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UNITED NATIONS  
INDUSTRIAL DEVELOPMENT ORGANIZATION

WORKING PAPER 07/2014

# Patterns of structural change and manufacturing development

INCLUSIVE AND SUSTAINABLE INDUSTRIAL DEVELOPMENT



RESEARCH, STATISTICS AND INDUSTRIAL POLICY BRANCH  
WORKING PAPER 07/2014

# Patterns of structural change and manufacturing development

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UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION  
Vienna, 2015

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## 1. Introduction

Economic growth has been associated with changes in economic structure. Before the Industrial Revolution in the 18<sup>th</sup> century, the world economy grew very slowly and its structure only changed very slightly in comparison to today (Kuznets, 1966; Maddison, 2003). Modern economic growth is characterized by an increase in population and an even faster increase in output, leading to higher growth in terms of per capita income (Kuznets, 1966). This sustained income growth has not been accompanied by a proportional increase in the outputs of different sectors, but by continuous changes in economic structure. A rapid increase in the share of industry and a decline of the agricultural share—in other words, industrialization—initially plays a key role in catapulting the economy onto a higher growth path (Ocampo, Rada and Taylor, 2009).<sup>2</sup> The importance of manufacturing for economic growth relative to agriculture has been attributed to the higher economies of scale of the former, to higher income elasticity of demand for manufactured goods and higher potential of productivity catch-up of the manufacturing sector (Kaldor, 1967; Chenery, Robinson and Syrquin, 1986; Rodrik, 2011, Weiss 2011). Manufacturing usually ceases to be a dominant engine of growth when countries reach a high per capita income of roughly US\$ 10,000 (in PPP constant 2005 US\$).<sup>3</sup> Then, the share of the services sector to the economy carries an increasingly larger weight, and the share of manufacturing tends to gradually decrease, although such a description based on official statistics is likely to conceal the increasing interdependent nature of the development of manufacturing and the rapidly growing business-related services sector (Franke and Kalmbach, 2005; Tahara, 2009; Tomlinson, 2012). The development of an efficient and dynamic services sector depends on the type of manufacturing structure a country has established (Guerrieri and Meliciani, 2005).

The manufacturing sector plays a key role in a country's development, and we therefore examine how the structure of the manufacturing sector is associated with different stages of a country's development. Modern economic growth is accompanied by structural change at broadly aggregated levels of agriculture, industry and services. Sustained economic growth entails structural change in manufacturing at disaggregated levels through technological upgrading and diversification, and possibly specialization at a later stage (Imbs and Wacziarg, 2003).

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<sup>2</sup> This relationship between growth and structural change is of course, not without exception. The key role the services sector has played in India's economic growth is a notable example.

<sup>3</sup> At which stage of development manufacturing share reaches its peak depends on geographic and demographic conditions and other country-specific factors besides income level (Chenery and Syrquin, 1975; Haraguchi and Rezonja, 2010).



Similar to the economy as a whole, structural change in manufacturing is attributable to 1) the demand and supply changes associated with income level, 2) the country's given demographic and geographic conditions, and 3) the country's created conditions (Chenery and Syrquin, 1975). Based on a general formulation of Engel's law, consumer demand tends to increase the share of a given group of goods and services over others as per capita rises (Pasinetti, 1981). This group of goods and services differs at different levels of income. On the supply side, a country's manufacturing production tends to evolve along the changing factor endowments as per capita increases (Lin, 2012). Lower income countries, therefore, focus on relatively labour intensive or resource intensive activities, and higher income countries are likely to specialize in capital intensive or technology intensive industries. While the relationship between income level and structure of manufacturing has some elements of universality since countries follow a fairly similar path of structural change as income increases, a country's geographic and demographic conditions implies natural advantages or disadvantages in the development of certain industries (Katz, 2000). For example, holding other conditions constant, an endowment of abundant natural resources usually works against manufacturing development (Haraguchi and Rezonja, 2010; UNIDO, 2012). Finally, the course of structural change in manufacturing is not only determined by the universal effects of income level and the given demographic and geographic conditions; there is room for countries to autonomously shape the structure. In other words, country-created conditions such as history, culture and policy also matter (Lin and Chang, 2009).

To provide empirical insights into the above discussion, Section 2 first presents the patterns of structural change for the entire economy, giving particular attention to changes in the amount of manufacturing value added and employment in the economy. It illustrates how the relative significance of the manufacturing sector changes at different income levels as countries develop. In addition to the patterns of structural change along income level, Section 2 also examines whether these patterns have changed over time and whether a shift in the weight of manufacturing has taken place in the economy.

Following the discussion on economy-wide structural change, Section 3 zeroes in on the manufacturing sector and carries out detailed analyses of structural change in the sector to illustrate the patterns of manufacturing development. Section 3 discusses the individual effects of the three major factors of structural change proposed by Cheney and Syrquin (1975), namely income level, geographic and demographic conditions and other country-specific factors. In addition, the emerging trends of manufacturing development based on shifts in the patterns over the last 30 years are discussed.

Section 4 reviews the temporal aspect of structural change in manufacturing. It sheds insight into the development speeds of individual manufacturing industries as well as the transformation of the manufacturing sector as a whole. The section also compares recently successful countries with countries that industrialized sooner to determine how the speed of industrialization has changed.

Finally, the summary synthesizes the analyses of different explanatory factors of manufacturing structural change discussed in Sections 3 and 4, and illustrates how these factors are individually related to the patterns and country specificities of manufacturing development and produces a unique development path for the respective country's manufacturing sector.

## **2. Structural change and manufacturing sector in the economy**

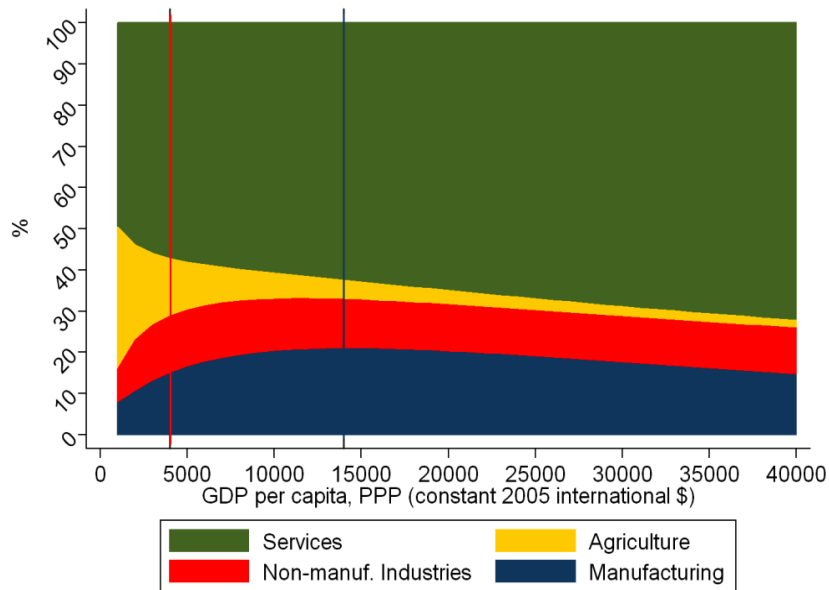
As a country's income increases, the share of agriculture tends to decline while the share of services gradually increases. Unlike these two sectors, the weight of manufacturing in the economy does not continuously reduce or increase throughout the course of a country's development. It usually, however, acts as an engine of growth at a certain stage of development. Figure 1 presents the estimated patterns of structural change across income levels based on the panel data of 100 countries. As countries develop, the share of agriculture declines quite rapidly while that of the other sectors increases. At low and lower middle income levels, in particular, the share of manufacturing increases fast, disproportionately contributing to economic development at a relatively early stage of development.<sup>4</sup>

However, the increase in manufacturing share slows down in the upper middle income stage and reaches its peak (blue vertical line) before the country moves into a high income level.

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<sup>4</sup> The income levels are defined in terms of GDP per capita at constant 2005 PPP values. To align the income classification of countries with the World Bank's classification, low and lower middle, upper middle and high income are defined as US\$ 6,500 or less, US\$ 6,500 - US\$ 15,000 and more than US\$ 15,000, respectively.

**Figure 1 GDP composition by income and sector, 1963–2007**



*Note:* Pooled data for 100 countries

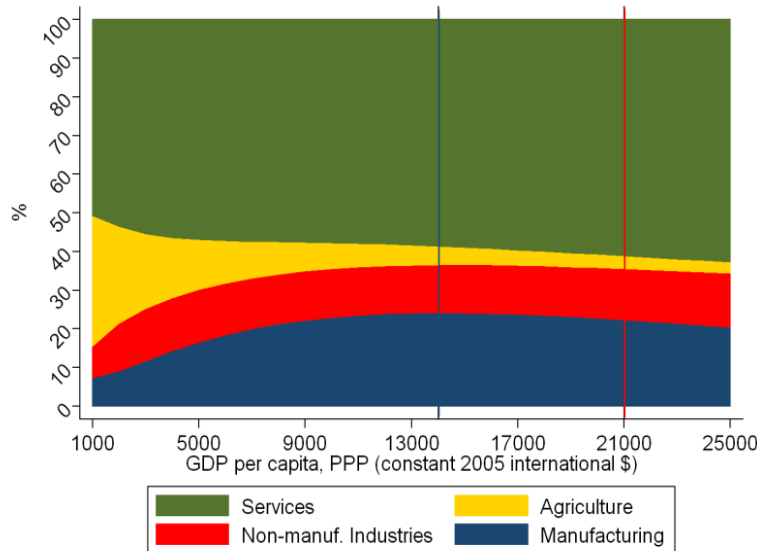
*Source:* UNIDO Industrial Development Report 2013 (based on CIC 2009 and World Bank 2013)

Figure 1 illustrates the structural change pattern, representing a long-term period of more than 40 years from 1963 to 2007. International development discourse changed over that period; globalization progressed and many advanced countries began experiencing de-industrialization. Figure 2 compares the patterns between the earlier and later periods of 1963–1980 and 1991–2007.

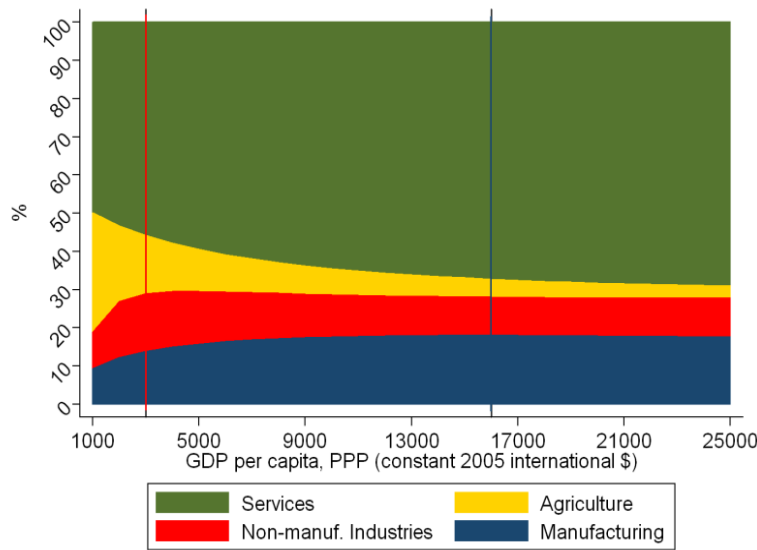
A and B in Figure 2 clearly indicate that countries’ manufacturing share generally used to undergo more changes, increasing from less than 10 percent to more than 20 percent, and had higher peak shares in the past. These results might lead us to think that the role of manufacturing in economic development has slightly diminished in recent years. However, further analyses need to be conducted before we can reach that conclusion. As more countries reach a high level of income, their manufacturing share (particularly of advanced countries) reduces because high income countries generally tend to lose their advantage in manufacturing and become service-oriented economies. If the overall lower manufacturing share in recent years is primarily attributable to the lower manufacturing share of an increasing number of advanced countries, the significance of manufacturing as the engine of growth for economic development might still hold.

**Figure 2 GDP composition by income and sector, 1963–1980 and 1991–2007**

**A 1963–1980**



**B 1991–2007**



*Note:* Pooled data for 100 countries

*Source:* UNIDO Industrial Development Report 2013 (based on CIC, 2009 and World Bank, 2013)

Secondly, Figures 1 and 2 could be considered the average patterns of structural change, treating all countries' manufacturing share as equal. However, if manufacturing activities have been more concentrated in large countries in recent years, the country average might underestimate worldwide manufacturing value added share relative to those of other sectors. In this regard, it is important to look at world manufacturing share in world GDP. A decrease of the world's manufacturing share in world GDP implies that the relative significance of manufacturing is

shrinking. If this is not the case, then manufacturing activities remain concentrated in larger countries and the relative size of world manufacturing value added does not change. Hence, the significance of manufacturing and the development opportunities it offers have not changed, but some (large) countries have been more successful in developing their manufacturing industries than others; it is a matter of competitiveness rather than a general shift in global economic structure. Countries that have hitherto been unsuccessful have the opportunity to reverse the course in the future.

Figure 3 A and B present the changes in the share of manufacturing value added in all countries as well as in developing countries only based on two different methodologies: country average and total manufacturing value added divided by total GDPs (hereafter referred to as aggregate share).<sup>5</sup> In the case of all countries (including advanced countries), the trend for both country average and aggregate share is straightforward: the manufacturing share is declining. This trend is statistically significant for both methodologies. By contrast, if we look at developing countries only, the country average share indicates a rising trend up to the early 1990s followed by a declining trend. No statistically significant change in the aggregate share is evident since 1970. The manufacturing share in developing countries has not changed since 1970 and has always hovered around 20-23 percent. This result confirms that the significance of manufacturing in developing countries is not decreasing relative to other sectors. It seems, however, that manufacturing production has been more concentrated in a smaller number of large countries rather than a larger number of relatively smaller countries in the last 20 years, resulting in lower manufacturing shares when calculated as country averages.

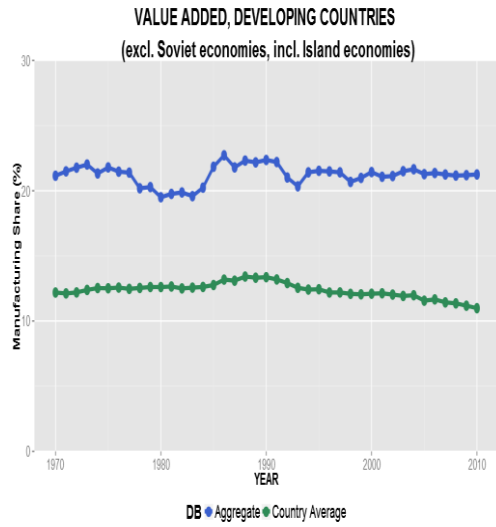
When we look at manufacturing employment shares in Figure 4, the trends for all countries are declining in terms of both country average and aggregate shares. However, if we limit our sample to developing countries, the aggregate manufacturing employment share indicates a statistically significant increasing trend since 1970 for the entire period and a non-declining trend after 1990 while the country average share exhibits a declining trend since 1990.

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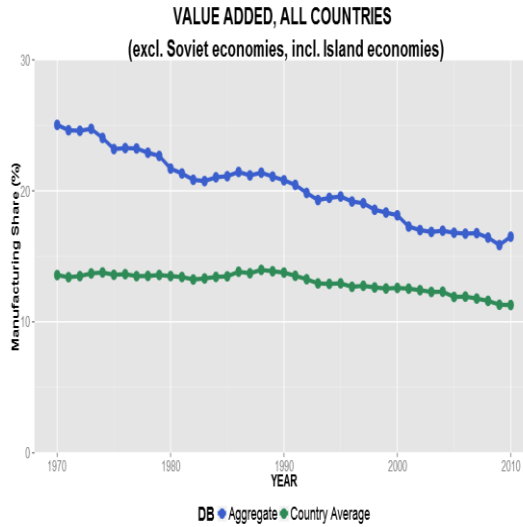
<sup>5</sup> The countries of the former Soviet Union are excluded from the calculations for the entire period because their disintegration and economic restructuring does not necessarily represent the long-term general trend of structural change. Nevertheless, including former Soviet economies in the calculations does not change the country average aggregate trends after 1990.

**Figure 3** Changes in manufacturing value added shares

**A. Manufacturing share, all countries**



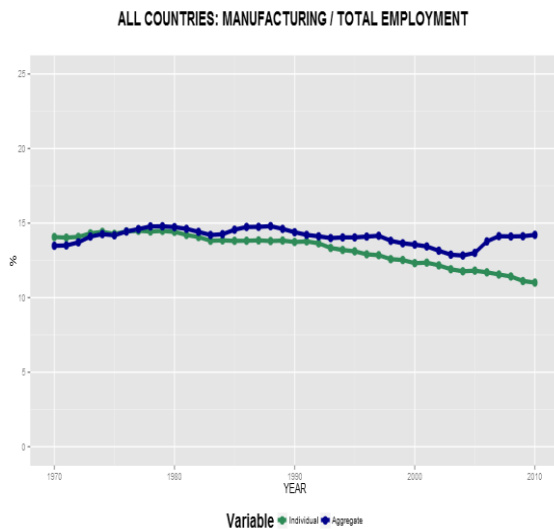
**B. Manufacturing share, developing countries**



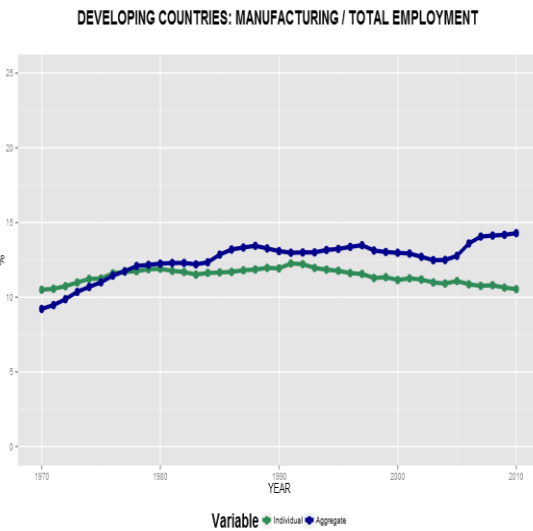
Source: United Nations Statistics Division, National Accounts Main Aggregate Database

**Figure 4** Changes in manufacturing employment shares

**A. Manufacturing share, all countries**



**B. Manufacturing share, developing countries**



Source: Groningen Growth and Development Centre (10 sector database and African sector database); ILO (ILOSTAT database and KILM database)

Note: The coherence of different databases, if used, was maximized by calculating the share of manufacturing employment in each database and then multiplying this with the total employment number from the Total Economy Database of the Groningen Growth and Development Centre.

The above results reveal that the manufacturing sector's significance for developing countries has not changed over the last 40 years. Manufacturing activities in developing countries added the same value to the countries' economies as they did in 1970 and generated the same share of employment, if not higher. The difference between country average and aggregate shares, however, seems to indicate that world manufacturing activities have been more concentrated in a smaller number of large countries in the last 20 years. This trend is likely to have reduced the manufacturing shares of a large number of countries resulting in lower worldwide manufacturing shares if calculated as country average. However, if countries that have enjoyed a disproportionately higher volume of manufacturing production in recent years move to a mature stage of industrialization in the future, their share of manufacturing value added is likely to start decreasing following the development path of current high income countries. Once this takes place, there will be greater opportunities for manufacturing development in many developing countries. Industrialization is thus as relevant and important for developing countries' economic development as it was in the beginning, if not more so.

### **3. Structural change in manufacturing**

As Section 2 has already illustrated, the manufacturing sector has always contributed 20-23 percent of total value added in developing countries. Considering that stronger backward linkages from manufacturing to other industries exist than the other way around, the contribution of manufacturing to the economy is likely to be higher than its value added share indicates.<sup>6</sup> We have discussed the manufacturing sector's position within the structure of the economy; this section looks into structural change in the manufacturing sector.

Chenery and Syrquin (1975) argue that a country's structural change depends on: (i) the normal effect of universal factors that are related to level of income<sup>7</sup>; (ii) the effect of other general factors such as country size or natural resources over which the government has little or no control; (iii) the effects of the country's individual history, its political and social objectives, and the specific policies the government has followed to achieve these. Subsection 3.1 illustrates the relationship between structural change in manufacturing and income level (i) and subsection 3.2 examines the effects of geographic and demographic conditions, namely country size,

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<sup>6</sup> For example, in the case of the BRICS countries, see Haraguchi and Rezonja (2015) *Structural change in the BRICS' manufacturing industries*, in *Structural Change and Industrial Development in the BRICS*, eds. Naudé, Szirmai and Haraguchi (2015), Oxford University Press, forthcoming.

<sup>7</sup> Income effect includes both the supply and demand effect. The demand effect is usually associated with the fact that rising income leads to changes in the composition of demand, of which the decline in the share of agriculture (Engel's law) is the most notable feature. Supply effect, on the other hand, entails two factors of general significance: (i) the overall increase in capital stock per worker, and (ii) the increase in education and skills of all kinds. Since the production in which labour, capital and skills can be combined varies from industry to industry, a change in factor supplies causes a systematic shift in comparative advantage as per capita income rises (Chenery, 1960).

population density and natural resource endowment (ii). Subsection 3.3 reviews different countries' experiences in manufacturing structural change (iii). Appendix 1 explains the regression and data used for the estimations of the structural change.

### **3.1 Structural change in manufacturing along income levels**

#### *Value added*

Figure 5 presents the estimated patterns of structural change in the manufacturing sector. The figure illustrates the development of ten major manufacturing industries (ISIC at the two-digit level) at different income stages. The dotted vertical lines separate income into four development stages which represent distinct manufacturing structures. In the first stage at a very low income level, three industries usually dominate the manufacturing sector: food and beverages, textile and wearing apparel. The three manufacturing industries are closely related to basic human needs and usually exist before industrialization even takes off in a country. In this stage, labour intensive industries<sup>8</sup> clearly have a higher development potential in terms of value added, and their growth rates are not much lower than those of the emerging capital intensive industries.

The ebb and flow of labour intensive and capital intensive industries become apparent in the subsequent stage of development. A slowdown of labour intensive industries becomes increasingly visible. Manufacturing structure gradually shifts from a labour intensive to a capital intensive orientation. By the time countries reach around US\$ 10,000 GDP per capita, many capital intensive industries start surpassing the value added levels of the textile and wearing apparel industries.

In the third stage, capital intensive industries assume a dominant position in terms of output. All capital intensive industries, including resource processing industries such as basic and fabricated metals, as well as those that make use of such processed materials to produce final products (including electrical machinery and motor vehicles industries), experience rapid growth. The difference in growth rates between capital intensive and labour intensive industries becomes increasingly apparent in this stage.

In the last stage at a very high income, labour intensive industries (with the exception of the food and beverages industry), declines, and even some capital intensive industries, such as

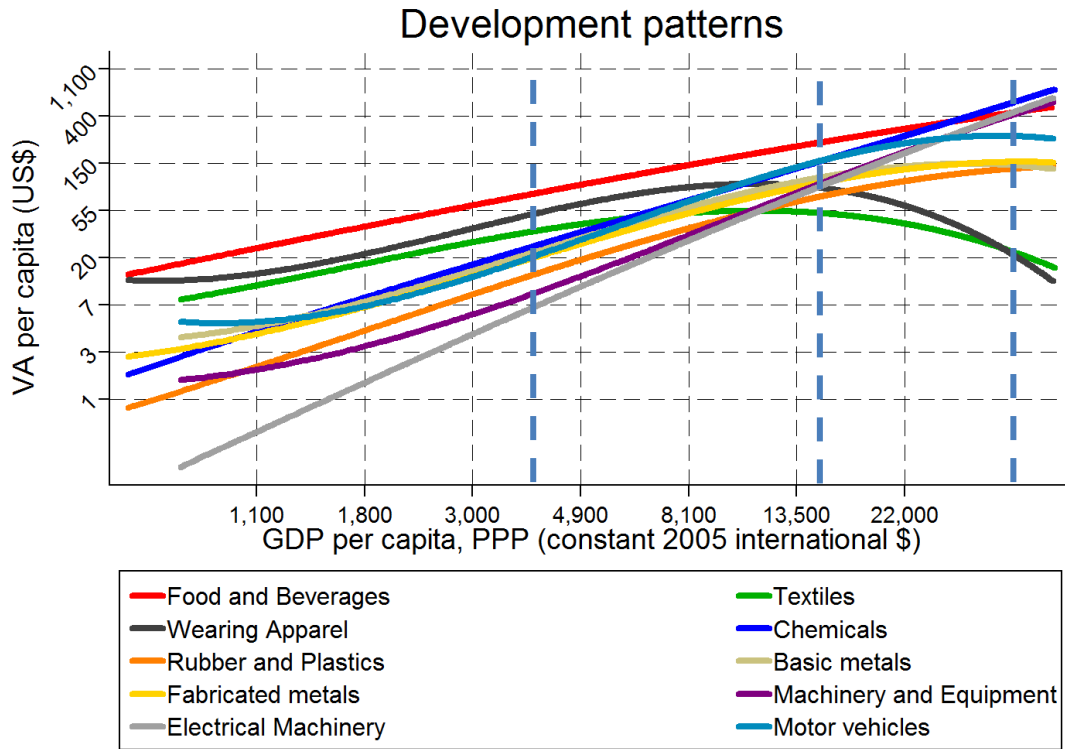
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<sup>8</sup> To determine labour intensity, employment per unit of value added was estimated at US\$ 5,000 and US\$ 20,000 per capita GDP as the labour intensity changes along income level. If an industry's labour intensity was higher than the median of 18 manufacturing industries at both income levels, it was considered labour intensive. Among the industries presented here, food and beverages, textile and wearing apparel are labour intensive while the others are relatively capital intensive industries.



resource processing industries, start slowing down. Those industries that usually sustain a fast growth of value added are the chemicals, machinery and equipment, and electrical machinery and apparatus industries.

**Figure 5** Patterns of structural change in manufacturing



*Source:* UNIDO's elaboration based on Penn World Tables version 8.0 and UNIDO INDSTAT 2014

The development stages of all 18 manufacturing industries for which data are available are listed in Table 1. The early industries are mostly those which are relatively labour intensive and/or domestic-oriented industries. The middle industries include industries that process natural resources to produce materials for other manufacturing industries. Finally, those that belong to the late industries tend to have a higher level of intensity in the application of technology and knowledge to production, and with the exception of rubber and plastic, produce capital or consumption goods for final use by firms or households.

**Table 1 Development stages of manufacturing industries**

Early	Food and beverages, Tobacco, Textiles, Wearing apparel, Wood products, Publishing, Furniture Non-metallic minerals
Middle	Coke and refined petroleum Paper Basic metals Fabricated metals
Late	Rubber and plastic Motor vehicles Chemicals, Machinery and equipment, Electrical machinery and apparatus, Precision instruments

*Note:* Manufacturing subsectors are classified into early, middle and late industries if an industry's share in GDP is estimated to peak before US\$ 6,500 GDP per capita in PPP (constant 2005 prices), between US\$ 6,500 and US\$ 15,000, and after US\$ 15,000, respectively. These income ranges correspond to our income classifications—low and lower middle, upper middle and high incomes—in terms of GDP per capita PPP. Table 1 first lists industries that peak at the lowest income level up to those that peak at the highest income level in terms of their value added share in GDP. Industries that peak at approximately the same income level are listed horizontally.

Figure 5 draws clear and solid estimated lines for the development patterns of manufacturing industries, which might give a false sense that the reliability of the estimations are similar among industries and across income levels. However, the challenges and risks countries face vary according to the characteristics of the industries and stages of development, in addition to country-specific factors. Countries therefore tend to deviate more from the estimated line for given industries and given stages of development.

Figure 6 presents the estimated development patterns of industries with 95 percent confidence intervals. These intervals denote some important characteristics of manufacturing development. First, there are considerable differences in the performance of the industries, which play a crucial role in relatively early stages of development. The confidence intervals around the estimated lines of both the textile and wearing apparel industries are wider, indicating a higher level of uncertainty with respect to the development of these industries. This implies that the risks countries face are relatively high at early stages of development. Hence, the most difficult part of industrialization may be to trigger it, i.e. the take-off of industrialization.

One characteristic shared by middle and late industries, in particular, is the high level of uncertainty at early and mature stages of development. As Figure 6 shows, the confidence intervals of middle and late industries are wider at the low and high income ends, with a narrower interval in the middle. This seems to indicate that country-specific conditions tend to have a significant influence on the development of industries at a low income when they are in their incipient stages, leading to wider variance in the performance between countries. However,

once the industries take off and start accumulating experiences, the differences in the performance among countries that are at the same income level shrink. As countries approach the end of the upper middle income stage (at around US\$ 15,000 GDP per capita in PPP at 2005 constant prices), they once again exhibit larger differences in terms of performance.

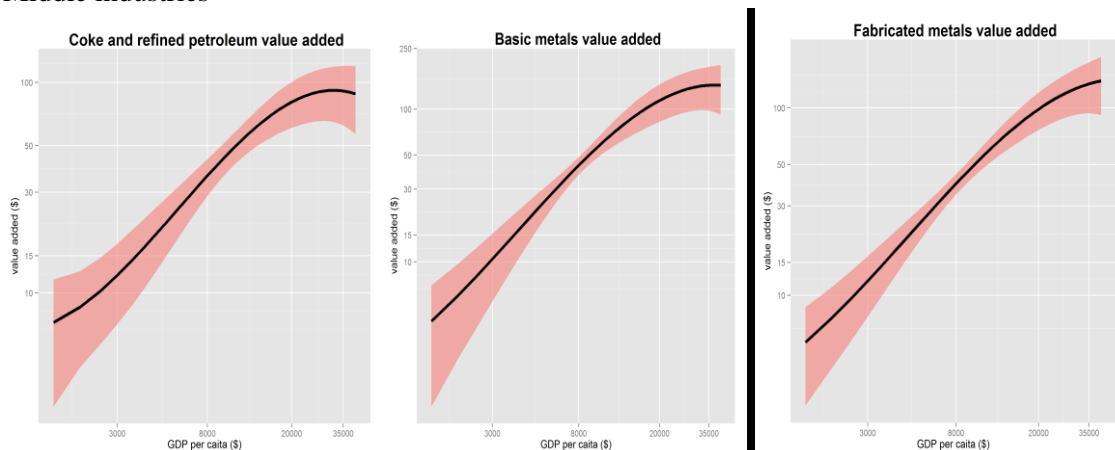
The greater uncertainty in manufacturing development from this stage onwards is attributed to the fact that countries ‘graduate’ from manufacturing development through the acquisition of existing technologies from advanced countries and move to a stage where they have to take more risks to generate knowledge and technology on their own to directly compete with technology leaders (Lee, 2013). At high incomes, countries that create successful inventions and innovations can sustain high growth rates of some manufacturing industries such as machinery and equipment and electrical machinery and apparatus, as indicated by the upper bound of their confidence intervals. Continued growth of these industries will be important to prevent premature de-industrialization, to promote technological development and generate employment in manufacturing as well as related service industries, in order for the manufacturing industry to continue to contribute to a country’s inclusive development.

**Figure 6 Confidence intervals for the estimated patterns, value added**

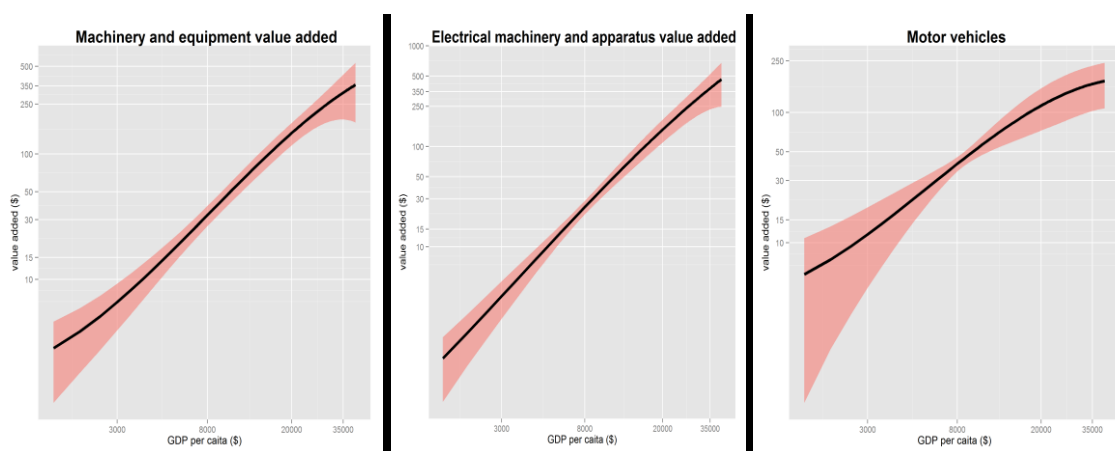
Early industries



### Middle industries



### Late industries

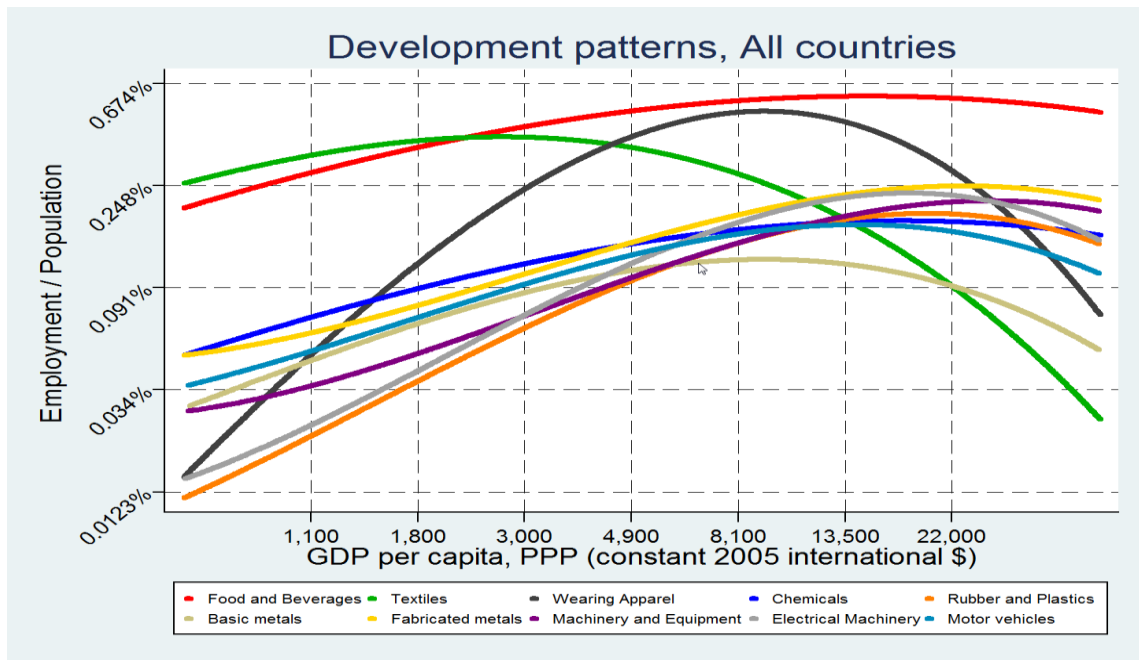


Source: UNIDO’s elaboration based on Penn World Tables version 8.0 and UNIDO INDSTAT 2014

### Employment

The employment picture of structural change in manufacturing (Figure 7) differs quite significantly from that of value added depicted in Figure 5. The food and beverages, textile and wearing apparel industries are the three major sources of manufacturing employment. No other industries usually reach the peak employment level of any of these three industries at any income level. Food and beverages is a major and stable source of employment for all countries, regardless of income level. The textile industry creates jobs at earlier stages of development than does the wearing apparel industry. Unlike food and beverages and other industries, employment in the textile and in the wearing apparel industry, in particular, drops relatively fast once their peak employment levels have been reached. The late industries steadily increase their employment and reach their peak employment levels which are lower than those of the three labour intensive industries discussed here.

**Figure 7** Patterns of employment change in manufacturing



*Note:* Employment population ratio is expressed as employment divided by population and multiplied by 100

*Source:* UNIDO's elaboration based on Penn World Tables version 8.0 and UNIDO INDSTAT 2014

### 3.2 Impacts of demographic and geographic conditions on manufacturing structures

#### *Country size*

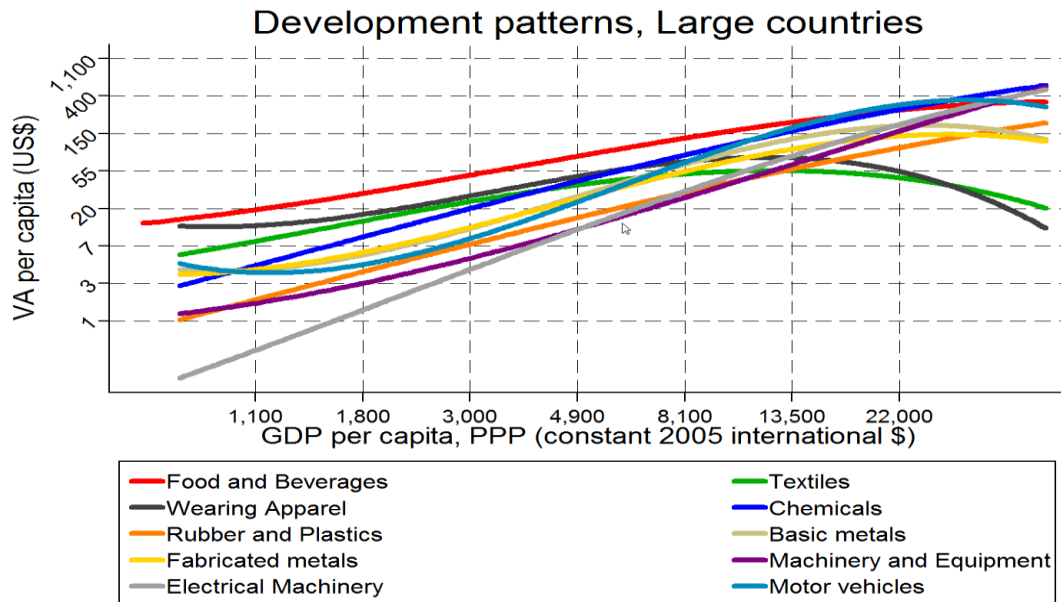
Past studies acknowledge that country size has an overarching influence on economic structural change (Chenery and Taylor, 1968) with the effects on both the intercepts as well as the slope of the estimated patterns. It is recommended to estimate the patterns for different country sizes using data samples classified according to country size.<sup>9</sup>

The patterns in small countries (Figure 9) are similar to those in large countries (Figure 8). Labour intensive industries develop at a relatively early stage and capital intensive industries surpass the value added levels of labour intensive industries at around US\$ 8,000-US\$ 10,000 GDP per capita. The difference between large and small countries is that labour intensive industries tend to develop earlier in small countries. Once they reach their peak levels of output, they decline fairly rapidly. The growth rates of industries at high income levels vary far more in small countries than in large ones. One industry whose development path differs considerably in

<sup>9</sup> To classify countries into two groups of different sizes, we established thresholds to divide them into small and large countries. We then examined at which threshold level the maximum number of manufacturing industries are found, whose development patterns statistically differ from one another. This was achieved by applying the Wald test. Based on our test results, we used a threshold 12.5 million to divide countries into small and large countries.

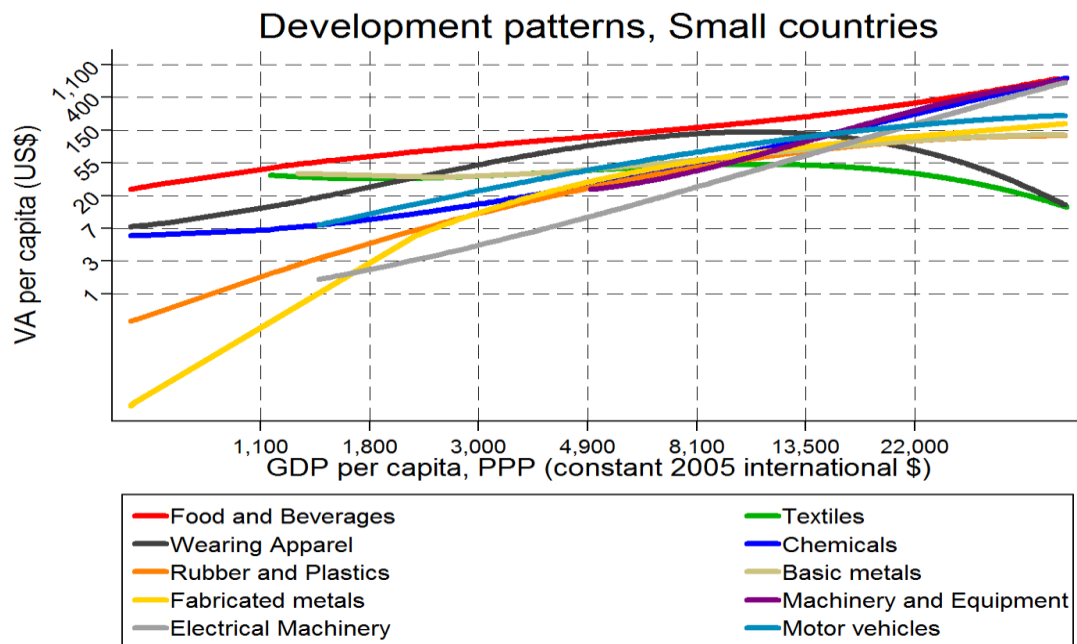
small countries is motor vehicles. The level of development of the motor vehicles industry is much lower in small countries, and unlike in the case of large countries, it does not sustain the growth at high incomes.

**Figure 8** Patterns of structural change in manufacturing in large countries



Source: UNIDO's elaboration based on Penn World Tables version 8.0 and UNIDO INDSTAT 2014

**Figure 9** Patterns of structural change in manufacturing in small countries



Source: UNIDO's elaboration based on Penn World Tables version 8.0 and UNIDO INDSTAT 2014

### *Population density and natural resource endowment*

Keesing and Sherk (1971) show that population density plays an important role as regards patterns of trade and development. Densely populated areas appear to have a greater impact on increased exports of manufactured goods relative to primary products. This indicates that demographic conditions could affect the pattern of manufacturing development. Population density here is determined by the simple division of the country's population size by its total area.

In addition, the negative impact of natural resource abundance on industrialization is well documented. A country's natural resource endowment affects the pattern of industrialization through two related factors. First, countries focus on industrialization due to their lack of natural resources, a fact that prompts countries to find an alternative export base other than natural resources (Chenery and Syrquin, 1975). This explains why resource poor countries are more likely to specialize in manufacturing than resource rich countries. Second, Sachs and Warner (2001) discuss the reasons why natural resource rich countries tend to have a lower level of manufacturing development. Their arguments build on the natural resource curse theory or the Dutch disease, emphasizing the cost disadvantage for tradable (typically manufacturing) sector due to the rise in domestic prices, including input costs and wages, driven by the wealth created by the natural resources sector.

Figure 10 summarizes the effects of high population density (left column) and high natural resource endowments<sup>10</sup> (right column) on manufacturing development. The industries on which these conditions have positive (negative) effects are listed upper (lower) cells in the table. For both columns of population density and natural resources, industries are listed from that which is most positively affected to that which is most negatively affected by the given conditions.<sup>11</sup> A positive (negative) effect means that the development pattern of the industries in Figure 5 shifts upward (downward).

Generally speaking, high population density tends to have a positive effect on manufacturing development, especially for capital and technology intensive industries, while a high natural resource endowment tends to have the opposite effect – a negative impact on manufacturing development, in general, and on capital and technology intensive industries, in particular. This

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<sup>10</sup> The natural resource proxy variable was calculated as the difference between exports and imports of crude natural resource commodities and expressed in per capita terms. The commodities included are those categorized under SITC revision 1 in Code 2 (crude materials, inedible, except fuels), 32 (coal, coke and briquettes), 331 (petroleum, crude and partly refined) and 3411 (gas, natural).

<sup>11</sup> Out of 18 industries listed in Table 1, only those on which population density or high natural resource endowment had a statistically significant impact are included.

result seems to indicate that densely populated countries possess logistical and agglomeration advantages which would be especially conducive to the development of industries that involve relatively complex and lengthy production processes and supply chains, such as machinery and equipment and electrical machinery. As expected, high natural resource endowments have negative impacts on the majority of manufacturing industries. The negative impacts are especially strong on industries that require a higher level of processing, which usually increases the share of non-material costs in total costs. As high natural resource endowments tend to increase processing costs due to higher intermediate input costs and wages, process-oriented, technology intensive industries are especially negatively affected by natural resource abundance.

**Figure 10** Effects of high population density and high natural resource endowment

	High population density	High resource endowments
+	<b>Strongly positive</b>	<b>Strongly positive</b>
	Machinery and Equipment Electrical machinery Rubber and plastics Chemicals Precision instruments Non-metallic minerals Wood products Fabricated metals Motor vehicles	Basic metals
-	<b>Strongly negative</b>	<b>Strongly negative</b>
	Wearing Apparel Textiles Printing and Publishing Tobacco	Food and Beverages Wood products Printing and Publishing Motor vehicles Fabricated metals Tobacco Chemicals Furniture, n.e.c. Non-metallic minerals Rubber and plastics Machinery and Equipment Electrical machinery

Source: UNIDO's elaboration based on Penn World Tables version 8.0 and UNIDO INDSTAT 2014

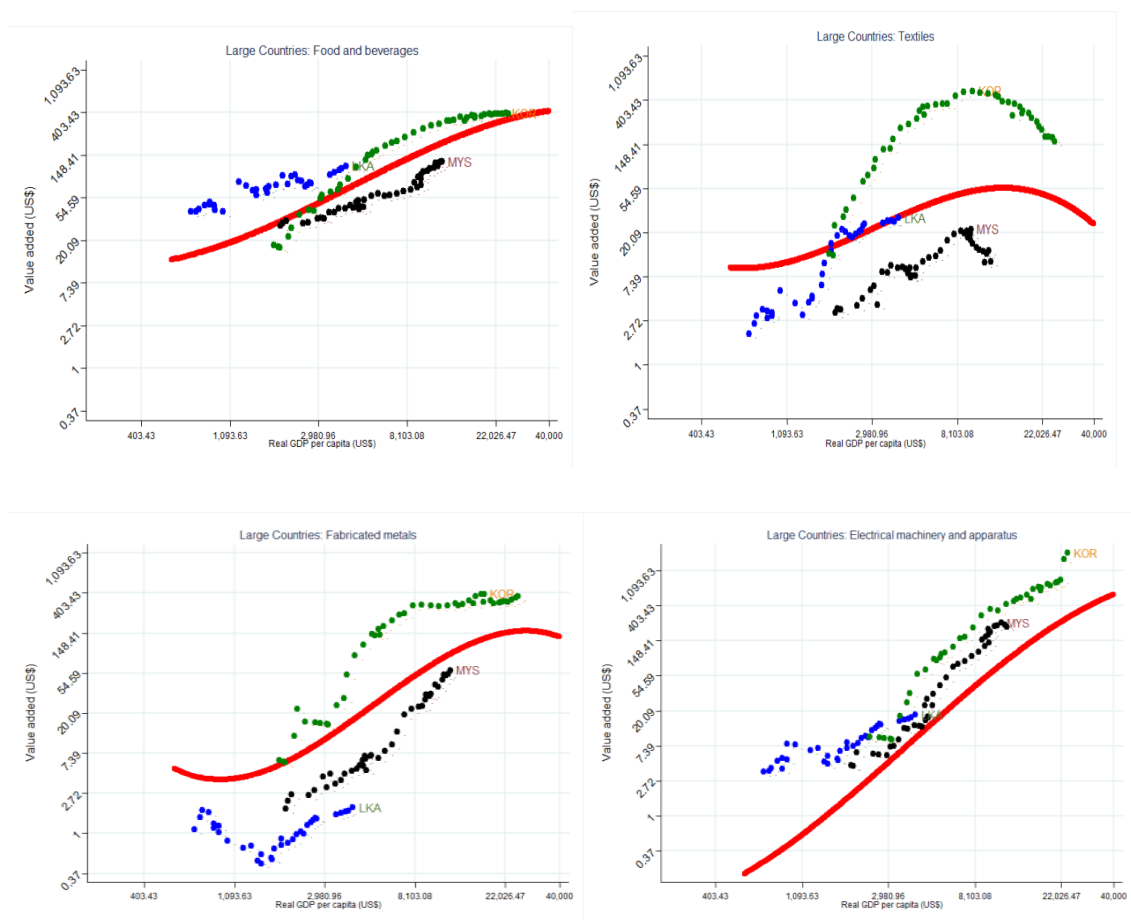
### 3.3 Country-specific conditions

Aside from income level and country-given conditions such as demographic and geographic conditions, country-created effects have influence over the patterns of manufacturing



development. These are related to institutions, history and policies, which engender systematic and consistent differences in the potential levels of manufacturing development across countries over a long period of time. As seen in the examples of the Republic of Korea (in green), Malaysia (in black) and Sri Lanka (in blue) (Figure 11), countries can positively deviate from the estimated pattern (above) or negatively (below). In terms of their development trajectories, however, the three countries tend to follow the development patterns of industries represented in more or less parallel movements along the estimated lines. These development characteristics are also generally applicable to other countries.

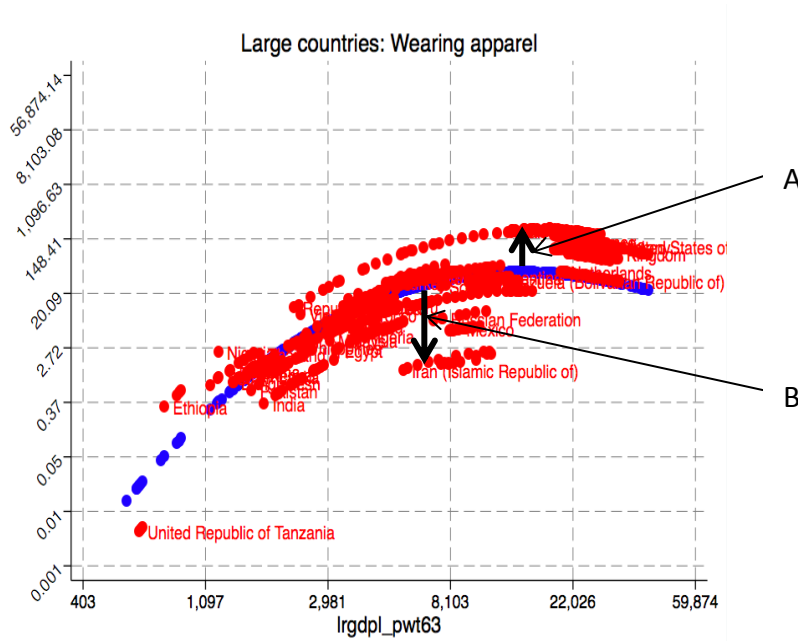
**Figure 11** Manufacturing development trajectories of the Republic of Korea, Malaysia and Sri Lanka



Source: UNIDO's elaboration based on Penn World Tables version 8.0 and UNIDO INDSTAT 2014

Country-specific conditions can be estimated using a regression with country fixed effects as illustrated in the example of the wearing apparel industry in large countries (Figure 12). Some countries (A) have characteristics that give them a distinct advantage over other countries, while others (B) have attributes that result in a consistently lower performance over a long period of time.

**Figure 12 Country-specific effects on manufacturing development**



Source: UNIDO’s elaboration based on UNIDO INDSTAT and Penn World Tables.

If country-specific effects have an influence on the potential level of manufacturing development, one needs to ask whether such effects are mostly related to the development of the manufacturing sector as a whole or to specific to subsectors of manufacturing industries (such as food and beverages, wearing apparel, motor vehicles, etc.). Insights into the characteristics of country-specific effects provide useful information on the types and priorities of industrial policies that countries should consider for implementation. Table 2 classifies countries that reported data for at least 12 out of 18 industries into three groups, based on whether their performance across different manufacturing industries is consistent or not. It is interesting to note that 60 percent of the countries’ performances are consistent, with either above or below average performance relative to their peers (similar country size and income level) across nearly all manufacturing industries. This seems to indicate some general conditions exist that are essential for the development of the manufacturing sector as a whole. These can include political transparency, macroeconomic stability, quality of infrastructure, and factor prices relative to other countries’ at a similar GDP per capita.

**Table 2 Consistency of manufacturing performance**

1. Consistently high performance across most of the manufacturing industries	Czech Republic, Brazil, Canada, Denmark, France, Finland, Germany, Iceland, Ireland, Israel, Italy, Japan, Republic of Korea, Netherlands, Norway, Singapore, Slovenia, Spain, Sweden, UK, USA
2. Consistently low performance across most of the manufacturing industries	Azerbaijan, Ethiopia, Georgia, India, Indonesia, Iran, Kenya, Kyrgyzstan, Mauritius, Mongolia, Oman, Philippines, Republic of Macedonia, Republic of Moldova, Senegal, Turkey, Egypt, Yemen
3. Differences in performance depending on industries	Australia, Bulgaria, China, Colombia, Costa Rica, Cyprus, Estonia, Greece, Hungary, Jordan, Kuwait, Latvia, Lithuania, Malaysia, Mexico, Morocco, Peru, Poland, Portugal, Qatar, Romania, Russian Federation, Serbia, Slovakia, South Africa, Sri Lanka, Trinidad and Tobago, Uruguay

*Source:* Produced by the author based on Penn World Tables version 8.0 and UNIDO INDSTAT 2014

*Note:* Countries which had data to calculate the fixed effects for more than 12 industries are included. In case countries have a higher performance than the average for more than 80 percent of their reported industries, they are assigned to the first category in the table. Countries that have a lower performance than large countries' average for more than 80 percent of their reported industries are assigned to the second category. Countries that cannot be assigned to either of the above are placed in the third category.

To confirm the overarching effects of a country's general conditions on manufacturing industries, regressions are run to determine the relationship between the extent of country fixed effects and the conditions that seem to remain unchanged for a fairly long period and affect industrial development. The results in Table 3 confirm that factors which shape the general business climate, such as the level of unit labour cost and rule of law, mostly have negative and positive effects, respectively, across all manufacturing industries.

There would be significant benefits in improving the general business climate and institutional environment prior to investing into industrial policies for specific manufacturing industries, especially in developing countries with a very low level of manufacturing development. With such improvements, countries can increase the potential level of development of all manufacturing industries that can be achieved at different levels of income, while industry-specific measures under a hostile business environment might not affect the performance of industries.

**Table 3 Correlations between country size and fixed effects and business conditions**

Industry	Unit labour cost		Rule of law	
	-			
Food and beverages	0.1083	(-0.3100)	0.2599	(3.8800)
	-			
Textiles	0.4336	(-3.7500)	0.3387	(6.4400)
	-			
Wearing apparel	0.5886	(-3.5400)	0.2195	(3.5400)
	-			
Chemicals	0.5029	(-3.3300)	0.3282	(6.1500)
Basic metals	0.0524	(0.2000)	0.4894	(8.2700)
	-			
Fabricated metals	0.1526	(-2.9500)	0.4167	(8.0100)
Electrical machinery and apparatus	-			
	0.1095	(-0.4500)	0.3746	(5.4000)
	-			
Motor vehicles	0.0743	(-0.3500)	0.3427	(5.2700)

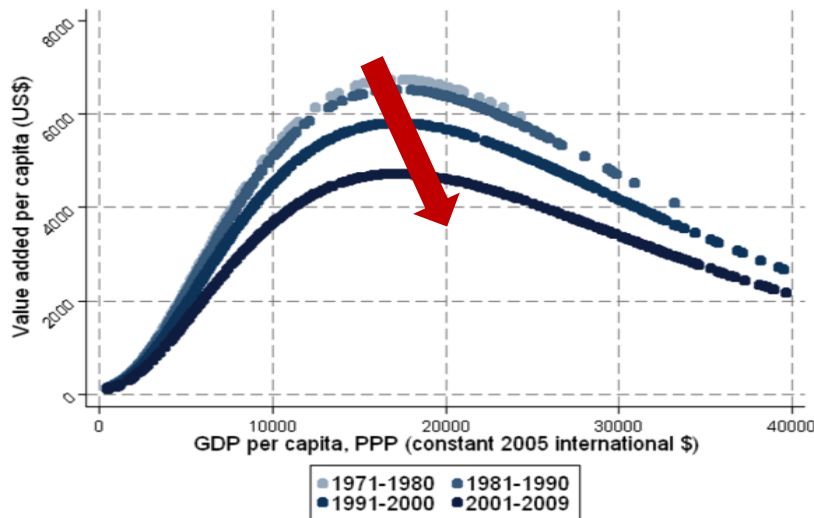
*Source:* UNIDO's elaboration based on Penn World Tables version 8.0 and UNIDO INDSTAT 2014

*Note:* The dependent variable in the regression is country fixed effects. The numbers in parentheses are t-values. Unit labour was calculated based on nominal wages divided by real value added. The variables for the rule of law and road conditions are based on the Worldwide Governance Indicators and the World Development Indicators of the World Bank, respectively.

### 3.4 Emerging trends of manufacturing industries

The development patterns of some industries have shifted over time as seen, for example, in the declining trend of the textile industry's value added (Figure 13). This declining trend differs from the decrease in the industry's value added along its increases in income. The steady downward movement of the pattern indicates a gradual shift in consumer demand and technology, thus reducing the value added of the textile industry at all income levels. This is a change in the characteristics of the industry as well as in consumer preferences for its products over time in contrast to changes in demand and supply that arise due to the country's different income levels.

**Figure 13** Shifting pattern of textile industry over time



Source: UNIDO Industrial Development Report 2013

Table 4 summarizes the emerging trends in manufacturing based on the shift in the patterns of value added and employment (according to the criteria described in the note added to Table 4). The tobacco and textile industries reduce both their value added and employment level over time and become less attractive in terms of their contribution to the economy and job creation. In contrast, the rubber and plastic industry has been increasingly reaching higher levels of value added and employment, making the industry relatively more important than before. Many middle and late industries are changing their production technologies in such a way as to increase capital intensity, substituting capital for labour. Furniture is the only industry that is becoming more labour intensive. The technological characteristics of the food and beverages industry have remained stable over time.

#### **4. Speed of manufacturing development and structural change**

Our analysis so far indicates that certain patterns of manufacturing development exist, which countries tend to follow, even though the precise speed at which they move along the pattern differ from country to country (due to country-specific effects). In this case, the speed of an industry's development is crucial for income increase, manufacturing upgrading and structural change. As shown in Table 1, different industries tend to emerge at different income levels. On the one hand, labour intensive, low-tech industries such as food and beverages and the wearing apparel industries, are major manufacturing industries for low income countries; on the other, capital intensive and technologically sophisticated industries, such as electrical machinery and apparatus and motor vehicles, are usually dominant industries in high income countries. If countries move across patterns of manufacturing development associated with income levels, it

is very much in the country's interest to develop industries based on existing comparative advantages as quickly as possible in order to increase the income alongside such development (Figure 5) and move on to the next emerging industries.

**Table 4 Emerging characteristics of manufacturing industries since 1980**

<b>Emerging characteristics since 1980</b>	<b>Industry</b>
<b>Rising</b>	Rubber and plastics
<b>Declining</b>	Tobacco Textiles
<b>Intensifying capital use</b>	Paper Chemicals Non-metallic minerals Basic metals Fabricated metals Electrical machinery and apparatus Motor vehicles
<b>Intensifying labour use</b>	Furniture
<b>Stable</b>	Food and beverages

*Note:* When value added and employment record a statistically significant increase in all three decades since 1980, the industry is classified as "Rising". When an industry witnesses continuous decline in both variables, it is "Declining". If an industry's value added increases while its level of employment is decreasing (or at least not increasing) the industry is "Intensifying capital use". When there is evidence of an increase in employment and a decrease or no change in value added, the industry is "Intensifying labour use". If there is no significant change in either value added or employment, the industry is deemed "Stable".

*Source:* UNIDO Industrial Development Report 2013

Table 5 presents the speed of manufacturing development in Malaysia, the Republic of Korea and Sri Lanka, expressed in terms of annual increase in value added per capita. All eight manufacturing industries developed much faster in the Republic of Korea than in Malaysia and Sri Lanka during the same income range between US\$ 3,000 and US\$ 4,500. In turn, five out of the eight industries developed faster in Malaysia than in Sri Lanka. However, the speed and level at which a country moves across the pattern (country-specific effects) are not necessarily associated with each other. For example, Sri Lanka followed the development pattern of the textile and basic metals industries at a higher level than Malaysia, even though the former moved slower than the latter. The optimal situation is the case of the Republic of Korea, which

moved faster than Malaysia, Sri Lanka and most other countries at higher levels, allowing the Republic of Korea to generate greater value added from each industry while rapidly upgrading its industrial structure.

**Table 5 Speed of manufacturing development in Malaysia, the Republic of Korea and Sri Lanka**

Industry	Malaysia	Republic of Korea	Sri Lanka
Food and beverages	1.49	5.26	3.03
Textiles	0.70	21.47	0.43
Wearing apparel	1.40	42.97	1.81
Chemicals	1.69	4.05	3.04
Basic metals	0.53	6.33	0.34
Fabricated metals	0.29	11.51	0.04
Electrical machinery and apparatus	0.77	8.10	0.42
Motor vehicles	0.61	4.97	0.02

*Source:* UNIDO's elaboration based on Penn World Tables version 8.0 and UNIDO INDSTAT 2014

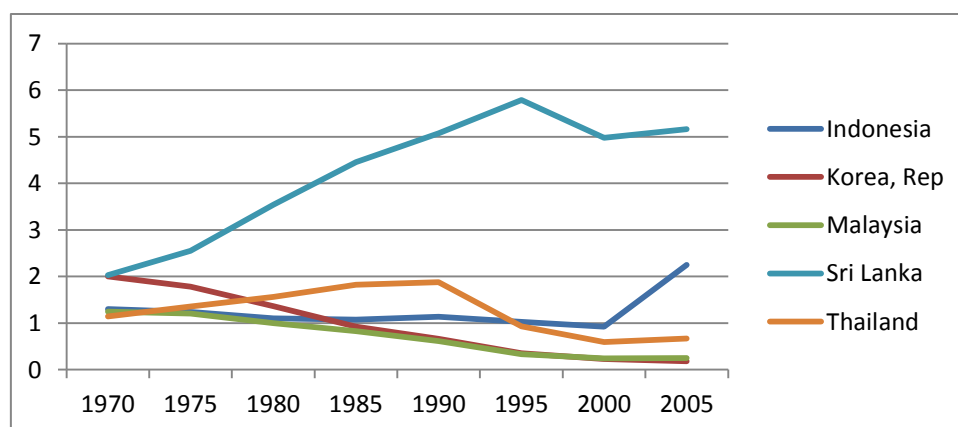
*Note:* Speed is expressed as an increase in value added per capita divided by the number of years taken over the range of GDP per capita from US\$ 3,000 to US\$ 4,500. The analysis uses this income range because different income ranges are associated with different growth rates, which allows us to look at the range in which the observations of the three countries overlap.

If a country rapidly climbs up a development curve of a given industry, it is expected that the country will also rapidly move towards emerging new industries and change its industrial structure. Figure 14 illustrates how countries shifted from one type of industry to another. The Y axis is the ratio of consumer goods to capital goods. The food and beverages, tobacco, wearing apparel, footwear and leather goods and furniture industries belong to the group of consumer goods industries while ferrous and non-ferrous metals, machinery, vehicle building and chemicals are included in the group of capital goods industries. The consumer goods industries roughly correspond to our early industries while the capital goods industries correspond to our classification of middle and late industries (Table 1). Moving to a small ratio thus implies that the country's manufacturing structure is becoming more capital intensive.

As illustrated in Figure 14, large differences exist even in relatively successful Asian countries. In 1970, the manufacturing structure of the Republic of Korea was dominated by consumer

goods industries or so-called early industries, which generated two-thirds of the manufacturing value added at that time, even more than in some other Asian countries such as Malaysia and Thailand. However, in the last 35 years, the country's manufacturing structure has rapidly and steadily shifted towards capital intensive industries. Today, the country's manufacturing structure is comparable to those of early industrialized countries such as the UK, Germany and Japan. In 1970, Malaysia had a more capital intensive manufacturing structure than the Republic of Korea. Subsequently, Malaysia's manufacturing structure became more capital intensity. However, the speed of the country's structural transformation was slower than that of the Republic of Korea and the latter caught up with Malaysia in 2000 in terms of the value added share of the capital goods industries in manufacturing. Sri Lanka as a lower middle income country has had a comparative advantage in early industries. The country's economic liberalization and privatization in the mid-1970s contributed to the emergence of its comparative advantage and the expansion of early industries. The country has finally started shifting its manufacturing structure towards more capital intensive industries. In 1970, Thailand and Indonesia had a lower consumer capital goods ratio than the Republic of Korea and approximately the same level as Malaysia's in 1970. However, Thailand only started reducing its consumer capital goods ratio after 1990 while Indonesia did not change it for 30 years and has only increased it since 2000.

**Figure 14** Speed of structural change in manufacturing



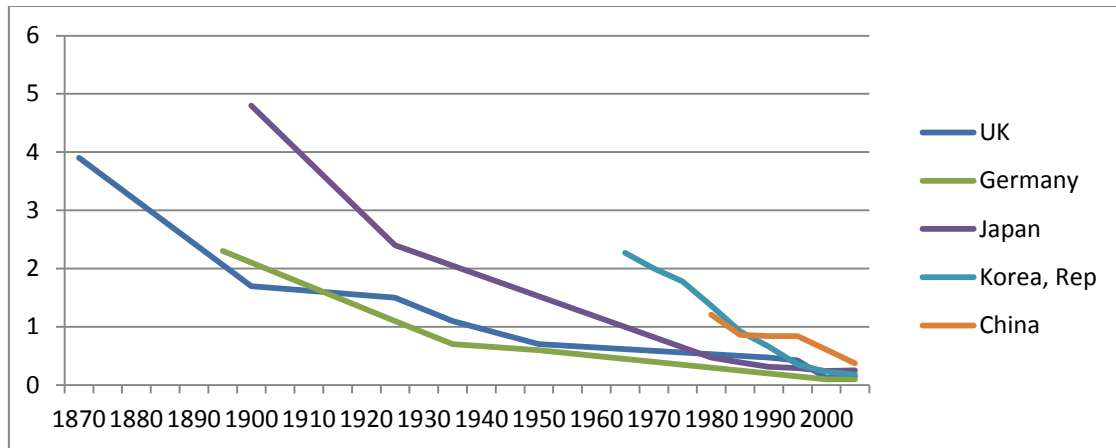
Source: UNIDO INDSTAT 2014

As shown in Figure 15, a low level of the consumer capital goods ratio is associated with the industrial structure of advanced countries, whose manufacturing sector is dominated by capital and especially technology intensive industries. What distinguishes the fairly recent case of industrialization in the Republic of Korea from the experiences of earlier industrializers is that the speed of structural transformation has been much faster in the Republic of Korea. It took approximately 105 years for the UK to reduce its consumer capital goods ratio from 2 to the



current level, 100 years for Germany, 70 years for Japan and only 35 years for the Republic of Korea. China is also industrializing at a similar pace. These recent examples indicate how quickly countries can transform their industrial structure by rapidly climbing up the development curve of individual industries, which in turn accelerates the structural change of the manufacturing sector.

**Figure 15 Long-term structural change in early industrialized countries**



Source: UNIDO and Hoffmann (1958)

## 5 Summary

This section synthesizes the discussion on manufacturing structural change to better understand how the different factors analysed in this chapter generate patterns and country specificities and produce a unique development path of industrialization. Following Chenery and Syrquin’s argument (1975), the first chapter discussed the three major factors that are said to shape structural change. The first of the three factors, stage of development, is the most fundamental force of structural change as the differences in supply and demand capabilities associated with income level drive the emergence of certain industries over others. Subsection 3.1 illustrated the patterns of manufacturing development along income levels. At an early stage of a country’s development, low-tech industries, such as the food and beverages, textile and wearing apparel industries, develop first. These are labour intensive industries and major sources of manufacturing employment up to an upper middle income stage. As the country moves to an upper middle to a high income, the dominant industries shift from the early to middle (e.g. basic metals) and to late industries (e.g. electrical machinery and apparatus) with the production process demonstrating increasing characteristics of capital and technology intensity. This pattern of structural change is usually found across countries, regardless of their country-specific conditions and time periods of development.

In addition to income level, which Chenery and Syrquin (1975) described as a universal factor of structural change, manufacturing development is also influenced by country-specific factors and produces a unique path of structural change in individual countries. Subsection 3.2 showed that a country's given conditions, such as its demographic and geographic effects over which the country has no or very limited control, affect manufacturing development. Smaller countries tend to develop labour intensive industries at an earlier stage of development than large countries and have a limited prospect for sustained growth of such industries, such as the motor vehicles industry. An abundant natural resource endowment has a negative impact on the development of nearly all manufacturing industries while a higher population density has a positive effect on capital and technology intensive industries, in particular.

Other country-specific conditions exist that increase or decrease an industry's level of development, even at an equivalent income level. Subsection 3.3 underscored the importance of the general business environment, which has an overarching effect on the development potentials of manufacturing industries across the board. In countries where all or most of the manufacturing industries record a poor performance, the first step in manufacturing development is to improve the general business climate, such as infrastructure, unit labour costs and macroeconomic and political stability before introducing industry-specific policy measures.

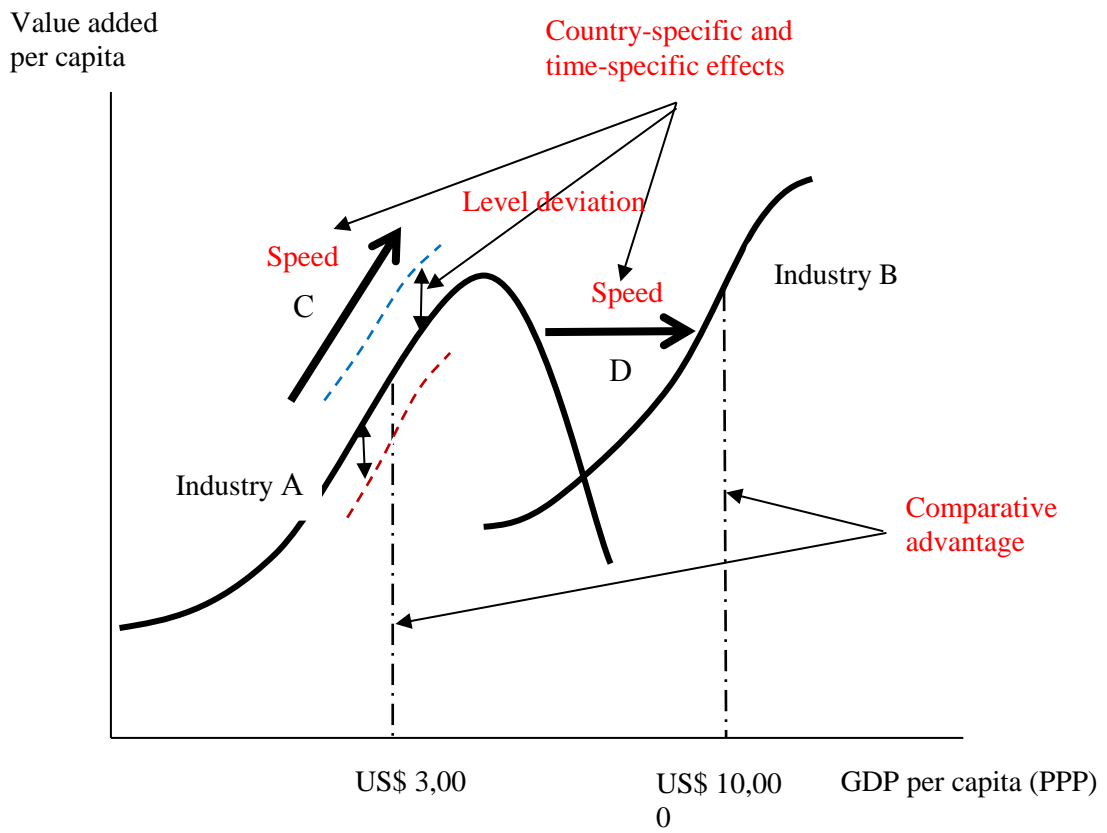
In addition to country-specific conditions, different time periods have time-specific effects on manufacturing development, shifting the development potential of industries upward or downward for a certain period across income levels. Subsection 3.4 traced time-specific effects for the last 30 years to identify emerging trends of manufacturing development. For example, the textile industry's development potential has reduced in terms of both value added and employment. The most common emerging characteristic is an increase in the production process's capital intensity. Several industries' value added has been increasing with disproportionately low additional inputs of labour or in some cases with the reduction of labour.

Finally, Section 4 discussed the speed of development as yet another dimension that affects a country's level of manufacturing development and structural change. Even though development patterns may be similar, some countries, such as the Republic of Korea, moved much faster than other countries along the patterns. From a historical perspective, the speed of industrialization and structural change in recently successful countries has been much faster than the speed of industrialization in Western countries and in Japan. This indicates that the increasingly globalized world could provide developing countries with greater opportunities for technical and policy learning, facilitated and incentivized by international assistance and competition.

The findings of this paper are illustrated in Figure 16. The development stage (income level) is the most fundamental factor shaping manufacturing development and structure based on a country's comparative advantage associated with income level. For example, Industry A can be considered a low-tech, labour intensive industry that develops rapidly at a relatively early stage of development, e.g. US\$ 3,000 GDP per capita, while Industry B, a capital and technology intensive industry, is likely to emerge and grow fast at a higher income level, such as US\$ 10,000 GDP per capita. Although countries generally follow a given development pattern and structural change path, they do not tread on a single path but may deviate upward (blue dotted line) or downward (red dotted line) due to their country-specific conditions, such as demographic and geographic conditions or other factors, including history, institutions and policy as well as time-specific effects. These country- and time-specific effects not only result in different levels of manufacturing development, but also generate different speeds for the development of individual industries (C) and for structural change (D).

Different schools of thought have put forward different effects of manufacturing development as a primary determinant for manufacturing development. However, as discussed in this paper and illustrated in Figure 16, each determinant differs in terms of where and how it affects manufacturing development, and it is the combination of these effects that ultimately determines the level and path of manufacturing development and structural change.

**Figure 16** Schematic representation of the role of comparative advantage, and country-specific and time-specific effects in manufacturing development



Source: Author's elaboration

## Annex 1

The following equation with fixed effects is used for the estimations of the development patterns of 18 manufacturing industries at the two-digit level of the International Standard of Industrial Classification. For each industry, the real value added, employment and labour productivity are estimated. The panel dataset used comprises time series from 1963 to 2010 and includes 75 and 110 countries, depending on the industries and variables estimated. Furthermore, we assessed the effects of population density, natural resource endowment and time periods on the three dependent variables.

The real value added per capita of each industry is calculated based on the industry-specific Index of Industrial Production.

$$\ln RVA_{ct}^i$$
$$\ln EMP_{ct}^i = \alpha_1 + \alpha_2 * \ln RGDP_{ct} + \alpha_3 * \ln RGDP_{ct}^2 + \alpha_4 * \ln RGDP_{ct}^3 + \alpha_c^i + e_{ct}^i$$
$$\ln LP_{ct}^i$$

*RVA* – real value added per capita

*EMP* – employment-population ratio

*LP* – labour productivity

*RGDP* – real GDP per capita (in constant PPP 2005)

$RGDP^2$  – real GDP per capita square,

$RGDP^3$  – real GDP per capita cubic

$\alpha_c$  – country fixed effect

*e* – unexplained residual

*i* – manufacturing industry (ISIC 2-digit level - 18 industries)

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