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Unravelling Manufacturing Development: The Role of Comparative Advantage, Productivity Growth and Country-specific Conditions

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Unravelling Manufacturing Development: The Role of Comparative Advantage, Productivity Growth and Country-specific Conditions

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Table of contents

List of figures

List of tables

1. Introduction

In Haraguchi and Rezonja (2010), we explored the patterns of manufacturing development in detail and illustrated when, how fast and for how long manufacturing sub-sectors grow as well as how such patterns differ in relation to a country's demographic and geographic conditions. Building on the results, the study further elaborated policy implications for developing countries. The present study focuses on the trends of productivity changes in manufacturing industries and—based on the patterns of manufacturing transformation elucidated in our previous work—determines the role of comparative advantage, productivity growth and country-specific conditions in manufacturing development. Comparative advantage is exemplified by the development potential of different industries at various levels of GDP per capita which, in turn, has strong correlations with a country's human and capital resource endowments and relative costs of production factors. To indicate a level of a country's technological capability, we use labour productivity growth as a proxy in our study and look at its relation to developments in manufacturing sub-sectors. Finally, to understand the distinct experiences and potentials of countries' manufacturing development, the paper investigates country-specific conditions, both positive as well as negative deviations from the development patterns.

Early development literature provides evidence of the association between the initial surge of modern economic growth and the sustained shift in the share of economic activities from agriculture to manufacturing (Clark, 1957; Kuznets, 1966). In turn, authors from the different schools of economics emphasize the significance of structural change within the manufacturing sector, i.e. upgrading the industrial structure to sustain industrialization (Taylor, 1968; Chang ed., 2003; Felipe, 2009; Lin, 2011).

In his proposition for new structural economics, Lin emphasizes the importance of structural change based on the comparative advantages of a country, which are largely shaped by the country's resource endowment structure (Lin and Monga, 2011; Lin, 2011). He highlights the dynamic and catalytic role of the manufacturing sector in economic development and argues that a country moves from one manufacturing industry to another, given that the development trajectory of each manufacturing industry follows an inverted U shape. Lin does not seem to concur with the possibility of a country leapfrogging to industries that it does not have a comparative advantage in. He perceives the government's role as priming the pump to facilitate industrial upgrading in relation to changes in comparative advantage, as moving to a new industry involves risks and will not be optimal if left to the market alone.

One school of thought places much more weight on technological capability and the competitiveness of industries than on the comparative advantages of a country as guiding points for economic development. According to this school, defying comparative advantage (to certain limitations) and building the technological capability required for industries that are more advanced than those based on a country's comparative advantage are crucial for industrialization (Lin and Chang, 2009). The government is expected to play a much more active role and implement industry-specific policies rather than to simply improve infrastructure and correct coordination failures.

This paper does not provide evidence to support one of these representative views on development. Nor does it propose an appropriate level and types of government intervention conducive to a country's development. The objective of this study is to discuss the empirical results to better understand how comparative advantage, productivity growth and country-specific conditions drive industrial development. To illustrate the three factors' respective roles in the path of development, this study analyses the evolving patterns of manufacturing industries and corresponding changes in productivity.

The starting point of our analysis is to identify a point where the above two schools overlap. Both acknowledge the manufacturing sector as the engine of economic development as well as the significance of the sector's continuous structural upgrading to sustain that engine. The manufacturing industry may offer more opportunities than other sectors for product diversification (Imbs and Wacziarg, 2003), for deepening the industrial structure and for productivity increase. Rodrik points out that unlike the case of the economy as a whole, countries' manufacturing sector reveals unconditional convergence. The further a country is behind the technological frontier in a manufacturing industry, the faster the growth of that industry's labour productivity will be (Rodrik, 2011).

One of the disagreements among economists who believe that the manufacturing industry plays a key role in economic development relates to the given sub-sector in manufacturing a country ought to enter or focus its development efforts on at different stages of development. On the one hand, those who put weight on comparative advantage recommend countries to align their development strategies with the signals arising from a country's changing endowment structure, which only shifts gradually. Others, on the other hand, focus on the prospects and types of technological development that manufacturing industries could generate and its long-term potential contribution to the economy in general. Still others stress the role of government to provide support for long-term investment in human and physical capital (World Bank, 1993).

This paper provides evidence of how different development aspects, comparative advantage, technological improvements and country-specific conditions, may relate to manufacturing development. The next section discusses the data and methodologies, followed by an analysis of the results.

2. Data, variables and estimations

To illustrate the development trajectories of individual manufacturing sub-sectors (hereafter referred to as manufacturing industries or simply industries) and to draw policy implications, this paper examines changes in the value added per capita in relation to increase in PPP adjusted GDP per capita[1] instead of changes in the value added share of each industry. An analysis based on changes in value added per capita allows us to gain insights into the development characteristics of each industry, as unlike in the case of changes in value added shares of individual manufacturing industries within the total manufacturing value added, the calculation is not affected by the rise and fall of other industries. However, taking a comparative perspective across industries is important for understanding changes in the relative importance of industries, since the rise of one industry inevitably affects others through the transfer of production factors. The development patterns of the different industries will therefore be compared with each other.

The analysis is conducted for the manufacturing industries at the two-digit level of the International Standard Industrial Classification (ISIC) revision 3. There are 23 industrial categories in total. However, as countries often report industries 18 and 19, 29 and 30, 31 and 32, and 34 and 35 together, we combined each pair into one industrial category to have a consistent data set across countries. Furthermore, we dropped industry 37, recycling, as it has only been reported by a very limited number of countries.

The following table presents the industrial classifications used in this study. Ideally, real value added should be calculated as an output in constant price excluding various purchases from other industries valued in constant prices. However, such price-adjusted data are not available for a large number of countries, in particular for developing countries, to reliably estimate the development patterns of manufacturing industries. Alternatively, to adjust changes in price we

[1] All subsequent references to GDP per capita in this paper denote PPP adjusted GDP per capita.

use the Index of Industrial Production (IIP) which is available at the two-digit level of the ISIC. Some countries have already begun reporting their industrial data based on the latest ISIC revision (revision 4); however, we use the IIP based on revision 3 of the ISIC, which has been widely used since the mid-1980s.

Table 1 Manufacturing data classification used in this study

ISIC description	*Abbreviation*	*ISIC code*
Food and beverages	Food and beverages	15
Tobacco products	Tobacco	16
Textiles	Textiles	17
Wearing apparel, and fur & leather products, and footwear	Wearing apparel	18 & 19
Wood products (excluding furniture)	Wood products	20
Paper and paper products	Paper	21
Printing and publishing	Printing and publishing	22
Coke, refined petroleum products, and nuclear fuel	Coke and refined petroleum	23
Chemicals and chemical products	Chemicals	24
Rubber and plastic products	Rubber and plastic	25
Non-metallic mineral products	Non-metallic minerals	26
Basic metals	Basic metals	27
Fabricated metal products	Fabricated metals	28
Machinery and equipment n.e.c. & office, accounting, computing machinery	Machinery and equipment	29 & 30
Electrical machinery and apparatus & radio, television, and communication equipment	Electrical machinery and apparatus	31 & 32
Medical, precision and optical instruments	Precision instruments	33
Motor vehicles, trailers, semi-trailers & other transport equipment	Motor vehicles	34 & 35
Furniture; manufacturing n.e.c.	Furniture, n.e.c.	36

Source: Created by the authors.

To obtain a longer time series data UNIDO has combined the IIP of revision 2 of the ISIC, which goes back to the early 1960s, with revision 3 to arrive at an IIP that covers the years 1963 to 2004 based on revision 3 of the ISIC. By multiplying such a series of volume indices by the value added of a given base year—1995 in the case of our study—we were able to approximate real value added for a time series.[2] However, the IIP is only available for around 70 countries; hence, when using this approach approximately 50 countries which do not have an IIP, but for which the nominal value added data for their manufacturing industries is available, cannot be included in regressions to estimate manufacturing development patterns. Since many countries without an IIP are developing and emerging countries, it is important to also reflect their development trajectories in the estimations of manufacturing structural change.

Manufacturing sector-wide value added (MVA) deflators are available for most of the countries without an IIP. However, applying an MVA deflator across manufacturing industries might produce biases, as inflation rates from one industry to another could differ significantly (e.g., between the food and beverages industry and the petrochemical industry) for given years.[3] To reflect the industry-specific inflation trend, we decomposed the respective country's manufacturing-wide deflation using an inflation structure based on the same year's IIP of another country located in the same region and at a relatively similar development stage. Using this approach, we try to reflect industry-specific inflation trends by equalling the sum of the nominal value added divided by the sum of the real value added of manufacturing industries with the country's MVA deflator. This approach allows us to include around 70 countries with and 50 countries without an IIP in our estimations. Appendix A explains this procedure in detail.

Past studies acknowledge that country size has an overarching influence on economic structural change (Chenery and Taylor, 1968), with effects on both the intercepts as well as the slope of the estimated patterns. Thus, instead of including population in the equation as an additional explanatory variable, many studies resort to dividing countries into size groups, applying a

[2] Depending on the given country, changes in the weight of quality and products in an industry may not necessarily be regularly updated in IIP. The gradual changes in the valued added share in output may not appropriately be reflected in the IIP despite regular adjustments.

[3] The authors first determined whether a manufacturing value added deflator (MVA deflator), i.e., a manufacturing sector-wide deflator, could be used for the 70 countries with an IIP. Where this was found to be suitable, a country's MVA deflator could be used to deflate the valued added across manufacturing sub-sectors within a country for all 120 countries with MVA deflators. To check this, the manufacturing development patterns were estimated for the 70 countries with an IIP and MVA deflators, using both their IIP and MVA deflator. The two estimated patterns based on the IIP and MVA deflator approaches were compared to determine whether the differences between the two were statistically significant. The two patterns significantly varied for many industries, so we were therefore not able to adjust nominal values by using MVA deflators, which were available for 120 countries.

certain population size as a threshold. The problem related to this approach in past studies has been that this threshold was often arbitrarily used without determining whether such groups statistically differ in terms of their development patterns. To classify countries into three groups of different sizes, we applied thresholds to divide them into small, medium and large countries, and examined at which threshold level the maximum number of manufacturing industries is obtained whose development patterns statistically differ from one another. This was achieved by applying the Wald test. Based on our test results, we used thresholds of 3 million and 12.5 million to divide countries into small, medium and large countries. In accordance with these thresholds, medium-sized countries with a population from 3 million to 12.5 million have different development patterns than small-sized countries with a population of less than 3 million for 13 out of 18 manufacturing industries. The development patterns of all industries in large-sized countries with a population of over 12.5 million differ from those in medium-sized countries.

It does not suffice to divide countries into three groups using the above method to unequivocally claim that a distinct pattern emerges for each group. Ideally, countries in the same group should at least have statistically equal coefficients for the slopes, if not for both the intercepts and slopes. To determine whether countries within the same group have similar development patterns, we examined the statistical significance of both the individual country intercepts and slopes of the explanatory variables used in the estimations. Individual country intercepts are significant across most of the countries and industries, therefore, it can be inferred that countries differ in terms of intercept levels. Individual slopes are statistically insignificant for the majority of countries across all industries, which indicates that countries in different size groups do not significantly differ from each other in terms of slope.

It is assumed that industries undergo three development stages—pre-takeoff, growth and decline—following a pattern of a cubic function. However, those industries which can sustain growth over a long period of time may have a more linear development trajectory, while other industries which experience growth from a very early stage of development and only decline at a later stage, may indicate a more quadratic pattern. Hence, we included cubic and square terms of GDP per capita in the equation in order for the results to denote possible patterns of manufacturing development, depending on the statistical significance of these GDP per capita terms. The objective of our study is to ascertain how industries in countries of different size groups are likely to develop. It is therefore useful to first only consider the relationship between value added per capita and GDP per capita to tease out the "average" industrial development patterns of the different country size groups. To control for the effect of unobserved country-specific conditions, we apply the fixed effect estimation procedure. For this purpose, the following equation is used for each manufacturing industry in the three groups of countries of different size:

$$\ln RVA_{ct}^{i} = \alpha_1 + \alpha_2 * \ln RGDP_{ct} + \alpha_3 * \ln RGDP_{ct}^{2} + \alpha_4 * \ln RGDP_{ct}^{3} + \alpha_c + e_{ct}^{\ i} \qquad (1)$$

Subsequent analyses address how demographic and geographic conditions shape the group-wide average pattern to demonstrate which other country conditions, aside from a country's development stage, affect the level of manufacturing development. Thus, the regressions equation includes variables for population density and natural resource endowment.[4]

$$\ln RVA_{ct}^{i} = \alpha_1 + \alpha_2 * \ln RGDP_{ct} + \alpha_3 * \ln RGDP_{ct}^{2} + \alpha_4 * \ln RGDP_{ct}^{3} + \alpha_5 * \ln POPD_{ct} + \alpha_6 * \ln RPC_{ct} + \alpha_c \quad (2)$$
$$+ e_{ct}^{\ i}$$

The subscripts of *c* and *t* denote country and year, respectively, whereas *i* signifies the respective manufacturing industry where *RVA* is real value added per capita. As for the right hand side variables:

- $RGDP$ stands for real GDP per capita,
- $RGDP^2$ denotes real GDP per capita square,
- $RGDP^3$ signifies real GDP per capita cubic,
- $POPD$ is population density,
- RPC represents natural resource endowment per capita,[5]
- α_c is country fixed effect
- $e_{ct}^{\ i}$ refers to unexplained residual.

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[4] The effects of landlockedness and tropical climate were also tested using the Hausman-Taylor IV estimator, as these variables are time-invariant. Landlockedness had almost no effect on manufacturing development, and tropical climate tended to negatively affect many capital intensive industries of medium-sized countries as well as some industries in large countries.

[5] The natural resource proxy variable *(RPC)* 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).

Both dependent and explanatory variables are expressed in logarithmic terms to measure the elasticity of each variable. The regression results are presented in Appendix B.

3. Results and analysis

In this section, we first identify the development trajectories of industries and how the growth potentials shift from one industry to another along a country's development path to determine whether there are any indications of the existence of comparative advantages at different stages of development. Subsequently, a given industry's development pattern is analysed together with the patterns of the industry's labour productivity changes to elucidate the role of technological development and gain further insights into the relevance of comparative advantage in industrial development. Finally, we select a relatively successful country and comparators which have similar endowment characteristics to the successful country, and examine the patterns of development they have followed and investigate the differences in their developments. In view of the limited space in this paper, only eight industries in the manufacturing sector are analysed—food and beverages, textiles, wearing apparel, chemicals, basic metals, fabricated metals, electrical machinery and apparatus and motor vehicles—which are considered representative of the different characteristics of the manufacturing sector in terms of their periods of emergence in a country's general and its technological development.

Patterns of manufacturing development

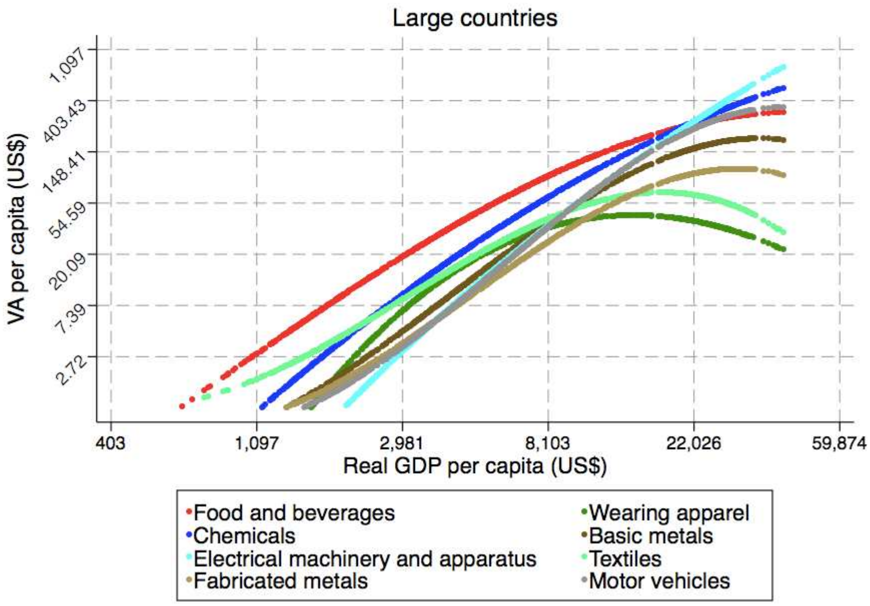
As discussed in the above section, we identified distinct patterns of development for each industry and group. Figure 1 illustrates the development patterns of the eight selected industries in large countries with a population of more than 12.5 million.

The food and beverages industry is the industry which typically is the first to take off, reaching an elasticity of 1 (i.e., the industry starts growing faster than the rate of GDP per capita) with less than US$ 100 GDP per capita. Other early industries shown here are the textiles and wearing apparel industries.[6] Aside from the food and beverages industry, the early industries tend to start slowing down earlier than other industries. For example, the textiles and wearing

[6] The 18 manufacturing industries studied in this paper are classified into early, middle and late industries depending on whether an industry reaches its highest share in total manufacturing value added before a GDP per capita of US$ 5,000, between US$ 5,000 and US$ 20,000 or after US$ 20,000, respectively. The early industries include food and beverages, tobacco, textiles, wearing apparel, wood products, printing and publishing, coke and refined petroleum, non-metallic minerals, and furniture, n.e.c. The middle industries are paper, basic metals, fabricated metals and precision instruments. The late industries comprise chemicals, rubber and plastic, machinery and equipment, electrical machinery and apparatus and motor vehicles.

apparel industries will start growing slower than the economy when large countries reach around a GDP per capita level of between US$ 7,000 and US$ 10,000.

Figure 1 Development patterns of manufacturing industries in large countries



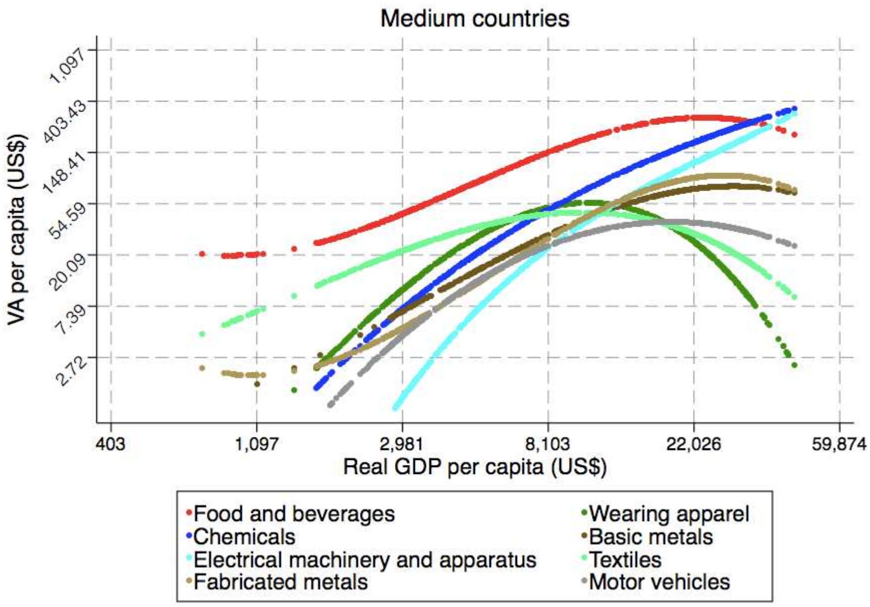
Source: Developed by the authors based on regression estimations.

The electrical machinery and apparatus, motor vehicles, fabricated metals and basic metals industries start their development later and can sustain their growth rates longer than the early industries, with the exception of both the food and beverages industry. Among these sectors, the basic metals and fabricated metals industries begin declining earlier than the others, when countries reach an approximate GDP per capita level of between US$ 17,000 and US$ 20,000, respectively. The motor vehicle industry is expected to start growing slower than per capita growth rate at a GDP per capita level of around US$ 25,000. The electrical machinery and apparatus industry is the most sustainable industry and can maintain a fast growth rate for a long period of time. Though not included in the figure, the rubber and plastic as well as the machinery and equipment industries also maintain a faster-than-the-economy growth rate until the country reaches around US$ 30,000 and US$ 45,000 GDP per capita, respectively.

Next, the manufacturing development patterns of large countries are compared with those of medium and small countries (Figures 2 and 3). The graphs illustrate the development patterns of the three country groups; the graphs for each individual industry can be found in Appendix C. The dotted lines which represent industries at a low and high GDP per capita level, especially in small countries, signify limited data availability and may consequently be less reliable representations of the development patterns. Generally, the sequence of development among industries in medium and small-sized countries is similar to that in large ones. As is the case in large countries, the food and beverages, textiles, and wearing apparel industries tend to also develop and have a larger share in terms of value added in the manufacturing sector during the early stage of a country's development. Among these, the food and beverages industry is more sustainable.

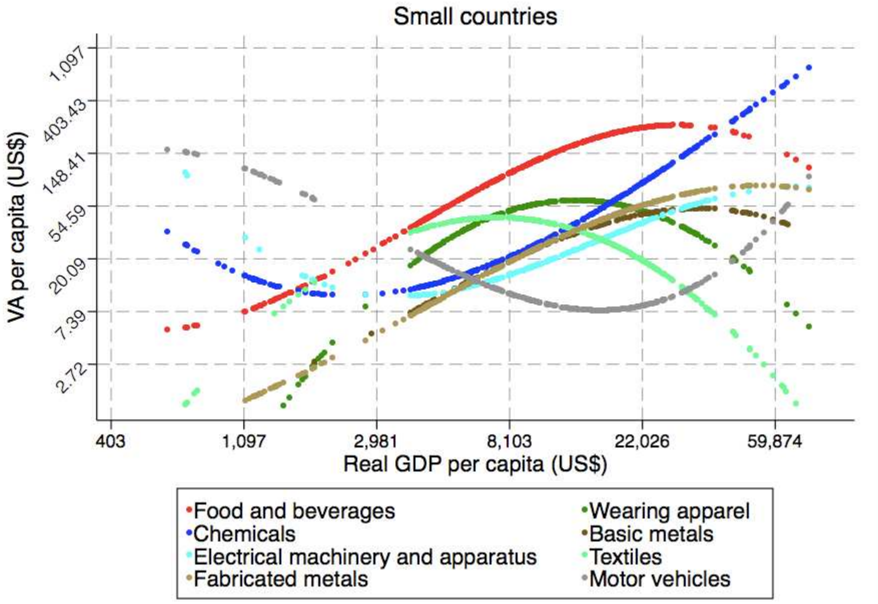
Some differences are evident among the three country groups. The early industries seem to hold more dominant positions in the manufacturing sector from the low to the middle income stages in medium and small countries in comparison with large ones (Figure 2 and 3). Furthermore, the early industries in medium and small countries reach their peak points (at which their value added per capita begins to decline) earlier than large countries.

Figure 2 Development patterns of manufacturing industries in medium-sized countries



Source: Developed by the authors based on regression estimations.

Figure 3 Development patterns of manufacturing industries in medium-sized countries



Source: Developed by the authors based on regression estimations.

For example, the textiles industry of medium and small countries is likely to start declining when a country's GDP per capita rises to between US$ 7,000 and US$ 10,000, while the decline of that same industry in a large country normally occurs after a GDP per capita level of US$ 15,000 has been reached. In the case of the food and beverages industry, the decline begins at around US$ 20,000 to US$ 30,000 GDP per capita for medium and small countries as opposed to around US$ 45,000 for large countries.

With regard to the middle and late industries, which predominate over the early industries at a later stage of development, the basic metals and fabricated metals industries of medium and small countries are less sustainable than those of large countries. [7]

The basic metals industries of medium and small countries start growing slower than the economy at a GDP per capita level of approximately US$ 10,000 to US$ 13,000, and the fabricated metals industry reaches that point at around US$ 15,000 to US$ 16,000 of GDP per capita, while the same slowdown becomes evident in large countries at a GDP per capita level that is US$ 5,000 higher than the equivalent in medium and small countries for the basic metals industry and US$ 2,000 higher, respectively, for the fabricated metals industry.

[7] For the definitions of the early, middle and late industries, refer to Footnote 5.

Larger countries, in particular, tend to have an advantage over smaller ones in the basic metals industry. The estimated highest value added per capita level the basic metals industry can reach in large, medium and small countries is US$ 191, US$ 76 and US$ 51, respectively. However, country size does not significantly impact the development of industries based on higher processed products such as the fabricated metals industry.

As Figure 1-3 indicate, the most notable difference between small and the other countries is the limited development prospects of the electrical machinery and motor vehicle industries in small countries. The electrical machinery industry of small countries begins to decline before reaching a value added of US$ 100 per capita, while it maintains a fast growth rate in medium and large countries, even at a high income level, and reaches a much higher level of value added per capita. The motor vehicle industry has very limited prospects for successful development in small countries. Economies of scale play a crucial role in the development of this industry, and country size seems to be of relevance. The motor vehicle industry (including parts and accessories) in medium-sized countries may reach a certain level of development, while the industry has a much higher development potential in large countries.

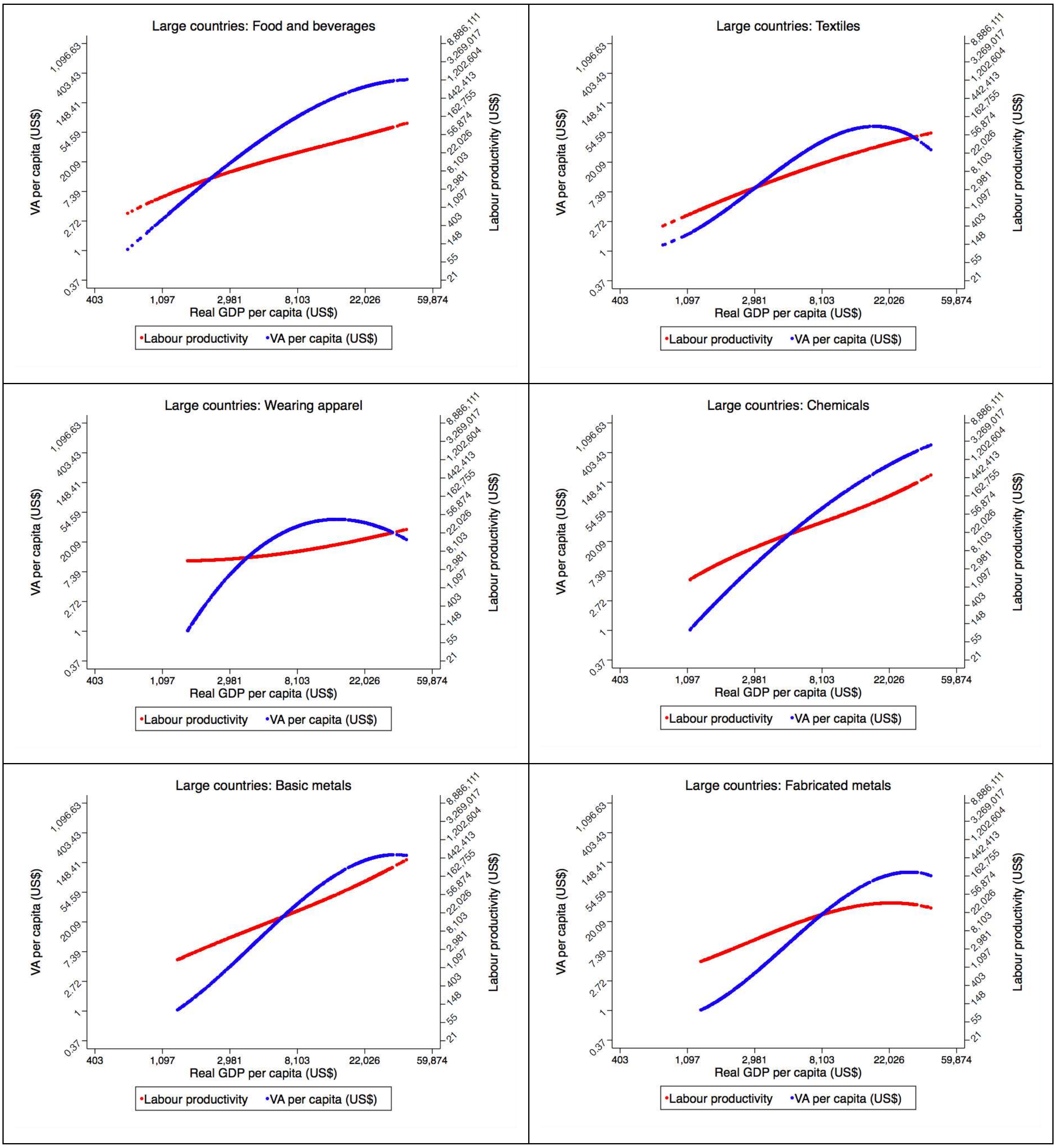
The above analyses on manufacturing development patterns within and across country groups of different sizes indicate that certain patterns exist in the sequence of manufacturing development, which correspond with countries' development stages. Furthermore, the development potential of each industry differs among and across countries of different sizes. Thus, through market mechanisms and, if necessary, with government facilitation, countries need to shift resources from one industry to another to foster the development of those industries that offer advantages in a particular stage of a given country's development. Among the industries selected in this study, the chemicals, electrical machinery and apparatus and fabricated metals industries of medium-sized countries are comparable to those of large countries in terms of the sustainability of their growth. Small countries do not seem to benefit from industries that require economies of scale to produce a large volume of materials for further processing, such as the textiles and basic metals industries. Small countries do not, however, seem to have less of an advantage in processing industries, namely in the wearing apparel, fabricated metals and chemicals industries, though the emergence of these industries in small countries may be slower than in the other countries.

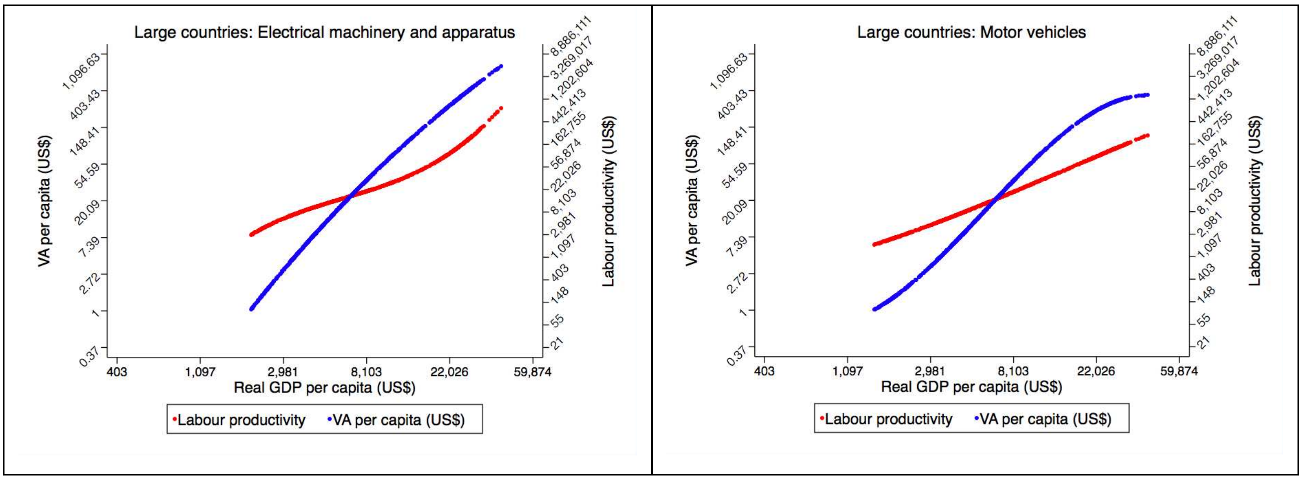
Industrial development and changes in productivity

The patterns of industrial development identified above purport the existence of comparative advantages in the sense that a given development period exists in which each manufacturing industry tends to prosper and, consequently, dominant industries change in accordance with a country's development, which proceeds with it changes in endowment structure. However, productivity growth may also be a reason behind the development of an industry. In that case, it is difficult to identify the clear-cut effects of comparative advantage on industrial development or even its existence. To further elucidate this, the patterns of both value added per capita and labour productivity changes are combined to analyse the role of the latter in industrial development.

Figures 4 to 6 illustrate how value added per capita (industry size in terms of value) and labour productivity change as GDP per capita increases for the eight industries introduced above. Thereby, some interesting attributes of industries are unearthed and provide insights into the question raised in this sub-section. For some early industries such as textiles and wearing apparel, labour productivity does not seem to play a significant role for their development. On the one hand, during their rapid growth period, labour productivity does not generally increase much, though degrees of difference do exist between the various country size groups. On the other hand, an increase in labour productivity in the later stages of their development does not seem to change the course of the industries' decline in terms of valued added per capita. The results indicate that labour productivity increases once these early industries mature because less competitive firms exit the industries and the remaining firms replace labour with capital as the wage rate increases. This represents a strong case for the role of comparative advantage in the growth of these industries, as the stage of development together with the related endowment structure seem to be a major determinant for the industries' development.

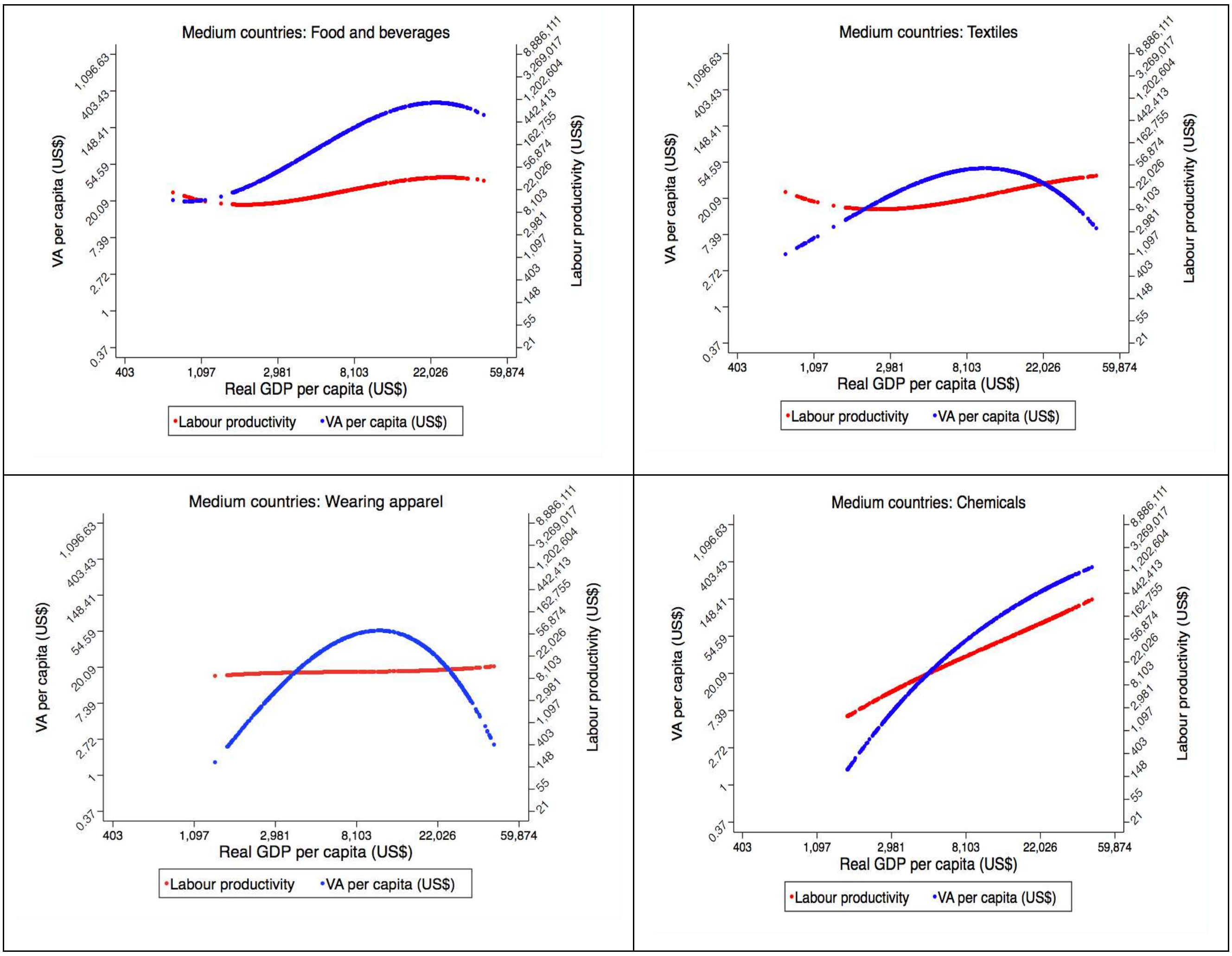
Figure 4 **Development patterns of value added per capita and labour productivity of manufacturing industries in large countries**

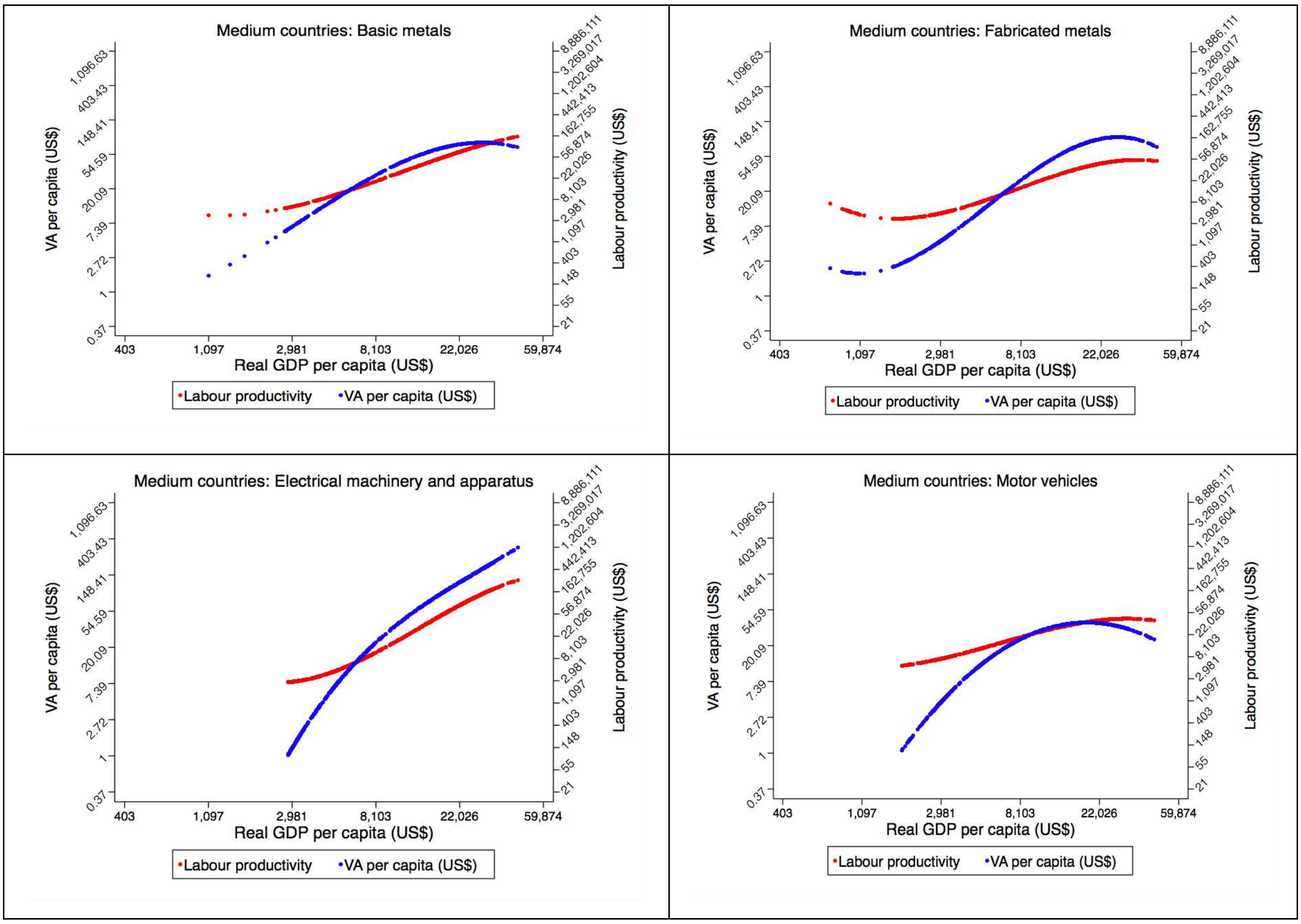




Source: Developed by the authors based on regression estimations.

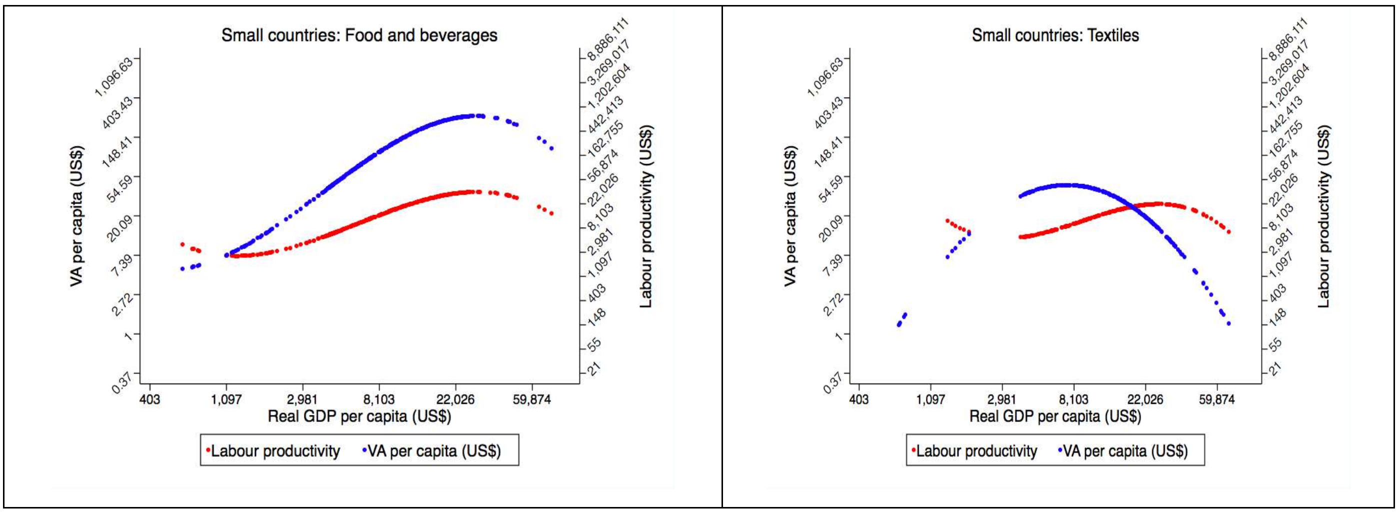
Figure 5 Development patterns of value added per capita and labour productivity of manufacturing industries in medium-sized countries

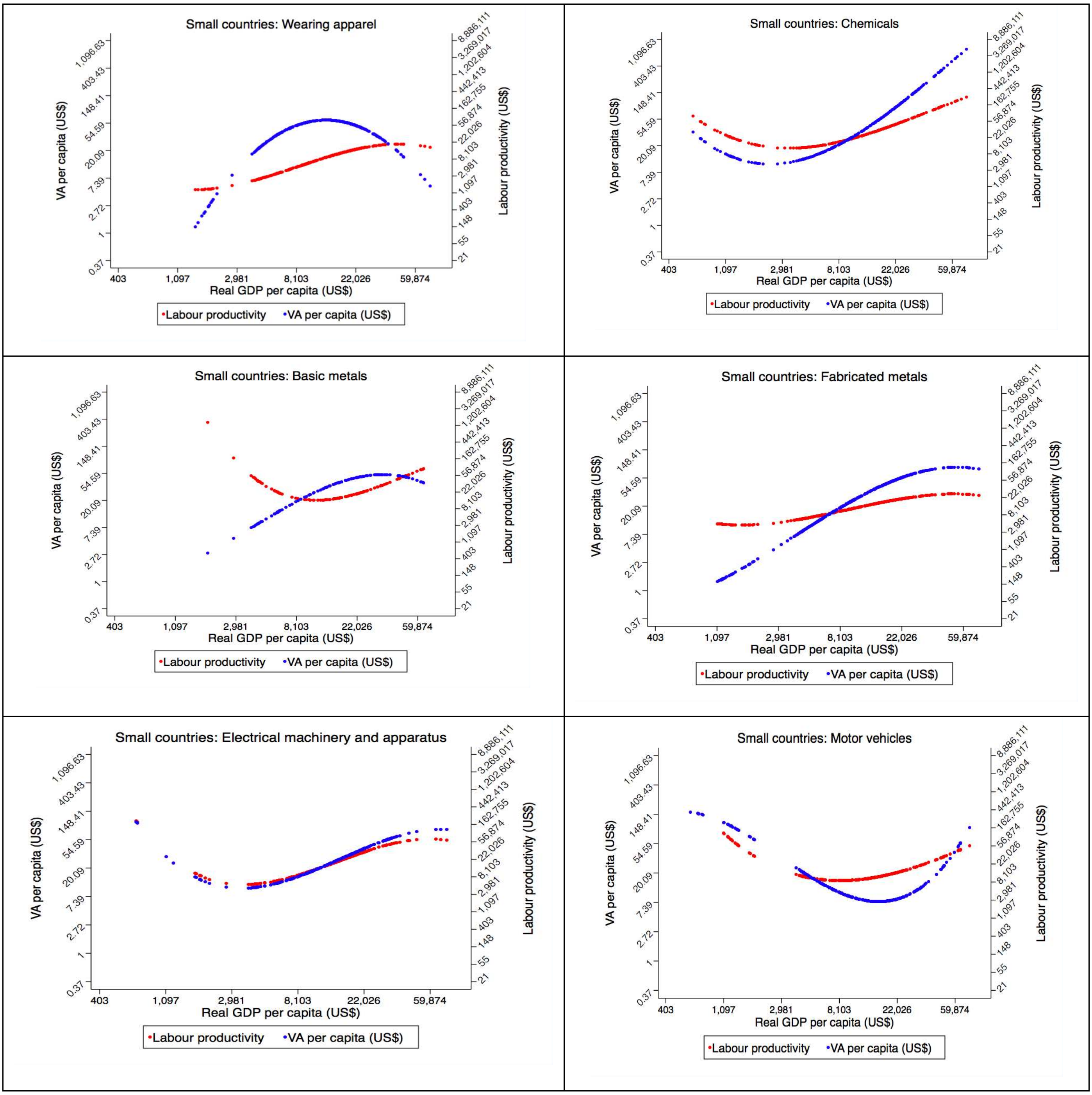




Source: Developed by the authors based on regression estimations.

Figure 6 **Development patterns of value added per capita and labour productivity of manufacturing industries in small countries**



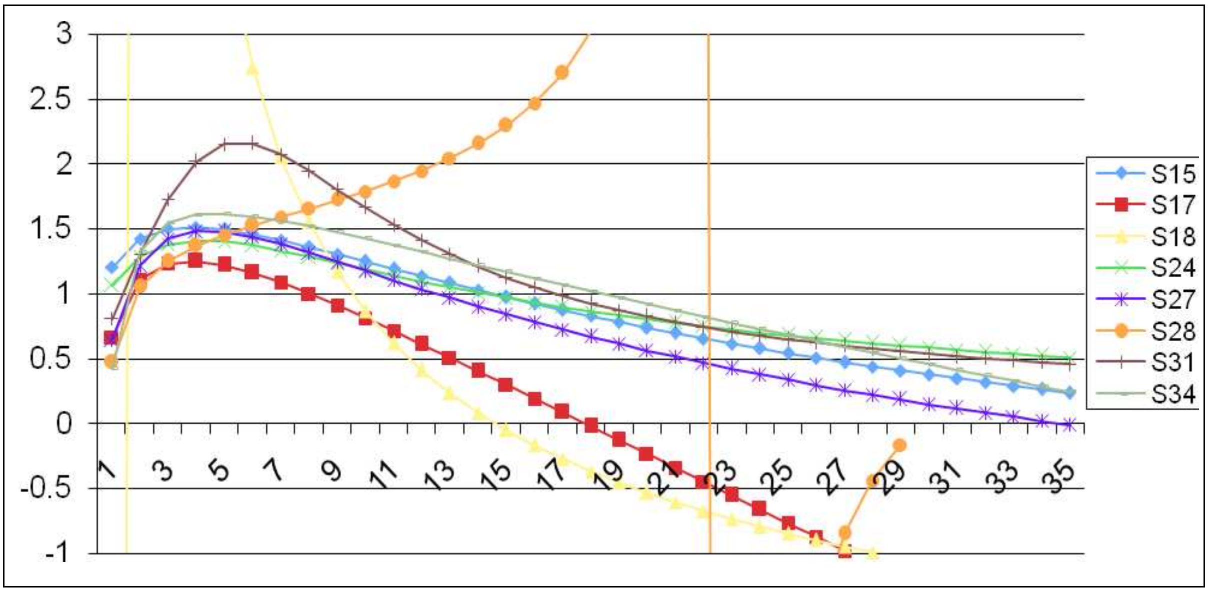


Source: Developed by the authors based on regression estimations.

The role of comparative advantage in the growth of the other industries may not be as obvious as in the case of the early industries, but the effects of comparative advantage on the growth of each industry becomes visible when looking at the points at which industries begin losing this advantage. For example, the value added per capita of the basic metals industry starts slowing down and declining at certain stages of development, even though the growth of labour productivity remains more or less unchanged. It is likely that an industry begins to lose its comparative advantage around the time the growth rate of valued added per capita becomes lower than that of labour productivity. Before reaching this point, the increase in productivity brought higher returns in terms of valued added per capita—higher than the efforts made to increase productivity—seemingly by a dint of the comparative advantage. However, once the growth of value added per capita starts becoming smaller than that of productivity, an increase in the industry's productivity translates into an increasingly smaller rate of the industry's expansion, again due to the onset of the industry's insurmountable comparative disadvantage.

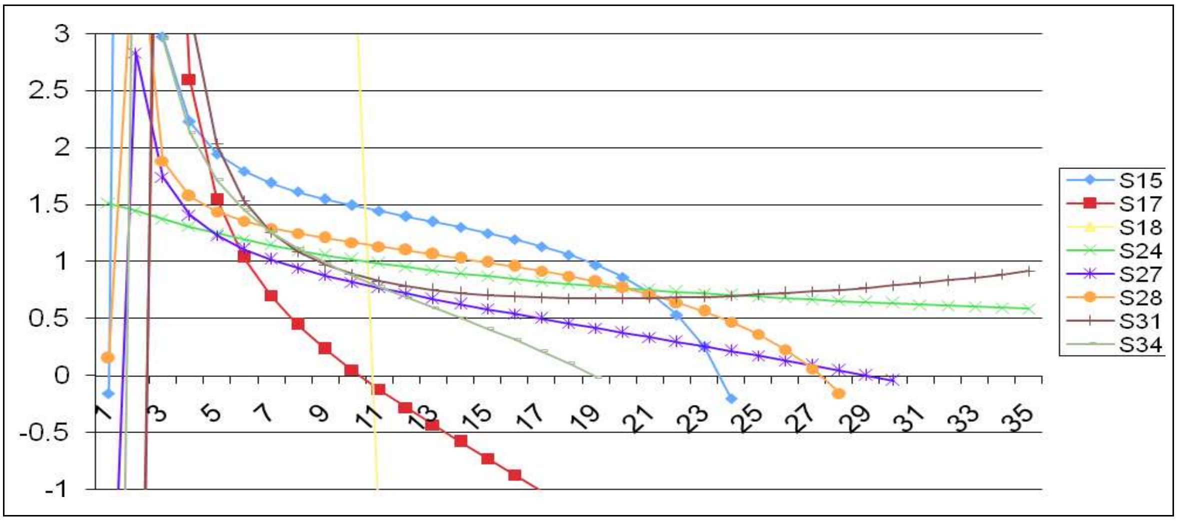
Likewise, the approximate time period of the loss of comparative advantage for each industry can be estimated by dividing the growth rate (slope) of value added per capita by the growth rate (slope) of labour productivity across GDP per capita levels. An elasticity value which is smaller than 1 and signifies the percent increase in value added per capita for a 1 percent increase in labour productivity, implies that the industry is disadvantaged relative to the industries that have a value higher than 1. Figures 7 to 9 illustrate how this elasticity changes on average and when industries lose their comparative advantage.

Figure 7 Elasticity changes (% change in value added per capita per % change in labour productivity) in accordance with GDP per capita increase for large countries



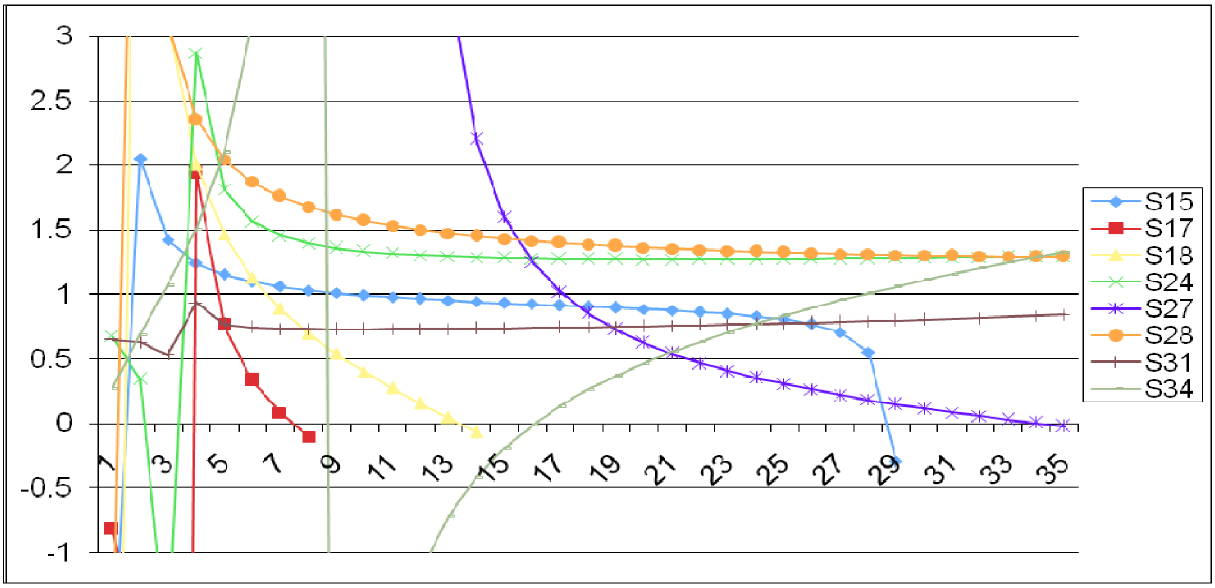
Source: Developed by the authors based on regression estimations.

Figure 8 **Elasticity changes (% change in value added per capita per % change in labour productivity) in accordance with GDP per capita increase for medium-sized countries**



Source: Developed by the authors based on regression estimations.

Figure 9 **Elasticity changes (% change in value added per capita per % change in labour productivity) in accordance with GDP per capita increase for small countries**



Source: Developed by the authors based on regression estimations.

As Figure 7 exemplifies, large countries lose comparative advantage in the textiles (S17) and wearing apparel (S18) industries when they reach GDP per capita levels of around US$ 9,000 and US$ 10,000, respectively (which are the levels that fall below an elasticity of 1 in the graph). As expected, advantages in these industries cease earlier than in the other industries included in our analysis. The extreme change in the elasticity of the fabricated metals industry (S28) is attributable to the decline of productivity before the value added per capita begins to fall. However, it can be presumed that this industry's advantage ceases at the latest once the value added per capita starts declining. Following the textiles and wearing apparel industries, large countries are likely to lose their advantage in basic metals production (S27) at around US$ 13,000 GDP per capita. Next, the chemicals (S24), food and beverages (S15), electrical machinery and apparatus (S31) and motor vehicles (S34) industries lose their advantage (in that order). The difference in the slopes of the descending lines between the early, except for food and beverages, and the other industries is worth noting. In the case of the textiles and wearing apparel industries, advantages decline rapidly despite an increase in labour productivity. Yet for late emerging industries, like the electrical machinery and apparatus industry, a rise in productivity is associated with the growth of the given industry much longer than with that of the textiles and wearing apparel industries, even after the advantage has ceased at an elasticity of 1. In other words, a loss of comparative advantage also seems unavoidable for the late industries, but unlike most of the early industries, they can potentially extend the growth through productivity increase.

In the case of medium-sized countries, as illustrated in Figure 8, there are shorter time lags in the decline of comparative advantage of both the textiles (S17) and the wearing apparel (S18) industries and that of others, excluding the chemicals (S24) and the electrical machinery and apparatus (S31) industries. With the exception of these two industries, it also appears that productivity increase has more limited effects on the sustenance of the growth of the late emerging industries, as evidenced by their shorter right-hand tails. Their productivity declines either soon after the value added per capita begins to deteriorate or the value added per capita drops despite the continued increase in productivity. The case of the motor vehicle industry (S34) is representative of this difference. Large countries lose their advantage in the motor vehicle industry at a GDP per capita level of around US$ 20,000. Medium-sized countries tend to pass this stage at half of that GDP per capita level. There seems little advantage for medium-sized countries in the motor vehicle industry. On the other hand, the chemicals (S24) and the electrical machinery and apparatus (S31) industries indicate good prospects for sustained growth.

Figure 9 shows that small countries lose comparative advantage in the textiles (S17) and the wearing apparel (S18) industries earlier than large and medium-sized countries. As already discussed in the above sections, small countries tend to have better prospects of development in the relatively high-level processing industries like the chemicals (S24) and the fabricated metals (S28) industries, and can expect to reach levels of development in per capita terms which are comparable to those of large and medium countries. Figure 9 shows that even though the electrical machinery and apparatus (S31) industry may also look advantageous for small countries due to the continued and fast increase of value added per capita compared with the growth in productivity, the decline of the industry starts at a much lower level of value added per capita than in large or medium countries (Appendix C). The level of development of the electrical machinery and apparatus industry is much higher in large and medium countries and its contributions to their economies are much greater.

Speed and levels of industrial development

The previous sub-sections have shown that a country's stage of development, which is associated with endowment structure, and size imply a comparative advantage for specific industries which seem to have a significant effect on manufacturing development at different stages of development. An improvement in productivity is not likely to considerably alter such patterns, though this could potentially extend the survival, in particular, of relatively capital intensive industries. If countries with similar demographic and geographic conditions generally share patterns of shifts in comparative advantage, do some countries rapidly climb the growth curve of advantageous industries and accelerate the shifts in comparative advantage?

To determine whether productivity growth plays a role in speeding up industrial development, this sub-section investigates the relationship between the growth rate of value added per capita and that of productivity. In view of the above discussion, we know that the growth rate of industries changes in accordance with the country's stage of development, and we therefore only focus on a GDP per capita range from US$ 3,000 to US$ 6,000, which demonstrates a comparatively linear growth trend for most of the industries, as illustrated in Figures 1, 2 and 3. We take the highest and lowest values of the value added per capita of each country, which fall within that range of GDP per capita. We then take the labour productivity in those two years which correspond to the highest and lowest values of value added per capita and calculate their annual growth rates. We prepare these two datasets for each country that has data in the specified range and regress the growth rate of the value added per capita on that of labour productivity for each industry. This analysis uses the data of all available countries together without dividing the countries into three size groups, because only a limited number of countries have data for the given value-added per capita range of each industry.

Table 2 presents the results. All coefficients are positive and significant at 95 percent or higher levels. The higher the growth of labour productivity is, the faster a country moves in the development trajectories of the eight industries. This correlation is higher for more capital and technology intensive industries and lower for labour intensive ones. The results confirm that productivity growth plays a role in speeding up a country's structural transformation. Productivity growth is especially important for late emerging, advanced industries while productivity as well as other factors, such as wage rate, may be associated with the growth of early, labour intensive industries. Comparative advantage is associated with a specific stage of development, but productivity growth can facilitate the process of moving from one advantage to another by rapidly exploiting the current advantage.

Table 2 Correlations between growths of value added per capita and labour productivity

	Coefficient	*t-value*	*p-value*
Food and beverages	0.7614	6.26	0.0000
Textiles	0.4418	3.85	0.0000
Wearing apparel	0.3857	2.57	0.0130
Chemicals	0.8573	7.55	0.0000
Basic metals	1.4851	9.66	0.0000
Fabricated metals	0.8563	4.93	0.0000
Electrical machinery and apparatus	1.0727	5.9	0.0000
Motor vehicles	1.0775	6.37	0.0000

Independent variable: change in labour productivity per year
Dependent variable: change in value added per capita per year
GDP range: US$ 3,000 – US$ 6,000

Source: Calculated by the authors.

The discussion has so far addressed the trajectories (slope) and speed of manufacturing development. Countries with a similar size have statistically common development patterns, and higher productivity is associated with a faster rate of development. Hence, the slopes of the trajectories and movement on them are linked to development patterns and productivity.

The lines in the figures discussed above are drawn using the intercepts of the fixed effect model before including country-specific conditions in order to exemplify the general patterns of industrial development. However, the level of a country intercept, which reflects country-specific conditions, differs from country to country and, in addition to the general pattern and speed of the movement on that pattern, this unique country intercept is the third element which plays a role in a country's manufacturing development.

We identify two types of country-specific conditions. The first type includes country-specific conditions that are ubiquitous and have similar patterns of impact on industries across countries, though the degree or intensity of these conditions differs from country to country. The extent to which such conditions are present in a given country affects the level of an industry's development. The second type of country-specific conditions are not easily discernible and remain a country-specific advantage or disadvantage for manufacturing development even after controlling for all conditions which belong to the first type. For example, natural resource endowments are a country-specific condition that belongs to the first type, because an abundance of resources tends to have a negative effect on the development of certain industries across countries. However, some countries may be capable of effectively managing their natural resources and thus avoid any negative effects on and possibly even promote the development of manufacturing industries. This special capability represents the second type of country-specific conditions and is included in the country fixed effect of our model. We consider the first type of country-specific conditions first to determine how and what types of generally observable country conditions influence manufacturing development. For the second type of country-specific conditions, it is, by nature, only possible for us to imply the underlying factors related to the unique country conditions.

The variables examined for the first type of country-specific conditions are those relating to demographic and geographic conditions over which a government has no or limited control, at least in the short to medium term. The average group-wide patterns are shaped by the country conditions but are nonetheless considered exogenously determined—these patterns are "given" before any individual country policies have an effect. In addition to the size effect accounted for by dividing countries into three size groups whose development patterns statistically differ, variables reflecting the levels of population density and natural resource endowments are included, in addition to the polynominal terms of GDP per capita in the equation (Equation 2).

The results are presented in Table 2 of the appendix. The effects of population density and resource endowment on industries are summarized in Tables 3 to 5, depicting those industries that are most positively and most negatively affected (only statistically significant ones). Abundance of natural resource endowment is considered a negative factor, particularly for large countries, as it reduces the development potential of two thirds of their manufacturing industries. This condition has especially negative effects on capital intensive industries. It is noteworthy that the electrical machinery and apparatus industry, which is presumed to be a leading industry at a late stage of a country’s development, is negatively affected by a high level of resource endowment for large and medium countries. Population density seems to mostly have a positive effect on capital intensive industries while it usually has the opposite effect on labour and resource intensive industries. Thus, the effects of these demographic and geographic conditions on the industries included in Tables 3 to 5 shift the average patterns upwards or downwards, depending on the intensity of the given country’s conditions.

Table 3 Large countries

		Population density	*Resource endowments*
Positive	Marginal effect (↑)	Food and beverages Coke and refined petroleum Chemicals Rubber and plastic Non-metallic minerals Basic metals Fabricated metals. Machinery and equipment Electrical machinery and apparatus Motor vehicles	
Negative		Tobacco Wearing apparel Wood products Furniture, n.e.c.	Food and beverages Tobacco Wood products Paper Coke and refined petroleum Chemicals Non-metallic minerals Basic metals Fabricated metals. Electrical machinery and apparatus Motor vehicles

Source: Developed by the authors.

Table 4 Medium countries

		Population density	*Resource endowments*
Positive	Marginal effect (↑)	Coke and refined petroleum Chemicals Rubber and plastic Non-metallic minerals Basic metals Machinery and equipment	Wearing apparel Paper
| Negative		Tobacco Textiles Wearing apparel Paper Furniture, n.e.c.	Wood products Electrical machinery and apparatus -Motor vehicles Furniture, n.e.c.

Source: Developed by the authors.

Table 5 Small countries

		Population density	*Resource endowments*
Positive	Marginal effect (↑)	Food and beverages Paper Printing and publishing Chemicals Non-metallic minerals Machinery and equipment	.
Negative		Textiles Wood products Fabricated metals. Motor vehicles Furniture, n.e.c.	Non-metallic minerals

Source: Developed by the authors.

After controlling for these given conditions, countries still deviate from the patterns as a result of the second type of country-specific conditions which are captured by country fixed effects. These are, by nature, unique to a country, and are barely discernible when using available indicators. Such country-specific conditions are considered to be related to a deeper level of determinants which affect the outcome of manufacturing development. To gain a general overview of what might be linked to country fixed effects, regressions are run to determine the relationship between the extent of country fixed effects and the conditions which seem to remain in place for a fairly long time and affect industrial development. The following results confirm that the extent of positive deviation relates to a country's unique features, including capabilities, competency, work ethic or some other special circumstances which impact the level of infrastructure (proxied by the share of paved roads in the country), rule of law perception and unit labour costs. These factors relate to the general business climate which only changes through long-term functional government support in education and physical capital improvements.

Table 6 Correlations between the size of country fixed effects and business conditions

	Unit labour cost	*Rule of law*	*Roads*
Food and beverages	-0.20 (-6.7)	1.80(-23.16)	0.07(-3.97)
Textiles	-0.22 (-3.63)	4.42 (-32.84)	0.94(-28.08)
Wearing apparel	-0.65 (-18.56)	3.62 (-25.31)	0.72 (-22.96)
Chemicals	-0.66 (-14.1)	1.56 (-10.84)	-0.20(-6.23)
Basic metals	-0.39 (-10.92)	2.19 (-13.19)	-0.07 (-1.52)
Fabricated metals	-0.19 (-4.29)	3.48 (-32.03)	0.78 (-33.36)
Electrical machinery and apparatus	-0.55 (-9.32)	2.87 (-17.3)	0.74 (-21.33)
Motor vehicles	-0.04 (-0.71)	5.60 (-28.98)	1.31 (-33.07)

Source: Calculated by the authors.

Note: The dependent variable used for the regressions is country fixed effects.
The numbers in parenthesis are t-values. Unit labour cost was calculated by nominal wage 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.

Table 7 depicts, as contributions to R^2, the extent to which income level (GDP per capita), geographic and demographic conditions (population and natural resources) and country fixed effects explain the level of value added per capita of manufacturing industries.[8] GDP per capita makes the largest contributions to R^2 for all country size groups, although its contributions is much lower in small countries than in large and medium-sized countries. Population density and natural resource endowment usually represent only a small fraction of the explanation for manufacturing development. However, our results also indicate that these two factors explain more than 10 percent of the variance in value added per capita of wood products in medium and small countries and of the coke and refined petroleum, machinery and equipment, and electrical machinery and apparatus industries in small countries. While the contributions of GDP per capita to R^2 is lower in small countries relative to the other country groups, the weight of

[8] The contribution of GDP per capita, population density and natural resource endowment, and country fixed effects to R^2 were estimated based on the LSDV method by taking the difference between the R^2 obtained for the regression using all three categories of the variables and that obtained for the regression in which the category was removed. Table 7 shows the contributions of each category to R^2 as a mean of 18 manufacturing industries. As this procedure is based on LSDV including country dummies, the R^2 used for this analysis is different from the R^2 in Table 2 of Appendix B, which is based on the fixed effect model.

country fixed effects is twice as high in the explanation of manufacturing development in small countries than in medium or large countries. Our results confirm that income level is the most important factor associated with manufacturing development for all countries. However, manufacturing development in small countries is relatively more susceptible to country-specific capabilities and circumstances.

Table 7 Contributions of GDP per capita, population density and natural resource endowment, and country-fixed effects to R^2 of equation (2)

	Contributions to R^2		
	Large	*Medium*	*Small*
GDP per capita	82.0%	76.2%	57.5%
Pop. density & resource	1.5%	3.1%	2.2%
Country fixed effects	16.5%	20.7%	40.3%

Source: Calculated by the authors.

4. Discussion

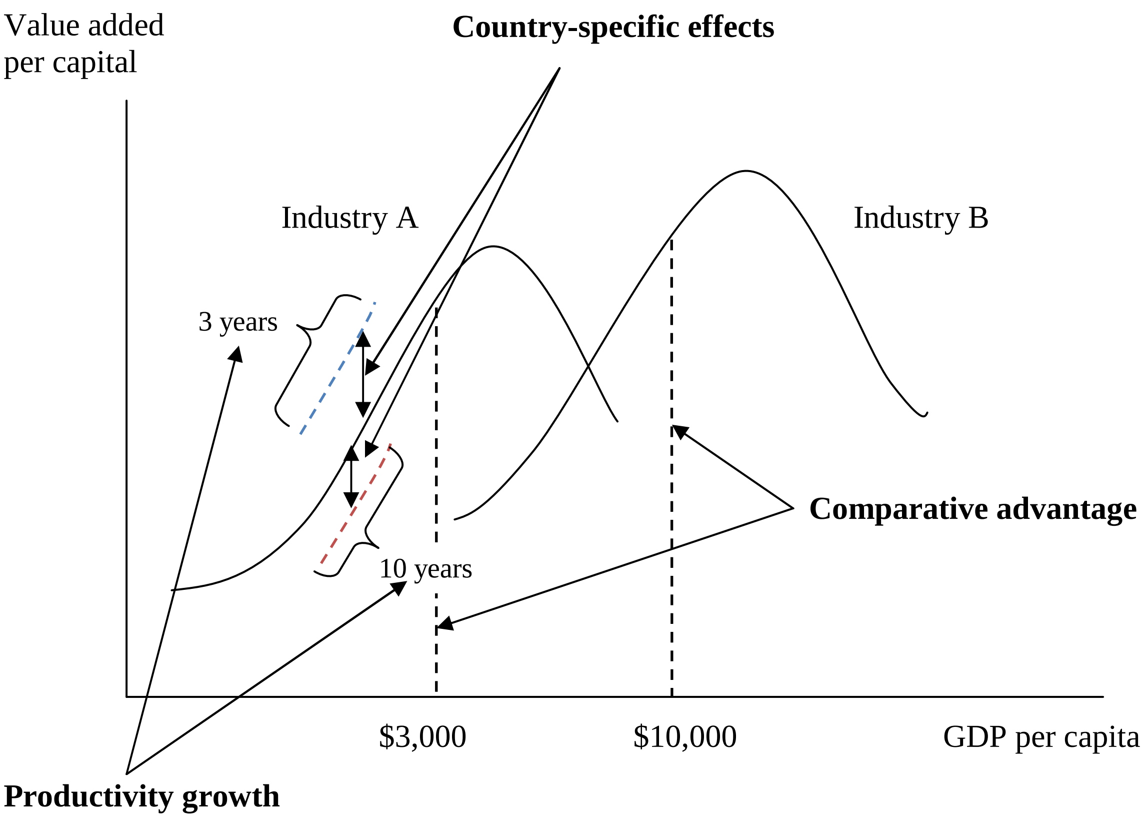
The analyses depict the trajectories of manufacturing development, which proceed in accordance with the stage of a country’s development and differ in accordance with its demographic and geographic conditions. This paper has identified the role of comparative advantage, productivity and country-specific conditions in manufacturing development and how they influence the potential and actual performance of manufacturing industries at different stages of development. This section connects the three factors of manufacturing development by describing the factors’ key elements and their interrelationships to elucidate the nature of manufacturing development and to draw some policy implications.

Broadly speaking, countries with comparable demographic and geographic characteristics tend to follow a similar pattern of manufacturing development, even though countries may follow a similar pattern at different output levels. The growth and decline depicted by each development pattern are posited to have overarching influence on manufacturing development and imply the existence of comparative advantage, which in turn relates to a country’s endowment structure. Thus, a loss of comparative advantage in and the eventual sunset of industries due to a shift in endowment structure are difficult to prevent through productivity increase, especially in the case of early labour intensive industries, yet a loss of comparative advantage is possibly postponed by such efforts, particularly for late emerging capital-intensive industries.

In view of the predominant influence exerted by comparative advantage, productivity growth plays an important role in accelerating the pace of development of each industry with a comparative advantage, thus contributing to a faster increase in GDP per capita, which in turn speeds up the shift in comparative advantage and the entire process of manufacturing structural change. Comparative advantage is linked to a specific stage of development; therefore, it is a static factor of development potential at a given point in time. Productivity growth adds a dynamic aspect of manufacturing development to this static concept of comparative advantage—how fast a country exploits comparative advantage also indicates the pace of the shift in comparative advantage. Besides the two factors relating to a country's endowment structure at a given stage of development and the speed of technological capacity building, a third factor, which relates to country-specific conditions, also plays a role. This includes given geographic and demographic conditions as well as a country's fixed effects—unique circumstances and capabilities which, as shown above, can either increase or decrease the level of manufacturing production by affecting the quality of institutions, infrastructure and the business climate. Such country-specific conditions, which only change slowly, are responsible for the differences in the manufacturing development performance of countries which have different intercept levels, while the slope of their development trajectories is similar. Our empirical findings are summarized in the following illustration.

Figure 10 reveals how comparative advantage, productivity growth and country-specific conditions together influence manufacturing development. As demonstrated in the average development paths of the industries, countries have a comparative advantage in industry A at a level of US$ 3,000 GDP per capita, but not in industry B, and at the given level of development have little potential of reaching a high level of value added per capita as well as a high growth rate in industry B. Given the dominant influence of development in terms of the level of development and endowment structure, the performance of two countries could differ, even though both focus on industry A in which they have a comparative advantage. Two different countries' performances will continually deviate from the average development pattern of industry A—as indicated by the dotted blue and red lines—due to country-specific conditions, such as the levels of resource endowment, population density, capabilities, competency, work ethics and, through these, levels of costs and infrastructure. Finally, two countries may differ in terms of the time it takes them to move from one level of development (value added per capita) of industry A to another. One country could, for example, take three years to increase the same amount of value added per capita of industry A while another may take 10 years. This speed of development is related to the growth of labour productivity. If a country rapidly exploited the comparative advantage of industry A as well as other industries in which its current comparative advantages lie, the country would likely increase its GDP per capita and rapidly shift its endowment structure and hence move its comparative advantage from industry A to, say, industry B, thus speeding up the entire process of manufacturing structural change. Productivity growth in the industries of a country's existing comparative advantage plays a dynamic role in manufacturing development, which influences the pace of structural change. As graphically illustrated, the three factors assume different roles in manufacturing development. Comparative advantage is static and relates to a given stage of development, while country-specific conditions are (almost) time invariant and are responsible for a persistent difference in performance across time. Productivity growth, in turn, is related to the dynamic aspect of manufacturing development. For clarity, country-specific effects and productivity growth are discussed and illustrated separately; however, they are by no means mutually exclusive. For example, country-specific effects might well influence a country's productivity growth.

Figure 10 **Schematic representation of the role of comparative advantage, productivity growth and country-specific conditions in manufacturing development**



Source: Created by the authors.

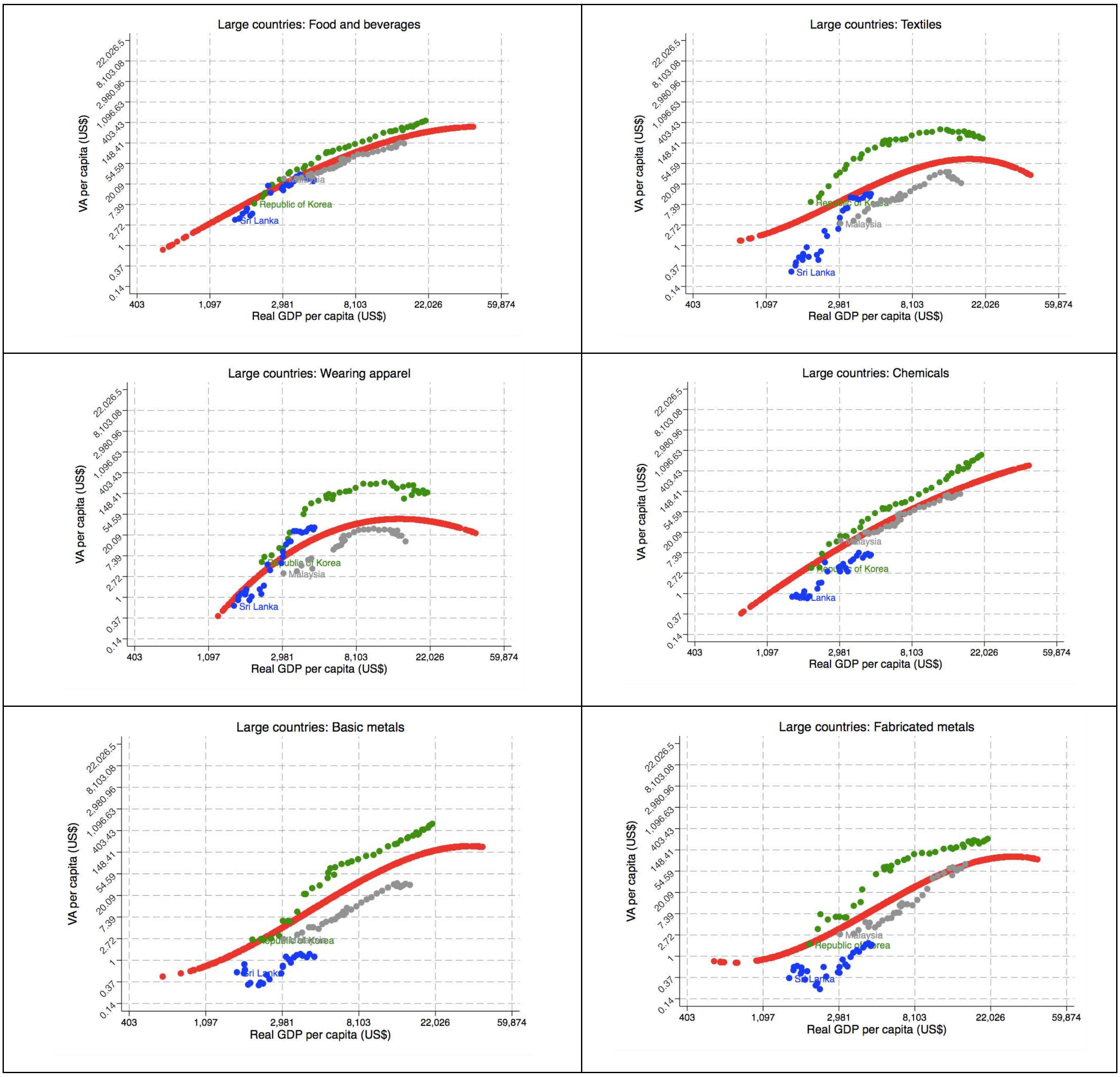
The following examples demonstrate how the above elaboration of comparative advantage, country-specific effects and productivity growth actually manifest in the development experiences of countries. These cases are based on the data of Malaysia, the Republic of Korea and Sri Lanka, because all three countries belong to the same group of large countries and have relatively long time series data, allowing us to investigate their development trajectories. They also have an overlapping range of GDP per capita, which allows us to calculate and compare the average annual growth rate of value added per capita at a comparable development stage.

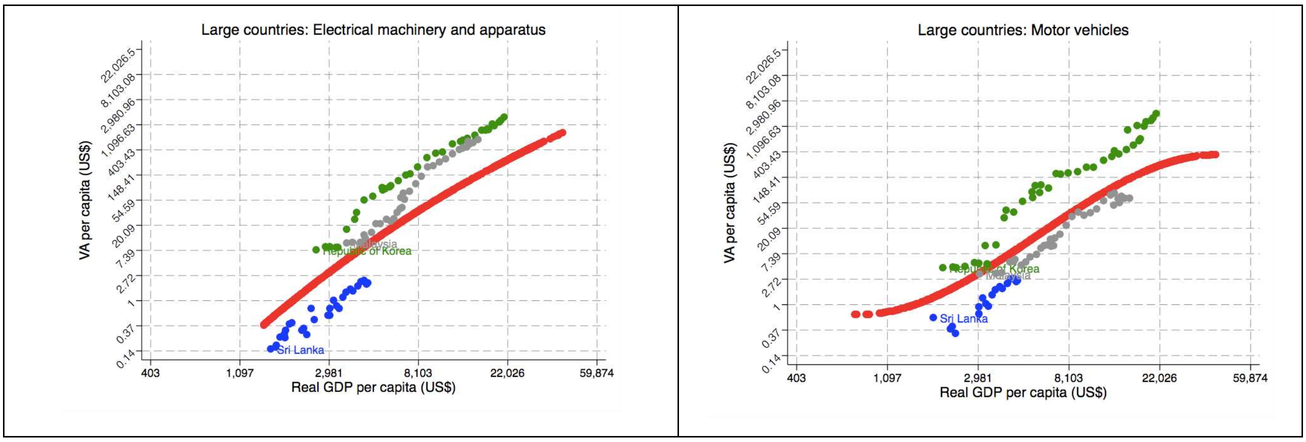
A set of graphs in Figure 11 illustrate the actual plots of the real value added per capita data of the three countries as well as the patterns estimated for the large country group based on the fixed-effect model of the panel data. The observations of the three countries' data indicate that their development patterns follow the estimated pattern (slope) of the group to which they belong remarkably close. The three countries deviate from the estimated pattern, but their deviations (intercepts) remain more or less constant, at least for a fairly long time, so that they tend to depict the development trajectories in parallel to the estimated patterns.

As indicated by the graphs, Sri Lanka currently has a comparative advantage in relatively labour intensive industries, such as food and beverages, textiles and wearing apparel, and hence rapid growth in these industries can be anticipated. Malaysia has already lost its advantage in these industries, but can still expect continued growth for some time in the basic metals, fabricated metals and motor vehicles industries as well as long-term growth in the chemicals and electrical machinery and apparatus industries. In the case of Republic of Korea, the country has already lost or is about to lose its comparative advantage in the basic metals, fabricated metals and motor vehicles industries, while the electrical machinery and apparatus and chemicals industries are likely to remain advantageous for Republic of Korea in the foreseeable future.

Although all three countries generally follow the estimated patterns and have comparative advantages that reflect their stage of development, the speeds with which these advantages are exploited and, hence, possibly the shift of advantage from one industry to another differ across the three countries. Table 8 shows how fast the manufacturing industries of the three countries moved over the range of GDP per capita from US$ 3,000 to US$ 4,500. This range has been chosen because the data of all three countries overlap over this period of development. For each industry, an average growth rate of value added per capita was calculated by dividing the increase in value added per capita by the corresponding number of years over the selected GDP per capita range. As seen in Table 8, all eight industries developed much faster in Republic of Korea than in Malaysia. In the textiles and wearing apparel industries, Republic of Korea increased the value added per capita around 20 times faster annually, on average, than Malaysia did, while more capital intensive industries developed approximately 10 times faster in Republic of Korea than in Malaysia. Over the same stage of development, Sri Lanka's industries, relative to Malaysia's, lagged behind in terms of development speed, with the exception of the textiles and wearing apparel industries.

Figure 11 Development patterns of value added per capita for large countries and actual country experiences of the Republic of Korea (green), Malaysia (gray) and Sri Lanka (blue)





Source: Developed by the authors based on regression estimations.

Table 8 Comparison of the speed of manufacturing development between Malaysia, Republic of Korea and Sri Lanka

Industry	*Malaysia*	*Republic of Korea*	*Sri Lanka*
Food and beverages	1.46	4.74	0.64
Textiles	0.60	11.49	0.61
Wearing apparel	0.66	13.37	1.43
Chemicals	1.32	3.55	0.19
Basic metals	0.38	3.62	0.03
Fabricated metals	0.24	2.71	0.09
Electrical machinery and apparatus	0.78	7.53	0.10
Motor vehicles	0.40	5.28	0.13

Note: The 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.

Source: Calculated by the authors.

In addition to development speed, the industries of the three countries differ in terms of the level of value added per capita, even at same stage of development. Though they tend to follow the estimated patterns, the development trajectories of the countries deviate positively and negatively from the patterns. For all the selected industries, Republic of Korea had higher positive deviations than the others. Indeed, for many industries, Republic of Korea's deviation was one of the highest among the countries included in our research. Malaysia had higher positive deviations than Sri Lanka in more capital intensive industries. In the case of electrical machinery and apparatus, Malaysia seems to have improved its country-specific advantage from the end of the 1980s and has narrowed the gap with Republic of Korea. Sri Lanka has country-specific advantages or fewer disadvantages in the food and beverages, textiles and wearing apparel industries. The geographic, demographic and country-fixed conditions explain such deviations. Considering that the Republic of Korea and Sri Lanka's conditions are similar in terms of their higher population density and lower natural resource endowment relative to the world median levels, the deviations from the patterns are more likely explained by the second type of country-specific conditions discussed above, which relate to a country's capabilities and other unique circumstances that enhance a country's infrastructure, institutions and relative cost level.

Based on the above results and analyses, countries are able to derive some general policy guidance for their long-term manufacturing development. First and foremost, the manufacturing development patterns in accordance with increase in GDP per capita indicate which industries a country has a comparative advantage in at a given stage of development. Comparative advantage is associated with the level of a country's development and, therefore, predominantly influences the types of industries a country may have the best chance of succeeding in at a given stage of development. When a country has a comparative advantage in a certain industry, it can expand this industry while simultaneously increasing labour productivity, occasionally even without increasing productivity by much. Similarly, an industry that is losing comparative advantage can contract while still increasing labour productivity by reducing employment in that industry.

Although the industries with a current comparative advantage may not be expected to have a development path that is as sustainable as that of more advanced industries, it is not advisable for a country to neglect its current advantage and jump into industries that will become advantageous for the country at a much higher income level. A country which targets industries that have no advantage would not only face difficulties developing such industries, it would also be confronted with a slowdown in economic growth due to sluggish developments of both the targeted industries and those in which the country does have a comparative advantage in due to resource transfers or policy mismatches. Such slow economic growth would stall GDP per capita growth and consequently slow down the pace of structural change, making the development of more technologically advanced industries unviable for a longer period of time.

Bearing in mind the timing of change in the comparative advantage from one industry to another, a country's industrialization efforts should be directed towards those industries of current comparative advantage. Such industries should develop faster than other industries and, if the productivity of those industries is improved, can develop even faster, accelerating the pace of structural change. While exploiting the current advantage, countries should also prepare for the industries of the near future by upgrading the levels of education and infrastructure in advance, thus ensuring that these long-term investments provide the appropriate skills and public goods to meet the demands of the industries towards which the country's comparative advantage is shifting.

Even at the same stage of development, countries differ in terms of the level of development of their industries of current advantage. Countries are likely to follow the estimated pattern (changes in slope), but may have different levels of positive or negative deviations at each stage of development. These deviations are related to country-specific effects, including demographic and geographic conditions and other unique features and capabilities. Referring to Tables 3 to 5, countries could consider the likely effects of their demographic and geographic conditions in their manufacturing development strategies. Other country-specific factors included in country fixed effects may also affect the levels of manufacturing development by impacting a country's long-term business climate, such as infrastructure, institutions and cost competitiveness. Further research is required to identify which unique circumstances and capabilities may create positive deviations in the levels of manufacturing value added per capita across income levels. Country fixed effects are, however, likely to be deeply rooted in culture, history and regional influence, which implies that econometric studies using readily available indicators may not shed much insight into these effects, because the observed differences reflected in the indicators are probably themselves the result of country fixed effects. In view of this, it may be more meaningful for countries to choose a comparator which belongs to the same size group and has a similar level of GDP per capita, yet enjoys a higher level of manufacturing value added per capita, and to conduct a comprehensive study about the comparator to tease out possible conditions that create systematic differences in manufacturing performance.

The deviation of a given industry's performance from the estimated pattern is usually similar across a country's manufacturing industries because country-specific conditions, which foster or obstruct the long-term performance of a given industry, are often applicable to other industries. In this regard, a country which has a positive deviation in the industry of its current comparative advantage may have a similar degree of positive deviations across manufacturing industries, including more technologically advanced industries, as is the case in Republic of Korea. However, it is not advisable for countries to try to achieve positive deviations in advanced industries with targeted interventions if the industries of current comparative advantage do not demonstrate a positive deviation. For example, according to Figure 11, if a country has a positive deviation along the blue dotted line, a similar degree of positive deviation in industry B at a GDP per capita level of US$ 3,000 would probably not distort the country's manufacturing structural change based on comparative advantage. But such a deviation in industry B may not be advisable, if the country is developing industry A along the red dotted line. Country-specific information, which stems from this research approach, could thus be used for benchmarking and monitoring a country's manufacturing development.

5. Conclusion

This paper analysed the process of manufacturing development in detail by estimating the development patterns of manufacturing industries. The patterns identified in this study indicate the existence of comparative advantage, whose shift is associated with changes in GDP per capita. Even successful countries like Republic of Korea have generally followed these patterns. What distinguishes countries that have reached the same stage of development and successfully focus on the industries of their comparative advantage from one another in terms of manufacturing performance is the speed in which the advantage of those industries is exploited and the country's unique capabilities and circumstances. The former is associated with a country's labour productivity growth in this study, while the latter affects development based on differences in a country's long-term advantage in infrastructure, institutions and relative cost levels.

Though still at an embryonic stage, our research suggests how different schools of thought on industrial development, such as comparative advantage, technological development and functional approaches, all have a place in explaining the performance of industrial development and account for different aspects of development. Future research is needed to further investigate country-specific conditions how they are translated into long-term country-specific advantages.

6. Appendix A

India has an IIP, but Pakistan does not. Both countries have MVA deflators. To make price adjustments on 1965 data, if Pakistan simply applies its 1965 MVA deflator across industries, the nominal values in 1965 will be increased by 63 percent for all industries. Since 1965, the nominal values in US dollars is higher in terms of US dollars in 1995 (the base year of the IIP), and the values will be higher after adjustments. To reflect sub-sector specific inflation trends, we use India's IIP in 1965, for example, and calculate Pakistan's IIP-based deflators. We used the following equation to arrive at results.

Pakistan deflator = ((MVA def-1)*(d.w. / i.w.))+1

We then used deflators for each sub-sector reflecting the industry-specific inflation rate. As seen below, those which have high deflators in India have higher deflators in Pakistan (or in this case, inflators). If we apply these deflators to Pakistan's nominal value, we obtain Pakistan's IIP-based real value added. Again, those industries which had higher deflators had higher real value added, but the total is still the same as it is when using an MVA deflator. This approach essentially decomposes manufacturing-wide inflation into each industry's inflation rate using the industry's inflation trend at that time. Using the inflation trend of the neighbouring country is reasonable, as manufacturing products are usually tradable and are usually traded more heavily with neighbouring countries or with similar trading partners.

1965 data

	India NVA	IIP_RVA	IIP_Def
S1	432,000,000	904,000,000	2.0926
S2	101,000,000	119,000,000	1.1782
S3	231,000,000	544,000,000	2.3550
S4	182,000,000	130,000,000	0.7143
S5	21,000,000	65,200,000	3.1048
S6	383,000,000	1,670,000,000	4.3603
S7	78,100,000	465,000,000	5.9539

	Pakistan NVA	MVA def	MVA def adjusted VA	India def	d.w.	i.w.	Pakistan Def	Pakistan IIP_RVA
S1	103,040,404	1.63	167,955,859	2.0926	0.1059	0.1290	1.5172	156,333,870
S2	89,393,020	1.63	145,710,623	1.1782	0.0596	0.1119	1.3357	119,399,487
S3	99,200,219	1.63	161,696,357	2.3550	0.1192	0.1242	1.6046	159,176,040
S4	119,293,843	1.63	194,448,964	0.7143	0.0361	0.1493	1.1525	137,485,039
S5	120,903,494	1.63	197,072,695	3.1048	0.1571	0.1514	1.6540	199,974,558
S6	125,903,040	1.63	205,221,955	4.3603	0.2207	0.1576	1.8820	236,950,078
S7	141,023,393	1.63	229,868,131	5.9539	0.3013	0.1766	2.0752	292,655,511
Total	798,757,413		1,301,974,583	19.7591	1.0000	1.0000		1,301,974,583

Def = deflator, VA = value added, RVA = real value added, NVA = nominal value added, IIP_RVA = IIP-based real value added, IIP_def = IIP- based deflator, d.w. = deflator weight, i.w. = industry weight.

If we use the MVA deflator for manufacturing price adjustment for countries without an IIP, we have to also use it for countries with an IIP for the purpose of consistency. For countries with an IIP, for example, India, we made the following adjustments: we calculated the IIP-based real value added using an own IIP for India. The total IIP-based real value added divided by total nominal value added gives us 2.7289. This is different from the MVA deflator of India in 1965, which was 1.573. We had to therefore make adjustments to ensure that all countries would be consistent as far as manufacturing-wide inflation trends are concerned. Hence, we calculated the ratio of the IIP-based manufacturing-wide deflator to India's MVA deflator in 1965. The result is 1.7347. We then divided the IIP-based real value added by this ratio, 1.7347, to arrive at the IIP-based real value added, which is consistent with the MVA deflator. If we divide the total of this by the total nominal value added, the result is 1.5731. The manufacturing-wide inflation is now consistent with the MVA deflator, albeit each industry's price changes are adjusted in their values.

India

	NVA	IIP_RVA	IIP_Def	1963 MVA def	MVA def adjusted IIP_RVA
S1	432,000,000	904,000,000	2.0926	1.5731	521,114,185
S2	101,000,000	119,000,000	1.1782	1.5731	68,597,996
S3	231,000,000	544,000,000	2.355	1.5731	313,590,837
S4	182,000,000	130,000,000	0.7143	1.5731	74,938,987
S5	21,000,000	65,200,000	3.1048	1.5731	37,584,784
S6	383,000,000	1,670,000,000	4.3603	1.5731	962,677,754
S7	78,100,000	465,000,000	5.9539	1.5731	268,050,991
Total	1,428,100,000	3,897,200,000			2,246,555,535

7. Appendix B

Table 1 Regression results based on the FE estimation method (GDP only)

Group	ISIC code[9]	GDPpc	(GDPpc)^2	(GDPpc)^3	Constant	N	R2 (overall)
Small country	15	-22.95***	2.96***	-0.12***	58.72**	354	0.61
Medium country	15	-32.32***	3.97***	-0.16***	88.30***	548	0.79
Large country	15	-3.41	0.81	-0.04*	-0.88	835	0.84
Small country	16	-57.70***	6.65***	-0.25***	166.06***	194	0.29
Medium country	16	-67.66***	8.16***	-0.32***	184.82***	475	0.43
Large country	16	2.34	0.20	-0.02	-18.66	726	0.59
Small country	17	9.15	-0.36	-0.01	-41.15	274	0.00
Medium country	17	-15.57*	2.31**	-0.11***	34.01	592	0.18
Large country	17	-34.00***	4.46***	-0.19***	83.60***	863	0.69
Small country	18	16.39	-0.93	0.00	-71.65	305	0.37
Medium country	18	-27.03**	4.21***	-0.20***	50.36	558	0.38
Large country	18	24.02**	-1.83	0.04	-93.83***	760	0.65
Small country	20	108.30***	-11.46***	0.40***	-335.92***	316	0.02
Medium country	20	-39.10***	4.75***	-0.19***	105.09***	524	0.61
Large country	20	-11.37	1.70**	-0.08**	22.30	787	0.64
Small country	21	-12.06	2.07	-0.10	15.54	246	0.54
Medium country	21	-53.03***	5.93***	-0.22***	157.97***	492	0.74
Large country	21	-5.53	1.02*	-0.05**	3.77	789	0.91
Small country	22	-53.61***	6.26***	-0.24***	150.49***	308	0.78
Medium country	22	-60.39***	7.13***	-0.27***	167.26***	541	0.86
Large country	22	3.56	0.06	-0.01	-23.76	763	0.84
Small country	23	82.55**	-8.03**	0.26*	-279.63**	105	0.39
Medium country	23	26.49	-2.50	0.08	-91.32	260	0.32
Large country	23	-15.32**	2.18**	-0.09***	31.72	574	0.70
Small country	24	-19.79**	1.97*	-0.06	65.16**	305	0.42
Medium country	24	16.71	-1.36	0.04	-64.34	561	0.75
Large country	24	3.61	0.00	-0.01	-22.75	849	0.88
Small country	25	-27.22	3.34*	-0.13**	73.66	261	0.37
Medium country	25	-25.22**	3.61***	-0.16***	51.65	550	0.85
Large country	25	4.83	-0.14	-0.00	-26.94	818	0.86
Small country	26	5.68	-0.34	0.00	-23.36	330	0.54
Medium country	26	-44.29***	5.50***	-0.22***	115.70***	568	0.83
Large country	26	14.79**	-1.18*	0.03	-57.10***	837	0.87
Small country	27	-18.43	2.39	-0.10	45.40	133	0.36
Medium country	27	-20.41*	2.71**	-0.11**	48.68	429	0.67
Large country	27	-31.54***	4.04***	-0.16***	77.91***	682	0.84
Small country	28	-12.47	1.68	-0.07	28.59	338	0.68
Medium country	28	-49.63***	5.98***	-0.23***	134.46***	556	0.84
Large country	28	-41.19***	5.11***	-0.20***	106.88***	804	0.87
Small country	29	-62.28**	6.74**	-0.24**	190.39**	221	0.16
Medium country	29	-6.92	1.60	-0.08	-5.34	471	0.80
Large country	29	-20.40**	2.56**	-0.10**	50.16*	783	0.82
Small country	31	-41.63	4.42	-0.15	130.61	233	0.16
Medium country	31	55.18***	-5.27**	0.17**	-192.18***	529	0.81
Large country	31	8.02	-0.44	0.01	-39.48*	828	0.84
Small country	33	-205.38***	23.75***	-0.90***	581.27***	97	0.59
Medium country	33	87.81***	-9.14***	0.32***	-284.14***	389	0.74
Large country	33	-26.12***	3.45***	-0.14***	59.75**	538	0.79
Small country	34	27.74	-3.65*	0.15**	-63.01	274	0.33
Medium country	34	11.95	-0.55	-0.00	-56.95	525	0.59
Large country	34	-45.21***	5.49***	-0.21***	119.47***	794	0.84
Small country	36	-57.65***	6.53***	-0.24***	170.92***	273	0.03
Medium country	36	-15.43	2.24*	-0.10**	31.86	471	0.69
Large country	36	21.58**	-2.06*	0.07	-74.02**	661	0.80
* p<0.10							
** p<0.05							
*** p<0.01							

[9] ISIC descriptions are as follows: 15 – Food and beverages, 16 –Tobacco, 17 – Textiles, 18 – Wearing apparel, 20 – Wood products, 21 – Paper. 22 - Printing and publishing, 23 - Coke and refined petroleum, 24 – Chemicals, 25 - Rubber and plastic, 26 - Non-metallic minerals, 27 - Basic metals, 28 - Fabricated metals, 29 - Machinery and equipment, 31 - Electrical machinery and apparatus, 33 - Precision instruments, 34 - Motor vehicles, 36 - Furniture, n.e.c.

Source: Estimated by the authors.

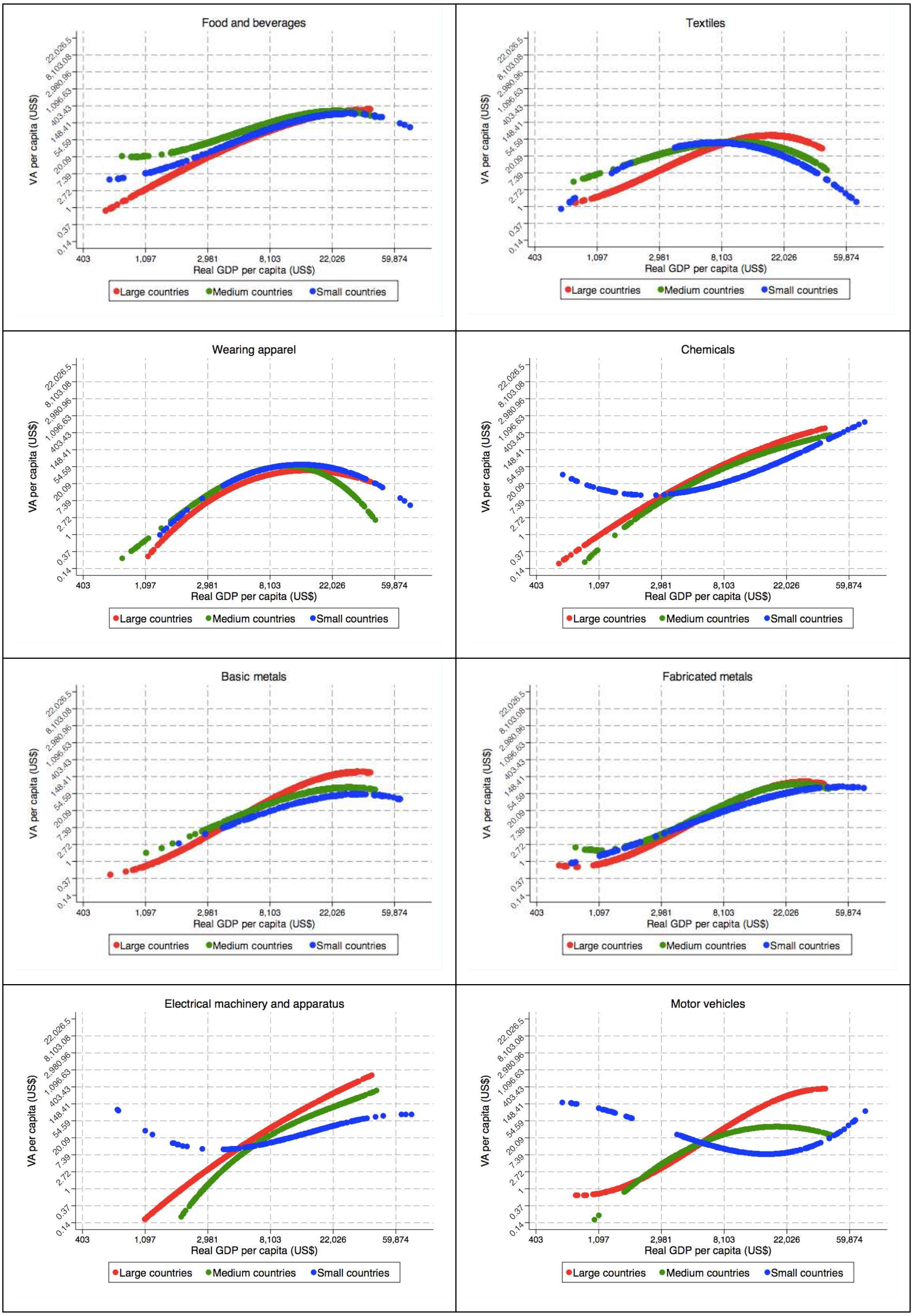
Table 2 Regression results based on the FE estimation method (all variables)

Group	ISIC code[10]	GDPpc	(GDPpc)^2	(GDPpc)^3	RPC	POPD	Constant	N	R2 (overall)
Small country	15	13.28	-1.11	0.03	-0.08	0.62***	-49.78	285	0.13
Medium country	15	-22.13**	2.89***	-0.12***	0.02	-0.02	56.69**	489	0.79
Large country	15	-5.89	1.05*	-0.05**	-1.76***	0.39***	20.84	739	0.66
Small country	16	-14.42	1.92	-0.08	0.31	0.11	31.68	172	0.32
Medium country	16	-40.17***	5.21***	-0.22***	1.00	-0.31***	92.42**	426	0.26
Large country	16	5.88	-0.14	-0.01	-1.89***	-0.34***	-13.55	672	0.45
Small country	17	-13.56	2.12	-0.10	0.05	-0.52***	29.63	249	0.04
Medium country	17	28.13***	-2.18*	0.05	0.11	-0.93***	-104.75***	550	0.00
Large country	17	-28.47***	3.84***	-0.16***	-0.16	-0.12	69.00***	775	0.65
Small country	18	-45.72	5.77	-0.24*	0.07	0.02	118.89	274	0.35
Medium country	18	-2.46	1.93	-0.13**	0.85***	-1.10***	-39.13	514	0.12
Large country	18	18.99*	-1.23	0.02	-0.53	-0.23*	-74.50**	685	0.56
Small country	20	97.45*	-9.75*	0.32*	-0.02	-0.90***	-315.55**	266	0.03
Medium country	20	5.97	-0.22	-0.00	-0.45*	0.29*	-27.36	492	0.35
Large country	20	-5.73	1.13	-0.06*	-1.09**	-0.32***	14.20	723	0.51
Small country	21	-28.13	3.83	-0.16	-0.02	0.73***	61.63	228	0.14
Medium country	21	-90.50***	10.09***	-0.37***	0.39**	-0.41***	267.86***	467	0.63
Large country	21	2.62	0.13	-0.01	-1.04**	-0.10	-11.66	712	0.92
Small country	22	-3.79	1.20	-0.07	-0.04	1.36***	-16.46	273	0.34
Medium country	22	-47.62***	5.72***	-0.22***	-0.29	-0.04	131.14***	510	0.86
Large country	22	13.95**	-1.08	0.03	-1.65***	-0.13	-40.85**	697	0.83
Small country	23	9.54	-0.23	-0.01	-0.02	-0.04	-52.09	93	0.46
Medium country	23	96.71***	-10.23***	0.36***	-0.35	1.29***	-303.15***	235	0.02
Large country	23	-9.93	1.54*	-0.07**	-1.81***	0.45***	30.68	535	0.46
Small country	24	18.85	-2.33*	0.10**	-0.14	1.09***	-51.76	255	0.33
Medium country	24	9.31	-0.84	0.03	-0.03	1.22***	-36.61	529	0.25
Large country	24	-1.65	0.50	-0.02	-2.05***	0.97***	9.30	758	0.51
Small country	25	-37.06	4.39	-0.17	-0.18	0.15	105.58	235	0.18
Medium country	25	-21.89*	3.05**	-0.13**	-0.31	0.65***	47.91	529	0.73
Large country	25	-0.44	0.38	-0.02	-0.72	0.78***	-6.01	755	0.65
Small country	26	-55.27	6.41	-0.24*	-0.44**	0.54***	160.85	280	0.05
Medium country	26	-36.73***	4.57***	-0.18***	-0.08	0.56***	95.28***	522	0.65
Large country	26	12.44**	-0.98	0.03	-1.20***	0.69***	-40.80**	756	0.57
Small country	27	-70.70	7.99	-0.30	0.08	0.33	205.31	116	0.02
Medium country	27	127.84***	-12.89***	0.43***	0.12	0.89***	-422.64***	405	0.08
Large country	27	-38.92***	4.82***	-0.19***	-3.35***	0.71***	126.92***	632	0.49
Small country	28	-36.78	4.49	-0.17	0.03	-0.63***	99.56	283	0.13
Medium country	28	-41.42***	5.14***	-0.20***	0.05	-0.12	107.81**	520	0.82
Large country	28	-41.23***	5.03***	-0.20***	-0.98**	0.78***	114.77***	719	0.61
Small country	29	-214.50***	22.85***	-0.81***	-0.09	0.31*	668.43***	202	0.03
Medium country	29	-10.16	1.83	-0.09	-0.12	0.37**	8.21	453	0.77
Large country	29	-42.33***	4.86***	-0.18***	0.85	1.36***	107.15***	699	0.44
Small country	31	-177.81***	18.66***	-0.65***	-0.35	-0.07	567.17***	210	0.00
Medium country	31	90.67***	-9.38***	0.33***	-1.37***	0.22	-282.81***	503	0.81
Large country	31	5.85	-0.30	0.01	-1.56***	1.12***	-21.06	739	0.62
Small country	33	-201.89*	23.46**	-0.89**	0.44	-0.15	564.93*	85	0.39
Medium country	33	88.85***	-9.32***	0.33***	-0.48	0.21	-281.89***	381	0.69
Large country	33	-22.11**	3.04***	-0.13***	0.54	-0.40*	43.89	527	0.66
Small country	34	41.98	-5.39	0.22	-0.07	-1.00***	-96.37	237	0.19
Medium country	34	87.14***	-8.67***	0.29***	-0.62*	-0.36*	-281.74***	495	0.43
Large country	34	-53.49***	6.35***	-0.24***	-1.94***	0.77***	159.29***	716	0.60
Small country	36	-89.95***	10.26***	-0.38***	-0.01	-0.64***	265.80**	233	0.16
Medium country	36	38.84**	-3.50**	0.10*	-0.58**	-0.79***	-131.76***	434	0.39
Large country	36	28.44***	-2.69**	0.09**	0.29	-0.91***	-97.77***	616	0.46
* p<0.10									
** p<0.05									
*** p<0.01									

Source: Estimated by the authors.

[10] ISIC descriptions are as follows: 15 – Food and beverages, 16 –Tobacco, 17 – Textiles, 18 – Wearing apparel, 20 – Wood products, 21 – Paper. 22 - Printing and publishing, 23 - Coke and refined petroleum, 24 – Chemicals, 25 - Rubber and plastic, 26 - Non-metallic minerals, 27 - Basic metals, 28 - Fabricated metals, 29 - Machinery and equipment, 31 - Electrical machinery and apparatus, 33 - Precision instruments, 34 - Motor vehicles, 36 - Furniture, n.e.c.

8. Appendix C



Source: Created by the authors.

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