseas subsidiaries and increased R&D activities in Malaysia (Yusuf and Nabeshima, 2009) and Carsem is upgrading into advanced semiconductor packaging technologies and offers more high value-aaded services, such as wafer probing and testing services. Meanwhile, new firms have also emerged, such as Vitrox, Ceedtec and Aemulus in equipment manufacturing and Inari Amerton in electronic manufacturing services. Many domestic firms have made use of government grants in recent years to upgrade and diversify (see Table 5.5).

Table 5.5 Incentives and grants to domestic firms in Malaysian electronics industry

Company	Profile	Government support
Electronics component manufacturing and services		
Carsem	Originally Malaysian-Australian venture, purchased by Chinese Malaysian conglomerate Hong Leong Industries in 1984. Provides semiconductor packaging. Part of Malaysia Pacific Industries together with Dynacraft Industries that manufactures leadframes.	Pioneer Status for selected products Reinvestment allowances3
UNISEM	Est. in 1992 with 3,800 employees and provides semiconductor packaging.	Pioneer status (1993-1998) Pioneer status in 2000 (design and production of ICs).

[201] Interview PN01, 128.

	Subsidiaries in Indonesia and China. Acquired specialised UK-based test and assembly provider. Set up JV with Advanpak and FlipChip for wafer bumping.	Surrendered pioneer status in 2003 to switch to reinvestment allowances. Grants of RM 12.7 million (USD 3.3 million) in 2004, RM 3.3 million (USD 960 thousand) in 2007 and RM 4.4 million (USD 1.2 million) in 2008
Globetronics	Established in 1991. Semiconductor assembly and packaging. JV in 1994 with Sumitomo for ceramic packages Listed in 1997.	MTDEC was original shareholder Grant RM 3 million (USD 900 thousand) (2008) Grants RM 20 million (USD 5.4 million) (2014-2014) Unspecified tax incentives Recent 10-year pioneer status for the development of proximity sensors
Salutica	Established in 1990 as plastics component manufacturer. Now a contract manufacturer for consumer electronics (Bluetooth devices) and branded ones.	Grant by MIDA (at least RM 3.9 million or USD 1 million).
Inari	Established in 2006. Listed in 2011. Electronics Manufacturing Service provider. Acquisition of Ceedtec (2012) Acquisition of US-based Amerton Inc., a contract manufacturer (2013)	Pioneer status for selected products. RM 9.2 million (USD 2.9 million) Matching MIDA grant (2014) Unsecured interest-free loan of RM4 million by NCIA (2012) RM 7.6 million (USD 1.8 million) MIDA matching grant (2017)
Equipment Manufacturers		
Ceedtec	Established in 2005. Inari acquired 51% stake in Ceedtec in 2012. Provides high-end PCB assemblies. High-mix, low-volume. Also manufactures telecommunication and testing equipment.	RM 9.8 million (USD 3.2 million) grant from NCIA for design and development of power supply products (2012). MSC status (2012-2017) RM 8 million (USD 2.5 million) matching MIDA grant (2013)
Pentamaster	Established in 1991. Manufactures automation equipment. Listed in 2004.	MSC status Pioneer status for certain products

		RM 32.5 million (USD 9.6 million) grants for R&D from MIDA (2006-2015)
Aemulus	Established in 2004 and listed in 2015. Manufactures semiconductor testing equipment Kazanah has 15% stake.	RM 4.4 million (USD 1.4 million) matching R&D grant from MIDA for two years (2013) RM 120 thousand (USD 38 thousand) training grant from MIDA for two years (2013)
Vitrox	Established in 2000. Manufactures automated vision inspection equipment.	MSC status (2004) Pioneer status for selected products Matching grant by MIDA for Centre of Excellence on Machine Vision (2013) Matching grant from MdeC for R&D on embedded inspection technologies (2013)

Notes: Other Malaysian-owned firms include SilTerra (a chip manufacturer) and Qdos (a flexible PCB manufacturer), which are not listed in the stock market and do not report publically grants and other incentives. Eng Teknologi was listed in 1993 but privatized in 2012.

Source: company annual reports, websites and interviews.

Despite these positive examples of upgrading, on the whole, the industry continues to be far from the frontier. As surveyed in Section 3, the aggregate indicators of upgrading either show stagnation or high volatility during the last five years. Survey data paints a similar picture. Out of approximately 103 firms surveyed by Rasiah (2010), only 11 engaged in product R&D and only 1 firm was involved in new product development, with elements of Original Business Manufacturing (OBM) activity. In a 2014 follow-up survey of 25 firms in the semiconductor sector (21 foreign and 4 domestic), no firms were found to engage in frontier technology development, although 7 foreign firms engaged in mature R&D. Out of the domestic firms, only one engaged in early-stage R&D (Rasiah, 2015). A look at the annual reports of the domestic firms presented in this Section, reveals that only Vitrox and Aemulus spend over 2% of their revenue on R&D with 8.3% and 22.7% respectively, similar to industry leaders such as Intel (20%) and Samsung (7.3%) (Table 5.6).

Table 5.6 Share of revenue spent on R&D, key domestic electronics firms, Malaysia

	2000	2005	2010	2015
Carsem[1]	0.4%	1.2%	1.1%	1.4%
UNISEM	1.7%	0.6%	0.4%	0.7%
Globetronics	0.8%	0.2%	0.1%	0.0%
Inari			0.3%[2]	0.2%
Salutica				0.7%
Pentamaster		3%[3]	2.7%	0.6%
Aemulus				8.3%
Vitrox		4.9%	14.7%	22.7%

Notes: [1]Figures are for the Malaysia Pacific Industries Group. [2]Figure is for 2012. [3] Figure is for 2006.

Source: Company annual reports

In conclusion, the electronics industry in Malaysia seems to be at an inflection point. On the one hand, FDI continues to account for the overwhelming majority of investments in the industry, especially in capital-intensive operations. On the other hand, market downturns, changes in consumer demand and increased competition from China are creating pressure to diversify. In this environment, domestic firms are increasing their capabilities and sophistication. Some are steadily upgrading their processing operations (e.g. Carsem and Unisem), others are spending high sums on R&D to develop original products (Aemulus, Vitrox), or are engaging in international Merger and Acquisition (M&As) to increase their reach and competitiveness in electronic manufacturing services (e.g. Inari's acquisition of Amerton). These trends may mark the beginning of a new phase in the development of the Malaysian electronics industry, characterised by increased technological capabilities among domestic suppliers, that is yet to be reflected in the aggregate statistics.

5.9 Conclusions

The Malaysian electronics industry has developed primarily by integrating into GVCs. Semiconductor assembly subsidiaries in the 1970s were followed by consumer electronics assembly facilities in the 1980s and electronics manufacturing service providers in the 1990s. After several decades of development, wafer fabs and IC design houses also started setting up operations in the country. However, despite its sustained growth, the industry remains technologically weak and lacks domestic firms with advanced capabilities in the core parts of the value chain.

Why hasn't the gradual upgrading of the Malaysian electronics industry led all the way up to the frontier? The country's federal and state governments followed much of the well-trodden path on leveraging GVCs for development: the country had few investment or trade restrictions, it offered market-based incentives for technological upgrading and linkages, it offered infrastructure and financing, set up research institutions to provide skilled human capital and so on. Nevertheless, despite some limited upgrading over time, the country's industry has not actually moved further up the chain to first tier supplier or knowledge-intensive supplier or brand.

During Phase I (1955-1967) and Phase II (1968-1985) the industry was seen as a potential employer, with incentives put in place to attract labour-intensive subsidiaries. No efforts were made to build a technological base and diffuse technologies to local firms. During Phase II (1986-2004), many of the initiatives pursued had some positive results (e.g. higher R&D spending by foreign subsidiaries, creation of linkages), but there was a mismatch between the instruments adopted and the needs of the industry (capital grants should have been used earlier; rewarding innovation in manufacturing, not only R&D; building up research and networking infrastructure in Penang where the main manufacturing hub was located). There were few efforts to spur the development of domestic firms (e.g. with targeted lending or grants) and incentives to encourage them to become bigger (e.g. government procurement) or engage in branding (e.g. protected domestic markets). The incentives for R&D were inappropriate for the small, unsophisticated domestic firms that were emerging and the infrastructure to help them was built far away and was targeted to science-oriented firms. During the latest phase (2005-now) some positive initiatives have been undertaken (e.g. attention to MIMOS and domestic firms, the offer of capital grants) but the frequent policy changes and the more challenging GVC dynamics continue to constrain upgrading.

The lack of sustained upgrading to "the top" of the chain demonstrates the limits of a GVC-led development strategy. On the one hand, Malaysia never became a strategic location for investments by Transnational Corporations (TNCs) in technology-intensive tasks and foreign subsidiaries continued to be reluctant to shift frontier activities to the country. On the other hand, the country's industrial policies were always out of synch with the needs of the industry, with the exception perhaps of the last few years. This prevented industrial policy from creating the right incentives for firms to engage in learning and taking advantage of the opportunities created by GVCs to further upgrade.

6 Conclusions

Research on Global Value Chains (GVC) has proliferated during the last two decades and several international development organizations have taken up the GVC framework (Neilson, 2014). Despite this increased attention to GVCs as a way to encourage industrial upgrading, an in-depth understanding of what the role of the state should be in the GVC context is lacking in this literature. It has been suggested that industrial policy requires a radical rethink, with the state's role confined to facilitating integration and helping local firms upgrade by adopting a more supportive stance, foregoing interventionist measures such as vertically-integrated 'national champion' initiatives (Gereffi and Sturgeon, 2013; Yeung, 2014, 2016; Coe and Yeung, 2015) or tariffs, that could discourage GVCs from taking root (Baldwin, 2014). However, these contributions have focused on a narrow range of industrial policy tools, such as tariffs and subsidies, and the arguments put forward do not stand up to theoretical and empirical scrutiny.

This thesis aims to fill this gap in the literature by exploring the scope for implementing industrial policy in the context of global value chains (GVCs). This is achieved by creating a theoretical framework that is the first to link the theory of industrial policy with that of GVCs by using insights from the innovation economics literature, and then by using that framework to examine the empirical case studies of industrial policy in the electronics industry in Guangdong province of China and in Malaysia. The implication of this research, supported by both theory and empirical evidence, is that while integration into GVCs can provide firms with (complementary) incentives and resources for upgrading, in the absence of industrial policy, developing country firms often find it difficult to accumulate enough capabilities to operate in the technological frontier, even after decades of supplying lead firms. The role of industrial policy in providing incentives for firms to invest in learning, in investing in the hard and soft infrastructure needed for an effective local innovation system, and in providing incentives to foreign firms to engage in technology transfer are crucial in the context of GVCs.

The conclusions of this thesis will present a synthesis of the main arguments made in this research and then it will consider the limitations of this work and avenues for further research.

6.1 A brief synthesis of the argument

6.1.1 Why industrial policy is important

Free market approaches to development argue that the choices that agents make based on market prices, will lead to an optimal allocation of resources, and over time, this will lead to development. The theory of comparative advantage, for example, argues that the removal of trade barriers will lead each country to specialize in the production of the good they have a relative cost advantage in, either because of relative abundance of the factors of production needed for their production or because of relative greater productivity (see Milberg and Winkler, 2013 for an overview). Some have theorized that countries' comparative advantage even changes through time, from agricultural and labour-intensive goods to capital-intensive goods, allowing developing countries to eventually catch-up with developed ones (Lin, 2017; Balassa, 1979). However, the theory of comparative advantage relies on strict theoretical assumptions (e.g. perfect competition; no mobility of capital; access to same technology and equal capabilities of using that technology) that when relaxed do not predict gains for all countries from liberalization (Deardorff, 2005). In contrast, new trade theories attempt to incorporate market imperfections (e.g. economies of scale at the industry level) (see Krugman, 1985). Even though some of the new trade theory models show that government intervention could be an optimal choice (e.g. to subsidize costs so that a new industry can achieve sufficient scale to compete with foreign imports), mainstream theorists continue to support free-trade as a means to develop, on the grounds that interventions may sometimes be optimal in theory, but in practice the risk of government failure is too high to try (Krugman, 1992).

The other side of the debate holds that free-markets cannot bring about development, owing to the existence of pervasive market failures in industry (e.g. increasing returns to scale and technological spillovers), the industrialization process (e.g. weak financial markets and scarce private capital in developing countries) and in accumulating technological capabilities (long investments in learning are required to enable firms to innovate and become competitive). Some of these are quickly reviewed below.

First, firms need to gain experience and skills in production in order to drive their production costs below those of their competitors. A period of temporary support to the *infant industry* can make producers able to compete. If this rent is invested by firms in learning, their unit costs of production will fall down over time and the industry could become globally competitive, without need for sustained support (List, 1983 [1885]; Chang, 2002).

Second, industrial policy could serve to mobilize (state-owned) capital to invest in firms and industries that are deemed strategic, especially in developing countries where domestic private capital is scarce. The state can also coordinate complementary investments, when these fail to be coordinated on the basis of market signals (e.g. when an upstream industry is profitable only when a local downstream industry has reached a certain scale) (see for example, Rosenstein-Rodan, 1943).

Third, and finally, industrial policy can encourage firm-level accumulation of technological capabilities and solve market failures that arise from the nature of firm-behaviour, firm-level learning and technology development (Cimoli, Dosi and Stiglitz, 2009). Developing country firms need to engage in learning to develop technological capabilities, a necessary precondition not only for effectively absorbing technology from abroad but also for engaging in minor innovations (see also Ernst et al, 1998; Katz, 1984). However, firms can only develop capabilities gradually and cumulatively, progressing from simple, less risky areas to increasingly more complex tasks and this process is influenced by the innovation system in which firms operate (e.g. the density, quality and type of interactions between firms, academic institutes and governments) (Lundvall 1992; Nelson 1993; Freeman, 1995). Industrial policy can help build and enhance domestic innovation systems (e.g. by building research institutes and encouraging linkages between them and local firms) and by providing incentives for firms to invest in learning, by, for example, lowering the cost of capital and increasing the supply of skills in the economy (Lall, 1992).

6.1.2 Why industrial policy is (wrongly) seen as incompatible with the expansion of GVCs

Traditionally market-oriented institutions have seen the expansion of GVCs as further justifying a hands-off approach to the economy (e.g. OECD, WTO and World Bank, 2014). This view is largely based on two observations that have weak foundations. The first is that even if selective instruments were successful in the past, such instruments are not relevant any more due to the fact that GVCs are organized according to tasks, not sectors (Grossman and Rossi-Hansberg, 2008). However, there is a great deal of asset specificity in production and both GVC governance (Gereffi et al, 2005) and systems of innovation (Malerba and Nelson, 2011) differ greatly by sector. This means that even if firms undertook the same tasks in different sectors, they would still face distinct opportunities and constraints to upgrading, arising from these unique sectoral characteristics. The second argument is that tariffs cannot be used since trade is essential for value chains and tariffs will disrupt them. However, tariffs are not normally implemented as an across-the-board measure, but as a highly differentiated policy tool that can be applied differently depending on whether imports are for the domestic market or for exports (e.g. duty-drawback system on imported inputs used for exports), or according to the stage of production (Akyüz, 2009).

The second line of critique against industrial policy in a GVC context is that grooming national champions is less likely to be effective nowadays, given the tight race at the top of the chain. Nolan (2001) has convincingly shown that there is an ongoing unprecedented struggle for market dominance between the top global lead firms in almost all sectors. These firms keep on growing by conducting M&As, which are feasible given their superior access to financial resources and high market capitalizations. They then invest in enormous R&D expenditures to sustain their technological dominance, branding power and state-of-the-art IT infrastructure, erecting formidable barriers to entry. In this context developing country firms are even more disadvantaged than before, as they have far fewer resources (even with industrial policy measures) and it would not be able to compete on price since cheaper production sites are also available to lead firms through outsourcing. Indeed, becoming a global leader today is indeed much harder than it was before the 'Global Business Revolution'. However, there are three further considerations one should take into account. First, technological leadership often changes not in 'head-to-head' battles over established business, but when there is a new technological 'window of opportunity' (Lee, and Malerba, 2016), but this requires the existence of firms that have already built considerable capabilities, which necessitates industrial policy measures. Second, developing country firms can also access large networks of suppliers, bypassing the cumbersome task of building advanced manufacturing capabilities in-house (Sturgeon and

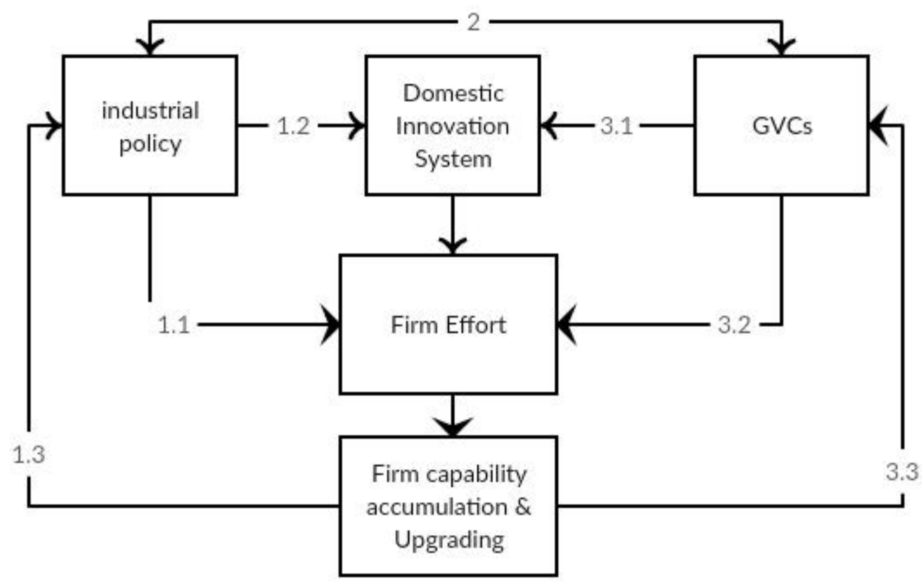
Lester, 2004). Third, becoming a global lead firm is one measure of success of many. Taiwan has secured a high standard of industrial performance not by having lead firms, but by being home to the top first-tier suppliers in the electronics industry.

Based on a combination of the arguments above, the view of the GVC literature, as represented by Gereffi and Sturgeon (2013), Coe and Yeung (2015) and UNCTAD (2013b), is one that envisions a role for industrial policy in developing local supplier capabilities but in a way that aligns with the interests of lead firms and buyers. This is achieved by emphasizing horizontal, rather than selective measures (e.g. infrastructure, human capital and R&D support, to both indigenous and foreign firms) and a liberalized trade and investment environment. However, successful building-up of technological capabilities often needs targeted action, as seen in the experience of Japan, Korea and Taiwan (Johnson, 1982; Amsden, 1989; Wade, 1990; Chang, 1994). More importantly, it is crucial to consider the role of industrial policy in areas where a conflict exists between the needs of lead firms and national economic development (UNCTAD, 1999; Christopherson and Clark, 2007; Evans, 1995).

6.1.3 An integrated framework

The framework considered here argues that there are three dynamics to consider in the context of industrial policy and GVCs. First, industrial policy can complement the endogenous incentives firms have for investing in innovation by shaping the environment faced by them, through changing relative prices, reducing uncertainty by providing markets, and encouraging cooperation between firms (Lall, 1992; Pack and Westphal, 1986; Cimoli, Dosi and Stiglitz, 2009) (Arrows 1.1 and 1.2). Second, industrial policy can be used to promote integration into GVCs (e.g. by selective tax incentives to FDI; encouraging standard-compliance; promoting specialized supplier clusters) and the type of policies pursued may depend on the GVC (Arrow 2). Third, integration into GVCs can enhance learning for suppliers, as lead firms may provide technical assistance to them as well as incentives for improving their technology (Hobday, 2001; Ernst and Kim, 2002; Pietrobelli and Rabellotti, 2011), while foreign subsidiaries also contribute to the local innovation system (Arrows 3.1 and 3.2). The level and nature of technology transfer and the type of industrial policies pursued will also change with the level of technological capabilities of the domestic supply base (Arrows 1.3 and 3.3). These relationships are put into the Figure 6.1 below to provide a visual representation of the framework.

Figure 6.1 Determinants of upgrading



Policy needs to be adapted in terms of the development stage of the country and the stage of maturity of a sector (Chang, 1994; Livesey, 2012). Infant industry policies (including subsidizing FDI) would be needed in the beginning to establish new sectors that are mature in the world stage. Then, as economy-wide technological capabilities evolve and suppliers can undertake more complex functions, the main goal of industrial policy would shift to maintaining competitiveness in the already existing segments and to promoting upgrading to higher value added segments. This dynamic is highlighted in the two case studies of this thesis, Guangdong province of China and Malaysia in the electronics industry. Using the framework developed here, this thesis reviewed the role of industrial policy in encouraging integration into GVCs and in developing the capabilities of domestic firms in the two cases. Moreover, following an evolutionary approach, the analysis identified different "periods" in which these dynamics differed.

6.1.4 Industrial Policy and GVCs in the Guangdong electronics industry

The province of Guangdong has successfully integrated into the electronics GVCs. Every large first-tier supplier in electronics has facilities in the province, while the clusters that have formed undertake a range of tasks, from design, prototyping and procurement to manufacturing and logistics services, predominantly in telecommunications equipment and computer peripherals. The province is also home to some domestic firms with brand-power (e.g. Huawei, ZTE, TCL, Oppo), which are sophisticated and conduct frontier R&D. However, this has not been the outcome of simply opening-up and encouraging integration into GVCs, leaving the rest to inter-firm knowledge transfers, but it is the result of complementary industrial policies that created the conditions for firms to develop their technological capabilities, which allowed them to upgrade within GVCs, and eventually even creating their own GVCs. Where industrial policy remains weak in the province is in the public-sector education and research capabilities, and in providing access to patient credit to the private sector, especially SMEs. This has constrained the development of a dense system of innovation in the province, making it difficult for firms that do not have large internal resources, to invest in R&D and commercialize it.

Even though the province is well known in the literature for pursuing an outward-oriented path for industrialization (Yeung anf Chu, 1998; OECD, 2010; Vogel, 1989), this is the first effort in the literature to provide a comprehensive account of the province's trajectory in the electronics industry, the province's largest exporting sector. This is achieved by providing an account of the development of state-owned and state-supported firms (national champions), other indigenous firms and foreign subsidiaries, rather than focusing selectively on one of these categories, and by updating the analysis of the province's development to include the last ten years, which is important given the change of direction in policy that has taken place since 2008, pushing the province away from labor-intensive manufacturing towards technology-intensive activities.

Guangdong first integrated into GVCs in the electronics industry during 1979-1992, by providing fiscal incentives towards FDI. While the aim was to attract high-tech investments and to diffuse advanced technologies, most of the operations that were set up were low-end, labor-intensive ones and few (if any) incentives were put in place to change that. However, the industry was not entirely new to the province. A small number of electronics factories had been created during the Maoist period (1949-1978), with the aim of securing self-sufficiency in the province for basic components, especially in radio and telecommunications equipment. As the province opened up, central and provincial government leaders saw this as an opportunity to harness openness for learning in the domestic sector, made up mostly of SOEs at the time. Domestic firms were not only the beneficiaries of import-substitution policies and support schemes enacted by the central and provincial governments, but were also encouraged to integrate into GVCs as chosen partners for large JV projects or suppliers in processing trade arrangements. Firms in Guangdong province were therefore employing a mixed strategy, on one hand using integration into GVCs to earn foreign exchange and additional income and to learn how to export and meet foreign market demand, and on the other hand, they could produce for a protected home market.

During the next phase (1993-2005), the provincial government continued its mixed strategy, but the emphasis shifted towards encouraging greater scale in indigenous firms and in building up the local infrastructure to lower the cost of exports. The provincial government chose 10 enterprise groups and 16 ‘backbone enterprises’ to support, most of them top brands already and state-owned, with the exception of privately owned Huawei. Due to the provincial government’s budget constraints, support was disbursed by way of preferential policies and loans, with priority given to projects that boosted the industry’s technological development. The champions were expected to invest on key projects of importance during this time, which were in general prioritized at least in terms of finance and land availability (Liu, 1995). However, these firms remained integrated into GVCs (as suppliers) and continued to import most of their sophisticated components from abroad, with only gradual efforts to substitute them for own-produced ones. Central-level policies also provided learning rents to the telecommunication segment, by, for example, allowing only a handful of local suppliers to provide mobile phone equipment to the domestic market. As a result, large telecommunications equipment and consumer electronics companies emerged, such as TCL, ZTE, Huawei and Konka, which launched their own brands and developed notable technological capabilities. Owing to the province’s sustained efforts to improve transport and telecommunication infrastructure and the continued migration of small-scale suppliers from Hong Kong and later from Taiwan to the province, Guangdong also became a favored destination for the assembly facilities of large lead firms and first tier suppliers (e.g. Foxconn and Flex), which local firms could also use to outsource manufacturing. One of the reasons that GVC-led development and industrial policy were complementary during this period undoubtedly has to do with China's large domestic market, which provided a vast space for learning for domestic firms (and the possibility to reach minimum efficiency scale), while also accommodating imports from selected foreign firms. Additionally, the threat of exposure to global competition after entry into WTO and the attention of Guangdong primarily to well-performing firms, may have acted as instruments of discipline for domestic firms that enjoyed rents.

During the latest phase (2006-now) industrial policy has not only focused on a handful of chosen firms, but has been supporting the upgrading of capabilities in their entire industry, including in foreign firms and the private sector. Instead of subsidizing capital construction, instruments are focused on applications of sophisticated technologies in industry, the renewal of equipment and funding of R&D. Moreover, approval of FDI projects has become stricter, especially for the more advanced cities of the province, in an effort to align FDI with the developmental objectives of the province. Industrial policy during this phase has increased in ambition (regarding the technological capabilities of firms), in tandem with the shift of the industry from a state of catching-up to one where reaching the frontier is possible. Going forward, further enhancing the quantity and quality of research institutes and universities and their linkages with local firms, as well as improving access to patient finance for all firms, will be important in allowing the provincial electronics industry to catch-up.

A summary of the policy phases in Guangdong and their characteristics is presented in Table 6.1.

Table 6.1 Summary of Guangdong's experience in the electronics industry

	Industrial Policy	**Policies for integration into GVCs**	**GVC developments**	Result
1949-1978	Centrally-planned development of research and production units. Emphasis on self-sufficiency and development in remote inland areas.	No integration (largely closed off to foreign investment and trade, apart from agricultural goods).	Expansion of GVCs starts in the 1960s with the offshoring of assembly activities.	No integration, but a small (state-owned) domestic production base develops, albeit with low technological capabilities.
1978-1995	State-owned capital is injected to create a seed of domestic firms (SOEs) in Shenzhen and Guangdong. Marketisation reforms	State encourages JVs between SOEs and large export-oriented firms. Processing trade is promoted, involving	Acceleration of GVC expansion. Rising wages and the appreciation of the Japanese Yen in the mid-1980s	Dual integration. 1) Small-scale labour-intensive FDI-led suppliers create vast P&A clusters; 2) Some

	are implemented. Some measures to incentivize upgrading are put in place.	both domestic and foreign firms. Foreign investors flock in, particularly from Hong Kong. Infrastructure and incentives in place in SEZs and elsewhere.	incentivise firms to relocate production from Easy to Southeast Asia and China. US firms undertake large-scale outsourcing in the 1990s.	SOEs engage in export-oriented production and use knowledge to produce branded products at home.
1996-2005	1996-2000: Guangdong selects a handful of firms to support with subsidies and loans. Reform of the innovation system and incentives in place for high-tech production 2001-2005: Firm-level support wanes and industry adjusts to entry into WTO.	Incentives from previous phase continue. Acceleration of infrastructure build-up and proliferation of industrial zones and parks. Liberalisation of tariffs ahead of WTO entry. Heavy investments in infrastructure.	Outsourcing/offshoring becomes widespread.	Some Guangdong firms become domestic brands and venture overseas. Innovation capabilities are still low. FDI by first tier suppliers and brands increases.. Labour-intensive assembly continues.
2006-now	Subsidies, tax incentives & financing (often given on a competitive basis) to innovative large firms. But few measures to improve higher education and public research, while private sector continues to lack access to formal finance.	Incentives for FDI eliminated. Labour-intensive, low-tech assembly discouraged.	China emerges as a coveted consumer market. Innovation activities become commoditized and outsourced. The rise of smartphones has a major impact on GVC leadership, with new firms emerging.	Guangdong firms are increasing their innovative capabilities and a few are becoming global brands. Hardware start-ups flourishing.

6.1.5 Industrial Policy and GVCs in the Malaysian electronics industry

The Malaysian electronics industry developed primarily by integrating into GVCs. Semiconductor assembly subsidiaries were established in the 1970s were followed by consumer electronics assembly facilities in the 1980s and electronics manufacturing service providers in the 1990s. The country now boasts TNC subsidiaries that perform IC design (e.g. Altera), product R&D (e.g. Intel) and first tier suppliers (e.g. Flex and Jabil). However, the industry, on aggregate, remains technologically weak and lacks domestic firms with advanced capabilities in the core parts of the value chain. Even though the Malaysian government followed almost all the prescriptions of what would be considered GVC-friendly industrial policy in electronics (no import-substitution, tax incentives for

R&D, investments in skills development), the firms (including TNC subsidiaries) have upgraded only to a limited extent and do not possess frontier technological capabilities. In Malaysia industrial policies did not create adequate incentives for indigenous firms to invest in technological learning and investments in the innovation system were too often not done in a way that did not maximize linkages with local firms (e.g. the Malaysian Institute for Microelectronic Systems – MIMOS- was not based in Penang where most indigenous firms were emerging, but near Kuala Lumpur).

The industry has evolved over four phases, each with its own opportunities and challenges for upgrading arising from the changing policy instruments, the changing dynamics of the electronics GVCs and the evolutionary character of capability accumulation within firms.

During the first phase (1957-1967) Malaysia undertook some import substitution efforts to stimulate industry, and the first factories in the industry were set up. However, it was during the second phase (1968-1985) that the industry really emerged based largely on the attraction of labour-intensive, export-oriented foreign investments. Electronics was simply viewed as an industry that could absorb extra labor, especially in areas that lacked vast primary resources, such as the region of Penang. Industrial policy during this time focused on FDI attraction, with targeted missions by the Penang and federal governments to attract investments, tax incentives and dedicated infrastructure provision. During this time the government made no efforts to develop domestic firms that could link to the industry or to target electronics FDI as a source of technological capabilities.

The third phase (1986-2005) saw the promotion of high-tech activities in foreign subsidiaries and the emergence of some domestic firms. Industrial policy shifted course and the government started populating the innovation system with research institutes, specialized science parks, tax incentives and (limited) grants for R&D, and invested in its own semiconductor fabrication facilities to drive the industry forward. However, the incentives used were not enough to push firms to engage in learning, especially domestic firms that were small in size and technologically weak, the resources mobilized were small, particularly for semiconductor manufacturing, and manufacturing firms were often excluded from initiatives on innovation (e.g. incentives and funding programmes by MOSTI were not open to established manufacturing firms). Some successful firms emerged as former TNC employees saw an opportunity to supply products that subsidiaries were looking to outsource, but this was also not encouraged by the government (with the exception of Globetronics), and firms found it difficult to gather the requisite financial capital. However, by making tax incentives more selective and conditional on R&D performance, and given the trend towards automation in electronics assembly in the latter half of the 1980s, many TNC subsidiaries upgrade their operations.

During the fourth phase (2005-now) the government has increased grants, not just for R&D, but also for capital-intensive manufacturing investments, and has earmarked grants specifically for domestic firms. While the industry continues to operate far from the frontier, some of the recent initiatives are promising and have sparked the emergence of a few sophisticated domestic firms that undertake advanced electronics manufacturing services and manufacture semiconductor fabrication equipment.

A summary of the policy phases in Malaysia and their characteristics is presented in Table 6.2.

Table 6.2 Summary of Malaysia's experience in the electronics industry

	Industrial Policy	**Policies for integration into GVCs**	**GVC developments**	Result
1955-1967	Import substitution policies and tax incentives for capital-intensive production (not targeted to electronics).	Openness to foreign capital. JVs promoted for domestic market oriented projects.	Beginning of assembly activities. Tariff-hopping domestic market oriented FDI mainly by Japanese firms.	First electrical machinery assembly operations established by Japanese investors, directed for domestic market.
1968-1985	Tax incentives for encouraging export-orientation in industry. Tariff protection and state involvement in heavy industries, but not in electronics.	Creation of Free Trade Zone, complete with infrastructure and tax incentives.	Expansion of GVCs, particularly in semiconductor assembly.	Integration into electronics GVCs expanded primarily through FDI in semiconductor assembly in Penang.

1986-2004	Tax incentives for high-tech production and R&D, grants offered for R&D, incentives extended to SMEs. Cluster infrastructure established in Selangor, Kedah and Johor. Research centres and institutions to bring together private and government stakeholders established. State owned capital flows into wafer fabrication.	Schemes to encourage SME-MNC linkages. Investment and trade liberalisation.	Acceleration of GVC expansion. Rising wages and the appreciation of the Japanese Yen in the mid-1980s incentivise firms to relocate production from Easy to Southeast Asia and China. US firms undertake large-scale outsourcing in the 1990s.	Expansion of electronics production in other regions (Kedah, Selangor, Johor), diversification into consumer electronics & emergence of local small-scale subcontractors and suppliers.
2005-now	Mix of tax and capital grants to encourage capital-intensive and R&D intensive projects. Funds earmarked for domestic firms. Governance for S&T and industry continues to lack integration.	Stricter conditions for FDI. FDI encouraged in R&D and semiconductor wafer design fabrication.	China emerges as a coveted consumer market. Innovation activities become commoditized and outsourced. The rise of smartphones has a major impact on GVC leadership, with new firms emerging.	Diversification into solar and LED sectors. More domestic firms enter the value chain. Continued lack of frontier R&D capabilities.

6.2 Limitations and areas for further research

This thesis has studied the electronics industry in Malaysia and Guangdong province of China, but each place integrated in different parts of the electronics GVCs. In Guangdong, the industry developed on the basis of TNC-led assembly in consumer electronics and telecommunications equipment, which allowed domestic firms to integrate by producing simple components and then to launch their own-branded products with imported components. By contrast, semiconductor assembly offered a more limited scope for local sourcing, as components and equipment for semiconductor fabrication are highly complex. Nevertheless, even when consumer electronics facilities started being set up by TNCs in Malaysia in the mid-1980s, this did not stimulate domestic catch-up, which indicates that the findings of this thesis still hold despite the differences in the types of facilities that were first established in the two places.

The two case studies are also different in terms of level of government: Guangdong is a province and Malaysia is a country. This represents a problem as even though Guangdong is larger than Malaysia (Guangdong has a population of 110 million people, whereas Malaysia 31 million) and it has significant autonomy in setting policy agendas, the region has been influenced by China's national policies and the province was able to leverage the country's vast domestic market. This has been addressed in this thesis by making references to relevant central-level decisions and their impact on the industry where possible.

Future research should be extended to include more regions (within and outside of China) and other countries. For example, extending this research to provinces in the Yangtze River Delta in China would also show a different style of industrial policy and integration into electronics GVCs, one that has also been relatively successful, since the region is now home to many of China's local and foreign semiconductor facilities. The experience of countries such as Mexico and Costa Rica would also provide more evidence on the limitations of GVC-led development strategies, as these countries, similar to Malaysia, have struggled to develop their own firms and upgrade into the upper parts of the value chain. Research in more regions and countries can enrich our understanding of the dynamics between industrial policy and GVCs by revealing ways in which they can interact and encourage (or not) industrial upgrading. It could also lead to the construction of a typology of industrial policy and GVCs that could help determine why certain regions or countries adopt certain approaches and why they have been successful or not.

6.3 Future prospects for industrial policy and GVCs

The main concern of this thesis is the scope for implementing industrial policy in the context of global value chains (GVCs), but in a connected economic system, this also depends on conditions outside the scope of national or regional economies.

First, there is the question of policy space for governments to use industrial policy tools in the context of global agreements on trade and investment (see also Chapter 2). When the research for this thesis begun in 2013, it seemed clear that while industrial policy was back on the agenda of some developed and developing economies (for example the Advanced Manufacturing Partnership launched in the United States in 2011 and the Plan for the Development of Strategic and Emerging Industries launched in China in 2010), the policy space to implement industrial policy interventions remained narrow (Chang, 2006; UNCTAD, 2014). The world has not stood still. Most notably, tensions between the United States and China over the trade and investment are rising, with the United States threating a protectionist stance[202]. An optimistic scenario would be that this represents a historic moment to open up policy space for developing countries to implement interventions and help their economies to upgrade. The pessimistic scenario would be that developing countries are not part of this renegotiation of global governance rules and have to continue an uphill battle towards catching up.

Second, there is also the question of whether the 'new production revolution' (OECD, 2017), made up of emerging technologies (e.g. Big Data, artificial intelligence, robotics, 3D printing, biotechnology and nanotechnology), will change the shape and geography of GVCs and reduce opportunities for developing economies to integrate into GVCs and leverage this to upgrade. For example, Adidas has set up a fully automated factory in Germany and Atlanta that undertake flexible, customized production that can reach customers within the same season. The factories have 150 workers each and will be

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producing 1 million pairs a year (compared to 407 million pairs mass produced in Asia)[203]. There is not only high uncertainty over how these technologies will shape the production system in developed and developing economies, but also on what competences are needed for firms to succeed in the future and what skills the labour force should be equipped with. This calls for further reexamination on the tools and aims of industrial policy to ensure catch-up in a changing context (see Bianchi and Labory, 2018; OECD, 2018 for the case of Chile; Hallward-Driemeier and Nayyar, 2018).

Further research on the shifting global governance rules and the changing industrial landscape is necessary to ensure the debate on industrial policy remains relevant and forward-looking.

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[203] Green, D, 'Adidas just opened a futuristic new factory – and it will dramatically change how shoes are sold', 26 April 2018, Business Insider. Online, available at: http://www.businessinsider.fr/us/adidas-high-tech-speedfactory-begins-production-2018-4, accessed 5 August 2018.

Appendix 1. Chosen Champions in Guangdong, Business Details and Mode of Entry into GVCs

Name of Company	Establishment information	Mode of entry into GVCs	Product range
Shenzhen Huaqiang Group	SOE, established in Shenzhen in 1979. Privatized in 2005.	JVs with Sanyo. In 1993 for laser heads, in 1998 for color TVs. OEM services and attempts to make own brand products.	Electronic components, trading services, cultural industries
Konka Group	Sino-foreign JV (with SOE partner), established in Shenzhen in 1979. Now state-controlled listed company.	OEM services for Hong Kong partner and compensation trade in the beginning. Brand development in late 1980's and international sales since 1995.	Color TVs, mobile phones, consumer appliances, set-top boxes, LED products
TCL Group	Sino-foreign JV (with local government), established in Huizhou in 1981. Gradual reduction of state shares since 1998.	OEM & JVs with European, Japanese and US firms. Focus on domestic brand since early 1990's. 'Going out' by acquisition of Alcatel (2004), Thomson TV division (2003) and Schneider (2002)	TVs and mobile phones.
Shenzhen Electronics Group	SOE, established in in Shenzhen in 1986 as a horizontally organized conglomerate.	JVs with companies from Hong Kong, Japan for color screens. JV with SGS-Thomson for IC packaging, testing and IC design for exports.	Electronic components and devices, semiconductor assembly and design, trading and property.
Foshan Electronics Group (now part of Foshan Gongying Investment Holding)	SOE, established in Foshan in 1966. Restructured into other entities since 1998.		Electronic components
Guangdong Colour Picture Tubes (now part of Dongguan Development Holdings)	SOE, established in Dongguan in 1988	Imported Japanese technology (Hitachi) and set up JVs with Japanese companies. Recent JV with Hong Kong company for LED chips.	Used to manufacture color picture tubes, now switched to LEDs. Overall group is diversified with main business road construction.
SED electronics group (now China Electronics International Information Service Co. Ltd)	SOE, established in Shenzhen in 1987.	By 1992 it had almost 20 domestic, sino-foreign JVs and subsidiaries	Used to manufacture electronic and telecommunication products but now a service provider offering logistics,

			trading, advertising, exhibitions, engineering, property development.
DESAY Group	SOE, established in Huizhou in 1983.	Since the 1980's it established more than 30 sino-foreign JVs, among them with Siemens, Philips, Radioshack, Solectron, GE and Sony	Automobile electronics, rechargeable batteries, LEDs, IC design
Fenghua Advanced Technology	SOE, established in Zhaoqing in 1984.	Acquired 40% Taiwan's Viking Tech in 2015.	New electronic components, passive components.
Guangzhou Electronics Group	SOE, established in Guangzhou in 1996.		Electronic components manufacturing
Shenzhen Primatronix (Nanho)	Sino-foreign JV with SOE partner, established in Shenzhen in 1980.	OEM for Hong Kong partner.	Telephones, LEDs.
Guangzhou Radio Group	SOE, predecessor established in Guangzhou in 1957.	JV with Hong Kong company in 1984 to enter naval communications. JV with Ericsson in 1993 to produce mobile communication products Mainly OEM services and branded military-related products.	Wireless communications, banking electronics for the military, property management and trading.
Huawei Technologies Co. Ltd	Private company, established in Shenzhen in 1987.	Initial importer and distributor. Later OEM supplier and finally brand development since early 1990's. Rapid international expansion since mid-1990's.	Network technologies, telecommunications equipment and services, mobile communication devices.
China Great Wall Computer Shenzhen Co. Ltd	SOE, established in Shenzhen in 1987.	Three JVs with IBM (1994, 1995 and 2004) for the production of PC boards, PCs and servers. JVs with Hitachi and Kingston for hard disks. Own brand computers and devices as well as EMS/OEM services.	Computers and digital products, information security products, cloud computing technology, LCD displays and EMS services.
Shenzhen Kaifa Technology Co. Ltd	SOE, established in Shenzhen in 1985.	JV with Epistar Taiwan for LEDs OEM services.	Full turnkey manufacturing services. Specialized in hard disk rives, smart meters, automation equipment, touch panel, and LEDs.
Shenzhen Yuebao Electronics Technology Co. Ltd.	SOE, established in Shenzhen in 1984.	Imported technology from Japan for audio heads. ODM supplier	Magnetic sensing and identification components, precision manufacturing.

Chaozhou Three Circle Group	Originally SOE, established in Chaozhou in 1970. Employee owned since 1999	ODM supplier	Ceramic products for optic telecommunications, machinery and environmental protection
Shinwa Industries (China) Ltd	Sino-foreign JV, established in Huizhou in 1986 in Huizhou.	Production/assembly for Japanese partner	CD/DVD drives, Blue Tooth modules, UV/Camera filters and Coating and other electronic components
Zhongshan Kawa Electronic Group	Established in Zhongshan 1994. Now owned by HK group		Electronic viedo and audio equipment
Dongguan Shengyi Futongban (Now Shengyi Technology Co. Ltd)	JV with SOE partner, established in Dongguan in 1985.	OEM supplier	Copper clad laminates (used in PCB board manufacturing)
Guangdong GoWorld Co. Ltd	SOE, predecessor set up in Shantou in 1957.	JV with US company to introduce LCD technology. JV with Hong Kong company for telecommunication equipment. ODM and OEM supplier.	Sensors, PCBs, LCDs, Transducers, Copper Clad Laminates and other components.
Guangdong Jiali Group (Now Sanshui Liping)	Established in 1994 in Foshan.	OEM supplier.	Batteries, rechargeable batteries
Tianma Group	SOE, established in Shenzhen in 1983.	Compensation trade with Hong Kong companies in the beginning. Now ODM supplier with established international sales offices	LCD and LCM display products
Shenzhen Jinghua Electronics Co. Ltd (Jingwah)	SOE, established in Shenzhen in 1980.	JVs with Japanese companies for car audio systems. ODM supplier	Tablet PCs, handheld devices, IT digital products, navigation systems, automotive electronics, LEDs
Shenzhen Xianke Enterprise Group	SOE, established in Shenzhen in 1984.	ODM manufacturer	Audiovisual equipment, appliances, mobile communication devices.
AF Technology Co. Ltd	Sino-foreign JV with SOE partner, established in Zhuhai in 1989.	OEM supplier	System simulators and precision engineering

Appendix 2. Output and Value Added in the Malaysian Electronics Industry

	Output Value (RM 000)	Output Value as Share of Total Manufacturing	Value Added (RM 000)	Value Added as Share of Total Manufacturing	Value Added as Share of Output
1973	291,851	4%	147,218	6%	50%
1974	524,477	5%	205,056	7%	39%
1975	821,347	8%	277,963	9%	34%
1976	1,202,663	9%	360,938	10%	30%
1978	1,859,671	10%	470,067	9%	25%
1979	2,678,576	11%	680,921	10%	25%
1981	3,896,833	10%	258,075	13%	7%
1982	4,124,633	11%	314,846	3%	8%
1983	4,959,042	12%	1,363,041	13%	27%
1984	6,051,306	13%	3,788,734	31%	63%
1985	4,964,418	11%	1,556,602	13%	31%
1986	6,119,053	14%	1,665,727	14%	27%
1987	8,598,138	17%	1,916,486	14%	22%
1989	16,337,111	20%	3,377,691	16%	21%
1993	48,128,644	29%	10,008,777	23%	21%
1994	65,239,105	33%	15,136,110	31%	23%
1996	91,197,397	33%	25,783,183	36%	28%
1997	98,013,071	33%	23,082,306	29%	24%
1999	148,529,122	41%	31,789,298	36%	21%
2001	143,774,383	36%	26,655,497	28%	19%
2002	149,951,222	33%	27,605,764	25%	18%
2003	180,293,845	35%	31,991,483	26%	18%
2004	195,807,352	33%	35,683,894	26%	18%
2005	208,071,652	32%	28,317,413	24%	14%
2006	205,998,309	29%	28,088,664	22%	14%
2007	206,811,501	28%	31,832,026	22%	15%
2008	174,587,755	21%	30,476,932	19%	17%
2009	155,706,416	21%	25,207,896	18%	16%
2010	174,032,308	21%	31,035,494	18%	18%
2012	153,807,177	17%	39,975,510	20%	26%
2015	245,080,507	21%	47,427,590	18%	20%

Source: Author's own calculation on data from (DSM) (various years a and b).

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