Global Value Chain-Oriented Industrial Policy:

The Role of Emerging Economies

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1. Introduction

In the past two decades, profound changes in the structure of the global economy have reshaped global production and trade and altered the organization of industries and national economies. The geographic fragmentation of industries, where value is added in multiple countries before products make their way to consumers, has been accompanied by vast improvement in the functional integration of these far-flung activities, creating what have come to be known as Global Value Chains, or GVCs. As supply chains become global in scope, more intermediate goods are traded across borders, and more imported parts and components are embodied in exports (Feenstra, 1998). In 2009, world exports of intermediate goods exceeded the combined export values of final and capital goods for the first time, representing 51% of non-fuel merchandise exports (WTO and IDE-JETRO, 2011: 81). Governments and international organizations are taking notice of the effects of GVCs on global trade and development (OECD, 2011; WTO and IDE-JETRO, 2011; UNCTAD, 2013; World Economic Forum, 2013).

The rise of GVCs occurred in a period of falling trade barriers, the rise of the World Trade Organization (WTO), and the policy prescriptions associated with the "Washington Consensus" – i.e., governments had only to provide a strong set of "horizontal" policies (such as education, infrastructure, and macro-economic stability) and be open to trade to succeed. Of course, many observers noted that the fastest growing emerging economies did much more than this through a set of industrial policies that targeted key domestic industries for growth, either behind protectionist walls, known as import-substituting industrialization (ISI), and/or increased market access through export promotion, known as export-oriented industrialization (EOI). The goal of these "domestic industrial policies" was to nurture a set of fully blown national industries in key sectors that could eventually compete head to head with the industrialized nations (Baldwin, 2011).

Today, despite a growing list of signatories to the WTO, industrial policy is on the upswing. WTO accession often comes with allowances for selective industrial policies (e.g., trade promotion, local content rules, taxes, tariffs, and more indirect programs that drive local production) to remain in force for specified periods. Bilateral trade agreements can supersede what has been agreed to under WTO rules, and a handful of relatively large and advanced emerging economies (such as those in the G-20) have more clout in the institutions of global governance and are using it to create greater leeway to engage in activist industrial policies.

Still, the fragmentation of global industries in GVCs complicates industrial policy debates. In this chapter we argue that there can be no return to the ISI and EOI policies of old. Domestic industries in both industrialized and developing countries no longer stand alone and compete mainly through arms-length trade; instead, they have become deeply intertwined through complex, overlapping business networks created through recurrent waves of foreign

direct investment (FDI) and global sourcing. Companies, localities, and entire countries have come to occupy specialized niches within GVCs. Because of this, today's industrial policies have a different character, and generate different outcomes than before. Intentionally or not, governments currently engage in GVC-oriented industrialization when targeting key sectors for growth. In this paper we develop the notion of GVC-oriented industrialization through a comparison of seven emerging economies and a case study of Brazil's consumer electronics industry.

The roots of GVCs extend back to the experiments with global sourcing by a handful of pioneering retailers (e.g., JC Penny, Sears, Kmart) and manufacturing enterprises (e.g., IBM, General Motors, Volkswagen) that set up production in East Asia, Mexico, and a handful of other locations around the world in the 1970s and 1980s with the explicit purpose of lowering production costs and exporting finished goods back to home markets (Fröbel *et al*, 1980; Dassbach, 1989; Gereffi, 1994; 2001).

After 1989, the opening of China, Russia, India and Brazil (the so called "BRIC" countries) added huge product and labor markets that had been all but outside the capitalist trading system, nearly doubling the field of play for international companies (Freeman, 2006). Faced with slow growth at home, large "lead" firms in GVCs rushed to set up operations in BRIC countries, especially China, in an effort to carve out brand recognition and market share in rapidly expanding consumer markets and to cut costs on goods produced for export back to home markets. This greatly accelerated the globalization process, since these giant economies offered seemingly inexhaustible pools of low-wage workers, increasingly capable manufacturing and trade infrastructures, abundant raw materials, and huge underserved domestic markets with incipient middle classes.

Over time retailers and branded manufacturers in wealthy countries became more experienced with international outsourcing. In response, developing countries acquired the infrastructure and capabilities needed to sustain larger scale operations, and suppliers upgraded their capabilities in response to larger orders for more complex goods (Hamilton and Gereffi, 2009). In the 1990s, the most successful U.S.- and Europe-based manufacturers quickly became huge global players, with facilities in scores of locations around the world (e.g., Siemens, Valeo, Flextronics), and a handful of elite East Asian suppliers (e.g., Pao Chen, Quanta, Foxxcon) and trading companies (e.g., Li & Fung) also took on more tasks for multinational affiliates and global buyers. These firms expanded production, not only in China, but also in other Asian countries and more recently in Africa, East Europe, and Latin America as well. As the resources in the global supply-base improved, more lead firms gained the confidence to embrace the twin — and often intertwined — strategies of outsourcing and offshoring.

In the 2000s, the industries and activities encompassed by GVCs grew exponentially, driving trade in finished goods and customized intermediates (e.g., components and subassemblies), spreading from manufacturing into energy, food, and a growing set of services previously considered to be "untradeable," ranging from call centers and accounting, to medical procedures and R&D (Dossani and Kenney, 2003; Engardio et al., 2003; Engardio and Einhorn, 2005; Wadhwa et al., 2008; Cattaneo et al., 2010; Staritz et al., 2011). The impact of these changes was felt most strongly in a handful of countries. China became the "factory of the world," India the world's "back office," Brazil had a wealth of agricultural and primary commodities, and Russia possessed enormous reserves of natural resources plus the military technologies linked to its role as a Cold War superpower. For goods that require shorter supply lines such as "fast fashion" apparel and automobiles, the countries of East Europe joined more traditional "export processing" locations such as Mexico and North Africa.

The rapidity of these changes left the scholarly community struggling to catch up. Beginning in the early 2000s, the GVC concept gained popularity as a way of framing and characterizing the international expansion and geographical fragmentation of contemporary supply chains (Gereffi et al., 2001; Dicken at al., 2001; Henderson et al., 2002; Gereffi, 2005; Feenstra and Hamilton, 2006; Gereffi and Lee, 2012). Much of this research and theoretical work has focused on how "lead" firms in specific GVCs have driven this process in various ways. Decisions about outsourcing and offshoring are, after all, strategic decisions made by managers. But such decisions are not made in a vacuum. The policies and programs of countries and multilateral institutions set the context for corporate decision-making, and we have seen an evolution in the form and effects of industrial policy along with the evolution of the business networks that comprise GVCs.

Today the organization of the global economy is entering a new phase, what some have referred to as a "major inflection point" (Fung, 2011), which could have dramatic implications for both emerging and industrialized countries, firms and workers. As world trade rebounds from the 2008-2009 economic crises, emerging economies have become a major engine of growth. Slow growth in the global North since the mid-1980s was dampened further by the latest crisis, whereas demand is quickly growing in the global South, particularly large emerging economies like China, India and Brazil (Staritz et al., 2011). Over the period of 2005-2010, the merchandise imports of the European Union and the United States increased by 27% and 14%, respectively, while emerging economies expanded their merchandise imports much faster: Brazil (147%), India (129%), China (111%) and South Africa (51%). These differences represented more than an acceleration of previous global sourcing arrangements, they represented a shift in end markets to the developing world: in 2010, a full 52% of Asia's manufactured exports were destined for developing countries (WTO, 2011).

Clearly, developing countries are now in a position to exert greater influence over the shape the global order, economically and politically, as the impact of the "Washington consensus" as a paradigm for developing countries wanes (Gore 2000). However, no overarching alternative development strategy has taken its place. Thus, our analysis of GVCs in this new period must take account not only of changes in the organization of production and trade on a global scale, but also the role of emerging economies as new markets and production hubs in the global economy.

The remainder of this chapter is divided into four parts. First, we examine the export performance of seven of the most significant emerging economies: China, India, Brazil, Mexico, Russia, South Korea and South Africa, noting the changing distribution of their exports across four broad technology categories between 2000 and 2011. Second, we then examine the kinds of industrial policies utilized by these emerging economies, and propose a new typology that includes the category of GVC-oriented industrial policies. Third, we illustrate how industrial policy intersects with GVCs in the context of the consumer electronics industry in Brazil. We conclude with a reprise of GVC-oriented industrial policies and provide some reflections about the implications of these trends for the future of the global economy.

2. Emerging Economies in Comparative Perspective

A dynamic set of large emerging economies, initially referred to as BRICs (Brazil, Russia, India and China), are becoming significant drivers of aggregate supply and demand in the global economy.[1] In this section, we broaden the focus to a set of seven emerging economies that belong to what O'Neill (2011) sees as contemporary "growth economies": China, India, Brazil, Mexico, Russia, South Korea and South Africa. These countries are quite diverse in terms of their economic and social characteristics. However, they are all centrally involved in distinct types of GVCs in agriculture, extractive industries (mining, oil and gas), manufacturing, and services. Together, these seven emerging economies account for 45% of the world's population, 23% of gross domestic product (GDP), and 22% of global exports, and their GDP growth rates are nearly double the world average (4.8% versus 2.7%) (see Table 1).

The specific roles of these seven countries in the global economy vary according to their openness to trade and foreign investment; endowments of natural, human, and technological

[1] Jim O'Neill (2011), the Goldman Sachs executive who coined the term BRIC in 2001 to refer to Brazil, Russia, India and China , now argues that there is a much larger number of "growth economies" (BRICs plus 11) that fall into this category. These include the MIST nations (Mexico, Indonesia, South Korea and Turkey), and other periodic high-performers such as Bangladesh, Egypt, Pakistan, the Philippines, and Vietnam (Martin, 2012). The original BRIC classification was extended to BRICS with the addition of South Africa in 2010. For purposes of this paper, the origin of these acronyms is less important than the collective effect of this set of so-called emerging economies, which are reshaping both supply and demand in many GVCs.

resources; their geopolitical relationships to the world's most powerful countries; and the characteristics of their immediate neighbors. Many have significantly improved their relative position in global economy, surging ahead of the advanced industrial countries in terms of export performance for example. Between 1995 and 2007, the global export shares of the United States and Japan fell by 3.8 and 3.7 percentage points, respectively, while China more than doubled its share from 4% in 1995 to 10.1% in 2007, making it the world export leader (ahead of Germany, the United States and Japan). South Korea, Mexico, Turkey, South Africa, and the former transition countries in central Europe also increased their export shares during this period (Beltramello et al., 2012: 9-10).

Although collectively these seven nations have considerable economic clout, China is the global pacesetter of the group. While China and India are the most populous countries in the world at 1.3 and 1.2 billion inhabitants, respectively, China is the undisputed export leader with $1.9 billion in exports in 2011. China's export total is equal to that of South Korea, Russia, India, Brazil and Mexico combined, while China's GDP has grown at over 9% per year for over 30 years. It is now the second-largest economy in the world (trailing only the United States) and has overtaken Germany as the world's largest exporter (Beltramello et al, 2012). Notwithstanding China's rapid economic growth, its GDP per capita is the second lowest among the emerging economies in 2011 ($5,445), well ahead of India ($1,489), but less than half that of Brazil and Russia, and just one-quarter that of South Korea. On average, the GDP per capita of these seven emerging economies is about 10% above the world average in 2011 (see Table 1).

An indicator of the roles emerging economies play in GVCs can be found in their export profiles, broadly classified by the technological content of their exports. Using a classification scheme introduced by Sanjaya Lall (2000) that groups traded goods according to primary products plus four types of manufactured exports (resource-based, low-tech, medium-tech, and high-tech), Table 2 highlights some of the differences between these countries in terms of their export profiles. Three of the emerging economies are heavily oriented toward primary product or resource-based exports (the first two columns in Table 2): Russia (72%), Brazil (69%), and South Africa (59%). Half of India's exports are resource oriented, with another 40% being low tech (primarily apparel products) and medium technology manufactured goods.[2] China, South Korea, and Mexico, by contrast, are heavily involved in manufacturing GVCs. Over 90% of China's exports are manufactured goods, while a preponderance of the exports by South Korea (72%) and Mexico (60%) are medium technology (automotive, machinery) and high technology (mainly electronics) exports.

[2] However, Lall's categories only cover goods, and India is also the world leader in exports of offshore services, with 45% of the global total (see Fernandez-Stark et al., 2011).

If we look at trends in these export patterns between 2000 and 2011, we see that China and India have increased their exports over six fold, Brazil and Russia each increased their exports around 360%, and South Africa and South Korea more than doubled their exports (Table 2). The fastest growing exports in these countries were primary products and resource-based manufactures. The boom in primary product exports since 2000 has largely been driven by China's imports of the raw materials needed to fuel its industrial growth. At the same time, low-technology exports declined in all of these emerging economies, reflecting slack consumer demand in advanced economies, especially as a result of the 2008-2009 economic recession.

Though such gross export figures do not account for the technological content of imported inputs, which new data sets will allow us to determine in future research,[3] it is still notable that these emerging economies made their most significant gains in exports of high and medium-technology products, previously the stronghold of advanced industrial countries. While the export of final products provides only a partial picture of the technological development of each economy, it does signal that these countries have come to play important roles in the GVCs of relatively advanced products in technology-intensive industries, such as electronics and motor vehicles. This phenomenon was mainly driven by China, whose share of exports of goods in high-tech industries (mainly electronics) soared by 13.5 percentage points in the period 1995-2007, moving it ahead of the United States as the world's largest exporter of high-tech products (Beltramello et al., 2012: 10).

In summary, our focus on these seven emerging economies serves two purposes. First, we demonstrate that these large, dynamic countries are deeply entrenched in GVCs, but in very different ways. Second, given recent changes in the global economy, we believe that the role of emerging economies in GVCs is undergoing a number of changes in the post-Washington Consensus era, including an increasingly central role for China, a greater emphasis on production and upgrading for the domestic market, shifting export markets with a greater role for South-South trade, and a new form of industrial policies in emerging economies (Gereffi, forthcoming). It is to this latter topic that we now turn.

3. GVCs and Industrial Policy: An Evolving Debate

Twentieth-century debates over the merits of industrial policy as a strategy for

[3] Two recently announced international databases will permit us to examine the domestic versus foreign (imported) content of value added in export production. The first comprehensive effort is the OECD-WTO Trade in Value Added (TiVA) database, which presents indicators for 40 countries (all OECD countries, Brazil, China, India, Indonesia, Russian Federation and South Africa) covering the years 2005, 2008 and 2009 and broken down by 18 industries (see http://www.oecd.org/industry/ind/measuringtradeinvalue-addedanoecd-wtojointinitiative.htm). In addition, there is the UNCTAD-Eora GVC database, which was launched in February 2013, and it covers 187 countries during the 1990-2010 period for 25-500 industries, depending on the country (UNCTAD, 2013: 3).

economic development occurred before there was broad recognition of the importance of GVCs (Amsden, 1989; Wade, 1990; World Bank, 1993; Evans, 1995; Chang, 2002). The GVC lens provides some crucial insights into the processes of contemporary economic development. A main difference is the potential for vertical specialization, not only at the level of firms, but at the level of nations. China might be the "world's workshop," but much of the work is in producing products designed and developed elsewhere. The central goals of industrial policy in the GVC context shift from creating fully-blown, vertically integrated national industries to moving into higher value niches in GVCs.

Industrial policies that take the new realities of GVCs into account include traditional measures to regulate links to the global economy, especially regulation of trade, foreign direct investment, and exchange rates used in ISI and EOI policies that sought to elevate the position of "national champions." (Baldwin, 2011). Today, GVC-oriented industrial policy focuses to a greater extent than in the past on the intersection of global and local actors, and it takes the interests, power and reach of lead firms and global suppliers into account, accepts international (and increasingly regional) business networks as the appropriate field of play, and responds to pressures from international non-governmental organizations (NGOs). Upgrading national firms in this context is not an easy task. Because GVC lead firms induce suppliers in different countries to compete with each other for orders, and they often choose to work with the same global suppliers in multiple locations to reduce transaction costs, states tend to have less leverage to demand local content requirements or less scope to develop links to domestic suppliers.

In the face of such challenges, some large emerging economies are shifting their development strategies inward, and relying more extensively on regional production networks buttressed by regional industrial policy. China's upgrading strategy now operates on a global scale because Chinese firms have become such a large foreign investor and buyer of raw materials (Kaplinsky et al., 2010). China's rise as a major global buyer means that South-South trade will continue to expand as a share of world trade. While China has instituted policies to ensure domestic processing of raw materials from the rest of the world, these are being resisted by China's trading partners.[4]

One example is South Africa, whose policy emphasizes regional integration as a basis for industrial upgrading, focused on mining, agriculture and pharmaceuticals (Davies, 2012). South Africa has announced a strategy of additional processing of regionally sourced minerals shipped to China in order to drive skill development, higher wages and large profits within Africa. While it remains to be seen how other countries in sub-Saharan Africa respond to these ideas since

[4] This is particularly clear in the case of Brazil's soybean exports to China, discussed in the next section of this paper.

higher value processes are likely to be concentrated in South Africa, this regional industrial policy is based on the view that African companies will have access to more minerals and raw materials, greater productive and processing capacity, and larger markets, resulting in region-wide upgrading.

This suggests that regional integration strategies, including preferential trade agreements (PTAs), economic cooperation arrangements and regional production networks, will increasingly be based on supply-side strategies, rather than the traditional demand-side considerations that usually justify regional integration. The demand-side logic of regional integration highlights expanding the market size, market access and the possibility of capturing FDI and better scale economies by serving this larger market. The supply-side approach uses regional integration to create scale and complementarities that can drive more production and processing and thus higher value exports from the region.

Large emerging economies clearly have more options in terms of upgrading within GVCs than small economies. They can focus on manufactured exports, as China and Mexico have done since the mid-1990s, but they can also reorient their productive capacity to serve domestic demand if export markets become less attractive. While both small and large countries can pursue upgrading at the regional level by diversifying or adding new capabilities that aren't available at the national level, large countries clearly have more leverage in such arrangements. Large countries with high potential for market growth (such as the BRICs) can also institute policies to drive FDI in technology- and capital-intensive sectors, such as electronics and motor vehicles.

Small countries have fewer options. Their market size is not large enough to attract FDI for the local market, and domestic firms tend to be small-scale and less advanced. However, the regional organization of some GVCs has created opportunities for smaller countries to leverage low costs and proximity to large markets to build export capacities in specialized GVC niches (e.g., intermediate goods) in the context of regional production systems. Costa Rica, for example, has clear supply-side constraints related to productive capacity and skills, and conceivably could partner with Mexico to enhance its training programs and skills development. Nicaragua, whose apparel firms have been buying textiles from East Asia, is consciously pursuing supply arrangements with textile firms in Honduras and Guatemala. In sum, specialization and regional GVC linkages matter for political and economic integration in a way that was not the case previously.

In order to view these industrial policies in a more systematic way, we have created a typology of the various kinds of industrial policies that characterize the contemporary emerging economies (see Table 3). We distinguish three types of industrial policies: "horizontal" policies that affect the entire national economy; "selective" (or "vertical") industrial policies targeted at

particular industries or sectors; and GVC-oriented industrial policies that leverage international supply chain linkages or dynamics to improve a country's role in global or regional value chains.

"Horizontal" policies focus on the basic building blocks of competitive national economies, such as education, health, infrastructure, and R&D expenditures. Although these areas all provide attractive opportunities for private investors, the public sector typically plays a role in providing widespread access to these factors as public goods. While "horizontal" policies are cross-cutting and in principle have economy-wide effects, such policies may also target particular national industries or GVCs (e.g., tax credits for shale gas or oil investors). In these cases, the policy in question could be analyzed in either of the other two categories in Table 3.

Domestic industrial policies tend to be "selective" or "vertical" because they are associated with prioritizing particular industries at the national level. This has been justified for various reasons, including the following: (a) these industries are considered strategic in terms of natural resources (e.g., oil, natural gas, and minerals in the Middle East and Latin America); (b) they present exceptional opportunities for forward and backward linkages with domestic suppliers (e.g., autos in Mexico and Brazil; electronics in Japan, South Korea, and China); (c) they have an impact on national security in terms of defense or critical consumption needs (e.g., military procurement, essential medicines, basic foodstuffs during famines or droughts); and/or (d) the policies support "infant industries" that need temporary protection from larger and more established international competitors. In practice, these industrial policies were associated with the import-substitution (ISI) development strategies that became popular in Latin America, South Asia and other developing regions from the late 1950s through the early 1980s, and effectively they were disrupted by the Latin American debt crisis of the 1980s and displaced by EOI development strategies associated with the rise of East Asia and the "Washington Consensus" in the 1990s (Gereffi and Wyman, 1990; World Bank, 1993).

GVC-oriented industrial policies go beyond the domestic economy focus of ISI-style policy regimes, which try to recreate entire supply chains within a national territory. Given the international production networks associated with GVCS, this type of industrial policy explicitly utilizes extra-territorial linkages that affect a country's positioning in global or regional value chains. In the global apparel industry, for instance, a good illustration of GVC-oriented industry policies were the "triangle manufacturing" networks associated with East Asian economies, such as Hong Kong, Taiwan, and South Korea (Gereffi, 1999). In order to deal with the quota constraints put in place by the Multi-Fiber Arrangement that regulated apparel trade from the 1970s through 2005, East Asian textile and apparel manufacturers complemented the strengths of their domestic economies in product development, design and textiles by seeking out low-cost apparel suppliers in various regions of the world, and these East Asian middleman firms

would also sell to global buyers (large apparel retailers and brands) using flexible triangle manufacturing schemes to improve the competitiveness of East Asian economies in the apparel GVC by coordinating the activities of multiple actors across the chain.

Current examples include efforts to create and sustain regional supply chains that provide needed inputs for national export success, such as the East Asian supply base that has been created for China's electronics inputs needed for its exports of smart phones (Xing and Detert, 2010; Gereffi and Lee, 2012). Case studies in Central America and sub-Saharan Africa showcase efforts to create regional integration arrangements that could strengthen the export position of countries in each region by sourcing inputs from regional neighbors -- e.g., textiles and apparel in Central America or sub-Saharan Africa (Bair and Gereffi, 2013; Morris et al., 2011), and minerals processing in sub-Saharan Africa (Davies, 2012).

Table 3 highlights the varied industrial policy instruments utilized by the seven emerging economies that we focus on. Brazil, China, India and South Korea deploy the most extensive array of horizontal or economy-wide policies. In terms of selective domestic industrial policies, most of the emerging economies have particular industries that they deem particularly important, and these are supported by policies requiring local content, joint ventures, local R&D, or other benefits that tend to favor domestic over foreign firms. Finally, there is a third and relatively new category of industrial policies that are oriented to improving a country's position in GVCs. These policies recognize that a country's possibilities for upgrading depend at least in part on links across different segments of the value chain, within a regional or global context.

While free trade agreements are an enabling factor that permit greater openness to GVCs, these are often supplemented by policies that try to induce regional production networks in specific industries to facilitate functional upgrading or the opportunity of emerging economies to more fully exploit regional economies of scale and scope. In East Asia, China benefits from close economic ties with many of its East Asian neighbors that facilitate imports of materials and components that go into China's manufactured export products. In South Africa and Brazil, there are policies to limit the restrictions that trade partners (like China) have placed on the processing of primary product exports. Thus, GVC-oriented industrial policies seek to improve the ability of emerging economies to enhance their upgrading opportunities within these chains by facilitating both intermediate and primary goods trade.

4. GVC-Oriented Industrial Policies in Action: The Case of Brazil

Brazil's development strategy has both similarities and distinctive elements when compared to South Africa and China. Although Brazil belongs to Mercosur, a regional trade

agreement that includes Argentina, Uruguay, Paraguay and Venezuela, this does not reflect a pan-Latin America vision analogous to that of South Africa's economic integration plans for sub-Saharan Africa (Davies, 2012), nor does it embody the highly efficient regional division of labor that China participates in with its East Asian neighbors. Brazil dominates Mercosur by its size and level of economic development, and thus it occupies an asymmetric position in terms of regional integration. Mutual gains from the long-heralded complementarities between Brazil and Argentina in the automotive sector have been weakening. Like South Africa, Brazil is concentrated in primary product exports with relatively low levels of processing and is seeking to reverse the so-called "primarization" of its export profile (Jenkins, 2012)

This is not entirely a new situation. ASEAN had been driven in part by Toyota's and Ford's search for a secure regional production network through complementarity schemes (Sturgeon and Florida, 2004). Access to low cost auto parts was also an important consideration for the automotive firms that promoted the North American Free Trade Agreement. But today, these efforts are proliferating. China is seeking to strengthen the regional production system in East Asia, South Africa has announced a regional integration and industrial policy to promote upgrading in raw materials production, and Brazil and its Mercosur neighbors are broadening their customs union to build regional supply-side capabilities.

As we have already mentioned, a major challenge for some large emerging economies that have become primary product exporters based on high demand from China is how to increase the technological content of their exports in order to move into higher value activities. For example, China is Brazil's largest trading partner, accounting for about 15% of Brazil's exports and imports in 2010. From a GVC perspective, what is particularly notable is that the pattern of Brazil's exports to China is skewed toward products (both primary commodities and manufactured goods) with very low levels of processing.

The soybean value chain is a good example. About 95% of Brazil's soybean exports to China in 2009 were unprocessed beans. In contrast, there were virtually no exports of soybean meal, flour or oil to China. In order to pursue its strategy of promoting the Chinese soybean processing industry, China imposed a tariff of 9% on soybean oil imports, while the tariff on unprocessed soybean imports was only 3%. Imports of products based on processed soybeans were also levied a higher value-added tax rate in China than unprocessed beans. Similar protectionist policies, including both tariff and non-tariff barriers, have been imposed by the Chinese government on other primary and processed intermediate products from Brazil, including leather, iron and steel, and pulp and paper (Jenkins, 2012: 28-29).

On the import side, Brazil has also been influenced by China's structure of international trade. In 1996, low-technology products accounted for 40% of Brazil's imports from China, while high-technology products were 25%. By 2009, the pattern was nearly reversed: high-

tech products were 41.4% of the total, and low-tech products were 20.8%. If we look at this trend in terms of the end use of imports, consumer goods imports from China to Brazil fell from 44% to 16% between 1996 and 2009, while the imports of capital goods doubled from 12% to 25%, and parts for capital goods rose from 12% to 25% (Jenkins, 2012: 29-31). Thus, Brazil has fallen to the lowest rungs of the value-added ladder in its trade with China in recent decades.

While the trade relationship with China is the most severe challenge for Brazil, the problem is more pervasive. For example, Embraer, a successful Brazilian producer of regional passenger aircraft, depends on imports for 100% of its aircraft-grade aluminum, despite Brazil's abundance of the aluminum ore (bauxite) and rare minerals required for aircraft-grade alloys. South Africa has had some success in this regard. It is the largest exporter of catalytic converters for use in vehicle exhaust systems, products that rely on platinum, a precious metal that is abundant in South Africa.

Leveraging Consumer Electronics GVCs to Build Capabilities in Brazil

An instructive case of how GVCs intersect with national industrial policies can be found in Brazil's recent efforts to leverage its large and growing internal market to build domestic capabilities in the consumer electronics sector. A growing middle class in Brazil has begun to demand consumer electronics on an unprecedented scale. According to the World Bank (2012), Brazil's poverty rate declined from 41.9 percent in 1990 to 21.4 percent in 2009. As a result, mobile phone handset penetration in Brazil has nearly doubled in recent years, from 32 million units in 2004 to 58 million in 2011 (ABINEE 2012). In addition, Brazil is currently the world's third largest personal computer (PC) market, with 17 million units sold in 2012 (IDC 2011). The market is dominated by global lead firms such as Apple, Dell, Hewlett Packard (USA), and Lenovo (China), but a local producer, Positivo, has about 25% of the corporate PC market, and it recently unveiled several smart phone models based on Google's Android operating system. Demand for tablet computers is also growing quickly. Sales of smartphones and other Internet-connected mobile devices are expected to increase dramatically with Brazil's hosting of the World Cup soccer championship in 2014 and the Olympic Summer Games in 2016, and this will drive huge investments in equipment to upgrade Brazil's already strained infrastructure for voice connectivity and data communications.

Because of these changes, Brazil's overall trade performance in the electronics sector recently turned negative. Between 2007 and 2010, consumer electronics exports from Brazil declined by 25%, while imports skyrocketed by over 140% (see Table 4). A significant portion of this decline can be explained by the shift to smartphones, tablet computers, and notebook computers, products that are displacing the feature phones and desktop computers produced in Brazil, both for the local market and for export to developing country markets with compatible standards. For example, in 2004, before the smartphone market was fully

established, Brazil exported 10 million units per year and imported just 1.3 million units. By 2007, the year Apple computer introduced the first iPhone, Brazil's feature phone exports were valued at more two billion dollars per year. As the market for smart phones took off, export and local demand for feature phones plummeted, and by 2011 Brazil was importing 15.7 million handsets and exporting only 7.4 million (ABINEE 2012). In response, feature phone producers in Brazil, such as NEC (Japan) and Nokia (Finland), withdrew from local production.

These rapid market shifts brought a new set of players to the fore, namely Apple and the many makers of Android-based smart phone handsets, and the contract manufacturers that produce the bulk of these products, such as Flextronics (USA and Singapore) and Foxconn (Taiwan). Market growth and access to its Mercosur trading partners are providing Brazil with the leverage it needs to demand local production and content from consumer electronics and communications GVC lead firms, who in turn have put pressure on their key global suppliers to make investments in Brazil. To exploit this opportunity, Brazil is bringing to bear a range of old and new policies aimed at spurring local production in the electronics sector. The key laws and programs to stimulate local production are listed and described in Table 5.

Like the ISI policies of old, Brazil's current industrial policies consist mainly of tax incentives meant to spur local R&D, assembly, and component manufacturing. But because GVCs bring new actors and industry structures to the fore, the challenges, opportunities, and outcomes related to these policies are different. For example, a centerpiece of Brazil's strategy to increase local production of consumer electronics has been to attract global contract manufacturers, known in the industry as electronic manufacturing services (EMS) providers. As electronics lead firms such as Apple and Hewlett Packard continue to outsource manufacturing, contract manufacturers have become increasingly important players in the component purchasing, assembly, test, and after-sale service functions of electronics GVCs. But the threshold for new investments is high (large, globally operating contract manufacturers rarely open up a new automated circuit board assembly line for orders less than several hundred thousand units), and the promise of business from a single customer is rarely enough.

Seven of the 12 largest contract manufacturers are based in Taiwan (see Table 6). One of Taiwan's most successful contract manufacturers, Foxconn Electronics (Hon Hai Precision Industry), has eclipsed its competitors, bringing in almost three times the revenue of the second-place contractor, Quanta Computer. However, Foxconn, much like other EMS contract manufacturers, suffers from low profit margins (just 2.4% in 2011) and must compete on a global level to maintain market share (Mishkin and Palmer, 2012). Foxconn's close relationship with Apple has been its main driver of revenue growth. Contract manufacturers fill an increasingly complex role in the electronics GVC; they must not only work closely with lead firms to develop products and meet tight production schedules, but also with a worldwide

network of component manufacturers and distributors to ensure that they can meet demand and keep their lines operating at, or near, full capacity.

Thanks to Brazil's GVC-oriented industrial policies and direct pressure on the company from policy-makers, Foxconn has begun to assemble iPhones, iPads and most recently iPad minis for Apple in Brazil. While Foxconn currently imports 90-95% of its components, the company, which is more vertically integrated than most EMS firms, is likely to begin to manufacture components, including displays, in Brazil. Recent negotiations for a fifth Foxconn factory in Brazil have included language to suggest that once production is at 100% (projected to be 2016), Foxconn will be manufacturing components including cables, cameras, touch-sensor glass, LED products, and printed-circuit boards (Wang, 2012).

Hewlett Packard (HP) uses three global contract manufacturers to produce in Brazil (Foxconn, Flextronics and Jabil Circuit). Products include computers, desktop PCs, notebook PCs, workstations, computer servers, single function printers, and multi-function printers. Local production accounts for 95% of local sales. HP imports low volume products such as large format printers, high-end servers and some high-end portable computers, and makes printer ink cartridges in its own plant using a proprietary manufacturing process. Most components are imported except RFID chips for printer cartridges, which are developed by CEITEC, a local government-supported semiconductor foundry.

But hardware production is only part of the picture. In meeting the requirements for local R&D spending (4% of sales), HP Brazil employs 400 engineers and researchers in its lab in the south of Brazil and has contracts with another 1,000 collaborators from universities and research centers in the country. It also has four software centers working on local customer-specific applications, while contract manufacturers are being used to help meet the R&D spending requirement. Two of HP's research centers have been set up in collaboration with the Flextronics Institute of Technology (FIT): the RFID Center of Excellence, which has worked on over 100 RFID-related projects with HP; and the newer Sinctronics IT Innovation Center, which focuses on environmental compliance and product recycling (Flextronics International, 2012). Like manufacturing capacity, the R&D of contract manufacturers can serve multiple lead firms. In addition to the work it does for HP, FIT runs research institutes to develop software solutions for IBM servers and Lenovo computers. It even conducts R&D on behalf of competitors like Foxconn and Compal, which do not have the R&D facilities in Brazil needed to spend their R&D quota internally. In other words, Flextronics is been able to develop economies of scale in R&D, much like it does through its manufacturing and assembly services.

The presence of global contract manufacturers in Brazil creates a number of immediate advantages. The most obvious is jobs. For example, Foxconn currently employs 6,000 in Brazil and could add 10,000 more jobs by 2016 (Luk, 2012). Because contract manufacturers serve

multiple customers, their manufacturing capabilities can satisfy local content requirements for multiple brands. Production capacity is generic and flexible enough to effectively pool capacity across all high volume segments of the electronics industry. Capacity can be switched toward product categories and firms that are successful in the local market and in exporting. The focus of Brazil's GVC-oriented industrial policy on attracting investments by contract manufacturers, as well as GVC lead firms, signals a sophisticated understanding of the dynamics of the electronics GVCs by policy-makers. Contract manufacturers provide a leading edge, flexible, and scalable platform for local production and R&D. Lead firms like Apple and HP tend to use the same contractors on a global basis, and their presence in Brazil lowers the bar for localization.

5 Conclusions: What Do GVC-Oriented Industrial Policies Look Like?

Emerging economies are playing significant and diversified roles in GVCs. During the 2000s, they have become major exporters of intermediate and final manufactured goods (China, South Korea, and Mexico) as well as primary products (Brazil, Russia and South Africa). However, market growth in emerging economies has also led to shifting end markets in GVCs, as more trade has been South-South, especially since the 2008-2009 economic recession (Staritz et al., 2011). China has been the focal point for both patterns, since it is the world's leading exporter with an emphasis on manufactured goods, but it also has stoked the primary product export boom as the world's largest importer of a wide range of primary products.

The primary product exporting profiles of Brazil, Russia, and India (BRI) suggest that these countries are contributing to China's role as a materials processing and final assembly hub. Finished manufactured items are then exported from China back to these BRI countries and the rest of the world. Still, trade statistics cannot reveal where ownership, intellectual property (IP), and GVC coordination — and much of the profits in GVCs — lie. But from case studies (e.g., Linden et al., 2007; Xing and Detert, 2010) and new research on trade in value added (UNCTAD, 2013; Gereffi and Lee, 2012), we know that many of China's exports consist of foreign-branded products, contain core IP from industrialized countries (USA, Europe, Japan), and include sophisticated intermediate products imported from the most industrialized and advanced emerging economies, such as South Korea and Taiwan, as well as other developing countries in East Asia (Malaysia, Thailand, etc.). Thus, rising South-South trade may in fact signal the emergence of a GVC structure that undergirds China's role as "the world's workshop." This helps to explain efforts by the BRI countries to diversify away from primary commodities, first by adding more value to exported commodities, and second by moving into technology-intensive final products such as automobiles and electronics.

Various types of industrial policy are industry-specific. While this puts them in line for criticism when policy-makers are seen to be "picking winners," the industry focus is essential. Research at the level of global industries clearly shows that the structure and upgrading trajectories of GVCs vary significantly, and as a result, cross-industry comparisons are essential (Sturgeon et al., 2008; Cattaneo et al., 2010; Sturgeon and Kawakami, 2011; Staritz et al., 2011). For example, trade in customized intermediate goods is extremely high, growing, and global in scope in electronics, while trade in automotive parts tends to be organized in regional production systems (i.e., North America, Europe, Asia), and trade in intermediate inputs to apparel products (fiber and fabric) is actually falling as the major apparel producing countries (e.g., China and Bangladesh) gain huge capabilities in textile production (Sturgeon and Memedovic, 2010). The reasons for these differences are complex. On one hand, the detailed characteristics of product designs, intermediate components, final goods, and logistics requirements greatly influence the geography of industry GVCs (Gereffi et al, 2005). On the other hand, certain products (e.g., autos) come with high levels of political sensitivity that drive production toward end markets (Sturgeon and Van Biesebroeck, 2010).

As the Brazil consumer electronics case suggests, the formation of industrial policy does not always begin with policy-makers "picking" industries, but rather with attempts to improve the performance of existing industries that link their country to the global economy. This involves a search for mechanisms that can capture investment and improve a country's value adding position in highly mobile segments of GVCs that are already in the process of spreading to new locations, or may already be present in the jurisdiction that policy makers are responsible for. When Brazil's policy-makers try to capture more local value added in local markets that are *already* growing rapidly, they cannot be said to be picking winners.

Of course, policy-makers must also be concerned with slowing market growth by raising prices to levels that block consumers' access to leading-edge products. Broad economic growth can be slowed when markets for products that make the whole economy more efficient, such as smart phones and computers, are truncated. But it is possible for policies that pressure lead firms to add more value locally to be modest and targeted enough that they do not raise prices to the point where market growth is impeded and leading edge products fail to make it into the hands of the businesses and consumers that want them.

Once the proposition that a balanced approach is possible is accepted by policy-makers, the question then becomes how to craft effective GVC-oriented industrial policies. One way to examine this question is to ask how current industrial policies differ from traditional industrial policies. A superficial analysis of the Brazilian consumer electronics case might suggest that the motivations and policy tools being employed by large emerging economies simply replicate many of the features of traditional ISI industrial policy: driving import substitution with local

content requirements, instituting requirements for investment in local R&D, stimulating demand in key product areas, etc.

However, we see three major differences that highlight the distinctive nature of GVC-oriented industrial policies:

1. Global suppliers. Instead of merely demanding that lead firms make major investments, the GVC-oriented industrial policies described in this paper reveal an increasingly sophisticated understanding of the global-scale patterns of industrial organization that have come to the fore in GVCs since at least the 1990s. Lead firms are relying on global suppliers and intermediaries for an array of processes, specialized inputs, and services, and demanding that their most important suppliers have a global presence. Hence it is suppliers, not lead firms that are making many of the new investments that developing countries are seeking to capture. In many cases, suppliers generate the bulk of exports as well. Furthermore, the largest suppliers serve multiple customers, so the success of investments is not necessarily tied to the success of any single lead firm.[5] In the context of rapidly shifting market share among lead firms, and the sudden entry of new players (neither Apple or Google participated in the mobile communications industry before 2007), the capability to serve multiple customers takes on heightened importance. Therefore, is no accident that Brazil sought investments from Foxconn, rather than Apple, in its desire for iPhones and iPads to be produced in the country for domesticconsumption and export elsewhere in Latin America.

2. Global sourcing and value chain specialization. Policies that promote linkages to GVCs have very different aims from traditional industrial policies that intend to build fully blown, vertically integrated domestic industries. Policies can target specialized niches in GVCs. These can be higher-value niches suited to existing capabilities. They can also be generic capabilities that can be pooled across foreign investors. Either of these can serve both domestic or export markets. This sort of value chain specialization assumes an ongoing dependence on imported inputs and services. Reliance on global sourcing means that the entire value chain may never be captured, but it also assures ongoing involvement in leading-edge technologies, standards, and industry "best-practices." Clearly, industries in developing countries can no longer make outmoded products. As the Brazilian mobile phone case shows, consumers with rising incomes will no longer accept them.

[5] By serving multiple customers, global suppliers can generate enough business to justify capital-intensive investments that have high minimum scale requirements, such as electronic displays and automated production lines.

3. Moving to the head of GVCs. Encouraging global suppliers to establish facilities within a country can have long-term advantages. Local lead firms can rely on global suppliers in their midst, and on broader industry GVCs for a wide range of inputs and services, from design to production to logistics to marketing and distribution. This can lower risk and barriers to entry for local firms, provide access to capabilities and scale that far outstrip what is available domestically, and ensure that products and services are up to date, precisely because they participate in GVCs from the beginning. As long as policies have not driven costs above world norms, up-to-date, world-class products and services also open up export markets.

The use of industrial policies by emerging economy policy-makers should not come as a big surprise. Both developed and developing countries have used these policies in the past, and often with considerable sophistication, as in the case of East Asian economies, such as Japan, South Korea, Singapore, Taiwan, and now China.

There are two GVC-related features of emerging economies that are distinctive today. First, there is the centrality of China. A number of natural resource-based emerging economies, such as Brazil, South Africa and Russia, see China's procurement policies as limiting their ability to add value to their raw material exports, whereas manufacturing powers such as South Korea, Mexico, and to a lesser degree India, see China as their most formidable competitor in both export and domestic markets. Second, the flourishing of GVCs has led intermediate goods exports to exceed the total of final and capital goods exports for the first time. This raises a new competitiveness challenge over who wins the "trade in value added" battle. Countries now seek to capture the highest value segments of GVCs, not only to increase total exports, but to provide local firms with access to world class inputs. Thus, GVC-oriented industrialization and GVC oriented industrial policies appear to be elements of the current industrial landscape that are here to stay.

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Table 1. Seven Selected Emerging Economies in Comparative Perspective, 2011

Country	Population (Millions)	2011 Exports ($Billions)	GDP ($Billions)	GDP/capita (USD)	GDP/capita (PPP)	GDP growth YoY (%)	Percent of GDP: Agriculture	Industry	Services
China	1,344	$1,899	$7,318	$5,445	$8,450	9.1	10	47	43
Brazil	197	$256	$2,476	$12,594	$11,500	2.7	5	28	67
Russia	142	$516	$1,858	$13,089	$19,940	4.3	4	37	59
India	1,241	$303	$1,848	$1,489	$3,620	6.9	17	26	56
South Korea	50	$557	$1,116	$22,424	$30,340	3.6	3	39	58
Mexico	115	$350	$1,115	$10,064	$15,060	3.9	4	34	62
South Africa	51	$97	$408	$8,070	$10,710	3.1	2	31	67
Total or Avg.	3,140	$3,978	$16,139	$10,454	$14,231	4.8	6.4	34.6	58.9
World Total	6,974	$17,979	$69,980	$9,511	--	2.7	15.7*	31.8*	52.7*
% of World Total	45.0%	22.1%	23.1%	109.9%	--	177.8%	40.9%	108.7%	111.7%

Sources: World Bank: http://data.worldbank.org; UN Comtrade, International Trade Center.

*These world averages are taken from nations with existing data. Not all nations were consistent across categories.

Table 2. Export profile percentages of total exports: 2011

	Industrial Sector					Export	Change in Percentage Value 2000-2011					Export Value
Country	Primary Products	Resource Based	Low-Tech	Med-Tech	High-Tech	Value ($Bil)	Primary Products	Resource Based	Low-Tech	Med-Tech	High-Tech	2000-2011 % Increase
China	3	9	30	24	33	1898	(4)	(0)	(11)	5	10	662%
Brazil	32	37	5	19	4	256	11	10	(7)	(6)	(8)	365%
Russia#	45	27	2	8	1	478	(3)	8	(3)	(4)	(3)	364%
India	11	39	21	17	8	301	(3)	10	(18)	6	3	617%
S. Korea	3	16	9	45	27	555	0	5	(7)	11	(9)	223%
Mexico	20	8	9	38	22	350	7	3	(7)	0	(6)	111%
S. Africa	29	30	5	26	3	93	13	(0)	(5)	0	(2)	254%

Russia had more than 17% of uncategorized exports

Source: United Nations Comtrade, SITC Rev. 2.

Table 3. Overview of Industrial Policies in Emerging Economies

Horizontal Policies (economy wide)	Brazil	China	India	Mexico	Russia	S. Africa	S. Korea
Improved infrastructure, especially trade and transportation infrastructure	●	●	○	◑	◑	○	●
Increased education (particularly STEM education)	●	●	●	○	◑	○	◑
Workforce development	◑	◑	◑	◑	○	○	◑
Investment in R&D	●	●	●	○	●	○	●
Sustainable energy development	●	◑	◑	◑	◑	◑	●
Tax incentives	●	◑	●	●	◑	●	◑
Foreign direct investment	○	●	●	●	◑	○	◑
Free trade agreements	◑	●	●	●	○	○	◑
Vertical Domestic Industrial Policies (industry specific)							
Targeting specific industries, Including key upstream links or inputs	●	●	●	●	●	○	◑
Priority industries	Airline, defense	Advanced mfg./ consumer electronics	Electronics & IT	Export processing manufacturing	Oil/coal/autos	Autos/apparel/ horticulture	Chaebols (electronics, automotive)
GVC-Oriented Industrial Policies							
Specialization in GVC niches in global and regional production networks, to add value to primary or industrial commodities	◑	●	●	●	◑	●	◑
Local content requirements to attract global suppliers, and policies to facilitate intermediate and primary goods imports	◑	●	●	●	◑	◑	○
Use of GVC links to upgrade domestic production & brands (for large economies)	●	●	●	●	◑	●	◑

Key:

○	◑	●
Unimportant	Moderate importance	Particularly significant

Table 4. Brazilian Electronics Exports, Imports and Production, 2007-2010 Growth Rates

Electronics subsector	% Export Growth	% Import Growth	% Production Growth
Medical Electronics	25.4%	62.9%	107.6%
Computers and Storage Devices	-61.9%	31.9%	58.9%
Consumer Electronics	-24.8%	142.7%	39.6%
Industrial Equipment	7.9%	36.8%	35.1%
Computer Peripherals and Office Equipment	-12.5%	63.6%	35.0%
Automotive Electronics	12.6%	51.8%	33.1%
Communications Equipment	-46.8%	-26.0%	-28.8%
Electronic Components	-26.5%	96.6%	-48.5%
Total Electronics	**-32.3%**	**36.0%**	**13.5%**

Source: Production Data: Conversions from CONCLA Correspondence Tables; Data from IBGE; Trade Data: UN Comtrade

Table 5. Brazil's Electronics-related Industrial Policies

Policy mechanism	Details
Informatics Law:	The Informatics Law of 1991 initially recognized the importance of the electronics sector and sought to incentivize local production and R&D through the use of Basic Production Processes (PPBs) and R&D investment quotas.
Local content incentives:	Firms are encouraged to manufacture in Brazil through product-specific PPBs – "the minimum group of operations, within the industrial plan, which characterizes real industrialization of a certain product" (Egypto 2012). PPBs reduce industrial product taxes (IPI) on final products from 15% to nearly zero, and suspend IPI altogether when firms purchase raw materials, intermediate products and packaging goods used in the production process. In addition to federal incentives, PPBs allow for a reduction in ICMS (state VAT) in many states (Apex Brasil 2012). They can be claimed for production carried out in any area of the country (aside from the Manaus Free Trade Zone, which is governed by a different set of laws). PPBs are product, not company specific; only those products meeting the PPB's criteria receive benefits. They are defined and monitored by the Ministry of Science, Technology and Innovation (MCTI) and Ministry of Development, Industry and Foreign Trade (MDIC). PPBs set 'nationalization indices' that define how much of the incentivized product must be local in content in order to retain the incentives offered. For example, the PPB for computer tablets in 2012 set the nationalization index at 30%; the stated objective is to raise the nationalization index to 80% by 2014. The PPB goes below the aggregate product to develop it nationalization index. What does it mean for a tablet to be 80% 'Brazilian' by 2014? According to the tablet PPB, this means that by 2014, 95% of the motherboard, 80% of the wireless communications interface, 30% of the mobile network access card, 80% of the AC/DC converter, 50% of the memory card and 50% of the display must be produced in Brazil (Positivo 2012). Therefore, the future of nationalization indices for electronics products will depend largely on the development of a local component industry, something that the Brazilian government has sought to address for the last decade.
R&D spending requirements:	In exchange for these benefits, firms must invest 4% of gross revenue from incentivized products in local R&D.[1] What constitutes R&D is largely flexible, allowing firms to pursue strategic objectives largely unhindered by government requirements. The key stipulation is that R&D must involve the discovery of a new technology or the development of new workforce capabilities, and not simply extend an existing, mature technology (Egypto 2012).
Incentives for the semiconductor industry:	The Brazilian Microelectronics Program, launched by the Ministry of Science and Technology in 1999, sought to incentivize segments of IC manufacturing by offsetting exorbitant capital requirements involved in building a foundry with the latest technological capabilities. This focus on microelectronics continued through the 'Política industrial, Tecnológica e de Comércio Exterior' (PITCE) enacted by President Lula in March, 2004. PITCE focused on developing outward-oriented software and integrated circuit industries, among various others deemed to be of strategic importance to the country. Support for the microelectronics industry has expanded since then with the enactment of the Brazilian Program for the Development of the Semiconductor and Display Industry (PADIS) in 2007, a program was designed to develop local semiconductor and display industries by targeting companies investing in R&D and manufacturing capabilities in Brazil (Sales 2012). It has continued to be a focus of the country's broad industrial policies like the 'Productive Development Policy' (PDP) between 2008 and 2010 and 'Plano Brasil Maior,' which was enacted by President Rousseff in 2011 and will run through 2014 (Apex Brasil 2012).
Plano Tecnologia da Informação TI Maior:	Software is the fastest growing IT market segment in Brazil at 16% compound annual growth rate (CAGR) between 2011-2015 (Business Monitor International 2012); the market itself is worth $5.5 billion according to the MCTI. With the value of software increasing relative to the value of hardware, the government is creating policies to foster growth in this node of the electronics GVC. Brazil has long had a viable cluster of software SMEs. Plano TI Maior is the most recent attempt to scale these firms up, the majority of which remain small and unable to compete outside Brazil. Plano TI Maior seeks to leverage Brazil's existing base of firms and capabilities as well as the world's 7th largest IT market to foster local industry growth. The most important component of Plano TI Maior is CTENIC, an equivalent of the PPB for software. This certification is currently under development and will define what constitutes 'Brazilian software.' When developed, CTENIC will create opportunities for preferential procurement if firms develop software locally. Explicit efforts to bolster software development in Brazil are important, as software developers cost considerably more in Brazil than they do in China and India.

Table 6. Top Global EMS and ODM contract manufacturers in 2011

Rank	Company	Primary Business Model	Ownership	2011 Revenues (US$M)	Manufacturing Facilities in Brazil?
1	Foxconn Electronics	EMS	Taiwan	$93,100	Yes (4*)
2	Quanta Computer	ODM	Taiwan	$35,721	No
3	Compal Electronics	ODM	Taiwan	$28,171	Yes (1)
4	Flextronics	EMS	U.S & Singapore	$27,450	Yes (3)
5	Winstron	ODM	Taiwan	$19,538	No
6	Jabil Circuit	EMS	U.S.	$16,760	Yes (2)
7	Inventec Corp	ODM	Taiwan	$12,696	No
8	Pegatron Corp.	ODM	Taiwan	$12,418	No
9	Celestica	EMS	Canada	$7,210	No
10	Sanmina SCI	EMS	U.S.	$6,040	Yes (1)
11	Cal-Comp Electronics	ODM	Thailand	$4,469	No
12	Lite-On IT Corp	ODM	Taiwan	$4,125	No
*Foxconn agreed to open 5th plant in Sao Paulo in 2014, will reach full capacity and employ 10,000 in 2016					

Source: The Circuits Assembly, Top 50 EMS Companies 2011; Company Annual Reports, Bloomberg Businessweek