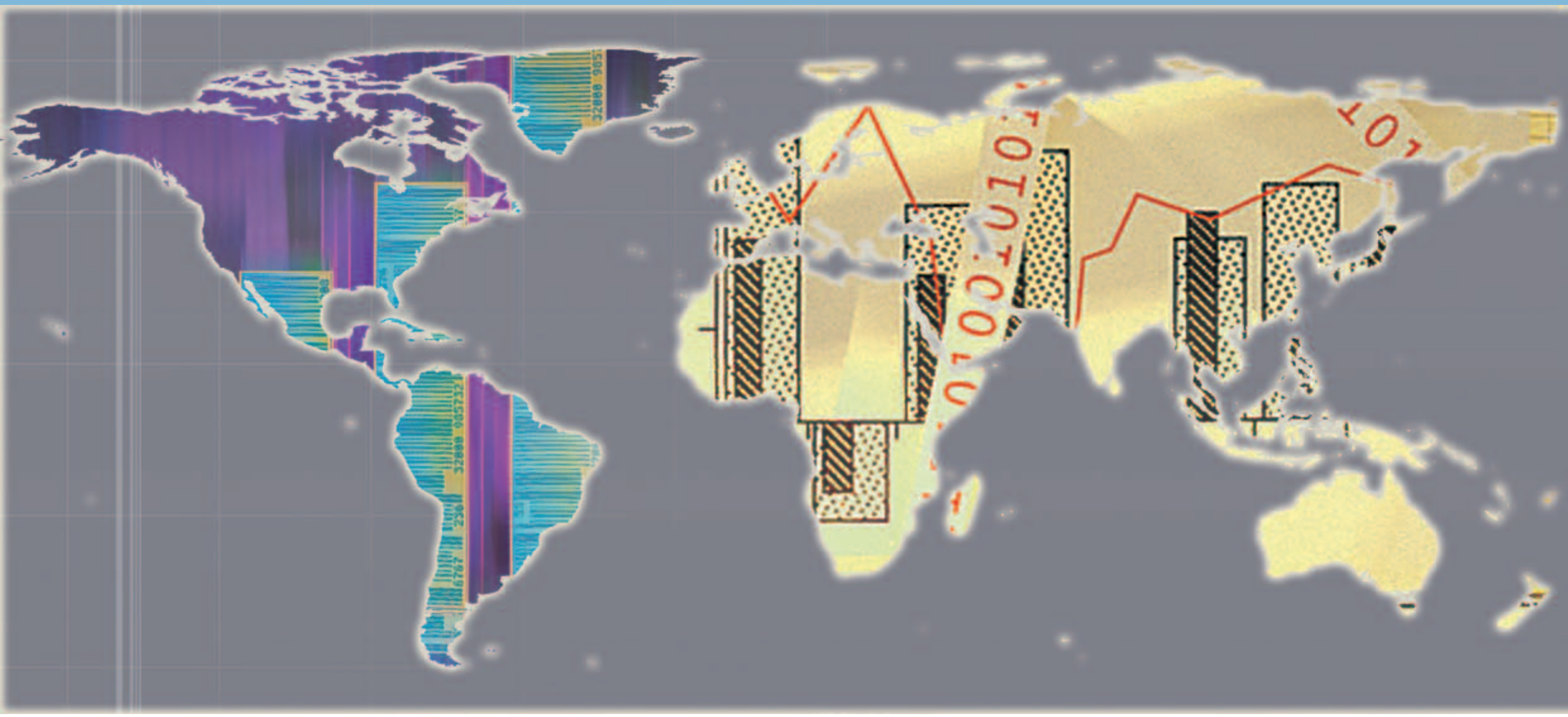
WORKING PAPER 02/2010



In Search of General Patterns of Manufacturing Development

UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

DEVELOPMENT POLICY AND STRATEGIC RESEARCH BRANCH
WORKING PAPER 02/2010

In Search of General Patterns of Manufacturing Development

Nobuya Haraguchi
Development Policy and Strategic Research Branch
Regional Strategies and Field Operations Division
UNIDO

Gorazd Rezonja
UNIDO Consultant

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna, 2010

Acknowledgements

We are grateful to Ms. Vivianna Prochazka for her helpful comments and editing. Ms. Iguaraya Saavedra, UNIDO staff member, was responsible for formatting the paper.

Table of Contents

List of Figures

List of Tables

1. Introduction

In the past, structural change was studied mainly at a broadly aggregated level—three sector classifications—to see whether the shares of the primary, industry and service sectors in economies changed as per capita incomes increased (Kuznets, 1957; Chenery and Taylor, 1968; Chenery and Syrquin, 1975; Kader, 1985; Chenery, Robinson and Syrquin, 1986; Syrquin and Chenery, 1989). Some of these studies attempted to estimate accurate, long-run patterns of industrial development by using a data set including a large number of countries and periods. Especially, Syrquin and Chenery regularly updated their studies on the manufacturing transformation by expanding country and period coverage and refining their estimation models (Chenery, 1960; Chenery and Taylor, 1968; Chenery and Syrquin, 1975; Syrquin and Chenery, 1989). They ended their pattern studies with "Patterns of Development 1950 to 1983" (Syrquin and Chenery, 1989) (S-C hereafter), which was considered to be more "accurate and robust" by them, as the data covered both the faster and slower growth periods of the world economy before and after the two oil shocks, respectively.

Given the past research on the patterns of manufacturing development, the objectives of this study are twofold. The first is to revisit S-C and compare their results with ours, which includes 135 countries in the data set and covers the period from 1963 to 2006. This period extends beyond the eras of rapid economic growth and maturation of industrialization in advanced countries including also the period of IT revolution and noticeable de-industrialization.[1] Thus, the period is suited to study the full development cycle of manufacturing industry, from rapid growth to slow down and decline.

Unlike the first objective, the second one is to explore a less charted area – estimating reliable development patterns of manufacturing sub-sectors at ISIC[2] two-digit level. S-C estimated the development patterns of some manufacturing sub-sectors. However, their results were considered more supplementary to the aggregate pattern of manufacturing industry as a whole and showed a single pattern for each sub-sector without taking into consideration countries' different demographic and geographic characteristics, which influence the relative importance of different sub-sectors. This study, therefore, attempts to establish the different development patterns at the manufacturing sub-sector level for several country groups with similar demographic and geographic characteristics. Since countries have no or limited control over

---

[1] We define de-industrialization here as a relative decline of manufacturing sub-sectors relative to others.

[2] International Standard Industrial Classification.

these characteristics, at least in short- to medium-run, the established patterns could be used as benchmarks to check the sub-sectoral developments of countries with comparable characteristics. Then, any deviations of actual developments from the benchmarks could be explained by future research, possibly looking into policy, historical and institutional factors.

The paper starts by reviewing the past work on the subject with a focus on the S-C study, which was the most comprehensive and complete work of their industrial development pattern studies. Given the review and comparison between S-C and our results, the next section proposes an alternative model for estimating the development patterns of sub-sectors within manufacturing industry. After presenting the regression results, the following section illustrates the patterns of sub-sectoral developments for ten different country groups based on their demographic and geographic conditions. Based on the results, some policy implications are suggested in the last section before drawing the final conclusions.

2. Review of past studies for estimating manufacturing share in the economy

The sectoral growth function contained in Chenery (1960) — based on the general equilibrium model of Walras — estimated the level of production as a function of demand-side variables as follows:

$$X_i = D_i + W_i + E_i - M_i \,. \tag{1}$$

X_i is domestic production of product *i*,

D_i is domestic final use of *i*,

W_i is the use of *i* by other producers,

E_i is the export of *i*,

M_i is the import of *i*.

Whereas Chenery felt it was necessary to have a sufficiently large sample, and because each demand component is a function of income level, he later decided to adopt single functions of income and population instead. This decision allows one to assess the effects of country size, using a linear logarithmic regression equation, to estimate the output level in the following way:

$$\log V_i = \log \beta_{i0} + \beta_{i1} \log Y + \beta_{i2} \log N \,, \qquad (2)$$

where V_i is per capita value added, and β_{i1} and β_{i2} represent income elasticity and country size elasticity, respectively. Cross-section data of 38 countries available for any year between 1950 and 1956 were used for this single equation. Equation (2) became the basis for the subsequent structural change research, and its modifications have been used for later studies. For example, Chenery and Taylor (1968) included a quadratic term for income as the decline in elasticities with rising income became apparent. In the latter years, Syrquin and Chenery settled with a more general equation as shown below, allowing a non-linear effect for population and including dummy variables for identifying period effects (Chenery and Syrquin, 1975; S-C):

$$x = \alpha + \beta_1 \ln y + \beta_2 (\ln y)^2 + \gamma_1 \ln N + \gamma_2 (\ln N)^2 + \sum \delta_i T_i \,, \qquad (3)$$

where x is value added share in GDP, y is per capita GDP in 1980 US dollars, N is population in millions, and T is a dummy variable for time periods taking non-zero values for different periods.[3]

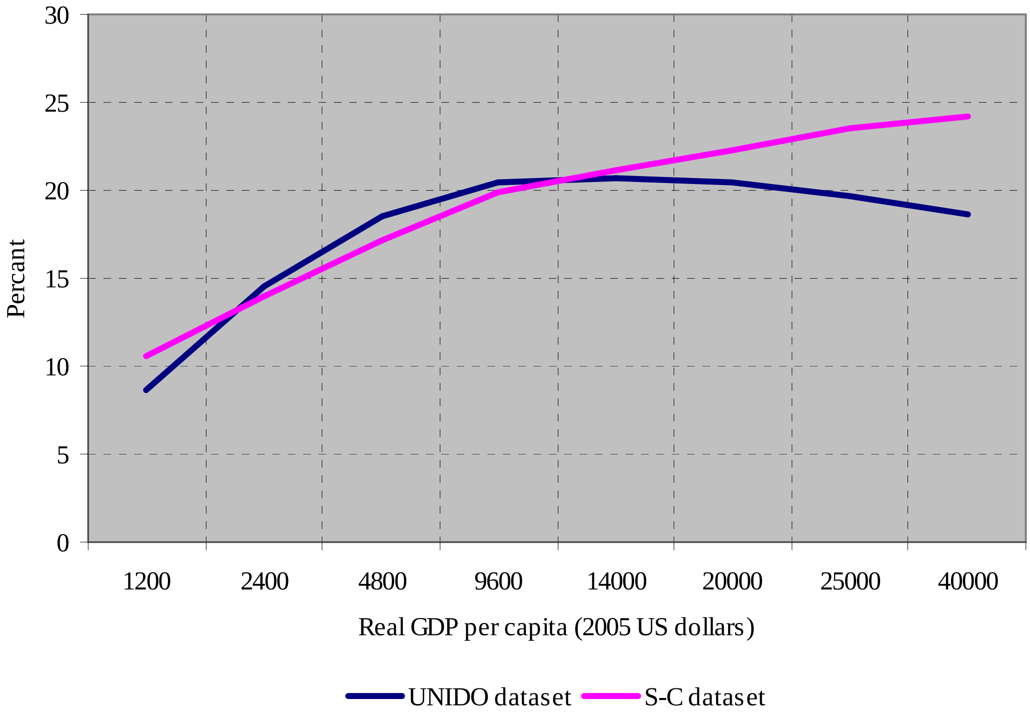
Firstly, based on the same equation (3), long-term transformation of manufacturing industry is compared between S-C and our results. In S-C, the pattern of manufacturing transition was estimated with data for 108 countries covering the period from 1953 to 1983. In order to compare the estimated patterns of manufacturing development we firstly use the regressions results as calculated by S-C (see S-C: p.103), where different levels of GDP per capita income were plugged into the estimated equation manufacturing sector as a whole. Secondly, we estimate the manufacturing patterns by the same equation used by S-C (equation 3), using data set including 135 countries for the 44 year-period from 1963 to 2006. Data on value added share *(VASHARE)*, obtained from the UNIDO Industrial Statistics Unit, are based on the two-digit level of ISIC for all manufacturing economic activities. Earlier revisions of ISIC were converted to the Revision 3 classifications by UNIDO Statistics Unit to obtain consistent, long-term time series data from 1963 to 2006. GDP per capita *(RGDPL)* is adjusted based on purchasing power parity (PPP). Population was kept constant at 20 million.

---

[3] Chenery, Robinson, and Syrquin (1986) concluded that the patterns are somewhat robust to time trend, therefore cross-country estimations ought to reflect somewhat “true patterns”.

Since S-C income data were set in 1980 US dollars, changes in the share of manufacturing industry for their study were estimated by using adjusted income levels set in 2005 US dollars.

Figure 1 Changes in manufacturing share in GDP at the selected per capita income levels. Comparison between S-C and UNIDO calculations



Source: Created by authors based on the regression results using equation 3 (S-C methodology).

Figure 1 clearly shows the diverging patterns of the two results for levels of GDP per capital above 13,000 US dollars. S-C result depicts a more linear pattern, indicating that the manufacturing share in GDP increases steadily and would start declining only after per capita income exceeds 390,428 US dollars. In contrast, our result shows a more concave pattern. It illustrates that the share of manufacturing industry increases at a faster rate than S-C pattern during the initial stages of industrialization, but once it reaches the income per capita level of 13,000 US dollars, manufacturing share in GDP starts declining. Based on existing data on the changes in manufacturing shares and experiences of advanced countries, it is very unlikely that the share of manufacturing industry continues to increase.

S-C made an important contribution to the studies on structural change of production by showing the patterns of the relative rises and declines of different industries (i.e. agriculture, construction and utilities, manufacturing, and service) along with a country's economic growth.

To further understand the development pattern of manufacturing, our study was able to revise and incorporate the de-industrialization phase in the pattern in order to present an accurate picture of long-term manufacturing transformation.

Acknowledging the stage of de-industrialization does not, however, undermine the importance of manufacturing industry for a country's development. In fact, our new development pattern suggests that the share of manufacturing industry increases at a faster rate than that of S-C pattern during the early stages of industrialization. Moreover, although the process of de-industrialization sets in after reaching a high income level, it is only an indication of how manufacturing industry as a whole is likely to evolve. There is a possibility that shares of some sub-sectors within manufacturing may be able to still increase and serve as drivers for output growth in other sub-sectors. Thus, to gain further insights into the pattern of manufacturing development, this study will show the changes in the shares of the disaggregated sub-sectors as manufacturing industry generally follows the concave pattern of figure 1. In contrast to the studies on structural change at ISIC one-digit level, there are a limited number of reliable studies (Chenery, 1960; Chenery and Taylor, 1968; S-C) aimed at understanding the structural change within manufacturing industry. To enter this still unexplored area, as a starting point this paper first repeats the above procedure – applying our data to the equation 3.

Our data set is based on the ISIC Revision 3 classification, originally entailing 22 manufacturing sub-sectors. Some countries were reporting value added figures combining two sub-sectors so it was necessary to merge the initial 22 sub-sectors into 18.[4]

S-C data set was based on the ISIC Revision 2 classification, entailing 9 separate branches of manufacturing. To make the two datasets comparable, the 18 manufacturing sub-sectors of our data set were further combined into the 9 sub-sectoral groups as used by S-C.

[4] The sectors merged are 18 (Manufacture of wearing apparel; dressing and dyeing of fur) and 19 (Tanning and dressing of leather; manufacture of luggage, handbags, saddlery, harness and footwear), 29 (Manufacture of machinery and equipment n.e.c.) and 30 (Manufacture of office, accounting and computing machinery), 31 (Manufacture of electrical machinery and apparatus n.e.c.) and 32 (Manufacture of radio, television, and communication equipment and apparatus), and 34 (Manufacture of motor vehicles, trailers and semi-trailers) and 35 (Manufacture of other transport equipment).

Table 1 ISIC Revision 3 classification

ISIC description	*ISIC abbreviation*[5]	*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: UNIDO 2010.

Table 2 includes both the original table of the S-C (p.32) and the results for the same equation using UNIDO dataset. Figure 2 illustrates the results of S-C and the authors in graphs, respectively.

[5] Throughout the text we use abbreviated sub-sectoral names from table 1.

Table 2 Manufacturing sub-sector shares in GDP at selected per capita income levels

		S-C dataset				*UNIDO dataset*			
		Income per capita (1980 US$)[6]				*Income per capita (2005 US$)*			
Sub-sector	*ISIC code (Rev. 2)*	*500 (-1200)*	*1000 (-2400)*	*2000 (-4800)*	*4000 (-9600)*	*1200*	*2400*	*4800*	*9600*
Food, beverages and tobacco	31	4.5	4.7	4.6	4.2	3.3	4.3	4.5	4.1
Textile and clothing	32	3	3.3	3.4	3.2	1.6	2.4	2.7	2.4
Wood and products	33	0.5	0.6	0.8	1	0.3	0.4	0.5	0.5
Paper and printing	34	0.4	0.7	1.1	1.6	0.3	0.7	1.1	1.4
Chemicals and rubber	35	3	3.6	4	4.2	1.7	2.6	3.3	3.8
Non-metallic minerals	36	0.8	1.1	1.2	1.3	0.6	1	1.2	1.2
Basic metals	37	0.9	1.3	1.7	1.9	0.2	0.7	1	1.2
Metal products and machinery	38	1.9	3.2	4.8	6.6	0.6	2.2	3.8	5.3
Other	39	0.1	0.3	0.3	0.4	0.1	0.3	0.4	0.5
Manufacturing	*3*	*15.1*	*18.8*	*21.9*	*24.4*	*8.5*	*14.6*	*18.5*	*20.5*
Overall gain/loss									
Food, beverages and tobacco	31				-0.3				0.8
Textile and clothing	32				0.2				0.8
Wood and products	33				0.5				0.2
Paper and printing	34				1.2				1.1
Chemicals and rubber	35				1.2				2.1
Non-metallic minerals	36				0.5				0.6
Basic metals	37				1				1
Metal products and machinery	38				4.7				4.7
Other	39				0.3				0.4
Manufacturing	*3*				*9.3*				*12*

Source: Created by authors based on the regression results using equation 3 (S-C methodology).

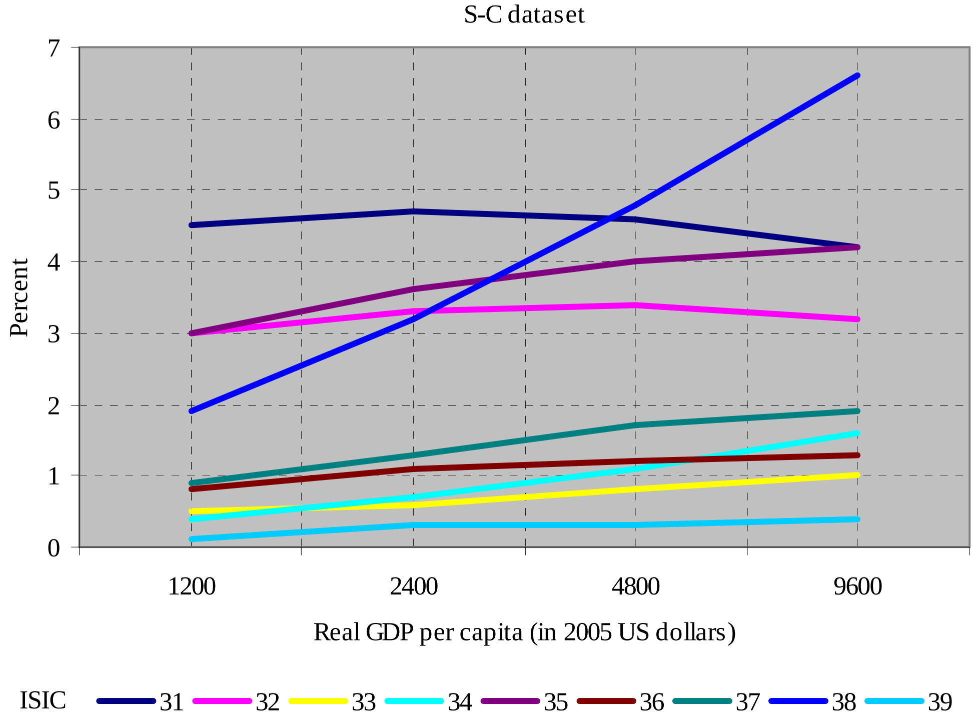
[6] The four income levels of S-C table (p.32) correspond to the income levels in the parentheses and figure 2 expressed in 2005 US dollars.

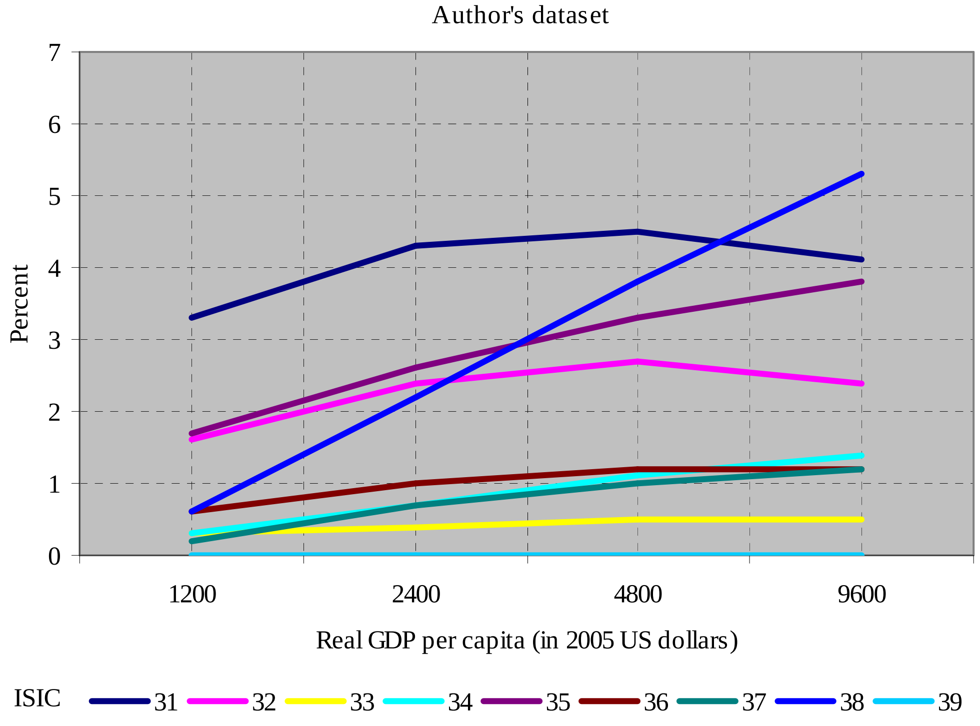
There are some similarities in the results between the two studies as shown in table 2.[7] The relative importance of each sub-sector in GDP at different levels of income is not that different. Furthermore, the two studies exhibit similar patterns regarding the approximate timing of each sub-sector reaching its highest share in the economy. For example, in both studies the ***food, beverages and tobacco***; and the ***textile and clothing*** reach their highest shares at a GDP per capita of 4,800 US dollars (in 2005 US dollars) while the sub-sectors ***chemicals and rubber*** and ***metal products and machinery*** peak at a later stage of economic growth.

Differences between the two studies become clear when we compare the shares of each sub-sector and of the manufacturing industry as a whole (figure 2). For most of the sub-sectors across different income levels, S-C show higher shares than our results, which is reflected also in their higher share of manufacturing industry as whole (as it is an aggregate of the sub-sectors). At the initial stage of development (500 in 1980 US dollars and 1200 in 2005 US dollars) the share of value added in manufacturing for S-C is almost two times larger than for our calculations. Such a high share of S-C results might be an overestimation, as many low income economies (which are less well represented in their sample) at their initial stage of development are usually faced with very low shares of manufacturing value added in their GDP. Review of real manufacturing shares of low income countries in our calculations seems to confirm this point.

[7] The VA shares in table 2 and figure 1 (based on S-C dataset) differ. The reason is that the VA shares in table 2 were taken from table 6 in S-C (p.32). Although these ought to be based on regression results in table 51 in the Appendix in S-C, there appears to be some discrepancy for some sectors, which seems to overvalue the share of manufacturing as shown in Table 6 in S-C and columns 3, 4, 5 and 6 in table 2 of this study.

Figure 2 Changes in share of manufacturing sub-sectors in GDP at the selected per capita income levels





Source: Created by authors based on the regression results using equation 3 (S-C methodology).

The above simple experiment to see the development patterns of manufacturing sub-sectors based on one of a few available past studies points out that we have only rudimentary understanding of the development patterns at this disaggregated level. Chenery and Taylor (1968) indicated that such patterns significantly differ according to a country's demographic characteristics. This point can be also easily summarised by the available evidence at a more aggregated level of manufacturing industry at large, where it is found that a country's characteristics have strong influence on its development patterns (Chenery and Syrquin, 1975; Kader, 1985; Chenery, Robinson and Syrquin, 1986; S-C; and Branson et al., 1998). To establish basic patterns for manufacturing sub-sectors, therefore, an alternative model and procedures will be presented in the following section.

3. Alternative model for assessing patterns of manufacturing development

This approach takes advantage of the increased availability of cross-section and time-series data and includes variables considered appropriate for establishing basic development patterns at sub-sector level, which can become benchmarks for assessing country-specific characteristics. As used in past studies on the estimations of sub-sectoral share changes, we use a single equation approach for the study of structural transformation.

For the purpose of this paper, two different equations are applied:

$$\ln VASHARE_{it} = \alpha_1 + \alpha_2 * \ln RGDPL_{it} + \alpha_3 * \ln RGDPL_{it}^2 + \alpha_4 * \ln POPD_{it} + \alpha * \ln RPC_{it} + countrydum\ mies + e_{it}^{\ d} \quad (4)$$

$$\ln VASHARE_{it} = \alpha_1 + \alpha_2 * \ln RGDPL_{it} + \alpha_3 * \ln RGDPL_{it}^2 + \alpha_4 * \ln POPD_{it} + \alpha_5 * \ln POPD_{it}^2 + \alpha_6 * \ln RPC_{it} + \alpha_7 * \ln RPC_{it}^2 + countrydum\, mies + e_{it}^{\ d} \quad (5)$$

Our model determines the dependent variable (share of the sub-sector value added in GDP) and gross domestic product (GDP) per capita, which is endogenously determined within the model. The Hausman test indicates that GDP per capita is, in fact, endogenous. An attempt is made here to resolve this by including instrumental variables (IV) and applying the generalized method of moments (GMM) regression technique, which extends the two stage least square estimator to better account for heteroskedasticity and/or serial correlation problems. In the model, GDP per capita (*RGDPL),* indirectly reflects the interaction between the demand effects of rising income and the supply effects of changes in factor proportions and technology, therefore it is expected that the rising income ought to bring about rather uniform patterns in structural transformation.

Since the purpose of this study is to establish basic development patterns of manufacturing sub-sectors, variables included other than GDP per capita are limited to those that define 'given conditions' of countries. Thus, our equation includes variables related to country's demographic and geographic characteristics, namely population density and resource endowments. In addition, the sample of countries is divided into two different groups based on the size of their population in order to see the effect of country size. Countries have no or very limited influence over these characteristics at least in the short- to medium-run, which enables us to separate the development patterns attributed to sub-sectoral characteristics from man-made conditions, such as policy-related, institutional and historical factors. This is the reason why the equation does not include variables related to a country's trade orientation or openness to trade, as employed in some past studies (Chenery and Syrquin, 1975; S-C).

Literature on structural change points out that country size has significant effects on the patterns of industrial development because economies of scale, resource endowments, and scale of domestic demand often vary with country size (Chenery and Syrquin, 1975; Chenery and Taylor, 1968; Syrquin, 1988). Past empirical evidence shows that the manufacturing industry of larger countries has a larger weight in their economies in the early stage of development than that of smaller countries. Also, manufacturing growth of the former group usually slows down before that of the latter group, which has more linear growth patterns across different income levels. The effects of this important exogenous factor on development patterns are investigated in the following section, as we see whether the longer time-series data used in this study confirm these results. The countries in our data set were therefore accordingly divided into small and large countries.[8] Depending on the sub-sector, equation (4) and (5) were applied interchangeably to both groups Generally, equation (4) was applied to large countries, because in medium- to long-run, large countries might show linear increases in both population density (*POPD*) as well as their resources per capita (*RPC*). The opposite might hold for small countries. Nevertheless, the specific form of equation for each sub-sector in small and large country groups is determined by applying equation (4), (5) or variants of these and examining the significance of their coefficients, R-squares and F-test results.

[8] Countries with a population exceeding 15 million in 1983, the middle year of the time series, are classified as large countries.

Although Chenery (1960:628) was aware of the significance natural resource can play in the process of industrialization, he was not able to find a statistical measure of resource supply for a large number of countries and he therefore excluded it from his regression equation (Chenery, 1960:630). Our resource proxy variable *(RPC)* has been calculated as a difference between exports and imports of relevant resource commodities and expressed in per capita terms.[9]

Keesing and Sherk (1971) show that population density plays an important role on the patterns of trade and development. Densely populated areas appear to have a greater impact, in particular, on increased exports of manufactured goods relative to primary products. This relationship would suggest that only the most densely populated, small developing countries can look forward to early successful export specialization in manufacturing sub-sectors—other than those based on proximity to natural resources. To control for differences in the quality of land among countries, this paper uses population per hectare of arable land and permanent cropland as a measure of population density.

The underlying purpose of our model is to get relatively accurate picture of structural transformation. The "exogenous" variables included in the model, population density per hectare of arable land and permanent cropland and resource availability per capita, reflected by a country's net exports of raw commodities, are determinants on which countries have less influence in the short- to medium-run. This means that any policy approaches countries might undertake are unlikely to bring about rapid changes to those variables. As such, the patterns reflect a picture based on manufacturing sub-sectoral characteristics relative to others. Once such benchmark patterns are obtained, the research can focus on explaining the deviations of a country's sub-sectoral development patterns from the benchmarks by examining policy-related, institutional and historical factors.

4. Results

The results presented in table 3 are based on equation (4), (5), or their variants. As countries were divided in two samples, regressions were run separately for each group. The estimation method GMM applied in combination with country dummies (fixed effects), enabled us to

[9] These include the commodities categorized under SITC (Standard International Trade Classification) revision 1 in codes 2 (crude materials, inedible, except fuels), 32 (coal, coke and briquettes), 331 (petroleum, crude and partly refined), and 3411 (gas, natural).

determine the significance of a country effect on the model as a whole and measure the respective deviation from the pattern.

By using fixed effects, the explanatory power of the model became relatively large, indicating importance of country-specific effects. Although most of the coefficients appear statistically significant, their impact varies with each sub-sector; therefore interpretation cannot be straightforward across sub-sectors. Significant for all sub-sectors, GDP per capita is positively related, explaining the largest part of sub-sectoral transformation. Squared GDP per capita is negatively related for all sub-sectors, except for ***precision instruments*** for small countries, and reflects diminishing rates of return as predicted by theory. The effects of population density, which are significant in almost all sub-sectors, except for ***furniture, n.e.c.***, are sub-sector-specific, being positive for some sub-sectors and negative for the others. Resource per capita shows a negative relation with value added share in most manufacturing sub-sectors.

Based on the regression results of table 3, figure 3 shows the patterns of value added shares for small (blue) and large (red) countries for each manufacturing sub-sector. First of all, the results confirm that even the shares of late developing sub-sectors will be in decline once countries reach an income level of 20,000 to 30,000 US dollars. Therefore, the results support our estimate for the changes in overall manufacturing share in the economy as shown in figure 1. Second, also being consistent with the available evidence at the aggregated level of manufacturing industry, country size has significant influence on the development patterns of sub-sectors within manufacturing. However, the results do not follow the patterns suggested by Chenery and Taylor (1968), which illustrated the delayed and more linear development of manufacturing sub-sectors for small countries than for large countries. Contrary to the findings of Chenery and Taylor and the implications of the S-C, development patterns are sub-sector-specific. There seems to be no distinct trend to characterize the patterns of large and small countries across sub-sectors.

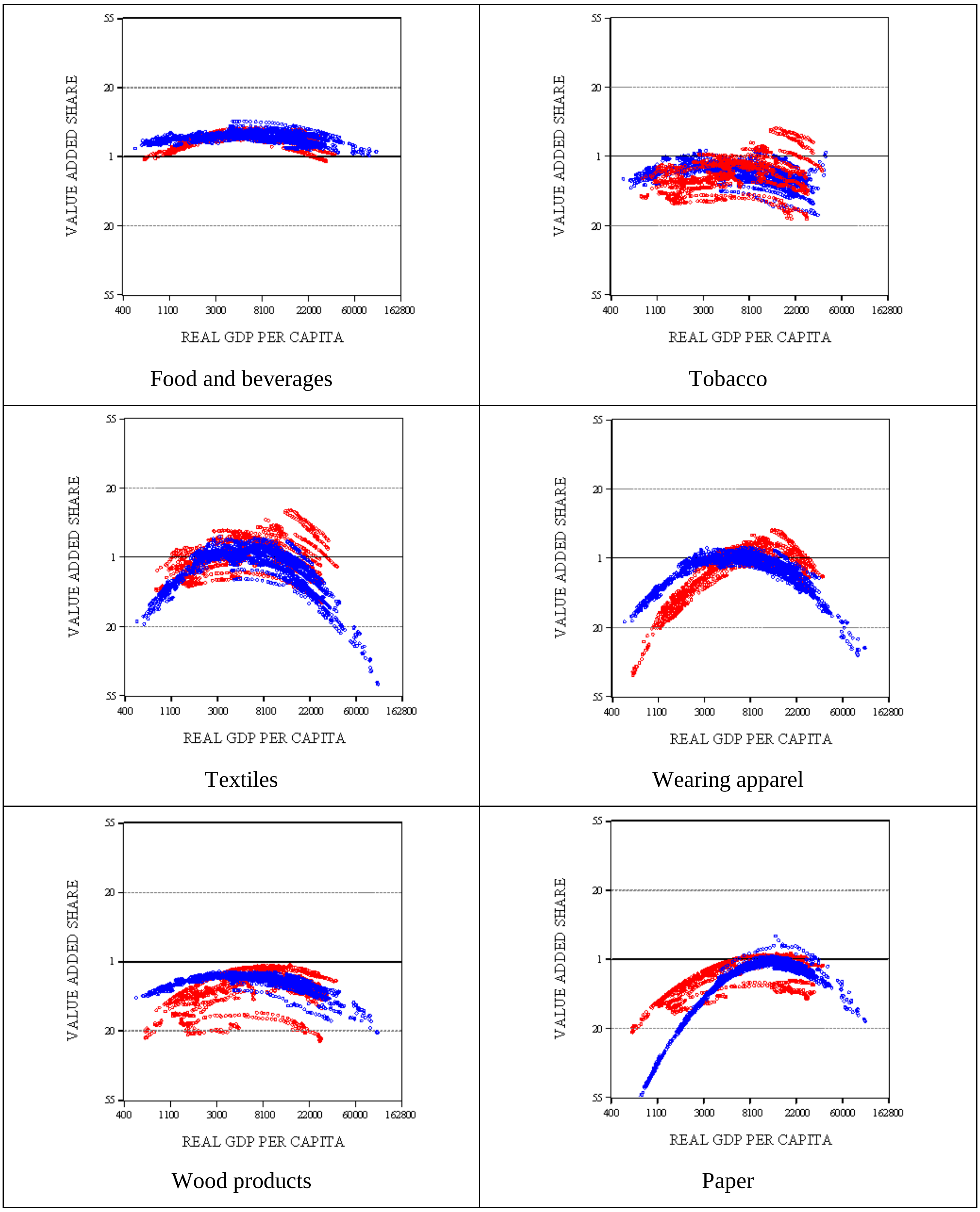
Table 3 Regression results

ISIC abreviation	Size	C	GDPPC	GDPPC^2	POPD	POPD^2	RPC	RPC^2	R^2_adj	N
Food and beverages	L.C.	-11.2970	4.9694	-0.2847	0.2290		-1.1454		0.7525	937
	S.C.	-19.1251	2.8766	-0.1734	0.3738	-0.0282	2.0171	-0.1257	0.8556	1443
	L.C.	0.0000	0.0000	0.0000	0.0077		0.0000			
	S.C.	0.0051	0.0052	0.0016	0.0000	0.0024	0.0195	0.0104		
Tobacco	L.C.	-631.6026	4.2361	-0.2372	-0.9729		146.7549	-8.7804	0.6241	905
	S.C.	30.8024	3.5568	-0.2164	-0.7725	0.0685	-12.2299	0.8159	0.7166	1262
	L.C.	0.1015	0.0000	0.0000	0.0000		0.1143	0.1150		
	S.C.	0.0027	0.0009	0.0002	0.0000	0.0001	0.0001	0.0001		
Textiles	L.C.	-30.9485	9.5605	-0.5535	-1.0196		-1.0126		0.6721	975
	S.C.	-22.6889	12.9973	-0.7503	-0.8159	0.0641	-7.6075	0.4464	0.8569	1474
	L.C.	0.0000	0.0000	0.0000	0.0000		0.0000			
	S.C.	0.0235	0.0000	0.0000	0.0000	0.0003	0.0002	0.0002		
Wearing apparel	L.C.	-57.9157	17.8981	-0.9845	-0.5922		-2.6878		0.7033	978
	S.C.	-45.2471	11.4662	-0.6582	-0.6119	0.0775	-0.4821		0.7351	1502
	L.C.	0.0000	0.0000	0.0000	0.0000		0.0000			
	S.C.	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000			
Wood products	L.C.	-23.9795	8.2055	-0.4519	0.4275	-0.4920	-1.6393		0.8448	965
	S.C.	-21.9363	4.4037	-0.2577	-0.2177		0.3044		0.8003	1509
	L.C.	0.0000	0.0000	0.0000	0.0028	0.0000	0.0000			
	S.C.	0.0001	0.0000	0.0000	0.0013		0.0001			
Paper	L.C.	-29.8650	8.7761	-0.4666	0.8272	-0.4413	-1.3926		0.7658	962
	S.C.	-69.1032	18.8514	-1.0019	0.1825		-4.7456	0.2803	0.8330	1424
	L.C.	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000			
	S.C.	0.0000	0.0000	0.0000	0.0027		0.0400	0.0428		
Printing and publishing	L.C.	-20.6961	6.8054	-0.3630	0.2896	-0.1621	-1.4009		0.8375	964
	S.C.	-30.6077	5.0113	-0.2659	0.1400		1.4998	-0.0879	0.8859	1474
	L.C.	0.0000	0.0000	0.0000	0.0011	0.0000	0.0000			
	S.C.	0.0000	0.0000	0.0000	0.0133		0.0493	0.0509		
Coke and refined petroleum	L.C.	-35.1040	9.7980	-0.5689	0.7649		-0.9858		0.6728	882
	S.C.	-35.3666	12.4579	-0.6732	0.7811	-0.0744	-5.2265	0.2893	0.7397	1143
	L.C.	0.0000	0.0000	0.0000	0.0087		0.0057			
	S.C.	0.0517	0.0001	0.0001	0.0222	0.0043	0.0017	0.0032		
Chemicals	L.C.	-25.1218	6.1827	-0.3475	0.5943		-0.2894		0.7409	953
	S.C.	-57.4935	9.5847	-0.4983	0.4912	0.0080	2.6447	-0.1547	0.7598	1405
	L.C.	0.0000	0.0000	0.0000	0.0000		0.0155			
	S.C.	0.0000	0.0000	0.0000	0.0052	0.6036	0.0394	0.0328		
Rubber and plastic	L.C.	-23.0836	7.8442	-0.4082	0.9863	-0.3722	-1.7912		0.7975	965
	S.C.	-59.4660	8.9610	-0.4816	0.9576	-0.0885	4.0747	-0.2558	0.8548	1436
	L.C.	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000			
	S.C.	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000		
Non-metallic minerals	L.C.	-26.4978	7.4703	-0.4251	0.4483		-0.8072		0.7705	967
	S.C.	-12.2119	6.3189	-0.3637	0.6703	-0.0545	-3.7211	0.2138	0.8078	1556
	L.C.	0.0000	0.0000	0.0000	0.0000		0.0000			
	S.C.	0.1041	0.0000	0.0000	0.0000	0.0000	0.0023	0.0028		
Basic metals	L.C.	-61.7357	17.3646	-0.9600	1.4276	-0.4419	-2.0140		0.7380	940
	S.C.	-53.9608	14.5194	-0.7966	1.2352	-0.1150	-3.6065	0.2303	0.7970	1220
	L.C.	0.0000	0.0000	0.0000	0.0000	0.0000	0.0002			
	S.C.	0.0000	0.0000	0.0000	0.0000	0.0000	0.0006	0.0002		
Fabricated metals	L.C.	-13.4028	5.5053	-0.2922	-0.3612		-1.4546		0.8310	954
	S.C.	-36.8424	8.4941	-0.4497	-0.6835	0.0664	-0.2930		0.7766	1447
	L.C.	0.0000	0.0000	0.0000	0.0001		0.0000			
	S.C.	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000			
Machinery and equipment	L.C.	-17.0820	7.3349	-0.3916	0.5402		-2.1768		0.8477	951
	S.C.	-56.3697	12.6013	-0.6464	0.4555		-0.7507		0.8522	1329
	L.C.	0.0000	0.0000	0.0000	0.0017		0.0000			
	S.C.	0.0000	0.0000	0.0000	0.0000		0.0000			
Electrical machinery and apparatus	L.C.	-29.9850	12.4077	-0.6506	0.8105	-0.4103	-3.4278		0.8315	960
	S.C.	-67.3752	14.8685	-0.7451	-0.4556	0.0374	-0.6984		0.8567	1421
	L.C.	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000			
	S.C.	0.0000	0.0000	0.0000	0.0262	0.0008	0.0000			
Precision instruments	L.C.	-33.9941	9.2772	-0.4877	1.9548	-0.3575	-1.6506		0.8480	912
	S.C.	30.5127	-6.8545	0.4360	0.4975	-0.0467	-1.9500	0.1217	0.8263	1057
	L.C.	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000			
	S.C.	0.0523	0.0013	0.0001	0.0859	0.0250	0.3554	0.3298		
Motor vehicles	L.C.	-33.1134	9.5813	-0.4975	-0.4973		-1.4033		0.7614	955
	S.C.	2.4964	6.5879	-0.3622	-0.6934	0.0565	-7.6622	0.4527	0.8422	1434
	L.C.	0.0000	0.0000	0.0000	0.0013		0.0004			
	S.C.	0.8279	0.0014	0.0008	0.0010	0.0012	0.0000	0.0000		
Furniture, n.e.c.	L.C.	-36.1018	11.3049	-0.6009	0.9730	-0.4933	-2.1130		0.8072	967
	S.C.	-4.9660	4.5322	-0.2419	-0.2818	0.0023	-3.7803	0.2124	0.6497	1502
	L.C.	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000			
	S.C.	0.7003	0.0473	0.0429	0.2461	0.9173	0.0117	0.0162		

Source: Authors' regression results using equation 4 and 5 (authors' methodology).
Note: Figures in shaded rows indicate the estimated coefficients while the non-shaded rows underneath show the p-values. L.C. and S.C. mean large countries and small countries, respectively.

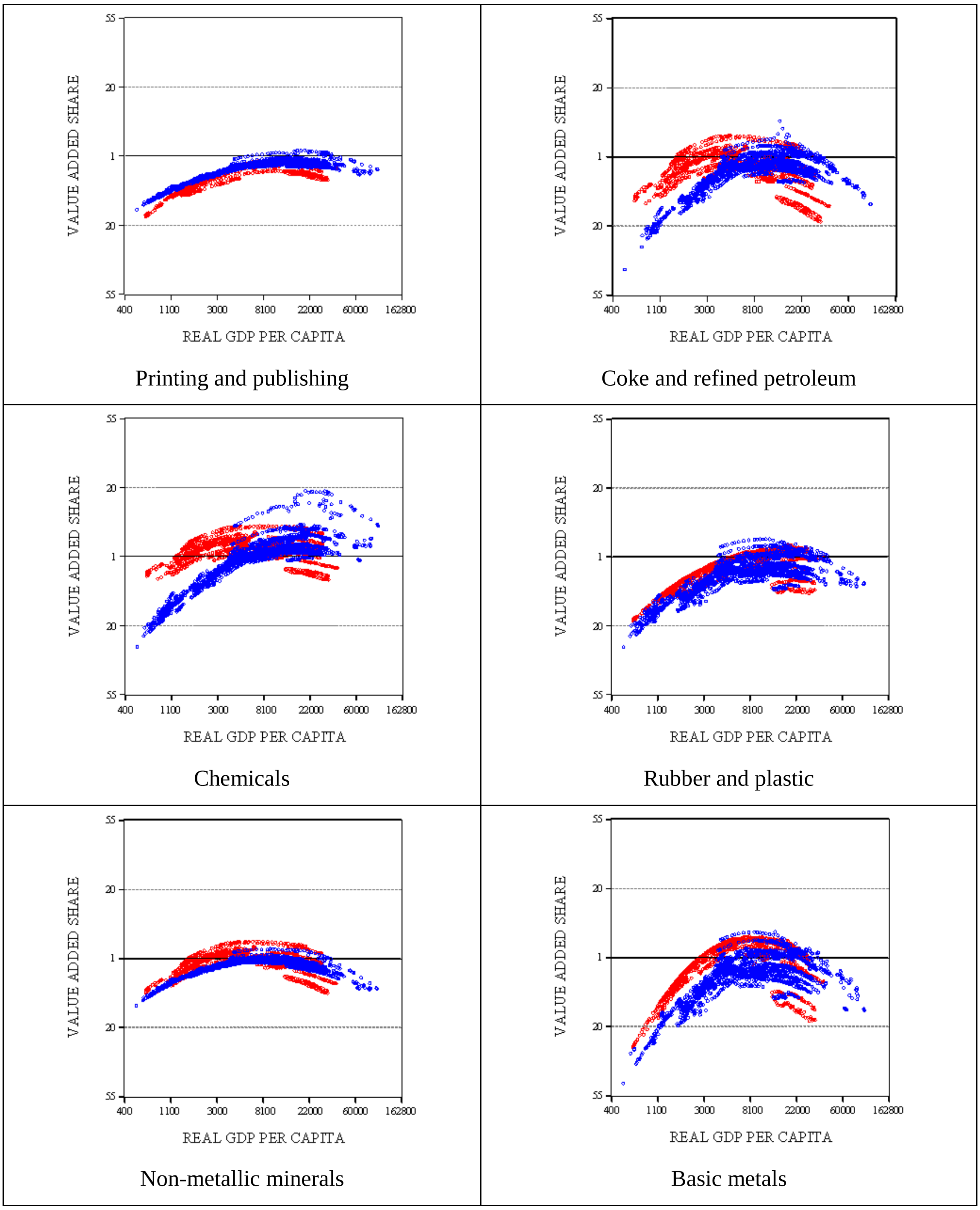
Figure 3 shows the development patterns of each sub-sector based on the changes in their relative shares in the economy as GDP per capita increases. For both large and small countries, the sub-sector ***food and beverages*** maintains a high share in the economy across different levels of GDP per capita while other manufacturing sub-sectors, such as ***tobacco*** and ***wood products*** almost never occupy significant shares in the economy throughout a country's development. During the early stage of development, the ***textiles*** sub-sector becomes important for both small and large countries. In addition, small countries are likely to experience an increase in the share of ***wearing apparel***. In the case of large countries, it is the ***chemicals***; ***coke and refined petroleum***; and ***non-metallic minerals*** that usually become prominent during these countries' low income period. From middle to high income period, both small and large countries witness increases in the shares of ***basic metals***; ***machinery and equipment***, and ***electrical machinery and apparatus***. ***Wearing apparel*** and ***motor vehicles*** also come late to increase their shares in the economy for large countries while small countries include ***chemicals*** in this category. Next section will examine sub-sectoral development patterns further in detail, assessing the impact of the differences in natural resource endowments and population density in addition to country size.

Figure 3 Sub-sectoral development patterns



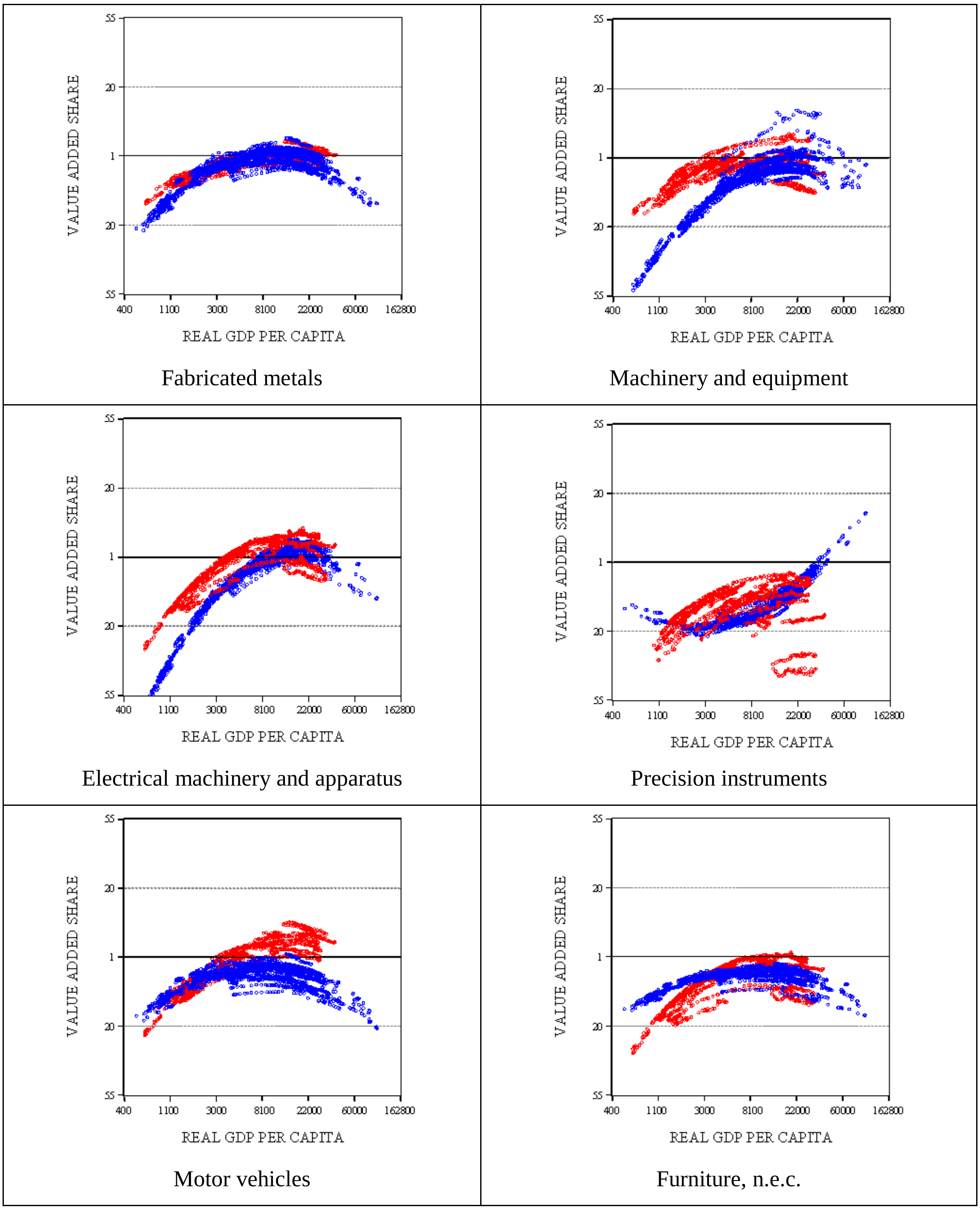
Source: Created by authors based on the regression results using equations 4 and 5 (authors' methodology).

Figure 3 Sub-sectoral development patterns (Cont'd)



Source: Created by authors based on the regression results using equations 4 and 5 (authors' methodology).

Figure 3 Sub-sectoral development patterns (Cont'd)



Source: Created by authors based on the regression results using equations 4 and 5 (authors' methodology).

5. Sub-sectoral development patterns

In this section, we estimate development trajectories, reflecting the differential impacts of population density and natural resource endowments based on the regression results described in section 4. In order to observe the sensitivity of the sub-sectoral transformation to the demographic and geographic factors included in the model, we change only one of the two variables from low to average and from average to high levels while keeping the other constant. By doing so, we can observe the sub-sectoral transformation with the evolution of GDP per capita, which captures the full cycle of development ranging from 1,000 US dollars to 29,000 US dollars, under restrictive conditions reflecting country characteristics and endowments.

This type of analysis can provide a reasonable typology of structural change, representing a benchmark upon which countries can be categorized. By positioning the countries within this framework in combination with other country specific characteristics, countries could effectively begin to manage and plan their development paths.

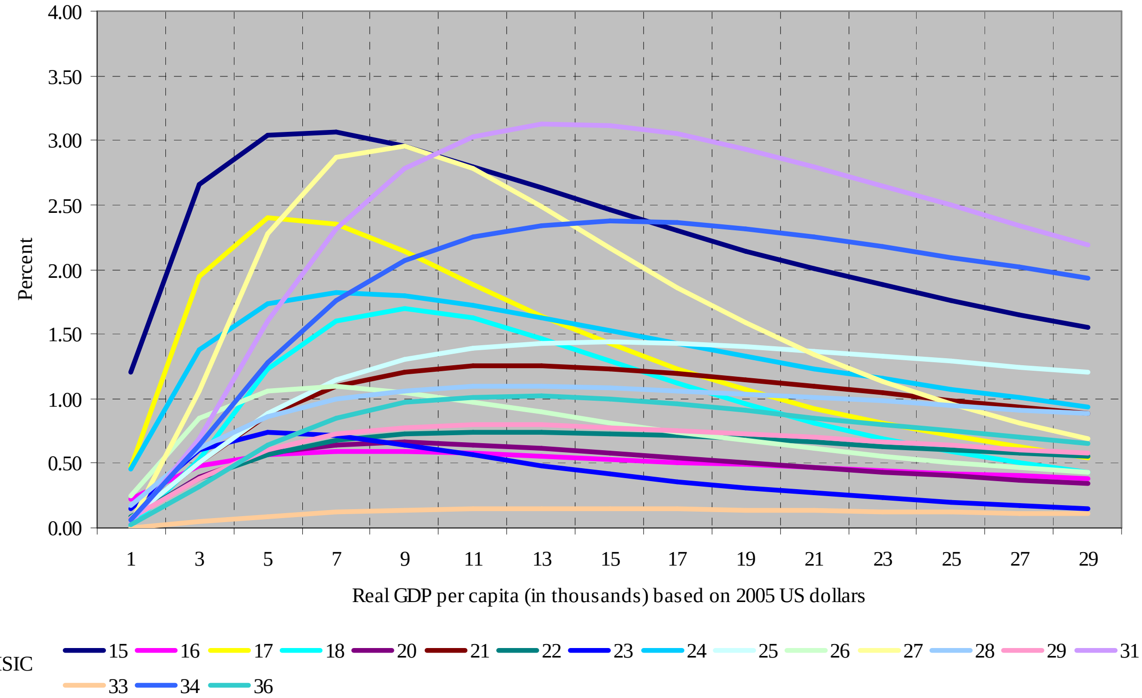
Large countries

Figure 4 shows the estimated patterns of sub-sectoral development for large countries with the average levels of both population density and natural resource endowments in the sample of 38 countries. These patterns of sub-sectoral development can be established by looking at whether the sub-sector ever becomes relatively large within the economy and, if so, when the sub-sector reaches such position and how long it can maintain its significance in the economy.[10] In an average large country sub-sector ***food and beverages*** is likely to be the largest sub-sector before the economy reaches 9,000 US dollars of GDP per capita and maintain a significant share even afterwards. On the other hand, several sub-sectors may never carry a significant weight in the economy. These include ***precision instruments***; ***coke and refined petroleum***; ***tobacco***; ***wood products***; ***printing and publishing***; and ***machinery and equipment***. Among the sub-sectors that experience a significant rise in their shares in GDP, broadly speaking there are three groups, depending on the timing of their peak relative to the country's per capita GDP. The early sub-sectors include ***textiles***; ***chemicals***; ***non-metallic minerals***. These sub-sectors reach their peaks at per capita GDP levels of between 5,000 and 7,000 US dollars. They are followed by the culmination of the middle sub-sectors such as ***basic metals*** and ***wearing apparel***, which peak at per capita GDP levels of between 7,000 and 10,000 US dollars. The declines of the early and

[10] In the total economy (including agriculture, manufacturing and services), there are around 100 sectors at 2 digit level of ISIC. Therefore, having a share of only one percent of GDP might not necessarily indicate a relative economic insignificance of any sector .

middle sub-sectors from then on are compensated by the rise of the late sub-sectors, such as ***electrical machinery and apparatus*** and ***motor vehicles***.

Figure 4 Changes in shares of manufacturing sub-sectors in GDP at the selected per capita income levels for large countries



Source: Created by authors based on the regression results using equations 4 and 5 (authors' methodology).
Note: For the correspondence of ISIC codes to sub-sector names, refer to the Table 1.

Unlike the early and middle sub-sectors, which rise and decline in a relatively short period of a country's development, the late sub-sectors emerge slowly and, after reaching their peaks at some 15,000 US dollars of GDP per capita, reduce their weights in the economy only gradually. This is the reason why the share of total manufacturing in the economy does not usually decline rapidly after passing the point of de-industrialization. Using the above average development pattern for large countries as a benchmark, we will now assess the effects of population density and resource endowments separately.

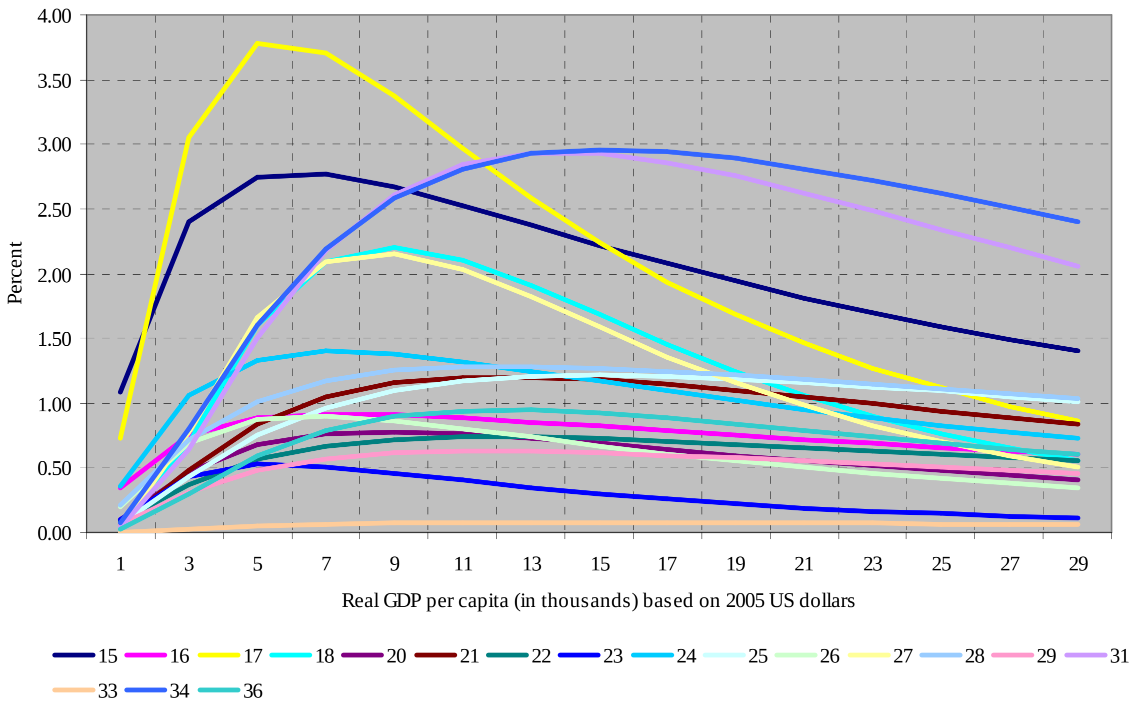
Effect of population density on sub-sectoral development in large countries

The comparison of figure 5 and figure 6 with the benchmark pattern of figure 4 indicates that low population density has favorable effects on the development of ***textiles***; ***wearing apparel***; ***fabricated metal***; and ***motor vehicles***. The positive effects of larger area of arable land relative to the number of people seem to point to the importance of scale economy for these sub-sectors. Meanwhile, it is estimated that high population density pushes up the shares of other sub-sectors instead, across the different levels of GDP per capita, most notably ***food and beverages***; ***chemicals***; ***non-metallic mineral***; ***basic metals***, and ***machinery and equipment***. An interpretation could be that more urbanized areas generally seem to foster more the development of these sub-sectors. Thus, agglomeration is likely to be an important factor for their growth.

Electrical machinery and apparatus shows a somewhat different development from other sub-sectors in terms of the effect of population density on the sub-sector's development. In the cases of both low and high population density, the share of the sub-sector in the economy was smaller than in the case of the average population density. Considering that a high population density reduced the share much more than a low population density, one can conclude that increases in population density up to a certain level help a large country's ***electrical machinery and apparatus*** sub-sector. Beyond this level, further rises in population density have a negative impact on the growth of the sub-sector.

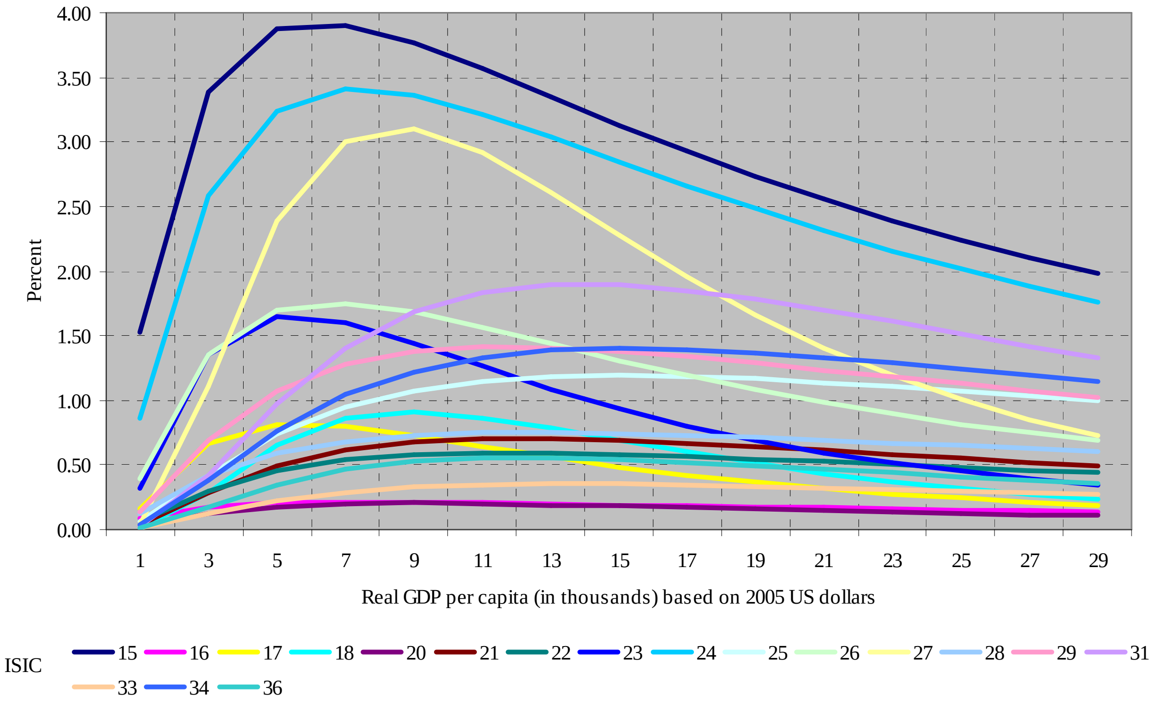
Among the sub-sectors, the development of ***textiles*** and ***chemicals*** are especially sensitive to the level of population density, which negatively and positively affect these sub-sectors, respectively.

Figure 5 Changes in shares of manufacturing sub-sectors in GDP at the selected per capita income levels for large countries of low population density



Source: Created by authors based on the regression results using equations 4 and 5 (authors' methodology).
Note: For the correspondence of ISIC codes to sub-sector names, refer to the Table 1.

Figure 6 Changes in shares of manufacturing sub-sectors in GDP at the selected per capita income levels for large countries of high population density



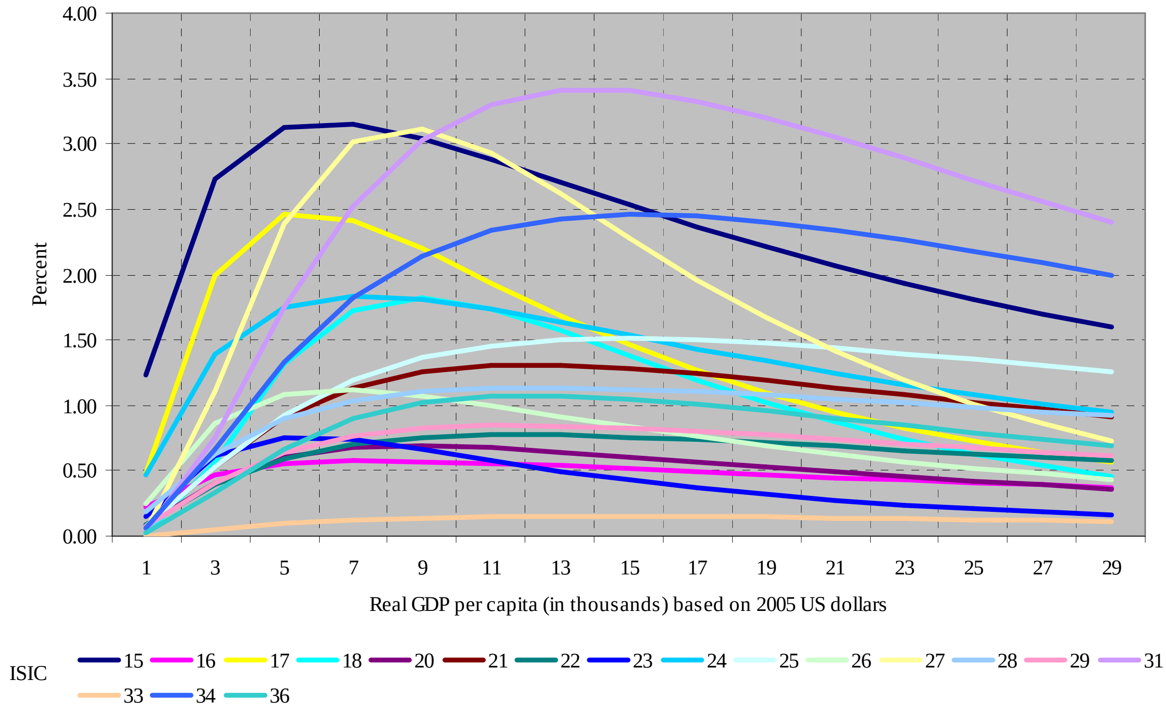
Source: Created by authors based on the regression results using equations 4 and 5 (authors' methodology).
Note: For the correspondence of ISIC codes to sub-sector names, refer to the Table 1.

Effect of natural resource endowment on sub-sectoral development in large countries

The comparison of figure 7 and figure 8 shows that a high natural resource endowment has a negative effect across all manufacturing sub-sectors, except for ***tobacco*** production. The negative effect on the individual sub-sectors is not extensive as evidenced in the comparison between the benchmark figure 4 and figure 8; however, the sum of the each negative effect could still become substantial and be reflected in a noticeably lower share of total manufacturing in the economy.

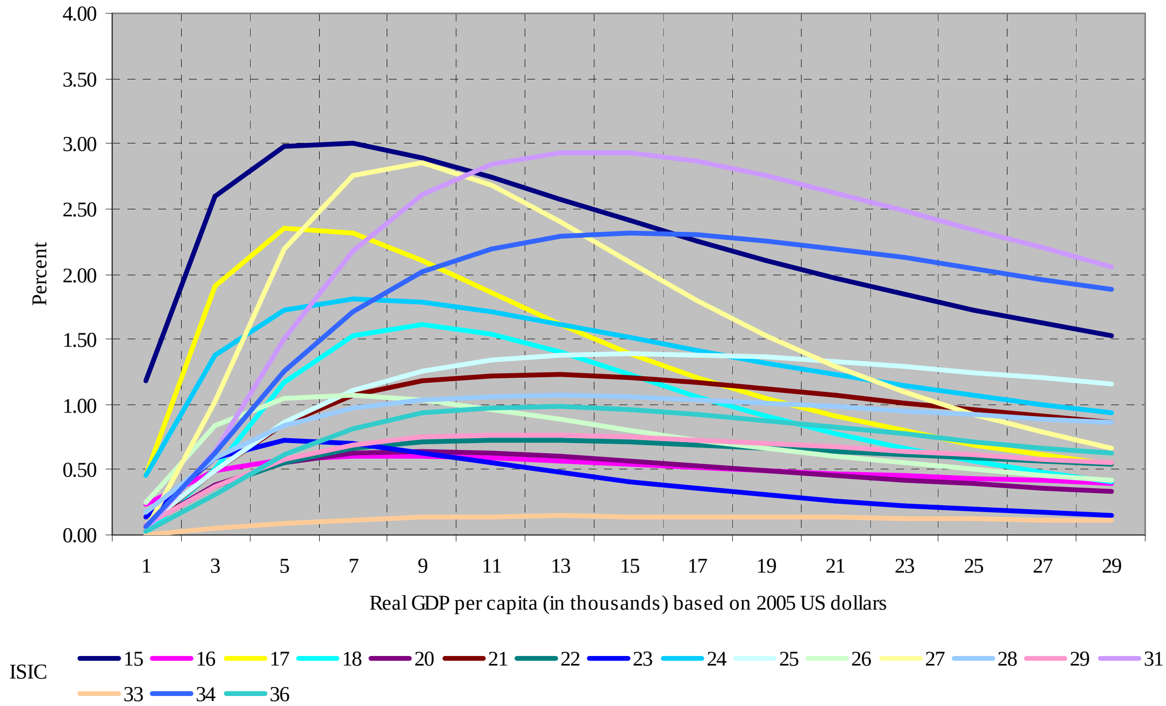
It is worthwhile to note the differences in the way the variables of population density and natural resource endowments affect manufacturing sub-sectors. On the one hand, the effect of population density is selective – shares of some sub-sectors are boosted by low population density and others by high population density. On the other hand, the effect of high natural resource endowment is less discriminatory – a higher level of natural resource endowment always lowers the shares in the economy across manufacturing sub-sectors, except for ***tobacco*** production, whereas low natural resource endowment has the opposite effects.

Figure 7 Changes in shares of manufacturing sub-sectors in GDP at the selected per capita income levels for large countries of low natural resource endowments



Source: Created by authors based on the regression results using equations 4 and 5 (authors' methodology).
Note: For the correspondence of ISIC codes to sub-sector names, refer to the Table 1.

Figure 8 Changes in shares of manufacturing sub-sectors in GDP at the selected per capita income levels for large countries of high natural resource endowment



Source: Created by authors based on the regression results using equations 4 and 5 (authors' methodology).
Note: For the correspondence of ISIC codes to sub-sector names, refer to the Table 1.

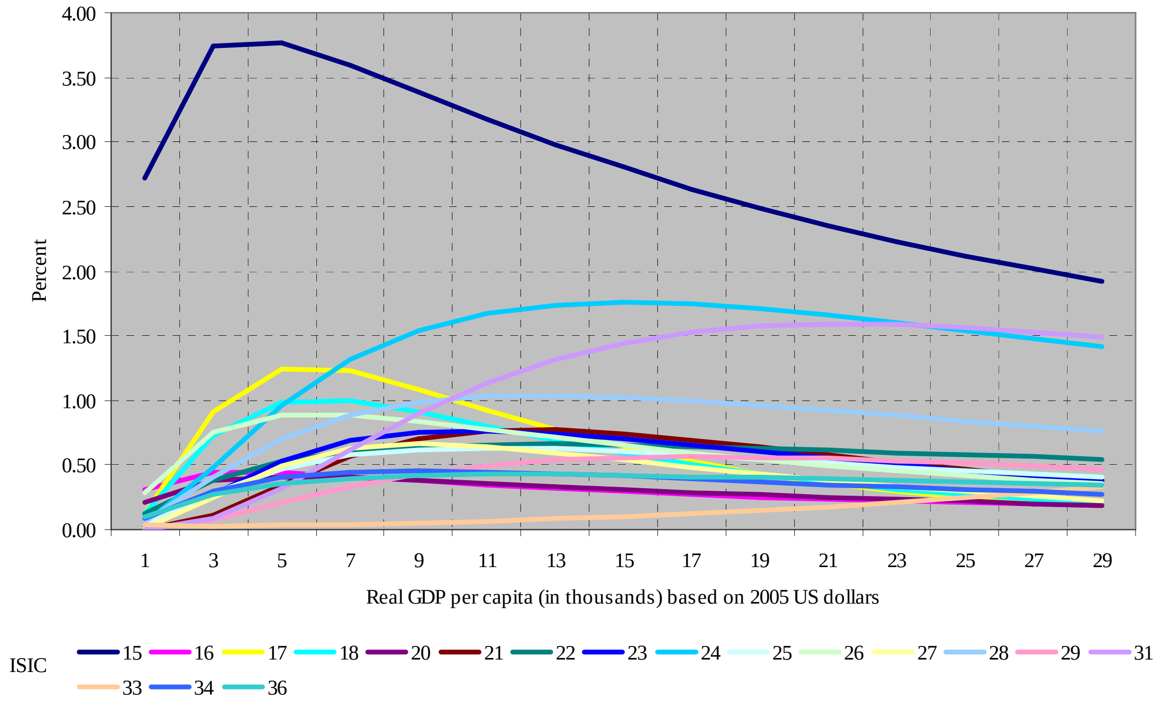
In addition, the effect of population density varies considerably from sub-sector to sub-sector. Some sub-sectors like ***textiles*** or ***chemicals*** change their shares in the economy greatly as the level of population density changes while the effect on other sub-sectors is negligible. In contrast to the case of population density, the effect of high natural resource endowment does not differ much across the sub-sectors: except for ***tobacco*** it always has relatively small and negative effects.

Small countries

Figure 9 shows the average pattern of sub-sectoral development for small countries. This benchmark pattern for small countries was constructed by using average levels of population density and natural resource endowment based on a sample of 97 small countries. The comparison between figure 9 and figure 4, benchmark pattern of large countries, clearly indicates that on average small countries have much limited prospects of manufacturing-oriented economic development and of diversification within manufacturing industry, relative to large countries. The only sub-sector whose share in the economy is higher in small countries than in large countries is the sub-sector ***food and beverages***. Indeed, this sub-sector is estimated to be the largest sub-sector within manufacturing industry in small countries regardless on their development stages. Although the shares of all other sub-sectors will be lower in small countries than in large countries at every level of GDP per capita, ***electrical machinery and apparatus***; ***chemicals***; and ***fabricated metals*** are likely to be prominent within the manufacturing industry of small countries. In fact, the shares of the latter two sub-sectors will come close to those of large countries.

In addition to the difference in the levels of sub-sectoral shares, there seems to be also a difference in the timing of the sub-sectoral development. Sub-sectors which play a central role in the industrialization of small countries are likely to reach their highest shares at higher levels of GDP per capita than in large countries. For example, the share of ***electrical machinery and apparatus*** peaks when the GDP per capita is 13,000 US dollars in large countries and 21,000 US dollars in small countries. The highest share of ***chemicals*** comes at the per capita incomes of 7,000 US dollars and 15,000 US dollars for large and small countries, respectively. Small countries, therefore, tend to experience a lower level of manufacturing development in general, and industrialization seems to come later for them than in large countries. As in the case of large countries, the following sections will examine the effects of population density and natural resource endowments in comparison to the benchmark pattern of figure 9.

Figure 9 Changes in shares of manufacturing sub-sectors in GDP at the selected per capita income levels for small countries.

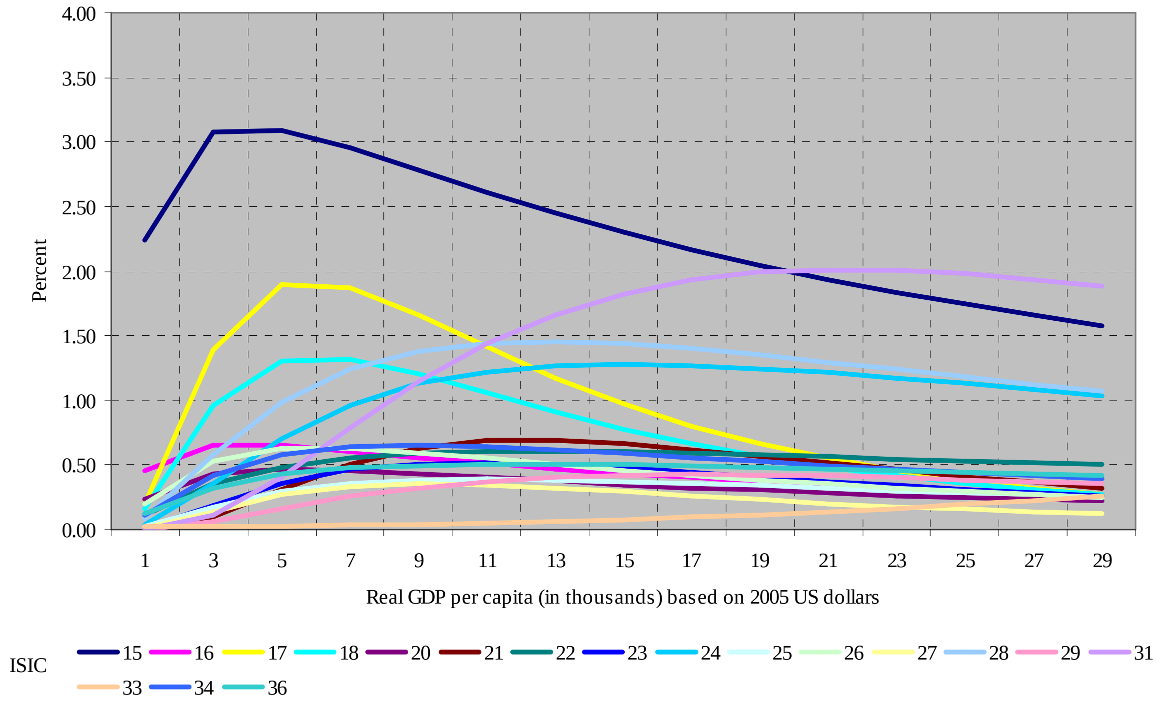


Source: Created by authors based on the regression results using equations 4 and 5 (authors' methodology).
Note: For the correspondence of ISIC codes to sub-sector names, refer to the Table 1.

Effect of population density on sub-sectoral development in small countries

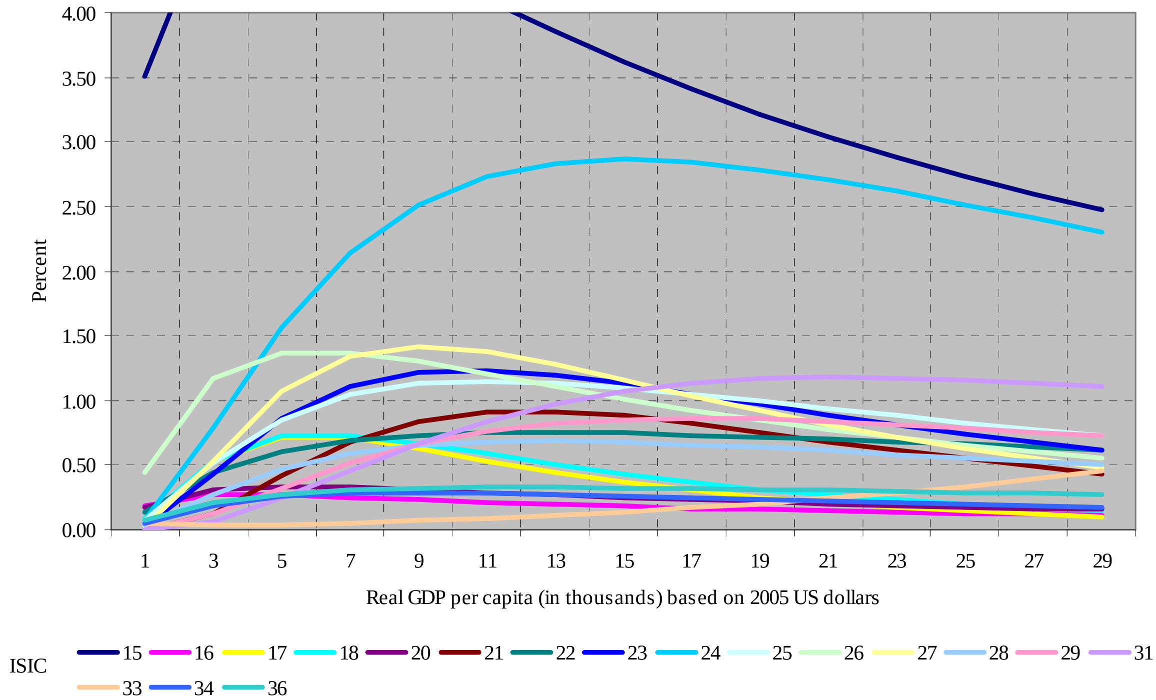
The comparison of figures 10 and 11 with the benchmark pattern of small countries, figure 9, points out that the effect of population density is similar to the case of large countries. Its effect on sub-sectoral development is selective: the development of some sub-sectors, such as ***textiles***; ***wearing apparel***; ***fabricated metals***; and ***motor vehicles***, is stimulated by lower population density, and that of others, especially ***food and beverages*** and ***chemicals***, is better fostered in an environment of higher population density. As seen from the graphs, one difference between large and small countries is that the positive effects of lower population density is greater than the positive effects of higher density in large countries while the opposite is the case for small countries. In other words, manufacturing industry as a whole would reach a higher share in the economy under the conditions of higher population density for small countries and of lower population density for large countries.

Figure 10 Changes in shares of manufacturing sub-sectors in GDP at the selected per capita income levels for small countries of low population density



Source: Created by authors based on the regression results using equations 4 and 5 (authors' methodology).
Note: For the correspondence of ISIC codes to sub-sector names, refer to the Table 1.

Figure 11 Changes in shares of manufacturing sub-sectors in GDP at the selected per capita income levels for small countries of high population density

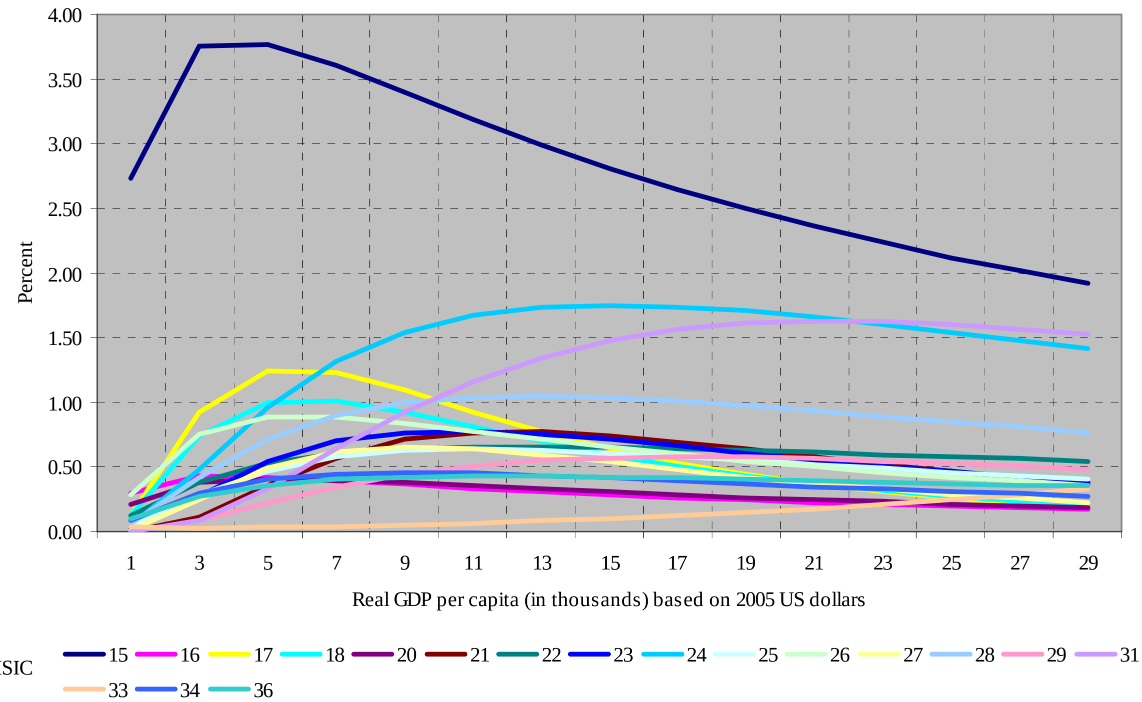


Source: Created by authors based on the regression results using equations 4 and 5 (authors' methodology).
Note: For the correspondence of ISIC codes to sub-sector names, refer to the Table 1.

Effect of natural resource endowment on sub-sectoral development in small countries

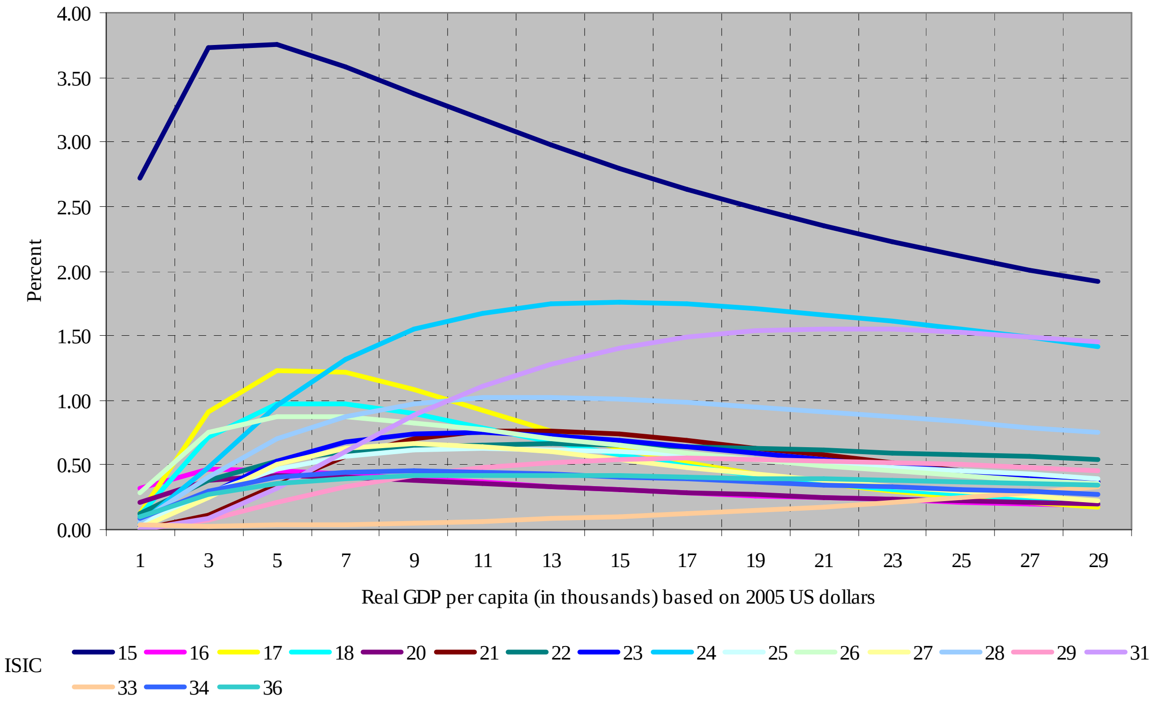
Compared with the benchmark pattern of figure 9, small countries with low natural resource endowment will usually have a higher share of manufacturing industry in the economy than those with high natural resource endowment, as in the case of large countries. The difference with large countries is that, at the individual sub-sectoral level within manufacturing industry, in addition to the ***tobacco***, there are a couple of more sub-sectors on which the effect of higher natural resource endowment is positive, such as ***wood products***; ***chemicals***; and ***basic metals***. In any case, the effect of natural resource endowment on sub-sectoral development, either positive or negative, is small, as was also the case of large countries.

Figure 12 Changes in shares of manufacturing sub-sectors in GDP at the selected per capita income levels for small countries of low natural resource endowment



Source: Created by authors based on the regression results using equations 4 and 5 (authors' methodology).
Note: For the correspondence of ISIC codes to sub-sector names, refer to the Table 1.

Figure 13 Changes in shares of manufacturing sub-sectors in GDP at the selected per capita income levels for small countries of high natural resource endowments.



Source: Created by authors based on the regression results using equations 4 and 5 (authors' methodology).
Note: For the correspondence of ISIC codes to sub-sector names, refer to the Table 1.

So far the discussion focused on the effect of population density and natural resource endowment on the sub-sectoral development patterns of large and small countries in comparison to their respective benchmark patterns. These two criteria allow us to divide small and large country samples into four groups within each country-size sample as shown in table 4 and 5, and respective sub-sectoral development patterns are shown from figure 14 to figure 21 in the Appendix. [11]

[11] As already indicated in the introduction, there are altogether 10 groups, which measure sub-sectoral development patterns in relations to GDP by keeping resource variable and population density constant. Table 5 and 6 show 8 groups, depending whether resources variable and population density variable are kept above or bellow median values. The other two groups can be seen in figure 4 and 9, where median values for both resource and population density variable are taken. The reason why median values were taken as oppose to average values for each variable is that average value might be affected by exceptionally small and large values.

Table 4 Large countries division based on population density and natural resource endowments

		Natural resource endowment	
		ABOVE MEDIAN	*BELOW MEDIAN*
Population density	*ABOVE MEDIAN*	Colombia, Egypt, Ethiopia, Indonesia, Mexico, Nepal, Peru, Vietnam	Bangladesh, China, Germany, India, Italy, Japan, Kenya, Pakistan, Philippines, Sri Lanka, United Kingdom
	BELOW MEDIAN	Algeria, Argentina, Australia, Canada, Iran, Iraq, Kazakhstan, Nigeria, South Africa, Sudan	Brazil, France, Morocco, Poland, Romania, Spain, Thailand, Turkey, Ukraine

Source: Created by authors based on the regression results using equations 4 and 5 (authors' methodology).

Table 5 Small countries division based on population density and natural resource endowments

		Natural resource endowment	
		ABOVE MEDIAN	*BELOW MEDIAN*
Population density	*ABOVE MEDIAN*	Albania, Azerbaijan, Bahamas, Chile, Gambia, Georgia, Guatemala, Haiti, Kuwait, Malawi, Norway, Oman, Papua New Guinea, Puerto Rico, Qatar, Saudi Arabia, Sierra Leone, Suriname, Swaziland, Tajikistan, Trinidad and Tobago, United Arab Emirates, Yemen	Armenia, Austria, Barbados, Belgium, Bermuda, Costa Rica, Cyprus, Dominican Republic, El Salvador, Eritrea, Iceland, Israel, Jamaica, Jordan, Lebanon, Lesotho, Luxembourg, Malta, Mauritius, Netherlands, Rwanda, Singapore, Slovenia, Somalia, Switzerland
	BELOW MEDIAN	Afghanistan, Angola, Benin, Bolivia, Bosnia and Herzegovina, Botswana, Burkina Faso, Cambodia, Cameroon, Central African Republic, Cuba, Denmark, Ecuador, Estonia, Gabon, Honduras, Latvia, Liberia, Malaysia, Mongolia, Mozambique, New Zealand, Paraguay, Tunisia, Uganda, Zimbabwe	Belize, Bulgaria, Burundi, Croatia, Czech Republic, Fiji, Finland, Ghana, Greece, Hungary, Ireland, Kyrgyzstan, Lithuania, Madagascar, Nicaragua, Panama, Portugal, Senegal, Slovakia, Sweden, Tonga, Uruguay, Zambia

Source: Created by authors based on the regression results using equations 4 and 5 (authors' methodology).

Within the sample of large countries, those located in the bottom right quadrant, which have below median levels of both population density and natural resource endowment; seem to possess the most favourable characteristics for industrialization among the four groups on the basis of our results. On the other hand, countries with higher levels of both population density and natural resource endowment in the upper left quadrant would expect the lowest level of the manufacturing share in the economy during the course of their development.

As discussed, small countries generally have a lower share of manufacturing industry in the economy than large countries. However, among them, countries with above-the-median population density and below-the-median natural resource endowments in the upper right quadrant can expect to have a relatively higher share of manufacturing industry in the economy while those with the opposite characteristics in the bottom left quadrant are likely to have the lowest level of the manufacturing share in the economy not only in the small-country sample but in the total sample of countries. The peak share of the manufacturing industry expected from the countries with the most supportive characteristics for industrialization in the bottom right quadrant of the large-country sample is some 11 percentage points higher (refer to the results in the Appendix) than the peak share that small countries with the least supportive characteristics in the bottom left quadrant could expect to achieve during the course of their economic development.

In addition to country size, population density and natural resource endowment, the authors considered that the landlockedness could be another factor to influence the degree of a country's industrialization. However, due to the small number of landlocked countries in the sample, the effect of landlockedness on manufacturing and its sub-sectoral shares in the economy could not be reliably estimated.

In light of the empirical results so far discussed, the following section will look into the policy relevance of this study.

6. Policy implications

The foremost contribution of this study to policy work is to identify structural change patterns, which are detailed and reliable enough to be used as benchmarks for checking the manufacturing development of countries with different geographic and demographic characteristics. Based on the results of this study, countries can identify the general trajectory of industrialization path, including the full evolution to maturity and ensuing de-industrialization as a country's income level increases. Such identification of manufacturing development patterns could help policy makers to plan a long-term development strategy for a country with such information as when manufacturing industry is likely to contribute to economic development most and when the leading driving force of the economy has to shift from manufacturing to services.

While a reconstruction of the development pattern at aggregate manufacturing level is more a scholarly contribution to the existing literature, detailed sub-sectoral development patterns within manufacturing industry presented in the latter part of this study will have higher relevance to policy work. In the past, Chenery and Taylor (1968) divided the manufacturing sub-sector into three categories, depending on the stage at which they contribute to the economy most. The early industries include ***food and beverages***; ***leather products;*** and ***textiles***. The middle industries comprise ***non-metallic minerals***; ***rubber products***; ***wood products***; ***chemicals***; and ***petroleum refining***, while ***clothing***; ***paper***; ***printing***; ***basic metals***; and ***metal products*** belong to the late industries. Similar categories were also used in S-C. This may provide us a very general indication of the structural change manufacturing industry could go through along a country's development; however, it may also hide the differences in the stages of sub-sectoral development existing between countries with different demographic and geographic characteristics. Therefore, this study avoided suggesting some general categories of sub-sectors, indicating the similarities of sub-sectoral development patterns; as such patterns depend on country characteristics. Instead, countries are categorized according to country size, population density and natural resource endowment, which shape the patterns of manufacturing development. This approach to studying structural change within manufacturing industry allows policy makers to have a benchmark pattern of manufacturing industry based on their countries' demographic and geographic characteristics and enable them to plan and monitor the countries' process of industrialization.

For example, the combined country characteristics of large country size, high population density and low natural resource endowments are more supportive of the development of ***food and beverages*** during the early stage of a country's development relative to those with low population density having the same country size and natural resource endowment level. The latter characteristics are more conducive to the development of ***textiles*** during the same stage. As countries move from low income to medium income and to high income stages, key sub-sectors for those with higher population density will shift from ***food and beverages*** to ***chemicals; basic metals;*** and ***electrical machinery and apparatus***. For countries with lower population density, the focus should shift from ***textiles*** to ***basic metals***, ***electrical machinery and apparatus****;* and ***motor vehicles****.*

Knowing which sub-sectors have advantages or disadvantages for development given certain country characteristics, policy makers can plan a path of industrialization consistent with their country characteristics without wasting much resource by investing in sub-sectors most unlikely to succeed. Specifically, the decline of some sub-sectors needs to be replaced with the emergence of others in the continuous process of structural change. The patterns of structural change presented for specific types of countries will help policy makers improve their sub-sectoral targets, resource allocation and monitoring by using their benchmark patterns as a reference.

The results of this study also provide the information on which comparators countries should use to emulate, learn the experiences from, and check their progress against. When it comes to learning industrialization, countries often look at the relatively successful region of East Asia and study experiences of the region's countries regardless of differences in demographic and geographic conditions and development stages. The findings showed that country characteristics have significant influence on a country's sub-sectoral development. Thus, it may not be so effective to adopt industrial policies which prompt countries to emulate others with totally different demographic and geographic characteristics, no matter how successful they are.

For example, Cameroon and China differ in all three country characteristics studied here – country size, population density and natural resource endowment. The characteristics of Cameroon are likely to be conducive to the development of certain sub-sectors while the characteristics of China are supportive of others. Therefore, emulating China's success, especially learning to adopt its sub-sectoral development patterns, by Cameroon will not only be ineffective, but it may also be distorting and damaging to development. Based on table 6, learning from the experiences of Malaysia and scrutinizing its industrial policies are more helpful for Cameroon's industrial development.

Among the three country conditions studied by this paper, population density is most pertinent to industrial policy. Compared to country size and natural resource endowment, there is more room for the government to plan and maneuver the effect of population density, which can be either positive or negative depending on specific sub-sectors. Our results indicated that high population density usually has favorable effects on the developments of ***chemicals***; ***non-***

metallic minerals; ***machinery and equipment*** while low population density tends to support the growth of ***textiles***; ***wearing apparel***; ***fabricated metals***; and ***motor vehicles***. Based on the patterns of manufacturing developments, as income level increases, countries would like to promote certain sub-sectors over others to replace declining sub-sectors. This result on the effect of population density would help countries to plan and guide industrial locations of specific sub-sectors. For example, to support ***chemicals***; and ***machinery and equipment***, the government might consider developing industrial districts housing these sub-sectors and related manufacturing and service firms or more generally strengthening the urbanization of the areas where these sub-sectors exist.

7. Conclusion

First, this paper revisited the long-term development pattern of manufacturing industry by Syrquin and Chenery, which was proposed in 1989 at the end of their series of work aimed at constructing an accurate and robust pattern of structural change. Using longer time series and a larger number of country data, we were able to further improve the accuracy of the pattern especially for the phases of relative slow down and decline of manufacturing industry which inevitably set in as countries industrialize. On average, de-industrialization seems to occur when countries reach a per capita income level of some 13,000 US dollars (in 2005 US dollars).

Contributions of this paper to the study of manufacturing structural change come more from the analysis of the sub-sectoral development patterns within manufacturing industry. Efforts were made to establish benchmark patterns for country groups sharing similar demographic and geographic characteristics, over which countries have no or very limited control in short- to medium-run. In essence, by focusing on these variables without mixing with policy variables, this paper attempted to reveal “given” development patterns of manufacturing sub-sectors for different types of countries. The results showed the significance of and differences in the way country size, population density and natural resource endowment affect such development patterns. These benchmark patterns should provide useful information to policy makers regarding the expected relative performance of manufacturing sub-sectors within their country and appropriate comparators for cross-country analysis.

As for the future course of research, the results of this study naturally lead us to be curious about the differences in the performance among countries with similar demographic and geographic conditions. As these given conditions are supposed to establish the basic patterns of sub-sectoral developments before the influence of a country’s policies, future studies aim at explaining the country deviations from benchmark patterns presented in this paper by investigating the effects of country-specific policies.

References

Chenery, H. B. (1960), “Patterns of industrial growth” *The American Economic Review*, 50(4): 624-654.

Chenery, H. B. and L. Taylor (1968), “Development Patterns: Among Countries and Over Time” *The Review of Economics and Statistics*, 50(4): 391-416.

Chenery, H. B., S. Robinson, and M. Syrquin (eds.)(1986), *Industrialization and Growth: A Comparative Study* Oxford University Press, New York.

Chenery, H. B. and M. Syrquin (1975), *Patterns of development 1950–1970* Oxford University Press, London.

Chenery, H. B. and M. Syrquin (1989), “Patterns of Development, 1950 to 1983” World Bank Discussion Paper, WDP41, Washington DC.

Edwards, L. and S. Golub (2004), “South Africa’s International Cost Competitiveness and Productivity in Manufacturing” *World Development*, 32(8): 1323-1339.

Kader, A. (1985), “Development Patterns among Countries Reexamined” *The Developing Economies*, 23(3): 199-220.

Keesing, D. B. and D. R. Sherk (1971), “Population Density in Patterns of Trade and Development” *American Economic Review*, 61(5): 956-961.

Kennedy, P. (2003), *A Guide to Econometrics.* MIT Press, Cambridge.

Kuznets, S. (1957), “Quantitative Aspects of the Economic Growth of Nations: II. Industrial Distribution of National Product and Labor Force” *Economic Development and Cultural Change*, 5(4) Supplement.: 1-111.

Maizels, A. (1968), *Exports and economic growth of developing countries* Cambridge University Press, London.

Syrquin, M. (1988), “Structural change and economic development: The role of the service sector” *Journal of Development Economics*, 28(1): 151-154.

Taylor, L. (1969), “Development Patterns: A Simulation Study” *The Quarterly Journal of Economics*, 83(2): 220-241.

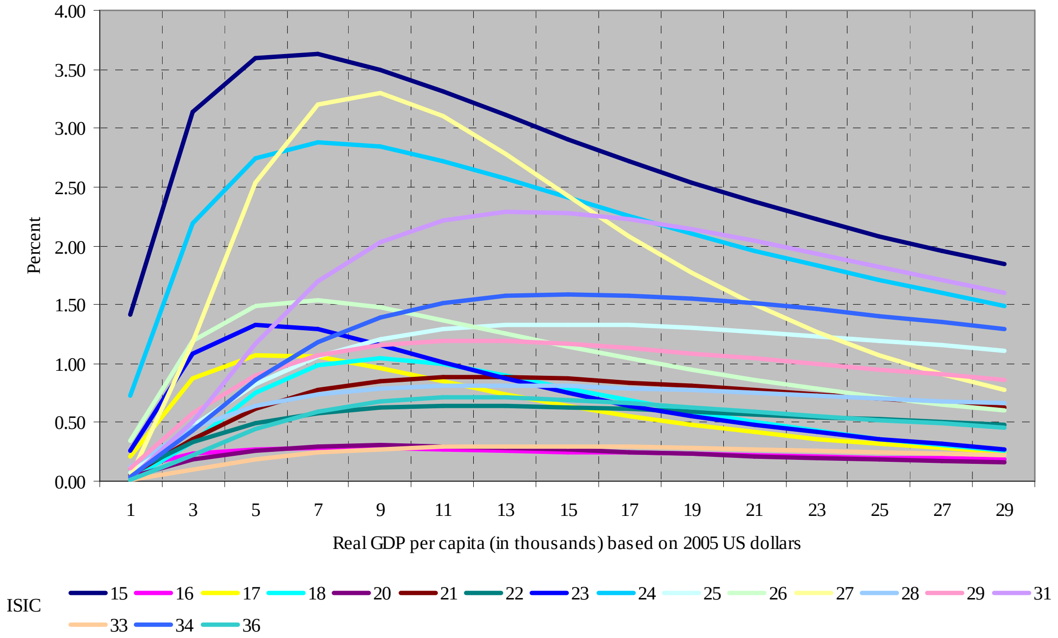
Turner, A. G. and S. Golub (1997), “Multilateral Unit Labor Cost Based Indicators of Competitiveness for Advanced, Developing and Transition Countries” *IMF Staff Studies for the World Economic Outlook*, December.

Turner, P. and J. Van't dack (1993) “Measuring International Price and Cost Competitiveness” *Bank for International Settlements Economic Papers*, 39.

Appendix

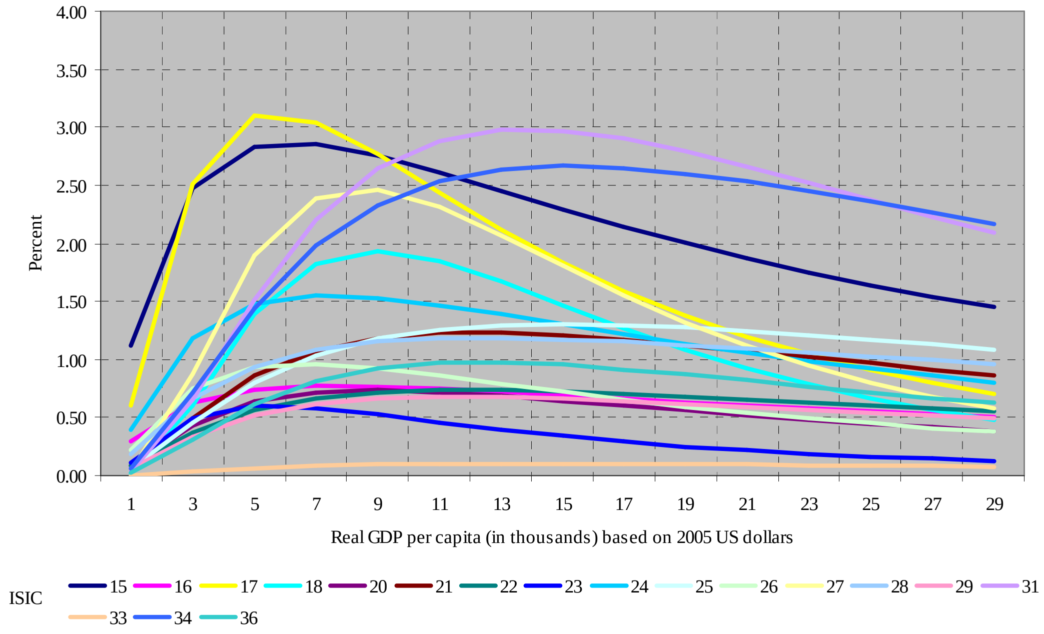
Large countries

Figure 14 Changes in shares of manufacturing sub-sectors in GDP at the selected per capita income levels for large countries of high population density and high resource endowments



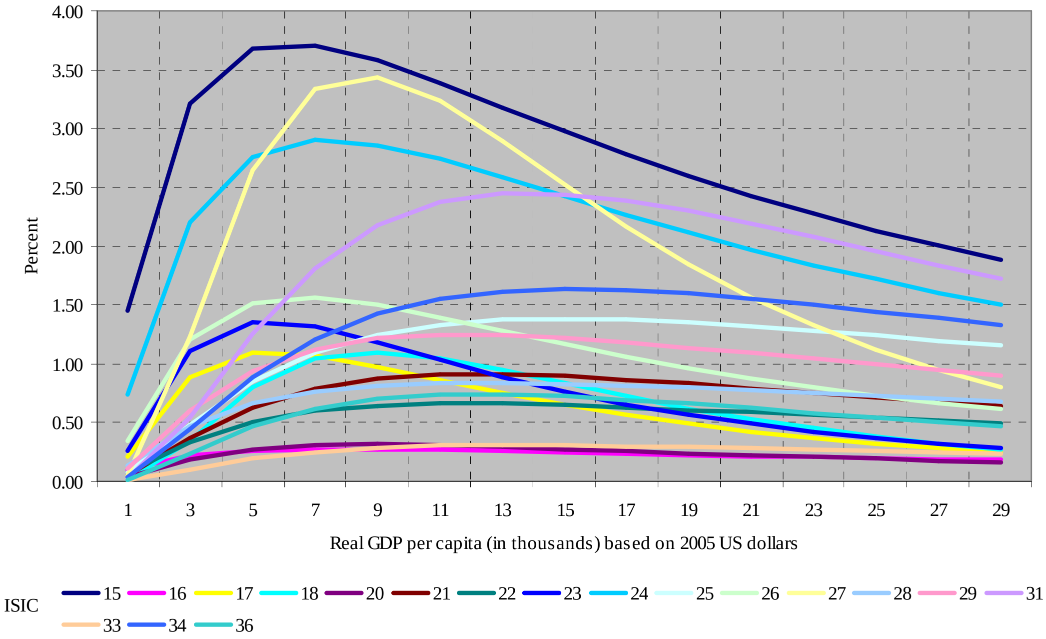
Source: Created by authors based on the regression results using equations 4 and 5 (authors' methodology).
Note: For the correspondence of ISIC codes to sub-sector names, refer to the Table 1.

Figure 15 Changes in shares of manufacturing sub-sectors in GDP at the selected per capita income levels for large countries of low population density and high resource endowments



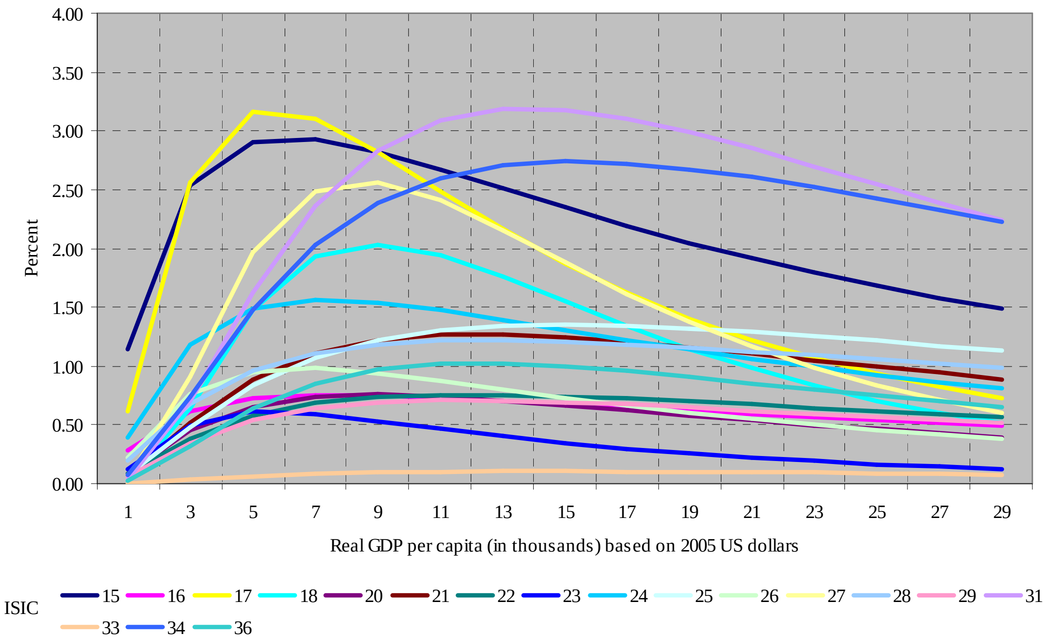
Source: Created by authors based on the regression results using equations 4 and 5 (authors' methodology).
Note: For the correspondence of ISIC codes to sub-sector names, refer to the Table 1.

Figure 16 Changes in shares of manufacturing sub-sectors in GDP at the selected per capita income levels for large countries of high population density and low resource endowments



Source: Created by authors based on the regression results using equations 4 and 5 (authors' methodology).
Note: For the correspondence of ISIC codes to sub-sector names, refer to the Table 1.

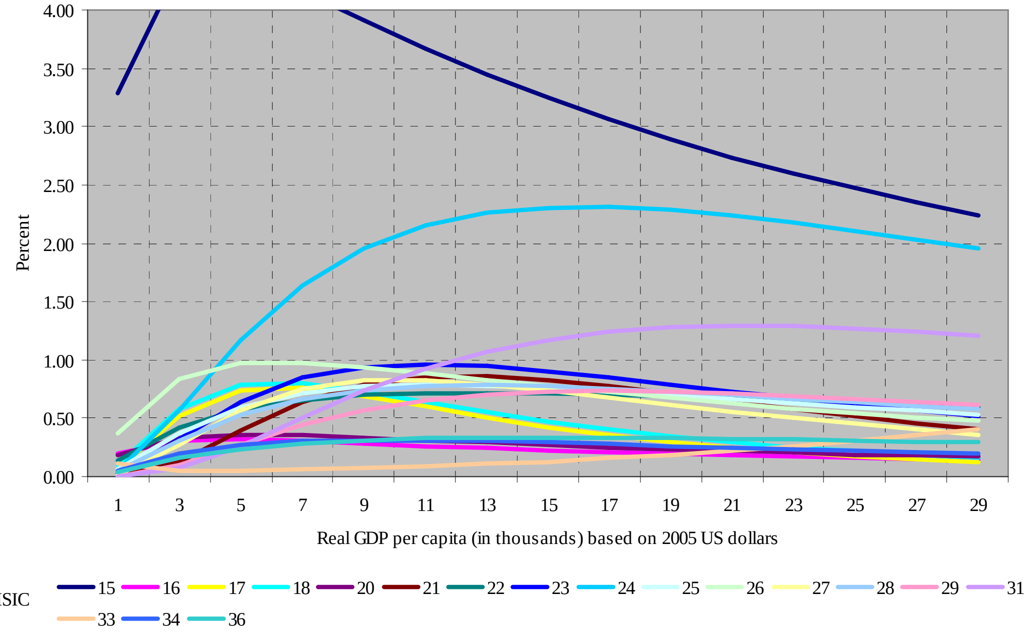
Figure 17 Changes in shares of manufacturing sub-sectors in GDP at the selected per capita income levels for large countries of low population density and low resource endowments



Source: Created by authors based on the regression results using equations 4 and 5 (authors' methodology).
Note: For the correspondence of ISIC codes to sub-sector names, refer to the Table 1.

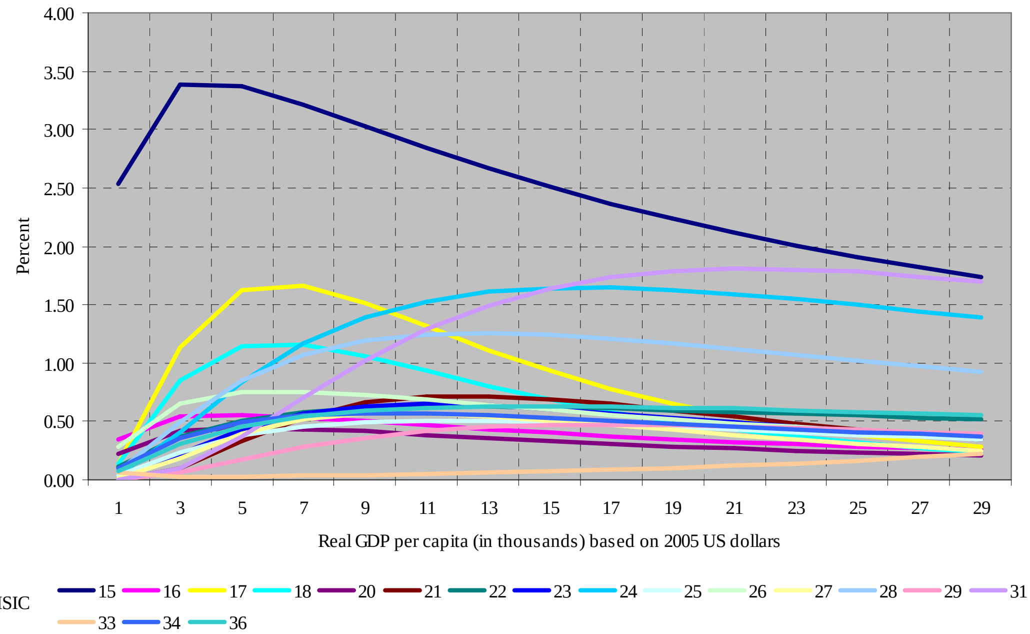
Small countries

Figure 18 Changes in shares of manufacturing sub-sectors in GDP at the selected per capita income levels for small countries of high population density and high resource endowments



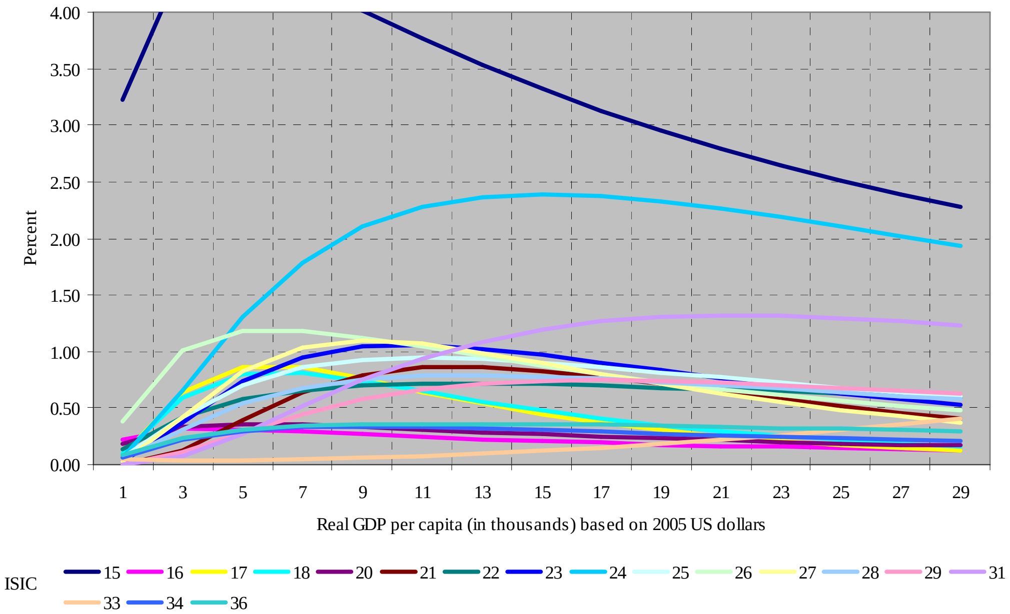
Source: Created by authors based on the regression results using equations 4 and 5 (authors' methodology).
Note: For the correspondence of ISIC codes to sub-sector names, refer to the Table 1.

Figure 19 Changes in shares of manufacturing sub-sectors in GDP at the selected per capita income levels for small countries of low population density and high resource endowments



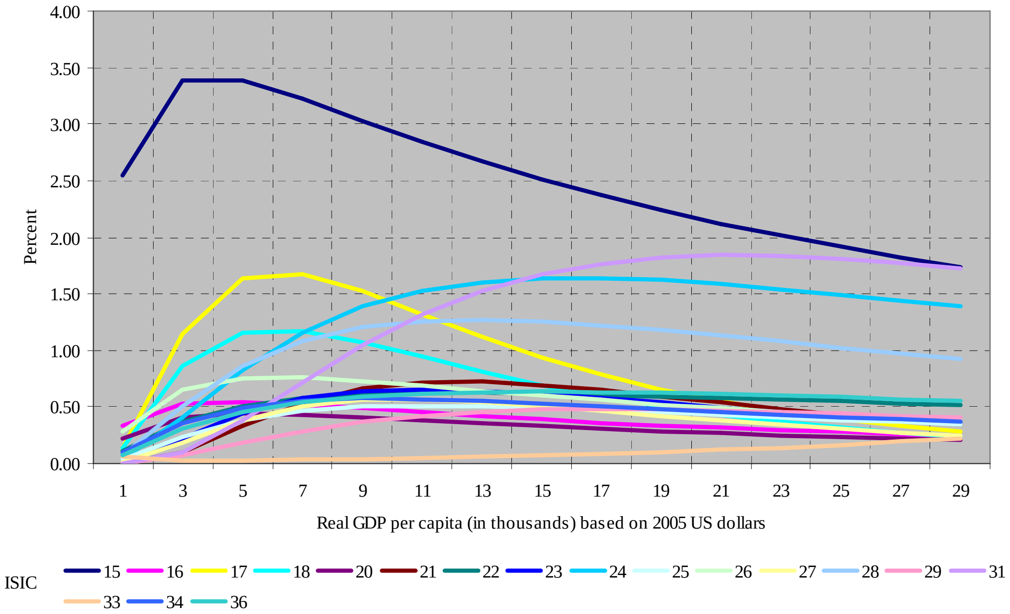
Source: Created by authors based on the regression results using equations 4 and 5 (authors' methodology).
Note: For the correspondence of ISIC codes to sub-sector names, refer to the Table 1.

Figure 20 Changes in shares of manufacturing sub-sectors in GDP at the selected per capita income levels for small countries of high population density and low resource endowments



Source: Created by authors based on the regression results using equations 4 and 5 (authors' methodology).
Note: For the correspondence of ISIC codes to sub-sector names, refer to the Table 1.

Figure 21 Changes in shares of manufacturing sub-sectors in GDP at the selected per capita income levels for small countries of low population density and low resource endowments



Source: Created by authors based on the regression results using equations 4 and 5 (authors' methodology).
Note: For the correspondence of ISIC codes to sub-sector names, refer to the Table 1.

Printed in Austria
V.10-58217—December 2010—260

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Telephone: (+43-1) 26026-0, Fax: (+43-1) 26926-69
E-mail: unido@unido.org, Internet: www.unido.org