TROUBLE IN THE MAKING?
THE FUTURE OF MANUFACTURING-LED DEVELOPMENT

Concept Note

Overarching message and structure of the report[1]

Changes in globalization patterns and new technologies are raising concerns that manufacturing export-led growth may no longer be as feasible a development strategy as before. Trade is slowing. GVCs are maturing. Support for expanding international trade agreements is waning as more protectionist approaches are being considered in some larger economies. With the expansion of ICT, automation, robotics and AI, the requirements for locations to be attractive sites for manufacturing are rising. This has implications not only for cutting edge innovation or the production of new advanced manufactured goods – it is likely to affect the ability to *use* many of the new process related technologies, including in the production of traditional manufactured goods. Much of the debate around new technology has focused on high income countries, but if low labor costs decline in importance as a source of comparative advantage, developing countries will need to broaden their development strategies. This involves a shift in thinking about what makes activities desirable and how to enable more people to move into them. Whereas scale economies, tradability, and being the primary driver of innovation and technological diffusion were traditionally associated with manufacturing, these are increasingly features of more services. With the pace of technological diffusion accelerating, the importance of improving the enabling environment and supporting capabilities of firms and workers is also rising to ensure future prosperity is shared.

The first part of the report looks at historical and recent trends in manufacturing. It looks at the contributions of export-led manufacturing to economic growth, how technology (manufacturing 3.0) spurred the fragmentation of production and the creation of global value chains, the rise of China as the 'world's factory' and the recent patterns of de-industrialization in many developing countries. The second part then looks at possible future trends based on how new technologies may shift the sources of comparative advantage, and how increases in demand for customization and speed, the maturing of GVCs, as well as agglomeration externalities in the ecosystem of certain subsectors will affect the location of production. While any forward looking discussion is inherently speculative, the aim is to identify possible challenges and opportunities for developing countries so as to help them position themselves now. The last section then looks at the policy agenda and how policy recommendations regarding innovation, regulatory reform, trade and targeted approaches to industrial competitiveness could be informed by changes in technology and globalization.

[1] This work originally began under DECPG (Philip Schellekens TTL), with T&C invited to be the partner GP (Mary Hallward-Driemeier, coTTL). While DEC has decided not to launch a new flagship series, T&C is keen to bring this work forward and to publish a report on a topic of keen interest to our clients. This concept note builds on the DECPG-T&C partnership; the contributions of the earlier team, its draft concept note, initial consultations and background papers are gratefully acknowledged.

I. MANUFACTURING AND DEVELOPMENT: HISTORICAL CONTEXT AND RECENT TRENDS

1. **The first chapter will focus on three questions:**

- First, over long periods of time and across space, what has been the historical relationship between manufacturing and economic development?
- Second, how has the global manufacturing landscape changed due to changes in technology (e.g. expansion of ICT) and globalization (e.g. evolution of GVCs, China's entry to the WTO), especially with regard to the period between 1990 and 2015?
- Third, why pay particular attention to manufacturing: what are the characteristics traditionally associated with different types of manufacturing that can have pro-development impacts – and are they now being seen in other sectors?

2. **Manufacturing-led development – the hitherto dominant development paradigm – has been associated with some of the biggest development gains in history.** [2] Technological change, driven by the steam revolution, and the resulting decline in trade costs spurred the Industrial Revolution from the late-1700s to the mid-1800s, led to a significant boost in growth among early industrializers.[3] The earliest industrializers in Western Europe and the United States registered rapid rates of per capita income growth of 1.0 and 1.3 percent over the period 1820−1870, compared with close to zero in other regions such as East Asia and Latin America (Figure 1). It was industrialization again that drove the catch-up of fast followers to the early industrializers. Starting in the late 19th century in Japan and then spreading to other parts of East Asia during the 1960s and more recently China, the adoption of manufacturing technologies and embrace of globalization helped spur economic growth and convergence. China, Republic of Korea and Thailand experienced high rates of per capita income growth between 1970 and 2010, which coincided with a significant increase in the share of manufacturing in employment and value-added (Figure 2).

3. **Not all countries benefited equally from industrialization, but most countries that reached high-income levels did so through manufacturing export-led strategies.** Economic history demonstrates that, by and large, "industrialized" continues to signify "rich." Those that led the Industrial Revolution are now among the richest economies in the world and the "East Asian miracle" provide a more recent example of the success of the manufacturing-export-led model.[4] Yet, not all countries that attempted industrialization were successful in climbing up the income ladder. Efforts to industrialize without openness, for example through import-substitution, led to many costly failures. Some countries saw progress stall after a transitory pick-up of economic growth, such as in Latin America (Agenor and Canuto 2015). Others, such as in Africa, never managed to break into manufacturing production by taking

[2] In what follows, the term "industrialization" refers to manufacturing only.

[3] Data for this paragraph is based on the Madison project (Bolt and van Zanden 2013).

[4] See World Bank 1993; Rodrik 1994; Leipziger 1997; Stiglitz and Yusuf 2001; Quibria 2002.

advantage of global value chains. There are only a few examples of countries that reached high-income levels without developing a manufacturing base – either through natural resource extraction or the exploitation of specific locational or other advantages.

4. **More recently, the ICT revolution and trade liberalization helped spur global production fragmentation, thereby creating new opportunities for manufacturing export-led growth.** The ICT revolution in the 1990s (Figure 3) enabled the fragmentation of production in global value chains (GVCs). This meant that developing countries, owing to the availability of low-cost labor, could become centers of manufacturing production by specializing in labor-intensive parts of the value chain. The integration of developing countries into GVCs and the spread of FDI was also associated with some dramatic reductions in tariff barriers which enabled the import of key intermediate inputs from abroad. Many countries in Latin America and the Caribbean, Africa, and Asia implemented a wide set of reforms including unilateral tariff reductions (Figure 4). Further, the transfer of technology, knowledge and ideas from lead firms in advanced economies to GVC participant firms in developing countries increased the productivity of the latter. In fact, this diffusion of ideas enabled late industrializers to grow more rapidly because it took other countries, such as the Republic of Korea, decades to develop these capabilities domestically (Baldwin 2011).[5] This perspective suggests that foreign direct investment (FDI) has played a key role on promoting income convergence between countries.

5. **These changes in comparative advantage combined with labor-saving technological change may have also had sizeable, but diverse, effects on labor outcomes**. These effects are translated in terms of the number of jobs created across workers with different skills, as well as their relative earnings, i.e. wage skill premia, consequently affecting income inequality within countries (Acemoglu, 2003; Cruz and Milet, 2017). In addition to the transfer of technologies and management practices to local firms in developing countries, deeper global integration through trade and FDI links have created high-paid jobs, notably by creating backward and forward linkages (Gorg and Strobl 2001, Javorcik 2015). At the same time, new labor-saving technologies have typically come to developing countries from advanced economies through trade and FDI largely in the manufacturing sector, thereby highlighting the transfer of skill-biased technical change. Compared to the acquisition of existing assets (M&A), Greenfield FDI – which primarily entails investment in new capital assets – is more likely to play a key role in job creation (Calderon, Loyaza, and Serven, 2004).

6. **Over time, however, global production fragmentation has also coincided with the geographical concentration of manufacturing activity among a handful of countries.** High-income countries show a relatively stable share of the manufacturing sector in value-

[5] It is worth noting that the production of manufactured goods typically represents a very small share of total value added in many GVCs, much of which is accounted for by upstream and downstream services.

added between 1970 and 2014 (Figure 5). [6] When taking into consideration global manufacturing value added, however, it is observed that present day advanced economies, such as the USA and those in Western Europe, experienced a decline in their share. This change is mostly explained by an increase in the share of value-added by Asian countries; the case of China is particularly noteworthy, having moved from less than 1% in 1980 to about 20% of global manufacturing in 2014 (Figure 6). This reflects the rise in competitiveness of Chinese firms attributable, at least in part, to changes in the business environment, China's accession to the WTO in 2001, and the attraction for MNCs of locating close to such a large and growing market. Consistent with the shift of production, the number of jobs in manufacturing sector globally are also increasingly concentrated in export driven Asian economies (Figure 7).

7. **The growing importance of Asia, particularly China, in global manufacturing has likely affected the comparative advantage of other countries.** Empirical evidence suggests that the rapid expansion of Asian economies in global manufacturing has had important effects on patterns of specialization, innovation, productivity, and employment across countries (David, Dorn, and Hanson, 2013, Bloom, Daca, and Van Reenen 2016, Hanson and Robertson, 2008). For example, the vast expansion of China's exports in low-skilled labor-intensive manufactures, owing to its size and distinctive endowment structure, market reforms, and accession to the WTO in 2001, has likely affected the comparative advantage of other countries – towards /resource-intensive primary production in developing countries and skill-intensive manufacturing/services in developed countries. For developing countries, this is likely to be a key influence on their industrialization prospects and their capacity to converge towards high-income countries (Romer 1990).

8. **Many developing countries are, in fact, experiencing premature de-industrialization.** The share of manufacturing employment and value added appears to be peaking at earlier levels of per capita income than in the past (Figure 8, Dasgupta and Singh 2007, Rodrik 2016). Asian countries have been largely insulated from these trends, while Latin American countries have been especially hard hit. This "premature deindustrialization" may have been driven by the fact that manufacturing output and employment saw a discernible shift towards Asia, starting in the 1990s. The commodity boom triggered by industrialization in these countries helped fuel growth for commodity exporters, but also dampened their manufacturing competitiveness. Therefore, many resource-abundant developing countries experienced a decline in the share of manufacturing in GDP as a result of both competitive pressures and the commodity pull. Last, but not least, premature deindustrialization may also reflect the fact that service activities that were earlier subsumed in manufacturing value added were subsequently accounted for as service sector contributions to GDP due to manufacturing firms had become more specialized in their core activity.

[6] The share of value-added is a function of factors allocated in the sector, but also prices. Therefore, even if manufacturing becomes more efficient in the use of factors (e.g. labor), the introduction of new and more expensive products can lead to some stability on the contribution of value-added.

9. **This is potentially of concern because the manufacturing sector has traditionally been associated with higher productivity compared to other sectors.** The manufacturing sector is typically more productive than other sectors of the economy[7] because it produces tradable goods, facilitating scale economies, technology diffusion, greater competition and other spillover effects (Rodrik 2015). At the same time, it can first absorb a substantial part of the economy's low-skilled labor[8] and thereafter place the labor it employs on a productivity path that rises up to the global frontier (Bartel and Sicherman 1998) owing these pro-development characteristics that enable 'learning-by-doing'.[9] Therefore, the association between high rates of economic growth and the increasing share of manufacturing in value added and employment may reflect (a) higher relative productivity growth in manufacturing and/or (b) a reallocation of resources from other sectors to manufacturing, which can be an additional source of productivity growth even in the absence of any productivity growth within sectors.

10. **At the same time, the features of manufacturing that were once thought of as uniquely special for development might be increasingly shared by other sectors, especially in services.** Manufacturing is not monolithic and its development contribution differs significantly across industries and firms. The boundaries between sectors are becoming blurrier. Other activities can share the same attributes that made manufacturing a powerful vehicle for development. Currently, a globally competitive agri-business sector involves a complex system of innovation, the use of technologies such as ICT and the need for efficient logistics and marketing services for delivering just-in-time production (Yonazi et al. 2012; Deichmann, Goyal, and Mishra 2016). Similarly, the assertion that productivity improvements in services are harder to achieve than in manufacturing may no longer be true for certain service activities. For example, large firms in the service sector, such as Google, Facebook, Alibaba, and Uber, demonstrate attributes such as the development, diffusion and use of technology, scale economies, international tradability and spillover effects across firms and sectors.

11. **Yet, the potential of the services sector to absorb unskilled labor and then place it on a high productivity trajectory may be limited by countries' endowments.** Evidence suggests that countries starting from lower labor productivity in the service sector grew faster than those with higher initial labor productivity in that sector (Kinfemichael and Morshed 2016). This relates to the fact that new ICT technologies, international tradability and increased competition, especially since the 1990s, were no longer within the exclusive domain of manufacturing. Yet, this 'catch-up' growth may be less relevant for unskilled workers who cannot be absorbed by high-end service activities – finance, information technology, accounting and legal services –without substantial investment of time and resources. In other words, without sufficient human capital, there are limits to how much labor can be absorbed in

[7] Manufacturing firms are, on average, more productive than firms in other sectors (Enterprise Surveys 2016).

[8] This is important for developing economies which have rapidly growing low-skilled working-age populations moving from rural to urban areas (Liwen, Zeng, and Yumei, 2011).

[9] Manufacturing industries tend to exhibit unconditional convergence in labor productivity (Rodrik, 2013).

highly skill-intensive service sectors. At the lower-end, evidence from India suggests that similar workers[10] earn less in wholesale and retail trade, hotels and restaurants, transport and community and personal services compared to industry (Nayyar 2011). Similarly, a Brookings Report shows that lower-wage workers in manufacturing earn about 11 percent more than their peers in other sectors, while high-wage workers earn just 4 percent more. There is also the question of the extent to which many high-end services can growth without a manufacturing core.

Background work/methodology

12. **The historical relationship between manufacturing and development will be assessed through a review of the literature.** This includes the well-established literature on structural change based on the experience of now advanced economies (Kaldor 1966, Baumol 1967, Clark 1960, Kuznets 1971) as well as more recent evidence on the 'specialness' of manufacturing as reflected in unconditional convergence of the sector's labor productivity across countries (Rodrik 2013). Another relevant strand of the literature highlights the discussion on productivity differences between sectors and the decomposition labor productivity growth in order to identify the contribution of gains within sectors versus those associated with workers moving from low-productivity to high-productivity sectors (McMillan, Rodrik, and Verduzco-Gallo 2014).

13. **The evolving global manufacturing landscape will be documented by a range of descriptive statistics and further statistical analysis.** This includes the analysis of how the manufacturing sector's absolute size, share in total value added and employment within countries, and the share in global value added and employment has changed over time for different countries and regions. The analysis will then be extended for different manufacturing industries.[11] This differentiation across industries and countries will also be explored in terms of FDI patterns. The same holds true for trends in exports, where the chapter will analyze domestic value added in gross exports to provide a more accurate description of trade in tasks. There is the possibility to further assess manufacturing export performance and the product space by adapting measures of 'complexity' based on the MIT Atlas of Product Complexity to use data on domestic value added in exports rather than gross exports.

14. **The chapter will also provide empirical evidence on the effects of China's global integration on patterns of specialization in manufacturing.** Empirical evidence suggests that China's opening lowered the share of labor-intensive manufacturing in the sum of labor-intensive manufacturing and primary output in other developing countries (Wood and Mayer 2011). Other studies suggest that countries with higher initial education levels experienced faster value-added and employment growth in schooling intensive manufacturing industries

[10] Controlling for range of relevant worker characteristics

[11] Manufacturing value added, disaggregated by sub-sector/industry, based on the UNIDO Industrial Statistics Database at the 4-digit level of ISIC. The database contains highly disaggregated data on the manufacturing sector for the period 1990 onwards.

during the 1980s and 1990s. The analysis will follow the empirical methodology in Ciccone and Papaioannou (2009) to identify the effects of competition with China on the relationship between factors of production (e.g. labor and human capital) and specialization of manufacturing, based on jobs, value-added, productivity, and exports. There is a two-step identification strategy – the identification of sectors that are more skill-intensive, and subsequently the analysis of whether countries with high initial education levels grew faster in schooling-intensive manufacturing sectors given China's deeper global integration in the early 2000s.

15. **Further, the chapter will extend the literature on premature industrialization.** In his analysis of premature deindustrialization, Rodrik (2016) gauges the effects of common shocks felt by the manufacturing sector in each of the time periods since the 1960s by introducing time dummies for each decade. We will first update this analysis to include the latest available data and then explore whether a number of possible covariates can explain away the statistical significance of the decadal time dummies. These covariates include the share of working age population, education, trade, competition with China, ICT etc.[12] Further, the importance of increased 'contracting out' from manufacturing to services as a contributing factor to 'premature deindustrialization' will be assessed through an accounting exercise that decomposes the growth of services value added into changes in intermediate demand[13] based on national "use" (input-output) tables for over 40 countries included in the World Input-Output Database (WIOD).[14]

16. **In addition, the chapter will analyze the effects of greenfield FDI across the manufacturing and service sectors on labor market outcomes.** The analysis aims to compare manufacturing FDI versus services FDI and analyze their effects on productivity and labor market outcomes. Although the effects of FDI on income inequality has been widely studied, this analysis will attempt to understand the heterogeneous association of FDI across different sectors with inequality between and within countries. First, it explores the association between growth in GDP per capita (and productivity) across countries and cumulative FDI flows between 2003 and 2013. Second, it analyzes the effects of FDI on within country income inequality through returns to education.[15]

[12] This exercise will use data from Groningen Growth and Development Centre (GGDC) 10-Sector Database, UN Population Projections (2015), Barro and Lee (2013), Industrial Development Organization (INDSTAT), harmonized household and labor-force surveys from the International Income Distribution Database (I2D2), and UN from WITS.

[13] The change in the input usage of services in agriculture, the change in agriculture value added given the initial input usage of services in agriculture, the change in the input usage of services in industry, the change in industry value added given the initial input usage of services in industry, the change in the input usage of services in services, the change in services value added given the initial input usage of services in services. The residual therefore corresponds to final consumption.

[14] It contains data for 35 ISIC industries, including agriculture, mining, construction, utilities, 14 manufacturing industries, and 17 services industries.

[15] This exercise will use several data sources. It combines data from the World Bank's International Income Distribution Data Set (I2D2) which contains harmonized household and labor surveys, with data on trade flows

17. **In order to explore the heterogeneity within the manufacturing and service sectors, the chapter will develop a typology with reference to a set of pro-development characteristics.** This includes scale economies (share of large firms), on-the-job learning (share of firms with formal training programs), tradability (direct exports-to-sales ratio), linkage effects (indirect exports-to-sales ratio), labor intensity (employment elasticity of output), capital intensity (capital expenditure per employee), skill intensity (years of schooling), innovation (the share of firms that introduce new products, use new methods of production and contribute to R&D spending), technology diffusion (share of firms that use a licensed technology from a foreign-owned firm) etc.[16] The statistical analysis will be based on the (latest available) World Bank Enterprise Survey for Brazil, China, India, Russia, China and Egypt as these countries have the survey representative at most disaggregated industry level.[17] In doing so, it will categorize each of these industries as 'low', 'medium' or 'high' along the entire range of attributes considered.[18]

II. Manufacturing and Development: The Changing Landscape

18. **The second chapter then shifts gears and looks forward, exploring what the implications of changing technology and globalization could be in shifting the sources of comparative advantage for production.** The first section will examine what the trends could be, with the second then looking at their implications in terms of challenges and opportunities for developing countries in terms of the geography and job intensity of production. It will address the following questions:

a. What are the key trends in technology and globalization that will likely affect the manufacturing landscape over the medium to long term? How do they interact with other global trends (e.g. demography, urbanization, climate change)?
b. How are these trends affecting the geography of production and its labor intensity?
c. How will differences across sub-sectors and country capabilities affect the prospects of manufacturing led development?

19. **Given their past importance, trends in technology and globalization are likely to be key trends that will profoundly affect the future of manufacturing.** Technology and globalization have been the basis of the expansion of manufacturing activity over time and

---

and trade policies from World Integrated Trade Solution (WITS), data on value-added an productivity from Penn World Tables (PWT), and data on FDI projects from fDi Intelligence. The identification strategy relies on variation in Greenfield FDI across sectors within the same location

[16] It should be recognized that there may be military strategic interests in having some domestic manufacturing capabilities too.

[17] (i) basic metals & metal products (ii) fabricated metal products (iii) non-metallic mineral products (iv) food (v) wood products (vi) plastics and rubber products (vii) leather products (viii) garments and textiles (ix) furniture (x) chemicals and chemical products (xi) electronics and communications equipment (xii) machinery and equipment (xiii) motor vehicles (xiv) construction (xv) hotels and restaurants (xvi) IT Services (xvii) wholesale and retail (xviii) services of motor vehicles (xix) transport and communications.

[18] The methodology follows Nayyar (2013). The McKinsey Global Institute (2016) also developed a similar typology, but it analyzes industries only within manufacturing and based (almost) exclusively on the United States.

across space. Yet, as will have been documented in Chapter 1, these two factors have recently contributed to a slowing pace of structural change and industrialization as well as even de-industrialization in many developing countries. Looking ahead, the technology and globalization trends themselves are expected to be subject to considerable change. A key question will be whether trends in technology and globalization will further weaken the industrialization prospects across a broad range of developing countries or whether they will create new potential to boost manufacturing output and exports and leverage them for growth.

20. **Emerging *technologies* and their increasing rates of adoption are creating new product lines and transforming manufacturing processes.** Technological advances are provoking a new Industrial Revolution through the integration of cyber, physical and bio systems (OECD 2016a, WEF 2016, UNIDO 2016). Their impact is felt in the creation of new product lines, such as in smart connected products (product Internet of Things—IoT), wearable tech, autonomous vehicles, bio-chips and -sensors, advanced energy storage technologies and new materials. Importantly, the impact is also felt through improved processes through greater efficiency, quality, and customizability of the manufacturing process, such as through industrial automation and advanced robotics, digitalization and internet-based systems integration (factory IoT) and additive manufacturing (3D printing). While not all these technologies are new (robots and 3D printing have been around for decades and IoT builds on ICT legacy technologies), cost innovation, software advances, and evolving business formats and consumer preferences are fueling adoption. The use of these new technologies, not only in advanced goods but also in the production of more traditional manufactured goods, could have significant impact in shifting which locations are attractive for production.

21. **The new technologies are being rolled out in an evolving global setting, with the pace of *globalization* taking a turn that may affect the prospects of export-led manufacturing.** Globalization, as manifested through freer cross-border flows in trade, capital, and ideas and the concomitant growth of global value chains (GVCs), has been an important driver of export-led manufacturing. Yet, the pace of globalization appears to be slowing. Following decades of rapid growth, diminishing returns have likely set in with global supply chains having reached a stage of maturity (Constantinescu, Mattoo, and Ruta 2015; Ferrantino and Taglioni 2014). Moreover, protectionist forces are on the rise among a wide range of countries seeking to either re-industrialize, upgrade or industrialize their economies and manufacturing sectors. Autonomous technological forces and the global search for efficiency, market potential and resource availability are supportive factors in this respect.

22. **The future manufacturing landscape will be influenced by many other trends, including demographic change, urbanization and climate change.** Developing economies will be responsible for much of the growth of the global labor supply in coming years, potentially improving their comparative advantage in labor-intensive manufacturing production (World Bank 2015a). Urbanization, which is proceeding rapidly in many developing countries could also boost manufacturing demand - and through agglomeration and localization effects could foster more production (Beeson 1987; Morosini 2004). Perhaps more importantly, greater urbanization can foster the exchange of ideas and attract talent since

centers of innovation tend to be urban areas (Malmberg and Maskell 2002; Padmore and Gibson 1998). However, urbanization is also raising a challenge, particularly in Africa and South Asia, where it is occurring at lower levels of income and without the same low-skilled manufacturing jobs available to absorb the growth labor force. Currently, many are employed in low productivity services, in some cases having structural change being associated with lower productivity. The labor dimension is the priority for many policy makers in these countries (World Bank, 2012). Finally, climate policy, like the Paris Agreement, will create incentives to produce new and different technologies and manufactured goods (World Bank 2010 and 2015b).

23. **These other trends are likely to underpin continued strong *global demand for manufactured goods.*** During the course of the 20th century, per capita material consumption in the U.S. rose from 1.9 tons to 12 tons. The per capita consumption of material products mostly produced by the manufacturing sector is lower in middle-income economies and far less in low-income ones. Thus we can expect a volume boost on the demand side as developing country populations expand and urbanize, incomes rise and material standards of living continue to converge (Kharas 2010; WEF 2012). Markets for lower quality lower priced manufacturing goods are also likely to remain for years to come; markets that are less susceptible to be replaced by higher end manufactured goods or to be made in smart factories. Local and regional markets, rather than global markets, may be feasible for more lower-income production locations. This should mitigate the medium-term concerns about secular stagnation and flagging productivity growth, especially in the high-income economies. Yet, there are likely to be broad changes in what the manufacturing goods demanded will be. Aging populations, growing middle classes and urbanizing populations will demand different types of goods, while the sharing economy and higher environmental standards may reduce the demand for certain goods. For this report, while it will raise the potential shifts in the composition of demand, the focus is on how the production of manufacturing is likely to be affected.

The Impact on the Geography of Production and Job-Creation Capacity

24. **Even if demand is upheld at the global level, how will the *geography of production* be affected by the technology and globalization trends?** Export-oriented labor-intensive manufacturing activity may well be less easily accessible for developing countries, although local markets for lower quality and low priced goods may remain. At the higher end, some firms may bring historically labor-intensive activities back to advanced economies ("re-shoring") or to adjacent countries ("near-shoring") either in response to technological trends making "re-localization" feasible, in response to increased demand for quick turnaround customized goods or trade policy trends resulting in "de-globalization". At the same time, Chinese manufacturers are increasingly turning to automation as a response to dealing with rising wage pressures (Figure 2b; Standard Chartered Global Research 2016). For example, the Taiwanese firm Foxconn recently replaced 60,000 factory workers with industrial robots in its Chinese factories (South China Morning Post 2015). China is expected to have more

installed industrial robots than any country in the world by 2018, with a third of the global total (IFR 2015). These recent trends suggest that while some light manufacturing activities may have migrated from China to developing countries with lower labor costs in the past[19], additional activities may not necessarily do so in the future.

25. **The geography of production is also being affected by the changes in what it takes for locations to be competitive in the global market place.** Manufacturing is becoming more services-intensive, provoking a value-added shift from production to services. Given shifting consumer preferences to speed and customization, the traditional manufacturing model of mass production is giving way to production lines that favor mass customization or shorter tailored production runs—both requiring enhanced flexibility afforded by advanced design for manufacturing and assembly and supported by superior logistics. Cheap labor cost as a source of competitive advantage is also giving way to more demanding requirements in terms of skills (shifts from operators to engineers) and the supporting eco-system (for example, backbone infrastructure for IoT and the density of the supply base). And it important to keep in mind that low wages in themselves are not sufficient, even for traditional manufacturing for local markets, when they are more than offset by other costs in the business environment, as remains the case in many Sub-Saharan and South Asian countries.

26. **Technological advances have raised concerns about the *job creation* capacity of manufacturing and the potential wide-scale displacement of workers by new technologies** – an expression referred to as technological unemployment (Mokyr Vickers, and Ziebarth 2015; Bessen 2016; Acemoglu and Restrepo 2016). Such concerns date back as far as to the Industrial Revolution; yet, two centuries of automation and technological progress have not made human labor obsolete. Several explanations offer themselves. The faster growth and job-creating effect of technological change has proven to be greater than any labor displacement effect. Automation of some tasks for some occupations have improved productivity, lowering output prices and boosting product and labor demand (Bessen 2015, 2016). Technological change in the past has also led to the creation of new occupations.

27. **While there will be new opportunities, the current episode of technological change may nevertheless be associated with significant disruptions and dislocations.** Emerging technologies in such areas as artificial intelligence, mobile robotics and smart factories are inherently strongly labor-saving by nature in that they are increasingly able to replace cognitive, non-routine tasks that could previously only be done by people (Autor, Levy, and Murnane 2003). In contrast, earlier technologies could only replace workers doing tasks that were routine and could be codified. Emerging technologies also tend to diffuse and be adopted more rapidly than technologies had in the past (Comin and Hobijn 2010; Brynjolfsson and McAfee (2011, 2014). As a result, an increasing body of evidence suggests that automation has led to job polarization in both advanced and developing economies, with the tasks in the

[19] It is argued that China is on the verge of graduating from low skilled manufacturing jobs, which can free up nearly 100 million labor-intensive manufacturing jobs, enough to more than quadruple manufacturing employment in low-income countries (Lin 2012).

middle of the skills spectrum most affected (Acemoglu and Autor 2011; World Bank 2016).[20] In addition, job creation in developing countries may be hampered if such countries were less able to take part in the manufacturing of the future causing a decline in the derived demand.

Differentiating the Impact: Manufacturing Subsectors, Country Capabilities and Activities Beyond Manufacturing

28. **The manufacturing sector is not monolithic and therefore the impact will also differ according to *manufacturing subsectors* that require different levels of capability**. Pharma, bio-tech and nano-tech are typically basic research-intensive manufactures conducted in advanced, urban, knowledge-intensive settings. Fashion garments and accessories, leather goods, cosmetics, jewelry and some food products are design-intensive, typically produced in small batches on short cycles and requiring proximity to consumer markets. Auto, aircraft, and space satellite industries and producers of heavy machinery are ecosystem-intensive, requiring closely-clustered suppliers that can provide inputs on just-in-time basis and work on enhancing technology with lead firms. Semiconductors, microprocessors and PV modules require reliable energy and water supplies and access to excellent transport services in order to bring materials in and to ship high value items out. Garments, footwear, light consumer electronics and household goods require labor-intensive assembly on a large scale and has been slow to automate.[21] Finally, there is the manufacturing that produces: construction materials that are bulky to transport or need to be produced close to construction sites; and chemicals needed by the agricultural sector and food processing industries for example – these are fairly capital- and energy-intensive and tend to be found everywhere. The chapter will look at how changes in technology and global production patterns are likely to vary across these different sub-sectors in their impacts.

29. **The impact of the changing development landscape needs to be differentiated according to *country capabilities*.** Looking ahead, only industries in the last category (e.g. construction materials and chemicals) are likely to remain widely dispersed. All the others are being or will be affected by automation, increasing skill and research intensity, displacement of semi and unskilled workers, servicification, and declining costs of transport. The winners could be the advanced countries (through onshoring) and middle-income manufacturers that have been early movers and have deepened skills and research capabilities, created urban eco-systems, begun building the services sector and have invested substantially in state of the art infrastructure. Should globalization and current technology trends persist, manufacturing could become more concentrated in advanced and upper-middle-income countries with knowledge-intensive metro regions enjoying agglomeration economies. If globalization goes into reverse, trade barriers sprout, and the pace of automation and the evolution of AI slows to a crawl, then the dispersion of manufacturing could continue however, in that sort of world, while GVCs would also start to atrophy.

[20] Alternatively, Maloney and Molina (2016) suggest that there is not strong evidence for polarization in less developed countries yet.

[21] However, global garments value chain is changing with slowing growth in the advanced countries, rising South-South trade, shifts in consumer demand, turnover of producers, and the efforts by lead firms to optimize their supply chains so as to improve service, and minimize costs and risks (Yusuf 2012).

30. **The impacts on manufacturing spill over to other sectors too.** The increasing servicification of manufacturing underscores both the importance of stronger service sectors to achieve manufacturing performance – as well as the service sector offering expanding opportunities itself as a source of productivity growth and jobs. Improving the ICT sector deserves special recognition as it underlies many of the process innovations and can itself be a source of new jobs and products. Agro-processing is likely to grow with increased urbanization and growing middle classes. There is significant scope for new technology to improve the efficiency of production here too, although in this case there is more likelihood of job destruction as labor-intensive work is mechanized.

Background Work and Methodology

31. **Chapter 2 will analyze the changing manufacturing landscape for development in three parts: trends, pathways and impacts**. First, it will identify how changes in the technological environment and changes to the patterns and pace of globalization are likely to affect the future of the manufacturing landscape. Other possible drivers will be discussed as well, although with less detail, as will the interaction between the various trends. Second, it will discuss the opportunities and challenges facing developing countries based on how these trends could affect the geography of production and the accompanying job dynamics. Third, it will bring together the identified trends and individual pathways and analyze how development outcomes may be impacted. Such analysis will be conducted under the assumption of a business-as-usual baseline, which will lay the foundation for the next chapter's discussion of institutional changes and policy adjustments that may be warranted in response.

32. **On the technology and globalization trends, the Chapter will bring a number of inputs.** It will develop a taxonomy to characterize the space of emerging technologies with reference to their potential impact on product lines and process improvements. Drawing on recent work in T&C on GVCs, ecommerce, FDI and the impact of trade agreements, it will characterize recent trends in globalization, highlighting the maturation of global value chains and the rise in protectionist forces, while also pointing out the untapped potential for further globalization.

33. **The geographical distribution of production and the capacity of the manufacturing sector to generate jobs will have a deeper analysis of China, the country with the largest global share of manufacturing value added.** Case studies are being planned on the automation efforts in China together with analysis of the evolution of unit labor costs in China relative to other countries. The extent to which new FDI and exports is shifting across manufacturing sub-sectors will also be examined, particularly the extent to which there is evidence that China is shedding lower value added goods. On labor market aspects, evidence of labor market polarization will be presented, examining whether the pace of skill-biased technical change exceeds the pace of skilled labor supply growth (and thus whether skill premia are likely to rise) – a new manifestation of the Tinbergen race between technology and education. In addition, breaking down occupations into tasks with varying levels of automatability, the approach of Arnzt, Gregory and Zierahn (2016) applied to OECD

economies will be extended to cover a broader set of economies to assess the threat of automation.

34. **On the analysis of the eventual development impact, the Chapter will provide illustrative CGE scenarios differentiated across countries and subsectors.** Understanding the impact of emerging technologies in manufacturing in developing economies is complicated by deep uncertainty in their trends and interactions. Deep uncertainty is when neither the states of the world nor their probabilities of occurring are known (Walker, Lempert, and Kwakkel 2013; Kalras et al. 2014). To address this deep uncertainty, the Chapter uses a scenario analysis approach to consider several stylized scenarios that illustrate the possible impact of some emerging technologies on manufacturing ad growth in developing countries. Scenario analysis allows for a way to examine the impacts of possible emerging outcomes without necessarily attributing probabilities to them. The scenarios will range from: one extreme where technological changes diffuse rapidly and are highly labor-saving even as the barriers to trade, capital flows and migration become much lower, to another extreme where technological change and diffusion is less rapid even as the world becomes less open.

III. FORWARD-LOOKING POLICY AGENDA

35. **The third chapter will look at how these potential trends in technology and globalization should inform the policy agenda for competitiveness.** It will differentiate where applicable the implications for countries that do not have a substantial manufacturing base to date and those – primarily middle-income countries – that have revealed comparative advantage in certain segments of the manufacturing sector. The chapter will address the following questions:

- Is the bar rising for locations to be attractive for production – not only for innovation and the production of advanced manufacturing goods, but also for the production of traditional goods, including through the use of new technologies? If so, what is the appropriate policy response?
- Does development strategy need to look beyond just manufacturing to focus on improving productivity and moving towards higher-productivity activities, wherever those might be?
- While much of the attention around emerging technologies and changing patterns of globalization has focused on the potential disruptions, what is the scope for countries to prepare to take advantage of new opportunities?

Requirements for locations to be attractive for production

36. **The "bar" for establishing or maintaining competitiveness in global manufacturing will likely be higher in the future for countries across the income spectrum.** The quality of infrastructure and logistics services, regulatory requirements, and information flow about markets are becoming increasingly important for better connectivity,

which will be key in reducing time-to-market and raising responsiveness to changing customer needs. Property rights and contract enforcement will warrant greater attention to support a production model reliant on outsourcing and highly differentiated tasks. Skill-biased technological change will raise the requirements for high-quality education to meet changing demands. The increasing 'servicification' of manufacturing will require more adaptable firms and workers. Moreover, a commitment to trade openness will remain key even in the face of disruptions due to technological change, in order to avoid efficiency costs and lost opportunities to use new goods coming from abroad.

37. **This rising bar will be relevant for the production of both advanced and traditional manufactured goods.** The rising 'policy bar' is expected not only with regard to the production of advanced manufactured goods and/or related innovations, but also in the ability to *use* the new technologies in the production of traditional manufactured goods (i.e. a smart auto parts factory; a 3D printer to make spare parts). Even using new technologies place greater demands on ICT infrastructure, intellectual property rights, protection and trade in data, and complementary services such as logistics, finance, consumer support etc.

38. **Given that the bar is rising, there is the question of whether targeted policies therefore become a more desirable and/or feasible alternative.** The chapter will discuss whether and how emerging technologies and changing patterns of globalization could inform the debates on sectoral and spatial policies. If the policy bar is rising, it may be that much more challenging to meet the requirements economy wide and zones may be seen as the only viable option. Yet, the cost of such zones may be rising if infrastructure and connectivity needs are expanding, and zones already have a mixed track record on efficiency making it all the more important to identify when they are an appropriate solution. There are also greater risks of the zone being an enclave if the gap with non-zone is larger. Further, if firms need a full ecosystem, a zone may not attract sufficient firms. For sector specific targeting, the question is whether sector specific market failures are likely to increase or decrease given the emerging trends in technology and patterns of globalization. The challenge is if change is happening all the faster, such programs may lag market realities. Policy makers also need to be realistic as to how great a technological leap is likely to be feasible. That said, particular market failures in R&D and innovation, information about standards, and coordination failures could provide legitimate grounds for interventions. In addition to identifying market failures, there is also the issue of the likelihood of successful government intervention (Maloney and Nayyar 2016) which may also be affected by the changing economic landscape.

Look beyond manufacturing and sector silos more generally

39. **Rather than focus on 'manufacturing', the attention should be on moving to higher productivity activities across sectors.** Rather than emphasize the importance of making "things", the focus should be on economic activities that convey benefits to development. In other words, as we search for ways to sustain productivity growth and job creation, the key may not lie in "what" will be produced so much as the potential of activities'

attributes to contribute to broader development processes. Addressing market failures should be the criteria for targeting policies to favor particular activities. While the manufacturing sector has traditionally been associated with pro-development externalities – scale economies, tradability, learning by doing, innovation and technology diffusion – there is a growing list of activities, including many services that exhibit them too. There may also be "pro-development features" these other sectors exhibit that manufacturing activities do not. New opportunities, for example, arise in the new services economy (zero marginal cost, network externalities, platforms for the sharing economy), even if there are also new challenges (data ownership, confidentiality and cybersecurity). Therefore, rather than taking 'structural transformation' narrowly as the movement from agriculture to manufacturing to services, the focus should be on moving to higher productivity activities, whether in the same or different sector.

40. **The increasing interdependence across sectors further emphasizes the need to look beyond sector silos.** Success in manufacturing needs supporting services. Similarly, success in agribusiness requires success in agriculture, manufacturing and services. Therefore, it makes little sense to focus on 'manufacturing' alone, even though the policy and business environment to support these other activities is also becoming more demanding.

Manage disruptions and enhance flexibility

41. **As countries adjust to the changing global economic environment, the likely disruptions and dislocations that may result will need to be managed.** Much of the attention to date has been on the potential for new technologies to be disruptive, in particular the extent to which workers can be displaced. Certainly, these pose important risks and it is appropriate to design social protection systems and safety nets to minimize the costs of adjustment and to support workers to move to new jobs. Complacency on this reform agenda is a costly option and not only in economic terms. The potential for greater polarization across and within countries has social and political risks, and policy makers will need to look closely at the impact on labor absorption and address distributional impacts.[22]

42. **At the same time, greater flexibility and an enabling environment is needed to be able to take advantage of new opportunities.** Past waves of technology have indeed brought disruption, but also new opportunities. Many new products and new types of jobs have been invented. Beyond worker protections, the agenda needs to be to provide a flexible environment to enable new businesses to start and expand. To be able to pursue new opportunities, countries need to be open to new technologies and business models, and reform and invest in supporting infrastructure and institutions. It also means that there needs to be policies to facilitate economic restructuring and the reallocation of resources (bankruptcy, capital to support new activities that have no physical collateral, new skills and the need for lifelong learning for

[22] Some also raise potential general equilibrium concerns that if there are significant job losses, will be able to afford the new goods and services? To date, disruptions of such a magnitude seem highly unlikely. But policy makers should look to ensure there is not a class of people who are excluded from job opportunities in the future.

workers, updated regulation for the new economy, a more innovation-friendly business environment, and updated social protection systems).

Background work/methodology

43. This discussion will be informed by work in the Global Units in T&C, with the focus on how the trends discussed in chapter 2 change the relative priorities among them for different types of countries as well as new policy areas that are emerging as important:

Innovation and technology diffusion

- I&E Note on Manufacturing 4.0 and its implications for national innovation systems, differentiating across country groups.
- Innovation flagship's lessons on the importance of firm capabilities in enabling firms to adopt and adapt new technologies effectively; stronger capabilities are likely to be increasingly important even as some of the new technologies provide ways of assisting with monitoring processes and targets.
- Summary of lessons on which approaches to encouraging technology adoption are most effective, including which instruments are more appropriate in different country contexts and for different types of firms.

Investment climate

- New information on the policy related drivers of FDI – both market and efficiency seeking
- Recommendations on how to foster greater firm linkages to facilitate technology diffusion
- Lessons on NQI as well as international standards and platform protocols to ensure interests of developing countries are included

Trade - including ecommerce and trade in data

- Recommendations to support further development of ecommerce and supporting rules in trade in services. In particular, lessons on ICT related policies, including data privacy and security, trade in data and localization requirements
- Recommendations for how to improve connectivity, particularly for non-hub locations

Strategy for industrial competitiveness

- Particular attention will be given to ensuring synergies with the new 'industrial competitiveness strategy"
- Insights from the diversification strategy will also be drawn on here.

- Work on agribusiness and tourism can also be featured as examples of non-manufacturing sectors with potential for many countries as a driver of growth. Key recommendations on green competitiveness will also be mentioned.

44. The work will not aim to summarize all of the recommendations in these areas, but rather to highlight how the priority, sequencing or appropriateness of recommendations may affected by potential changes in globalization and technology. Whereever possible, nuances by country typology, sector or firm characteristics will be noted.

Internal Consultations

The team has organized brainstorming sessions with IFC's Thought Leadership Group and at the IFC Manufacturing, Agribusiness and Services (MAS) Knowledge Forum. The team is also cooperating with task teams on new sources of growth in China and productivity in Brazil. In addition, the team is liaising with other teams in the Bank in connection with related research on structural change, including in the SSA and LAC Chief Economist Offices.

External Consultations

A number of external consultations have already taken place, including during a recent mission to Cambridge MA. The team gratefully acknowledges David Autor (MIT Economics), David Aitken (MIT Economics), Brian Anthony (MIT Mechanical Engineering), James Besson (Boston University Law), Jung-Hoon Chun (MIT Mechanical Engineering), Tyler Cowen (George Mason Economics), Richard Freeman (Harvard Economics), Alan Gelb (Center for Global Development), Ricardo Hausmann (Harvard Kennedy School), César Hildago (MIT Media Lab), Brad Jensen (Georgetown McDonough School), William Kirby (Harvard Business School), Josh Lerner (Harvard Business School), Justin Lin (Peking University), Andrew McAfee (MIT Initiative on the Digital Economy), John Page (Brookings), John Van Reenen (MIT Economics) and Jiang Yu (Chinese Academy of Sciences). The team has also held consultations with a number of private sector firms working on the topic of manufacturing or work in R&D in the areas of additive manufacturing and the application of new technologies to improve worker productivity, including: Deloitte, Tulip Interface, Formlabs, Samsung, NEC, Toshiba, Toray, UBS and Goldman Sachs. The team has presented at an OECD workshop with members of STI, the Development Center, Labor and Trade Departments, a KDI Conference on The 4th Industrial Revolution and the Future of Industry, and had numerous consultations with academics, think tanks and government agencies in Tokyo, Singapore, Hong Kong, Beijing and Shanghai.

Timetable

Concept note review	April 4, 2017
Review meeting	Mid-July 2017
Launch	October 2017

The report began as a DECPG flagship, with T&C as the partner GP. With DEC's decision not to launch a new flagship series, T&C is taking the work forward. It is drawing on much of the background work that was being jointly planned, with the scope narrowed somewhat to focus on issues within T&C's expertise. The report is expected to be 60-80 pages and to be helping set what is expected to be a larger multi-year work program.

Team

An advisory committee led by Anabel Gonzalez (Senior Director, T&C) and with Jose Ernesto Lopez Cordova (Practice Manager, GTCTC) and Jose Guilherme Reis (Practice Manager, GTCTC) are ensuring the work is well coordinated with key T&C deliverables on trade, industrial competitiveness and innovation. Homi Kharas, Shahid Yusuf and Carl Dahlman (OECD) are among the senior external advisors to the report.

Staff	**Position**	**Staff weeks**
Mary Hallward-Driemeier (TTL)	Senior Economic Adviser, GTCD4	8 weeks
Gaurav Nayyar (co-TTL)	Economist, GTCD2	12 weeks
Philip Schellekens*	Lead Economist, DECPG	8 weeks
Marcio Cruz	Senior Economist, GTCIE	2 weeks + background papers when in DECPG
Ileana Cristina Constantinescu	Economist, GTCD2	2 weeks
Innovation & Entrepreneurship team (e.g. Denis Medvedev, Natasha Kapil)		3 weeks
Trade team (drawing on the work of Daria Taglioni, Jakob Engel, Jean Francois Arvis, Olivier Cattaneo)		3 weeks
Competitive Sectors team (Aref Adamali, Michael Wong and Emiliano Duch)		3 weeks
Investment Climate team (e.g. drawing on work by Peter Kusek and standards team)		1 week
Kyun Suk Chang	STC	8 weeks
Linghui Zhu	STC	2 weeks

*Philip Schellekens (Lead Economist, DECPG) played a critical role in leading this project when DECPG was originally planning to do a flagship, with T&C as the partner GP. With the decision not to launch the new flagship series, T&C has built on this joint work in refocusing and developing this report. In addition to Philip's early leadership, the contributions of S. Amer Ahmed (Senior Economist, DECPG), Marcio Cruz (formerly Economist in DECPG) and Bryce Quillin (Senior Economist, DECPG) in discussions, consultations and in writing background papers are also gratefully acknowledged.

Budget

	FY17	**FY18**	**TOTAL**
Staff	$140,000	$40,000	$180,000
Consultants	$35,000	$10,000	$45,000
Editing, printing		$25,000	$25,000
Travel (consultation and dissemination)	$20,000	$50,000	$70,000
TOTAL	$195,000	$125,000	$320,000

References

Acemoglu, D. and Autor, D. Skills, tasks and technologies: Implications for employment and earnings. Handbook of labor economics (2011), 4, pp.1043-1171.

Acemoglu, D. and Restrepo, P. "The Race Between Machine and Man: Implications of Technology for Growth, Factor Shares and Employment". (2016). NBER Working Paper No. 22252.

Agénor, Pierre-Richard and Otaviano Canuto. "Middle-Income Growth Traps." *Research in Economics* 69, no. 4 (2015): 641–60.

Arntz, Melanie, Terry Gregory, and Ulrich Zierahn. "The Risk of Automation for Jobs in OECD Countries: A Comparative Analysis." *OECD Social, Employment and Migration Working Papers*, no. 189 (2016). OECD Publishing, Paris.

Assembly. "Automation Profiles: Robots Help Philips Shave Assembly Costs." *Assembly Magazine* June 1, 2012. Accessed October 5, 2016. http://www.assemblymag.com/articles/90173-automation-profiles--robots-help-philips-shave-assembly-costs-.

Autor, D. H., D. Dorn, G. H. Hanson, and J. Song. "Trade Adjustment: Worker-Level Evidence." *The Quarterly Journal of Economics* 129, no. 4 (2014): 1799–1860.

Autor, D. H., F. Levy, and R. J. Murnane. "The Skill Content of Recent Technological Change: An Empirical Exploration." *The Quarterly Journal of Economics* 118, no. 4 (2003): 1279–1333.

Barro, Robert J. and Jong Wha Lee. "A New Data Set of Educational Attainment in the World, 1950–2010." *Journal of Development Economics* 104 (2013): 184–98.

Bartel, Ann P. and Nachum Sicherman. "Technological Change and the Skill Acquisition of Young Workers." *Journal of Labor Economics* 16, no. 4 (1998): 718–55.

Beeson, Patricia. "Total Factor Productivity Growth and Agglomeration Economies in Manufacturing, 1959-73." *Journal of Regional Science* 27, no. 2 (1987): 183–99.

Bessen, James E. "How Computer Automation Affects Occupations: Technology, Jobs, and Skills." *Boston Univ. School of Law, Law and Economics Research Paper No. 15-49* 2016.

Bloom, N., Draca, M. and Van Reenen, J., 2016. Trade induced technical change? The impact of Chinese imports on innovation, IT and productivity. The Review of Economic Studies, 83(1), pp.87-117.

Bloomberg. "China No Match for Dutch Plants as Philips Shavers Come Home." *Bloomberg Technology*, January 2012. www.bloomberg.com/news/articles/2012-01-19/china-no-match-for-dutch-plants-as-philips-shavers-come-home-1-.

Bolt, Jutta and Jan Luiten van Zanden. "The Maddison Project: Collaborative Research on Historical National Accounts." *The Economic History Review* 2014: 627–51.

Brynjolfsson, Erik and Andrew McAfee. *The Second Machine Age: Work, Progress, and Prosperity in a Time of Brilliant Technologies*. New York, NY: W.W. Norton & Company, 2014.

Ciccone, A. and Papaioannou, E., 2009. Human capital, the structure of production, and growth. The Review of Economics and Statistics, 91(1), pp.66-82.

Comin, Diego and Bart Hobijn. "An Exploration of Technology Diffusion." *American Economic Review* 100, no. 5 (2010): 2031–59.

Constantinescu, Cristina, Aaditya Mattoo, and Michele Ruta. "The Global Trade Slowdown: Cyclical or Structural?" *World Bank Policy Research Working Paper*, no. 7158 (2015).

Dasgupta, Sukti and Ajit Singh. "Manufacturing, Services and Premature Deindustrialization in Developing Countries: A Kaldorian Analysis." In *Advancing Development*, 435–54. n.p.: Springer Nature, 2007.

David, H., Dorn, D. and Hanson, G.H., 2013. The China syndrome: Local labor market effects of import competition in the United States. The American Economic Review, 103(6), pp.2121-2168.

Deichmann, Uwe, Aparajita Goyal, and Deepak Kumar Mishra. "Will Digital Technologies Transform Agriculture in Developing Countries?" *World Bank Policy Research Working Paper*, no. 7669 (2016).

Deloitte. *Advanced Technologies Initiative: Manufacturing & Innovation*. Deloitte Touche Tohmatsu Limited, 2015.

———. *Global Manufacturing Competitiveness*. Deloitte Development LLC, 2016.

Devarajan, Shantayanan and Sherman Robinson. "Contribution of Computable General Equilibrium Modeling to Policy Formulation in Developing Countries." In *Handbook of Computable General Equilibrium Modeling SET, Vols. 1A and 1B*, edited by Peter B Dixon and Dale W Jorgenson, 277–301. North Holland: Elsevier BV, 2013.

Eichengreen, Barry and Poonam Gupta. "Exports of Services: Indian Experience in Perspective." *Indian Growth and Development Review* 6, no. 1 (2013): 35–60.

Farole, Thomas and Jose Guilherme Reis. *Trade Competitiveness Diagnostic Toolkit*. Washington, D.C: The World Bank, 2012.

Ferrantino, Michael J and Daria Taglioni. "Global Value Chains in the Current Trade Slowdown." *Economic premise*, no. 137 (2014). Washington, D.C: World Bank Group.

Financial Times. "Robot Revolution Helps Adidas Bring Shoemaking Back to Germany." *Financial Times*, June 2016. http://www.ft.com/content/7eaffc5a-289c-11e6-8b18-91555f2f4fde.

Frey, Carl Benedikt and Michael A Osborne. *The Future of Employment: How Susceptible Are Jobs to Computerisation?* 2013, Retrieved September 7.

Goos, Maarten, Alan Manning, and Anna Salomons. "Explaining Job Polarization: Routine-Biased Technological Change and Offshoring." *American Economic Review* 104, no. 8 (2014): 2509–26.

Gorg, H. and E. Strobl. Multinational Companies and Productivity Spillovers: A Meta-analysis," *Economic Journal* (2001): 111, F723-39.

Hanson, G.H. and Robertson, R., 2008. China and the manufacturing exports of other developing countries (No. w14497). National Bureau of Economic Research.

Humphrey, J and O Memedovic. "Global Value Chains in the Agrifood Sector." *United Nations Industrial Development Organization Working Paper* 2006.

International Federation of Robotics. "World Robotics: 2015 Industrial Robots." Accessed October 11, 2016. http://www.ifr.org/industrial-robots/statistics/.

Javorcik, B. S. (2015): Does FDI Bring Good Jobs to Host Countries?" *World Bank Research Observer*, 30, 74-94.

Kaldor, N. Causes of Slow Rate of Growth in the United Kingdom (1967). Cambridge University Press, Cambridge.

Kalra, Nidhi, Stephane Hallegatte, Robert Lempert, Casey Brown, Adrian Fozzard, Stuart Gill and Ankur Shah,. "Agreeing on Robust Decisions: New Processes for Decision Making Under Deep Uncertainty." *World Bank Policy Research Working Paper*, No. 6906 (2014): 1–37. Washington, D.C: The World Bank.

Kee, Hiau Looi and Heiwai Tang. "Domestic Value Added in Exports: Theory and Firm Evidence from China." *American Economic Review* 106, no. 6 (2016): 1402–36.

Kharas, Homi. "The Emerging Middle Class in Developing Countries." *OECD Development Centre Working Paper*, no. 285 (2010).

Leipziger, Danny M. *Lessons from East Asia*. Ann Arbor: The University of Michigan Press, 1997.

Lin, Justin Yifu. "From Flying Geese To Leading Dragons: New Opportunities and Strategies for Structural Transformation in Developing Countries". *Global Policy* (2012), 3: 397–409.

Liwen, Chen, Xiangquan Zeng, and Yang Yumei. "Rural Labor Absorption Efficiency in Urban Areas under Different Urbanization Patterns and Industrial Structures: The Case of China." *IZA Discussion Paper*, no. 6189 (2011).

Malmberg, Anders and Peter Maskell. "The Elusive Concept of Localization Economies: Towards a Knowledge-Based Theory of Spatial Clustering." *Environment and Planning A* 34, no. 3 (2002): 429–49.

Maloney, William F. and Molina, Carlos. "Are Automation and Trade Polarizing Developing Country Labor Markets, Too?" Policy Research Working Paper; No. 7922 (2016). World Bank, Washington, DC

Maloney, W. and Nayyar, G. "Industrial Policy, Information and Government Capacity", mimeo (2017), World Bank, Washington DC.

McKinsey and Company. Manufacturing the future: The next era of global growth and innovation. McKinsey Global Institute. 2012. http://www.mckinsey.com/business-functions/operations/our-insights/the-future-of-manufacturing

--. *Automotive Revolution—perspective towards 2030: How the Convergence of Disruptive Technology-Driven Trends Could Transform the Auto Industry*. n.p.: McKinsey and Company, 2016. www.mckinsey.com/industries/high-tech/our-insights/disruptive-trends-that-will-transform-the-auto-industry.

McMillan, Margaret, Dani Rodrik, and Íñigo Verduzco-Gallo. "Globalization, Structural Change, and Productivity Growth, with an Update on Africa." *World Development* 63 (2014): 11–32.

Mokyr, Joel, Chris Vickers, and Nicolas L. Ziebarth. "The History of Technological Anxiety and the Future of Economic Growth: Is This Time Different?" *Journal of Economic Perspectives* 29, no. 3 (2015): 31–50.

Monroy-Taborda, S, M Moreno, and I Santos. "Technology Use and Changing Skills Demands: New Evidence from Developing Countries." *Background paper for the World Development Report 2016*. Washington, D.C: The World Bank. Forthcoming.

Morosini, Piero. “Industrial Clusters, Knowledge Integration and Performance.” *World Development* 32, no. 2 (2004): 305–26.

Nayyar, G. “Inside the Black Box of Services: Evidence from India.” *Cambridge Journal of Economics* 37, no. 1 (2013): 143–70.

Nayyar, G. (2011), “The Quality of Employment in India’s Services Sector: Exploring the Heterogeneity”, *Applied Economics*, Volume 44, Issue 36, pp. 4701-4719

Newman, Carol, John Page, and John Rand. *Made in Africa: Learning to Compete in Industry*. United States: Brookings Institution, 2016.

OECD-WTO. “Measuring Trade in Value Added.” http://www.oecd.org/sti/ind/measuringtradeinvalue-addedanoecd-wtojointinitiative.htm.

Padmore, Tim and Hervey Gibson. “Modelling Systems of Innovation:” *Research Policy* 26, no. 6 (1998): 625–41.

Page, John. "Should Africa Industrialize?" (2010). *Journal of African Economies*, Vol. 21, AERC Supplement 2, pp. ii86–ii125

Quibria, M. G. “Growth and Poverty: Lessons from the East Asian Miracle Revisited.” *Asian Development Bank Institute Research Paper*, no. 33 (2002).

Rodrik, D. “King Kong Meets Godzilla: The World Bank and the East Asian Miracle.” *CEPR Discussion Papers*, no. 944 (1994).

Rodrik, D. “Unconditional Convergence in Manufacturing.” *The Quarterly Journal of Economics* 128, no. 1 (2012): 165–204.

Rodrik, Dani. “Premature Deindustrialization.” *Journal of Economic Growth* 21, no. 1 (2016): 1–33.

Romer, P. 2010. “What Parts of Globalization Matter for Catch-Up Growth?” *American Economic Review*. 100(2): 94-98.

South China Morning Post. *Rise of the Robots: 60, 000 Workers Culled from Just One Factory as China’s Struggling Electronics Hub Turns to Artificial Intelligence*. (South China Morning Post), September 21, 2015. http://www.scmp.com/news/china/economy/article/1949918/rise-robots-60000-workers-culled-just-one-factory-chinas.

Standard Chartered Global Research. *Global Supply Chains: New Directions*. Standard Chartered Global Research Special Report, 2016.

Stiglitz, Joseph E. and Shahid Yusuf, eds. *Rethinking the East Asian Miracle*. Washington D.C.: Oxford University Press, 2001.

Timmer, Marcel P, G. J de Vries, and K de Vries. “Patterns of Structural Change in Developing Countries.” *Groningen Growth and Development Center Research Memorandum*, no. 149 (2014).

Walker, Warren E., Robert J. Lempert, and Jan H. Kwakkel. “Deep Uncertainty.” In *Encyclopedia of Operations Research and Management Science*, 395–402. US: Springer, 2013.

Wood, A. and Mayer, J., 2011. Has China de-industrialised other developing countries? Review of World Economics, 147(2), pp.325-350.

World Bank. *The East Asian Miracle: Economic Growth and Public Policy*. World Bank: Oxford University Press, 1993.

———. *World Development Report 2010: Development and Climate Change*. Washington, D.C: World Bank Group, 2010.

———. *World Development Report 2012: Jobs*. Washington, D.C: World Bank Group, 2010.

———. *Global Monitoring Report 2015/2016: Development Goals in an Era of Demographic Change*. Washington, D.C: World Bank Group, 2015a.

———. *Towards More Effective Impact Measurement in the Tourism Sector: Observations and Key Issues*. Washington, D.C: WBG Sustainable Tourism Global Solutions Group, World Bank, 2015d.

———. *World Development Report 2016: Digital Dividends*. Washington, D.C: World Bank Group, 2016a.

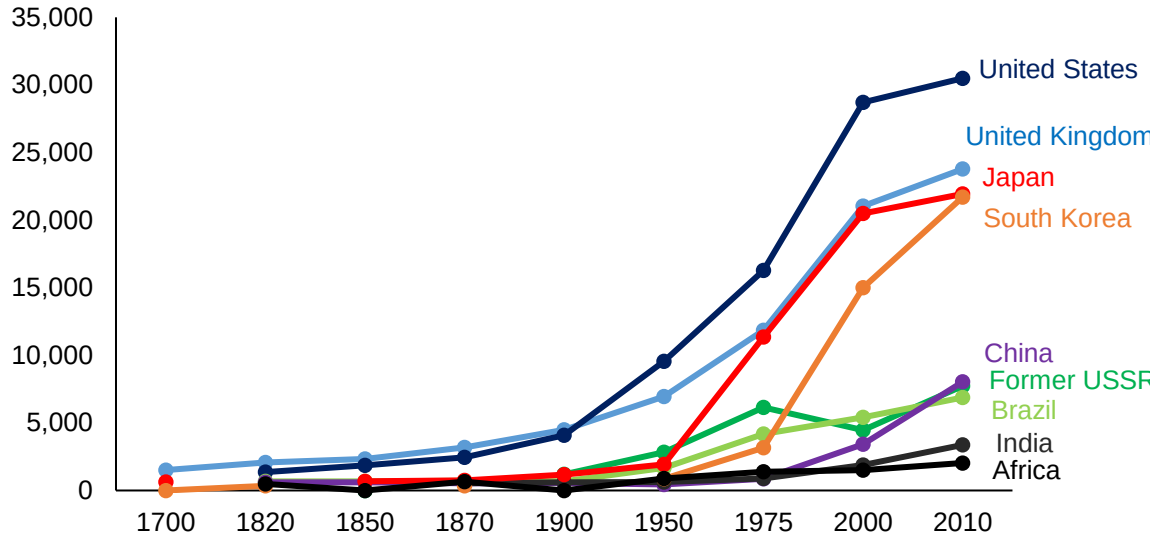
World Economic Forum. *Future of Manufacturing*. 2012, A World Economic Forum Report in collaboration with Deloitte Touche Tohmatsu Limited.

Yonazi, Enock, Tim Kelly, Naomi Halewood, and Colin Blackman. *The Transformational Use of Information and Communication Technologies in Africa*. Washington D.C: The World Bank, 2012.

Yumkella, Kandeh K, Patrick M Kormawa, Torben M Roepstorff, and Anthony M Hawkins. *Agribusiness for Africa's Prosperity*. Vienna: UNIDO, 2011.

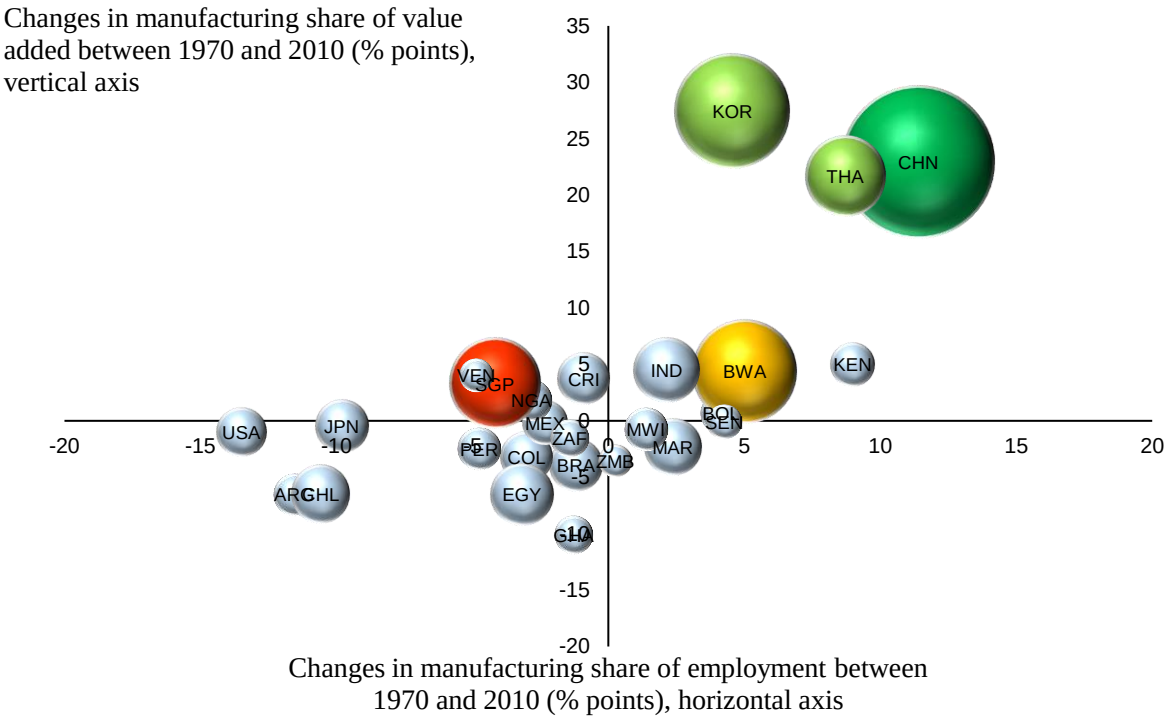
Yusuf, Shahid. "Garment Suppliers Beware: The global garments value chain is changing" (2012). International Growth Center Working Paper S-37044-PAK-1.

Figure 1. Development has been historically associated with industrialization
Per capita GDP (1700-2000)



Source: Madison project (Bolt and van Zanden 2013)

Figure 2. Countries with large increase in manufacturing as a share of employment and value added achieve high income growth

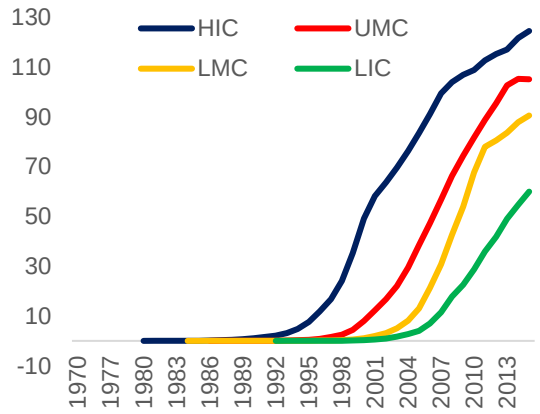


Source: GGDC 10-Sectors

Figure 3. Access to cell phones and the Internet increased in developing countries

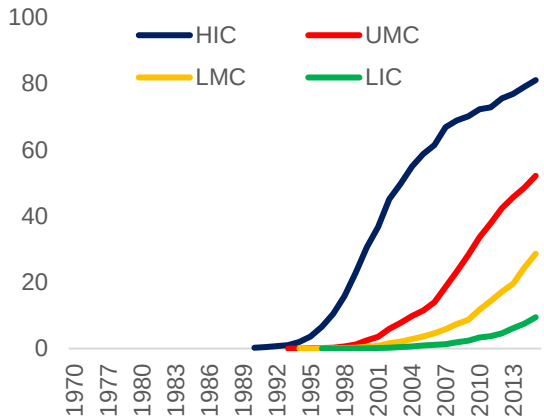
c. Access to cell phones increased in a much faster pace in developing countries

Mobile cellular subscriptions (per 100 people)



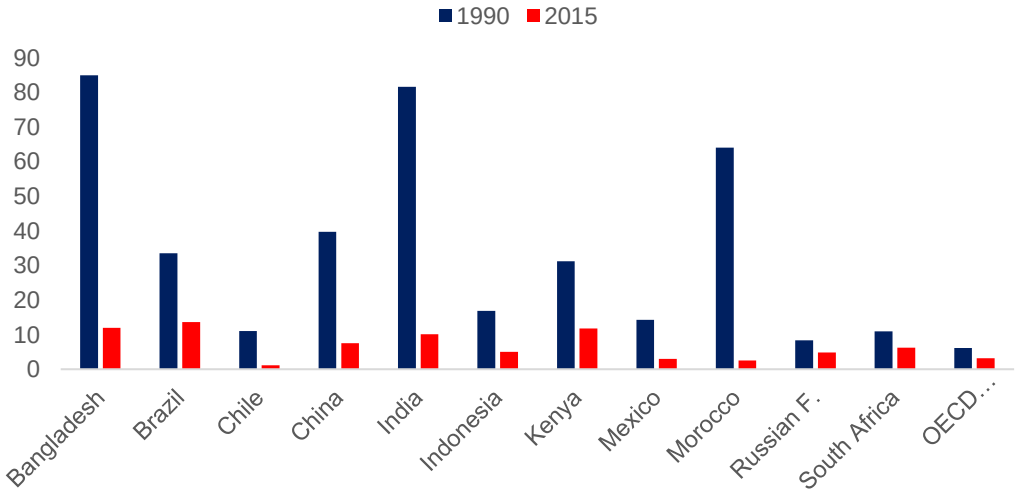
d. Access to Internet almost achieved universal coverage in HIC and continue increasing in developing countries

Internet users (per 100 people)



Source: World Development Indicator (2016)

Figure 4. Tariff reductions between 1990-2015

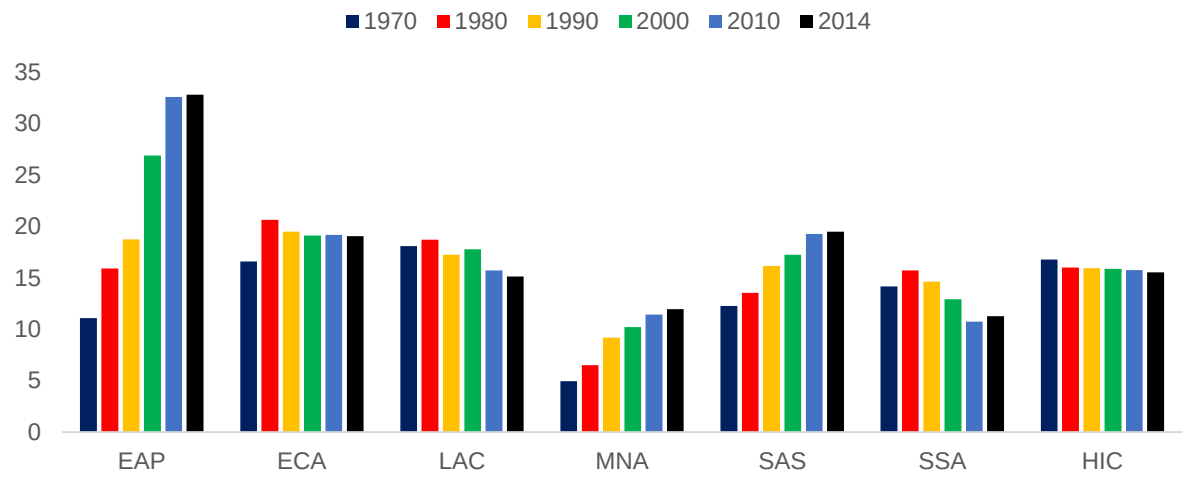


Source: WDI (2016)

Note: Tariff rate, applied, simple mean, all products (%)

Figure 5. Manufacturing share on real value added by WB region (%)

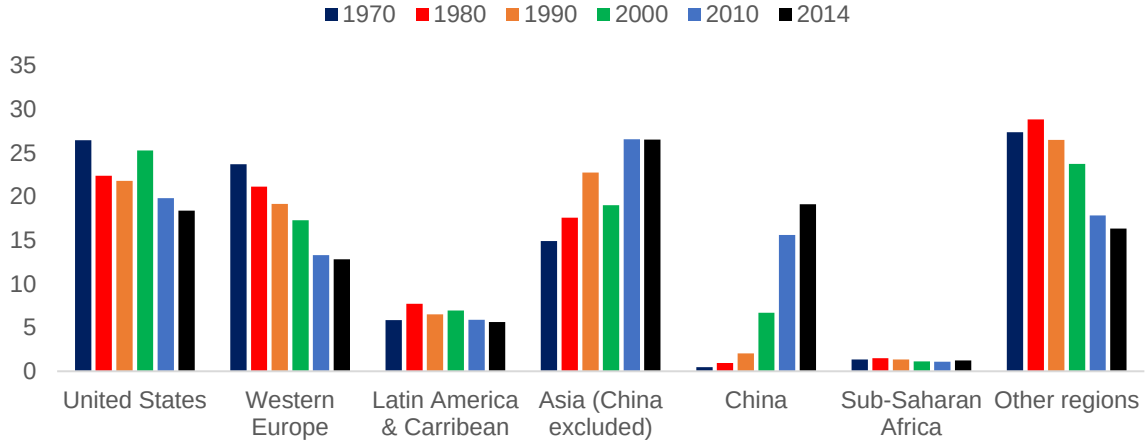
Manufacturing share on real value added by WB region (%)



Source: UN National Accounts Data
Note: The region's global share in manufacturing value added reports the share of manufacture value added that the region is responsible for from the total manufacturing value added in the world. China does not report manufacturing value added from 1970 to 2004. Thus, China's manufacturing value.

Figure 6. Share on global manufacturing real value added (%)

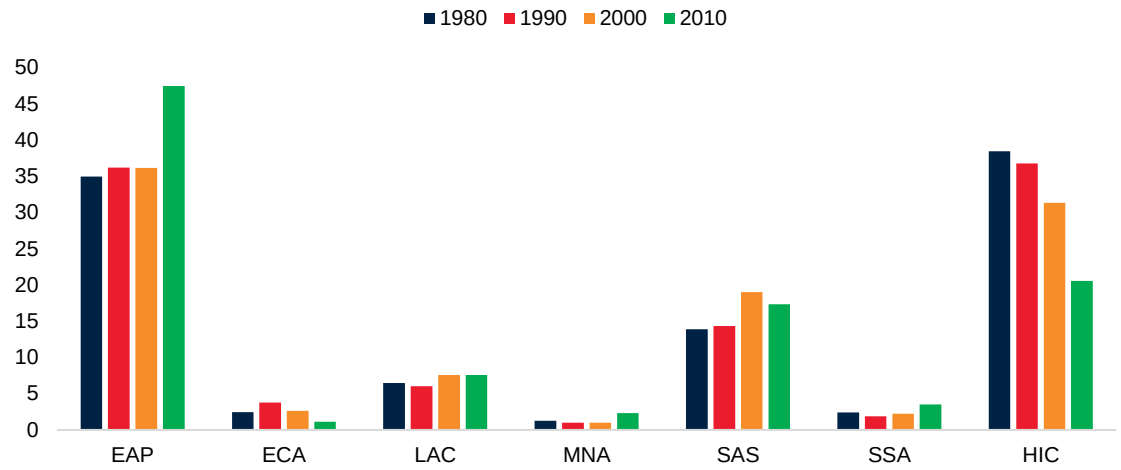
Share on global manufacturing real value added by country groups (%)



Source: UN National Accounts Data
Note: The region's global share in manufacturing value added reports the share of manufacture value added that the region is responsible for from the total manufacturing value added in the world. China does not report manufacturing value added from 1970 to 2004. Thus, China's manufacturing value.

Figure 7. Global share of jobs in the manufacturing

Share on global manufacturing employment by country groups (%)

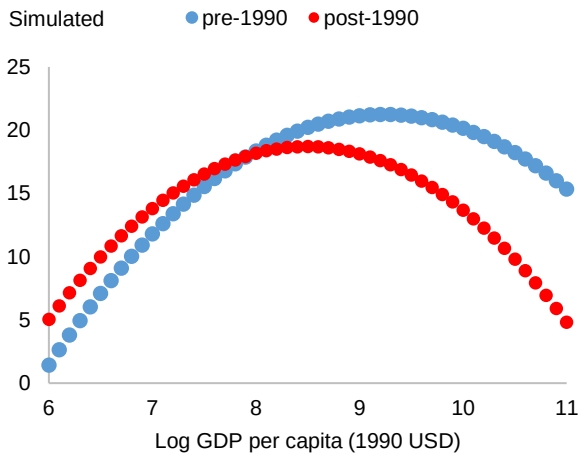


Source: UN National Accounts Data

Note: The region's global share in manufacturing value added reports the share of manufacture value added that the region is responsible for from the total manufacturing value added in the world. China does not report manufacturing value added from 1970 to 2004. Thus, China's manufacturing value.

Figure 8. Developing countries are seeing manufacturing employment peak at lower income levels than in the past

a. Manufacture share of employment (%) at peak (simulated)



b. Developing countries are seeing manufacturing employment peak at lower income levels