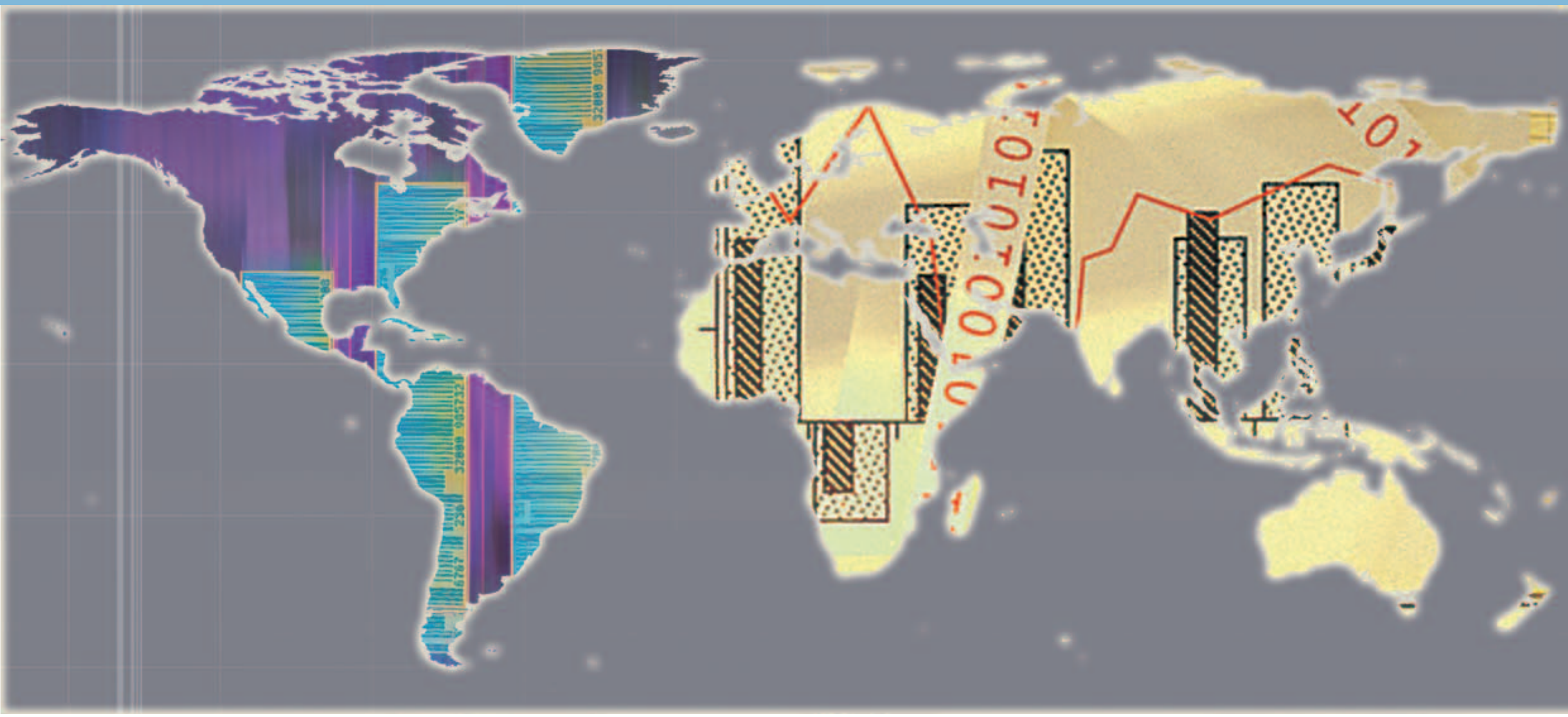
WORKING PAPER 04/2010



Emerging Patterns of Manufacturing Structural Change

UNIDO
UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

DEVELOPMENT POLICY AND STRATEGIC RESEARCH BRANCH
WORKING PAPER 04/2010

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Vienna, 2011

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1. Introduction

In the literature, the term "structural change" most commonly refers to long-term changes in the composition of an aggregate; this is attributable to changes in the relative significance of sectors[1] in the economy, to changes in the location of economic activity (urbanization), and to other concomitant aspects of industrialization which, taken together, are referred to as structural transformation. In one of his studies on structural transformation, Syrquin (2007: 4), referring to Kuznets, elaborates the concept:

> *"For Kuznets growth and structural change are strongly interrelated. Once we abandon the world of homothetic preferences, neutral productivity growth with no systematic sectoral effect, perfect mobility, and markets that adjust instantaneously, structural change emerges as a central feature of the process of development and an essential element in accounting for the rate of pattern of growth. It can retard growth if its pace is too slow or its direction inefficient, but it can contribute to growth if it improves the allocation of resources…"*

Next to Kuznets, there have been other attempts to study structural change and to establish some stylized facts, i.e., the patterns of development followed by most countries. The most well-known studies include Fisher (1939), Clark (1940), Chenery and Syrquin (1975), and Kader (1985), who aimed to demonstrate the shifts in production (from the primary to the secondary to the tertiary sector), which occur as economies grow. Although it is mostly descriptive, their research work intended to provide an overview of the development process with an emphasis on structural change. Although Chenery (1960) and Chenery and Taylor (1968) studied the development patterns in the manufacturing sector, studies on this topic at a detailed disaggregated level have not been given adequate attention. On account of a renewed interest in industrial policy for economic development in recent years, revisiting the work of Chenery (1960) and Chenery and Taylor (1968) seems appropriate to find out whether their models and empirical results are valid and robust. If they are not, alternative patterns need to be sought to provide sound structural underpinnings for formulating industrial policy.

By revisiting past models of structural transformation, in particular the work of Chenery (1960) on the patterns of industrial transformation, this chapter aims to establish new development patterns at the manufacturing sector level based on a revised theoretical approach and available data, which stretches over 50 years. A major conceptual contribution of Chenery's work was the identification of factors which affect a country's structural change, specifically: (a) The normal

[1] In this paper, 'sector' represents a component within manufacturing and is based on the two-digit level of the International Standard Industrial Classification (ISIC).

effect of universal factors that relate to the levels of income[2]; (b) the effect of other general factors such as market size or natural resources over which the government has little or no control; (c) the effects of the country's individual history, its political and social objectives, and the particular policies the government has followed to achieve these (Chenery and Syrquin, 1975: 5). In his seminal paper, Chenery's (1960) model, in which value added per capita was used as a dependent variable, mainly captured the universal effects of income. In their subsequent work, Chenery and Syrquin (1975) tried to identify the uniform factors (a) and (b), which also affect all countries, albeit at the more aggregated level, by using value added share in gross domestic product (GDP) as a dependent variable. The authors were to some degree, however, prevented from providing a full picture of structural transformation at the manufacturing level based on the three components described above due to: (i) Data limitation at a more detailed sectoral level; (ii) data that can capture important given (exogenous) country conditions, and (iii) availability of data over longer periods of time, which can capture a full development cycle.

Once such patterns of manufacturing transformation have been established, they can be used as benchmarks to determine the sectoral developments of countries with comparable characteristics. Subsequently, any deviations of actual developments from the benchmarks could be explained by future research, possibly looking at policy, historical, and institutional factors.

From this viewpoint, the following chapter first reviews the seminal work of Chenery and other authors, and conceptually and empirically examines their work based on available data and the maturity of econometric techniques that have significantly improved over the past four decades. Second, alternative patterns of industrial development are proposed here, which take account of the universal effects associated with income levels, the impact of other general factors such as market size or natural resources, and country-specific characteristics measured as the deviations from the predicted pattern. The fourth chapter presents the results of the regression analysis. In Chapter 5, which is based on newly reconstructed patterns, a sectoral typology is developed and policy implications deduced accordingly. Finally, Chapter 6 concludes our study and provides future research directions in the subject area.

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[2] The income effect includes both the supply and demand effect. The demand effect is usually associated with the factor that rising income levels lead to change in the composition of demand, of which the decline in the share of food (Engel's law) is the most notable feature. The supply effect, on the other hand, entails two factors of general importance: (1) The overall increase in capital stock per worker, and (2) the increase in education and skills of all sorts. Moreover, as the production in which labour, capital, and skills can be combined vary from sector to sector; the change in factor supplies causes a systematic shift in comparative advantage as per capita income rises (Chenery, 1960: 624-625).

2. Review of past models for estimating manufacturing output

As indicated in the introduction, this chapter builds on the work carried out by Chenery and other authors in order to revisit some stylized patterns of structural change within the manufacturing sector, which occur with economic growth. Embedded supply and demand factors contribute to different patterns across sectors and thus provide a benchmark for structural transformation based on income effect, 'exogenous' country characteristics, and country-specific characteristics as growth proceeds. Our ongoing research efforts (Haraguchi and Rezonja, 2010) aim to improve these patterns based on new data that is available, thus capturing a more complete development cycle.

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

$$X_i = D_i + W_i + E_i - M_i \quad (1)$$

Where 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*.

While Chenery initially felt it was crucial to have a sufficiently large sample size and for each demand component to be a function of income level, he later adopted single functions of income and population instead. This makes it possible to view the effects of income level and country size using a linear logarithmic regression equation to estimate the value added level in the following way:

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

where V_i is per capita value added and β_{i1} and β_{i2} represent growth elasticity and 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 foundation for subsequent structural change research and its modifications have been used in later studies. For example, Chenery and Talyor (1968) included a quadratic term for income as the decline in elasticities with rising income levels became apparent. In later years, Chenery and Syrquin adopted a more general equation as shown below, allowing a non-linear effect for population and including dummy variables to identify period effects (Chenery and Syrquin, 1975; Syrquin and Chenery, 1989):

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

where x is a dependent variable covering different aspects of structural change (usually expressed as a share in GDP), y is per capita GNP in 1980 US dollars, N is population in millions, and T is a dummy variable for time periods taking a non-zero value for different periods[3].

On account of conceptual and econometrical problems with equation (2), there are compelling reasons as to why the model ought to be revisited in order to explain the long-term patterns of industrial development. First, due to the simultaneous determination of supply and demand, output and income variables are endogenous—determined within the model. In such a case, the least square estimator applied by Chenery reveals biased and inconsistent results. Secondly, as determined in this chapter, using the panel data method, which can separate time as well as country-specific effects from the coefficients of the variables included in the equation, is more appropriate than the cross-section, single-period approach adopted by Chenery (1960).

Table 1 compares Chenery's results with those derived from applying model (2) to pooled country data for the period 1963-2006, which we use in this working paper. Although Chenery used value added per capita as a dependent variable, we use output per capita instead. The reason for this is that we were able to convert sectoral output into real values using the indices of industrial production. However, we calculated value added to output ratios across all sectors and observed that for a large majority of them, the ratios are stable with the growth of GDP and as such would not markedly affect the development patterns. Even though the income and size coefficients do not show considerably different trends—both coefficients tend to be higher for capital-intensive sectors—the goodness-of-fit of the regressions, as indicated here by the

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

adjusted R-squares, are lower for the pooled data for most sectors despite the higher number of observations. One of the reasons could be that the linear model employed by Chenery does not adequately explain the patterns of industrial development for longer periods over the four decades. Chenery's sample included countries that were industrializing at that time, with income per capita ranging from $58 in India to $1,291 in Canada. Therefore, the pattern derived from the cross-section data might not have been able to reflect the entire cycle of development from industrialization to deindustrialization. Indeed, according to UNIDO data covering the period 1963 to 2006, the most advanced countries experienced a slowdown—sometimes even a decline—in labour-intensive industries as their economies matured. This indicates that a quadratic function is again preferable to the linear function for estimating sectoral outputs.

Table 1 Comparison between Chenery's results and pooled data regressions for estimating valued added per capita of manufacturing

Sector	*Income coefficients* β_1		*Size coefficients* β_2		$\overline{R}^2$		*Number of observations*	
	Chenery	*Pooled*	*Chenery*	*Pooled*	*Chenery*	*Pooled*	*Chenery*	*Pooled*
Food and beverages	1.129	1.452	(0.001)	-0.097	0.846	0.832	31	2484
Tobacco	0.928	1.319	(0.234)	-0.066	0.344	0.6193	32	2283
Textiles	1.444	1.286	0.401	0.111	0.770	0.652	38	2609
Clothing	1.687	1.527	(0.065)	-0.024	0.837	0.576	35	2591
Wood, etc.	1.765	1.768	(0.080)	-0.059	0.815	0.584	34	2568
Paper	2.692	1.841	0.518	0.074	0.784	0.804	34	2401
Printing	1.703	2.121	0.177	(-0.01)	0.854	0.827	32	2363
Rubber	1.998	1.867	0.438	0.084	0.713	0.786	32	2339
Chemicals	1.655	1.767	0.257	0.181	0.846	0.7979	37	2422
Petroleum products	2.223	1.281	(1.040)	-0.2034	0.650	0.504	32	1520
Non-metallic minerals	1.617	1.636	0.164	-0.046	0.747	0.799	37	2446
Metals, etc.	2.143	1.882	0.419	0.212	0.726	0.677	32	1865
Machinery, etc.	2.799	2.476	0.315	0.308	0.834	0.750	30	2385
Transport equipment	2.327	2.279	0.256	0.484	0.717	0.686	31	2394

Note: Coefficients in parentheses are not significantly different from zero at the 95 per cent confidence level.

Source: Chenery (1960) and UNIDO (2009).

3. Alternative model for assessing patterns of manufacturing development

Taking the above discussions and possible deficiencies of past models into consideration, an alternative approach of reduced single-equation is presented in this chapter. While recognizing the importance of simultaneous-equation methodology which integrates both demand and supply factors, we adopted the single-equation method. Our approach takes advantage of the increased availability of cross-section and time-series data and applies a more conceptually appropriate econometric approach. Accordingly, the following equations were used to determine output per capita:

$$\ln ROPC_{cit} = \alpha_1 + \alpha_2 * \ln RGDPL_{ct} + \alpha_3 * \ln RGDPL_{ct}^2 + e_{ct}{}^{d} \quad (4)$$

$$\ln ROPC_{cit} = \alpha_1 + \alpha_2 * \ln RGDPL_{ct} + \alpha_3 * \ln RGDPL_{ct}^2 + \alpha_4 * \ln POPD_{ct} + \alpha * \ln RPC_{ct} + e_{ct}{}^{d} \quad (5)$$

$$\ln ROPC_{cit} = \alpha_1 + \alpha_2 * \ln RGDPL_{ct} + \alpha_3 * \ln RGDPL_{ct}^2 + \alpha_4 * \ln POPD_{ct} + \alpha * \ln RPC_{ct} + countrydummies + e_{ct}{}^{d} \quad (6)$$

The subscripts of *c* and *t* denote country and year, respectively, whereas *i* represents the respective sector. As indicated in the previous section, our model determines the dependent variable real output per capita (*ROPC*) and gross domestic product (GDP) per capita, which is endogenously determined within the model. Both the dependent and explanatory variables are expressed in logarithmic terms to measure the elasticity of each coefficient.

Equations 4 and 5 are both based on pooled data (ordinary least squares (OLS) estimation). They differ in that the two additional variables (resource per capita and population density) were included in the model. These two reflect country given (exogenous) characteristics. An additional country given (exogenous) characteristic is country size; however, we did not include size in the equation itself, but rather divided country into two groups.[4] Countries have no or very limited influence on these characteristics, at least in the short- to medium-term, which enables us to separate the development patterns attributed to sectoral characteristics from man-made conditions, such as policy-related, institutional, and historical factors. The equation, therefore, does not include variables related to a country's trade orientation or openness to trade,

[4] Countries with a population exceeding 15 million in 1983 are classified as large countries.

as has been the case in some past studies (Chenery and Syrquin, 1975; Syrquin and Chenery, 1989). In equation 6, the specification of fixed cross-section (country-specific) effects was applied, which is equivalent to including dummy variables (*countrydummies*) for countries in each of the equations as listed below. This model additionally examines the net effect of country-specific characteristics. Our purpose of using these equations was to estimate the effect the three components have on the development patterns as described in the introduction. For analytical purposes, i.e., in the analysis of the growth patterns of a given sector, equation 6 is correspondingly applied, as it includes the relevant determinants which explain most of the variation in output per capita.

Since the panel data approach is used for analytical purposes in this study, we need to test the significance of the country fixed effect as well as of the time fixed effect. We rejected the null hypothesis that all entities' coefficients are jointly equal to zero, therefore, country fixed effects were needed. To determine whether time fixed effects are needed we performed the joint test to establish if the dummies were equal to zero for all years. If they were, then no time fixed effects would be needed. We failed to reject the null hypothesis that years' coefficients are jointly equal to zero, therefore, no time fixed effects were needed.

Data on output per capita (*ROPC)* of the dependent variable was obtained from the UNIDO Industrial Statistics Unit. Earlier revisions of ISIC classifications were converted into Revision 3 by the Unit to obtain consistent, long-term time series data from 1963 to 2006. ISIC Revision 3 classification originally entailed 22 manufacturing sectors, however, as some countries began reporting output figures combining two sectors, it was necessary to merge the initial 22 sectors into 18.[5] Table 2 presents these 18 manufacturing sectors with their ISIC code and ISIC abbreviation.[6]

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 robust regression technique, which implements IV/GMM estimation of the fixed effects and first differences panel data models with possibly endogenous regressors. At the same time, the method extends the two-stage-least-square (TSLS) estimator to better account for heteroskedasticity and/or

[5] The sectors merged are 18 (*Wearing apparel, and fur*) and 19 (*Leather products, and footwear*), 29 (*Machinery and equipment n.e.c.*) and 30 (*Office, accounting, computing machinery*), 31 (*Electrical machinery and apparatus*) and 32 (*Radio, television, and communication equipment*), and 34 (*Motor vehicles, trailers, semi-trailers*) and 35 (*Other transport equipment*).
[6] Throughout the text we use the abbreviated sectoral names from Table 2.

serial correlation problems.[7] In the model, GDP per capita (*RGDPL)* indirectly reflects the interaction between the demand effects of rising income levels and the supply effects of changes in factor proportions and technology; therefore, it is expected that rising income levels ought to bring about rather uniform patterns in structural transformation. Data on GDP per capita based on 2005 prices are adjusted in accordance with purchasing power parity (PPP) and were retrieved from Penn tables. Our resource proxy variable *(RPC)* was calculated as the difference between exports and imports of relevant resource commodities and expressed in per capita terms.[8] Data on population density (*PD*) were obtained from World Development Indicators (WDI).

Table 2 ISIC Revision 3 classification

ISIC description	*ISIC 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: UNIDO, 2010.

[7] Although the growth patterns are based on the robust regression technique, some sections include results based on equations 4 and 5, which are estimated as OLS regressions as indicated above.

[8] 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).

The underlying purpose of our model is to obtain a fairly accurate picture of structural transformation. As already indicated, the "exogenous" variables included in the model, resources per capita and population density, are determinants which countries have no or little influence over. This means that the implementation of given policy approaches are unlikely to rapidly alter those variables. As such, the patterns relative to others reflect a picture based on manufacturing sectoral characteristics. Once such benchmark patterns have been derived, the research can focus on explaining the deviations of a country's sectoral development patterns from the benchmarks by examining policy-related, institutional, and historical factors.

Below we provide the results based on our regressions. The variables included in the regression enable us to determine, first, the universal effect of income, and, secondly, to estimate the significance of the universal effects of a country's given (exogenous) conditions through size, resource endowments, and population density. Based on the constructed patterns and country-specific deviations from those patterns, we were also able to take account of the third aspect of a country's development patterns at the manufacturing level. We will now move on to the analytical part, which primarily focuses on the growth patterns at the sectoral level, keeping in mind the distinction between the three dimensions that affect development patterns.

4. Results

4.1. Drivers of development patterns

4.1.1. Income effect

As we indicated in the introduction, the income effect includes both demand and supply effects, therefore, we can expect income to explain most of the variation in manufacturing output per capita.

Table 3 which presents the regression results based on OLS estimation by pooling the data, reveals that GDP per capita on average does in fact explain most of the variation in output levels. From this we can infer that the remaining results can be explained by a combination of country given (exogenous) characteristics and country-specific characteristics, which fall under factors (b) and (c), which explain the development patterns for any given country.

Table 3 Regression estimations based on equation 4 (OLS estimation) for all countries

ISIC	*C*	*GDPPC*	*GDPPC*^{2}	$\overline{R}^2$	*N*
Food and beverages	-11.8666***	2.5900***	-0.0669***	0.8012	2526
Tobacco	-7.8474***	1.1729***	0.0082	0.6149	2325
Textiles	-9.6716***	1.8937***	-0.0358*	0.6403	2651
Wearing apparel	-28.1268***	5.8315***	-0.2459***	0.5952	2634
Wood products	-4.7354*	0.0009	0.1001***	0.5774	2602
Paper	-5.9479***	0.3723	0.0811***	0.7906	2443
Printing and publishing	-4.8731***	-0.2630	0.1355***	0.8320	2404
Coke and refined petroleum	-20.7857***	4.3994***	-0.1724***	0.4847	1520
Chemicals	-5.0931***	0.4804	0.0694***	0.7677	2464
Rubber and plastic	-8.3382***	0.8738**	0.0548**	0.7824	2373
Non-metallic minerals	-11.4566***	1.8759***	-0.0131	0.7950	2480
Basic metals	-3.3597	-0.0275	0.0995**	0.6388	1907
Fabricated metals	-3.9601*	-0.2187	0.1245***	0.7525	2334
Machinery and equipment	-1.4955	-1.2840**	0.2086***	0.7263	2424
Electrical machinery and apparatus	-5.3868**	-0.0976	0.1269***	0.7314	2516
Precision instruments	-5.3620	-1.3559	0.2403***	0.7273	1890
Motor vehicles	-3.8013	-0.3635	0.1394***	0.5994	2428
Furniture, n.e.c.	-10.6044***	1.2474**	0.0380	0.7276	2070
* p<0.05, ** p<0.01, *** p<0.001	Average			0.6992	

Source: Calculated by authors based on regression estimations for small and large countries (equation 4).

4.1.2. Country given (exogenous) effect

First, we divided countries into small and large countries and used equation 4 to determine the difference between the income effects in both groups. Consequently, we applied equation 5, which also includes resources per capita and population density, to determine the impact of these two factors on both groups of countries. Based on the results in Table 4, which presents the regression results based on the ordinary least squares (OLS) equation by pooling the data for both small and large countries, GDP per capita on average still explains most of the variation in output levels. There are, however, important differences in both groups, as income explains about 64.73 percent of the variation in output per capita in small countries but 79.22 percent in large countries. This is an important difference, which demonstrates that sectoral variation in small countries also depends on the extent of the domestic economy's openness as opposed to large countries, where the effect of income at the domestic level is more pronounced.

Table 4 Regression estimations based equation 4 (OLS estimation) for small and large countries

ISIC	*Size*	*C*	*GDPPC*	*GDPPC*^{2}	$\overline{R^2}$	*N*
Food and beverages	Small	-19.4397***	4.3792***	-0.1703***	0.7495	1395
	Large	-4.1974***	0.7529**	0.0401*	0.8572	1131
Tobacco	Small	-21.8219***	4.2752***	-0.1619***	0.5873	1276
	Large	1.1734	-0.8501*	0.1194***	0.6764	1049
Textiles	Small	-14.9840***	2.9727***	-0.0906***	0.6094	1478
	Large	-8.4056***	1.6992***	-0.0289	0.7003	1173
Wearing apparel	Small	-49.5045***	10.5636***	-0.5055***	0.5772	1505
	Large	-13.9492***	2.6633***	-0.0706**	0.6686	1129
Wood products	Small	-6.8669	0.6865	0.0526	0.4555	1525
	Large	4.3691	-2.3113***	0.2409***	0.7231	1077
Paper	Small	-10.7520**	1.4666	0.0188	0.6744	1385
	Large	-3.6259**	-0.2186	0.1187***	0.8950	1058
Printing and publishing	Small	-9.6684***	0.7600	0.0824*	0.8313	1371
	Large	-4.2543*	-0.3298	0.1337***	0.8207	1033
Coke and refined petroleum	Small	-36.7747***	8.3241***	-0.4062***	0.2818	688
	Large	-3.7308	0.3506	0.0630	0.6094	832
Chemicals	Small	-34.8998***	6.9101***	-0.2764***	0.7563	1408
	Large	0.9510	-0.7723**	0.1359***	0.8732	1056
Rubber and plastic	Small	-35.5236***	6.6148***	-0.2472***	0.7720	1316
	Large	-6.6868***	0.6786*	0.0576**	0.8438	1057
Non-metallic minerals	Small	4.7769*	-1.6014**	0.1724***	0.7415	1405
	Large	-22.2822***	4.2293***	-0.1408***	0.8543	1075
Basic metals	Small	7.4576	-2.4888*	0.2360***	0.5508	1047
	Large	-14.9573***	2.5949***	-0.0443	0.7957	860
Fabricated metals	Small	-27.9696***	5.0522***	-0.1631***	0.7143	1317
	Large	3.9638*	-2.0113***	0.2258***	0.8159	1017
Machinery and equipment	Small	-46.3649***	8.0925***	-0.2804***	0.7535	1326
	Large	-4.1195*	-0.3278	0.1396***	0.8055	1098
Electrical machinery and apparatus	Small	-49.0279***	9.1999***	-0.3664***	0.7147	1398
	Large	-2.2961	-0.5953	0.1463***	0.8339	1118
Precision instruments	Small	-19.2716**	1.4153	0.1030	0.6858	1045
	Large	-6.0369	-0.9231	0.2027***	0.8187	845
Motor vehicles	Small	-47.9831***	9.0368***	-0.3626***	0.6109	1352
	Large	9.0479***	-3.1101***	0.2929***	0.8213	1076
Furniture, n.e.c.	Small	-5.1626	0.2475	0.0831	0.5857	1169
	Large	-4.6491*	-0.3128	0.1352***	0.8471	901
				Average: small	0.6473	
* p<0.05, ** p<0.01, *** p<0.001				Average: large	0.7922	

Source: Calculated by authors based on regression estimations for small and large countries (equation 4)

When resource per capita and population density are added to the equation (equation 5), the net effect on the explanatory power of the two is rather small (roughly 2 percent) for both small and large countries (Table 5).

Table 5 Regression estimations based on equation 5 (OLS estimation) for small and large countries

ISIC	*Size*	*C*	*GDPPC*	*GDPPC*^{2}	*POPD*	*RPC*	$\overline{R}^2$	*N*
Food and beverages	Small	-16.5287***	4.4403***	-0.1662***	-0.1540***	-0.3844**	0.7753	1178
	Large	24.2793***	1.5524***	-0.0087	-0.1589***	-3.7481***	0.8853	987
Tobacco	Small	-28.5027***	4.8834***	-0.1990***	0.1302***	0.4315	0.6096	1096
	Large	-0.6853	0.1454	0.0674*	0.2143***	-0.4375	0.7235	932
Textiles	Small	-19.7037***	4.5268***	-0.1796***	0.0545**	-0.2810	0.5998	1256
	Large	21.6928***	2.0567***	-0.0502*	0.0850***	-3.8463***	0.7211	1024
Wearing apparel	Small	-54.9350***	12.5858***	-0.6194***	0.1531***	-0.5088*	0.6283	1314
	Large	26.9595***	3.1192***	-0.0997**	0.0551*	-5.1639***	0.6738	995
Wood products	Small	-1.3412	2.1033	-0.0064	-0.4366***	-1.4071***	0.5011	1283
	Large	13.6054	-0.5336	0.1429***	0.0193	-2.0910**	0.7386	948
Paper	Small	-5.7926	2.7111***	-0.0395	-0.3681***	-1.1884***	0.7477	1240
	Large	10.0146*	0.6288	0.0663***	-0.1988***	-1.9513***	0.9082	940
Printing and publishing	Small	-6.4075	1.2698	0.0558	-0.0575***	-0.6562***	0.8279	1191
	Large	27.8214***	1.0613*	0.0522	0.0117	-4.5772***	0.8332	927
Coke and refined petroleum	Small	-32.6977***	7.4209***	-0.3664***	0.3011***	-0.0666	0.3565	599
	Large	36.1936***	-0.2965	0.0964	-0.0704	-4.4152***	0.6247	756
Chemicals	Small	-11.9692***	3.9796***	-0.1156**	-0.0729***	-1.1304***	0.7304	1180
	Large	24.2651***	0.7550*	0.0486*	-0.0238	-3.5986***	0.8970	920
Rubber and plastic	Small	-30.3586***	7.0686***	-0.2821***	0.0309	-0.7877***	0.7466	1145
	Large	13.0849***	0.3359	0.0765***	0.1083***	-2.2474***	0.8816	935
Non-metallic minerals	Small	8.2686**	-1.5460*	0.1654***	0.0457**	-0.4383**	0.7092	1183
	Large	-2.2191	5.0134***	-0.1856***	0.0392*	-2.8478***	0.8717	974
Basic metals	Small	-21.2584***	4.0095**	-0.1099	-0.2440***	-0.0913	0.5998	894
	Large	-1.9667	2.2067***	-0.0219	-0.0004	-1.3725*	0.8215	797
Fabricated metals	Small	-14.5077***	3.7887***	-0.0961*	0.0256	-0.9312***	0.7082	1105
	Large	30.6902***	-0.4836	0.1393***	0.0122	-4.0365***	0.8234	895
Machinery and equipment	Small	-19.4765***	5.2392***	-0.1216	0.0350	-1.7384***	0.7473	1128
	Large	22.3703***	0.7007	0.0847**	0.1652***	-3.8542***	0.8283	962
Electrical machinery and apparatus	Small	-33.4413***	7.5883***	-0.2722***	0.1456***	-1.1425***	0.7399	1190
	Large	39.2761***	-0.7824	0.1536***	0.0410	-4.9001***	0.8484	982
Precision instruments	Small	-49.3596***	8.4524***	-0.2689*	0.1102*	-0.4318	0.6919	921
	Large	6.7179	-0.6147	0.1878***	0.1916***	-1.8183*	0.8387	809
Motor vehicles	Small	-46.4507***	9.8346***	-0.3855***	-0.1500***	-0.7664*	0.6331	1140
	Large	37.5013***	-2.6879***	0.2653***	-0.0731**	-3.5818***	0.8232	965
Furniture, n.e.c.	Small	-19.5602***	3.8826***	-0.1158	0.0491	-0.2847	0.6065	1013
	Large	-6.5992	0.4972	0.0941**	0.1790***	-0.3260	0.8454	829
						Average: small	0.6644	
* p<0.05, ** p<0.01, *** p<0.001						Average: large	0.8104	

Source: Calculated by authors based on regression estimations for small and large countries (equation 5).

By applying equation 6, which includes country fixed effect, we denote the difference in predicated patterns of output per capita based on size, and secondly, we reveal the impact resources per capita and population density have on growth patterns (the regression results can be found in Table 10 below).

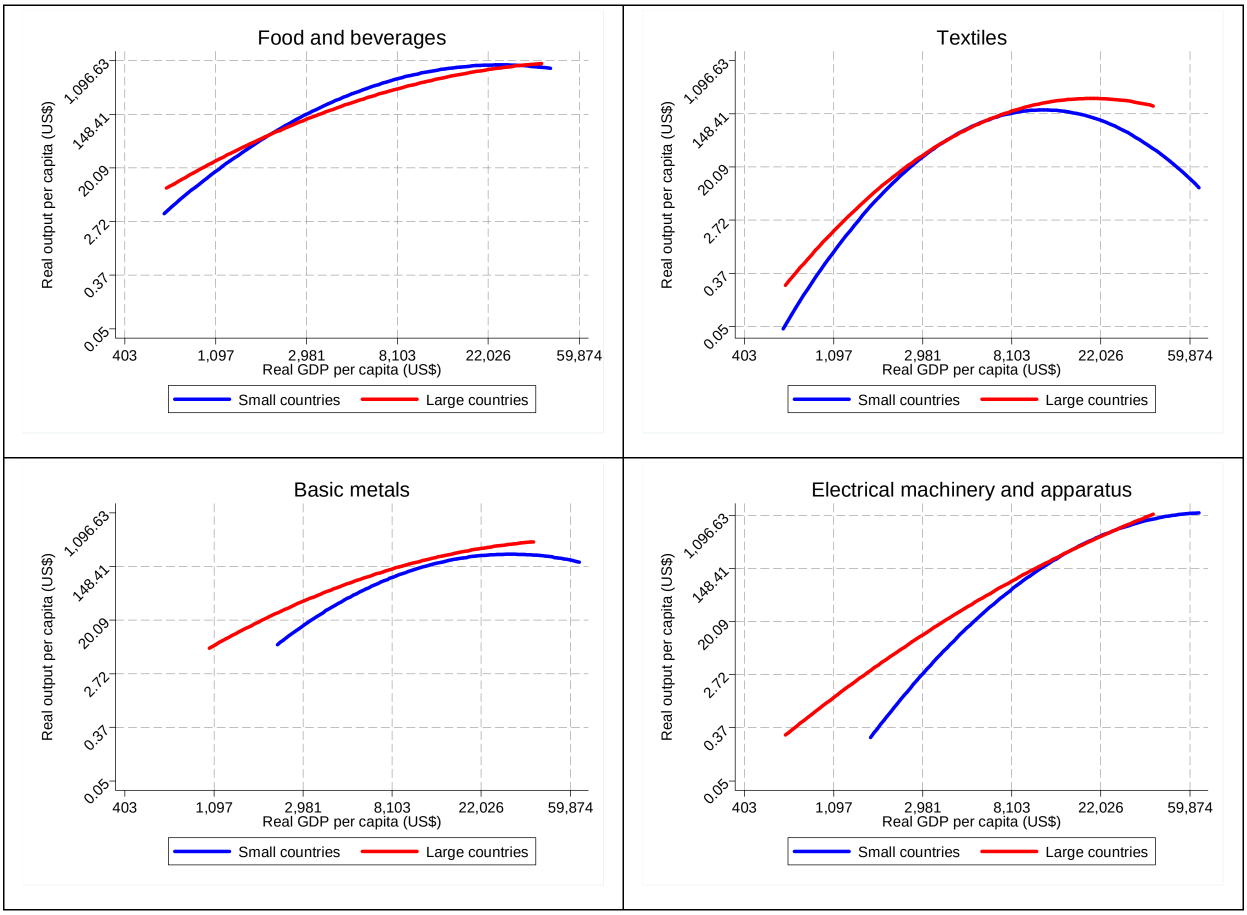
The literature on structural change points out that country size has significant effects on the patterns of industrial development, because economies of scale, resource endowments, and scale of domestic demand often vary with country size (Chenery and Syrquin, 1975; Chenery and Taylor, 1968; Syrquin, 1988). Past empirical evidence shows that larger countries' manufacturing industry has a larger economic weight at an earlier stage of development than in smaller countries. Furthermore, the manufacturing growth of the former group of countries usually slows down before the latter group's manufacturing growth does, which has more linear growth patterns across different income levels.

Figure 1 illustrates the development patterns of small and large countries for four manufacturing sectors: ***Food and beverages, Textiles, Basic metals,*** and ***Electrical machinery and apparatus.*** We used these four sectors because they differ in their significance at different stages of development. ***Food and beverages*** is an early sector for both small and large countries, ***Textiles*** is an early sector for small countries and a middle sector for large countries, ***Basic metals*** is a middle sector for both small and large countries, and ***Electrical machinery and apparatus*** is a late sector for both groups. These sectors also differ in that early sectors are more labour intensive, whereas middle and late sectors are more capital intensive.

According to Figure 1, larger countries start at a higher level of output per capita at the same GDP per capita level, but small countries are fairly quick to follow as they attain faster growth rates as development proceeds. However, small countries reach their peak in sectoral output earlier than large countries. The difference between the two will be analyzed in more detail in the analytical section on growth patterns.

Although Chenery (1960:628) was aware of the significance natural resources can play in the process of industrialization, he was not able to find a statistical measure for resource supply for a large number of countries and therefore excluded it from his regression equation (Chenery, 1960:630). 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 expect early successful export specialization in manufacturing sectors.

Figure 1 Sectoral development patterns for small and large countries (fitted lines)



Source: Developed by authors based on regression estimations for small and large countries (equation 6).

Although GDP per capita has the highest explanatory power in the model, the other two variables—resource per capita and population density—nevertheless depict the effect of both on output per capita and, at the same time, categorize countries into different groups. Once such an approach can be fine-tuned, it can provide a sound policy tool for countries at an early stage of development and as such facilitate the process of "self-discovery".

Estimation regressions in Table 10 indicate the following relationship between output per capita and additional independent variables included in the model: Resources per capita and population density (Table 6 and 7).

Table 6 Resource per capita and population density: Correlation between with output per capita for small countries

<table>
<tr><td></td><td colspan="3">Natural resource endowment</td></tr>
<tr><td rowspan="3">Population density</td><td></td><td>POSITIVE CORRELATION</td><td>NEGATIVE CORRELATION</td></tr>
<tr><td>POSITIVE CORELATION</td><td>Food and beverages
Coke and refined petroleum
Rubber and plastic
Fabricated metals
Precision instruments</td><td>Printing and publishing
Chemicals
Machinery and equipment</td></tr>
<tr><td>NEGATIVE CORRELATION</td><td>Tobacco
Textiles
Wood products
Paper
Non-metallic minerals
Basic metals
Furniture n.e.c.</td><td>Wearing apparel
Electrical machinery and apparatus
Motor vehicles</td></tr>
</table>

Source: Developed by authors based on regression estimations for small and large countries (equation 6).

Table 7 Resource per capita and population density: Correlation between with output per capita for large countries

<table>
<tr><td></td><td colspan="3">Natural resource endowment</td></tr>
<tr><td rowspan="3">Population density</td><td></td><td>POSITIVE CORRELATION</td><td>NEGATIVE CORRELATION</td></tr>
<tr><td>POSITIVE CORELATION</td><td></td><td>Chemicals
Rubber and plastic
Non-metallic minerals
Basic metals
Electrical machinery and apparatus</td></tr>
<tr><td>NEGATIVE CORRELATION</td><td>Textiles
Wearing apparel
Wood products
Printing and publishing
Machinery and equipment
Precision instruments</td><td>Food and beverages
Tobacco
Paper
Coke and refined petroleum
Fabricated metals
Motor vehicles
Furniture</td></tr>
</table>

Source: Developed by authors based on regression estimations for small and large countries (equation 6).

The results in Table 6 and 7, which denote the average impact of both variables on output per capita across all countries and years, are not straightforward. For large countries, we can see that resources per capita are negatively related to output per capita for most of the sectors. Exceptions are ***Textiles***, ***Wearing apparel***, ***Wood products***, ***Printing and publishing***, ***Machinery and equipment***, and ***Precision instruments***. For most sectors in large countries population density is negatively related to output per capita. Exceptions are ***Chemicals***, ***Rubber and plastic***, ***Non-metallic minerals***, ***Basic metals***, and ***Electrical machinery and apparatus.*** In small countries, on the other hand, resources per capita are positively related to output per capita for most sectors. Exceptions are ***Printing and publishing***, ***Chemicals***, ***Machinery and equipment***, ***Wearing apparel***, ***Electrical machinery and apparatus***, and ***Motor vehicles.*** The effect of population density is relatively equally spread across all sectors. Although both variables have a clear impact on development patterns, we cannot generally confirm the existence of a uniform relationship across all sectors.

Both small and large countries were categorized based on the median value of the resource per capita variable and population density. The categorization is presented in Table 8 (small countries) and Table 9 (large countries).

Table 8 Small countries categorized by population density and natural resource endowments: 105 countries

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

Source: Developed by authors.

Table 9 Large countries categorized by population density and natural resource endowments: 43 countries

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

Source: Developed by authors.

We find that such categorization is a good approximation of reality and as such has some useful and relevant implications on industrialization as well as on structural change itself. To relate this to the regression results, we constructed scatter graphs based on predicted levels of output per capita for certain sectors, which also includes the country-specific effect measured by the degree of deviation from the average pattern. The scatter graphs in Figure 2 of both small and large countries include the groups we present in Tables 8 and 9. We labelled the groups in the following way:

1. SMALL COUNTRIES:
   - SAA: Small countries, above median resources per capita, above median population density;
   - SAB: Small countries, above median resources per capita, below median population density;
   - SBA: Small countries, below median resources per capita, above median population density;
   - SBB: Small countries, below median resources per capita, below median population density.

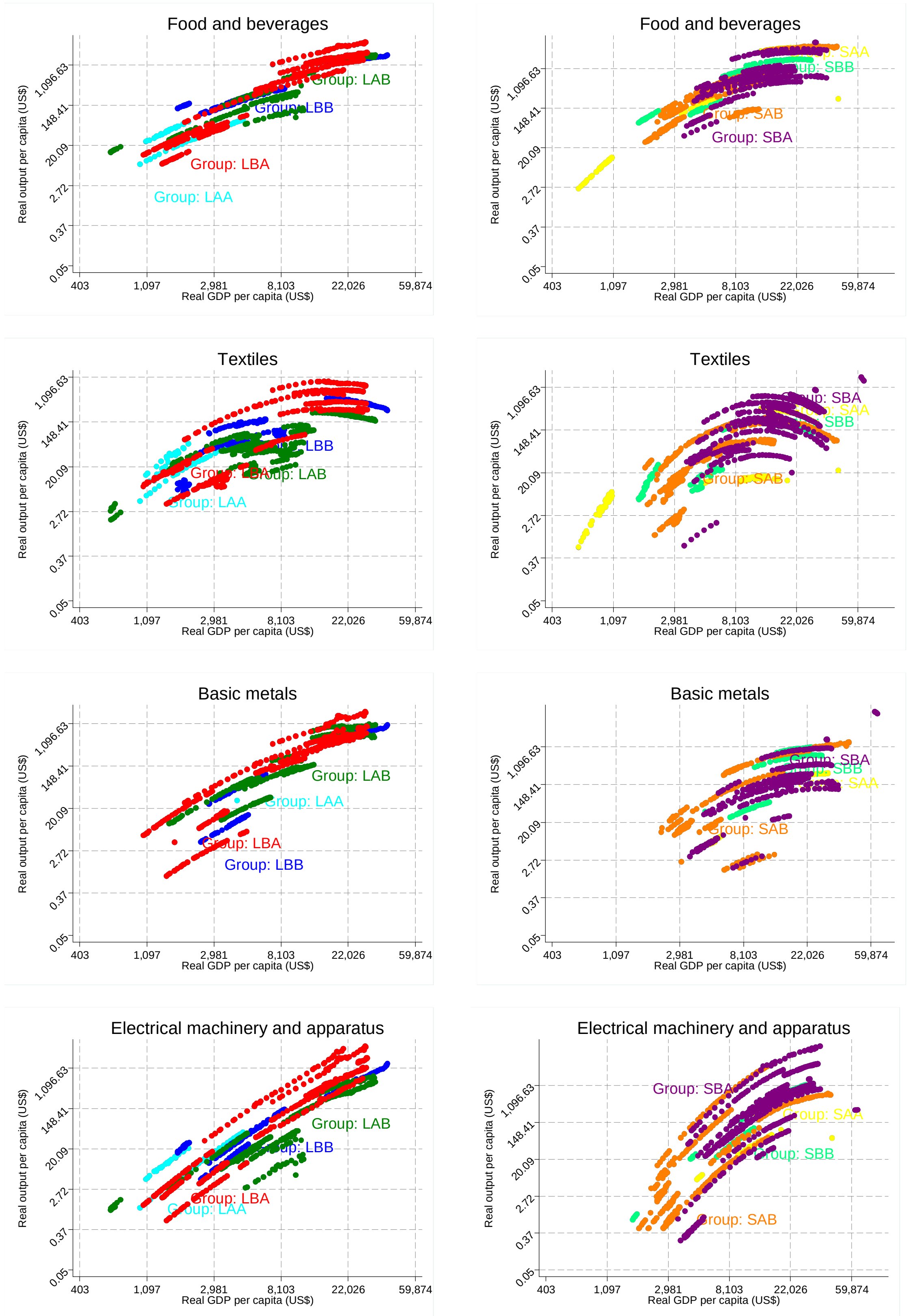
2. LARGE COUNTRIES:

- LAA: Large countries, above median resources per capita, above median population density;
- LAB: Large countries, above median resources per capita, below median population density;
- LBA: Large countries, below median resources per capita, above median population density;
- LBB: Large countries, below median resources per capita, below median population density.

Although there are some clear outliers as well as variations between sectors, we generally see that the groups we constructed in fact tend to exhibit particular patterns of their own. These tend to be clearer across small countries. The graphs in Figure 2 provide us with two sets of information:

1. Countries in the same group tend to exhibit similar growth patterns: For example, both small and large countries with below median resource endowments per capita and above median population density (SBA and LBA) tend to reach higher levels of output per capita with the growth of GDP per capita (both in quadrant 1 of Tables 8 and 9). The same applies to countries that have below median resource endowments per capita and below median population density (SBB and LBB) (both in quadrant 4 of Tables 8 and 9). On the other hand, small and large countries that have above median resource endowments per capita and below median population density (SAB and LAB), on average, reach lower output per capita levels with GDP growth (both in quadrant 3 of Tables 8 and 9). The same applies to countries with above median resource endowments per capita and above median population density (SAA and LAA) (both in quadrant 2 of Tables 8 and 9).
2. The presence of outliers clearly indicates that although resource endowments and population density do, in general, influence the patterns of industrial transformation, it does not necessarily mean that a country’s development path will be predetermined by these exogenous characteristic. In future, both negative and positive outliers will need to be looked at under the magnifying glass to draw relevant policy implications.

Figure 2 **Scatter graph with resource per capita and population density dummies**



Source: Developed by authors based on regression estimations for all countries (equation 6).

4.1.3. Country-specific effect

Table 10 presents the results based on equation 6, which include country-specific effects. Based on the average explanatory power across all sectors, we can see that the model explains most of the variation in output per capita. Country-specific characteristics add about a third of the explanatory power to small countries and a sixth of the explanatory power to large countries (compared to Table 5 in the previous section).

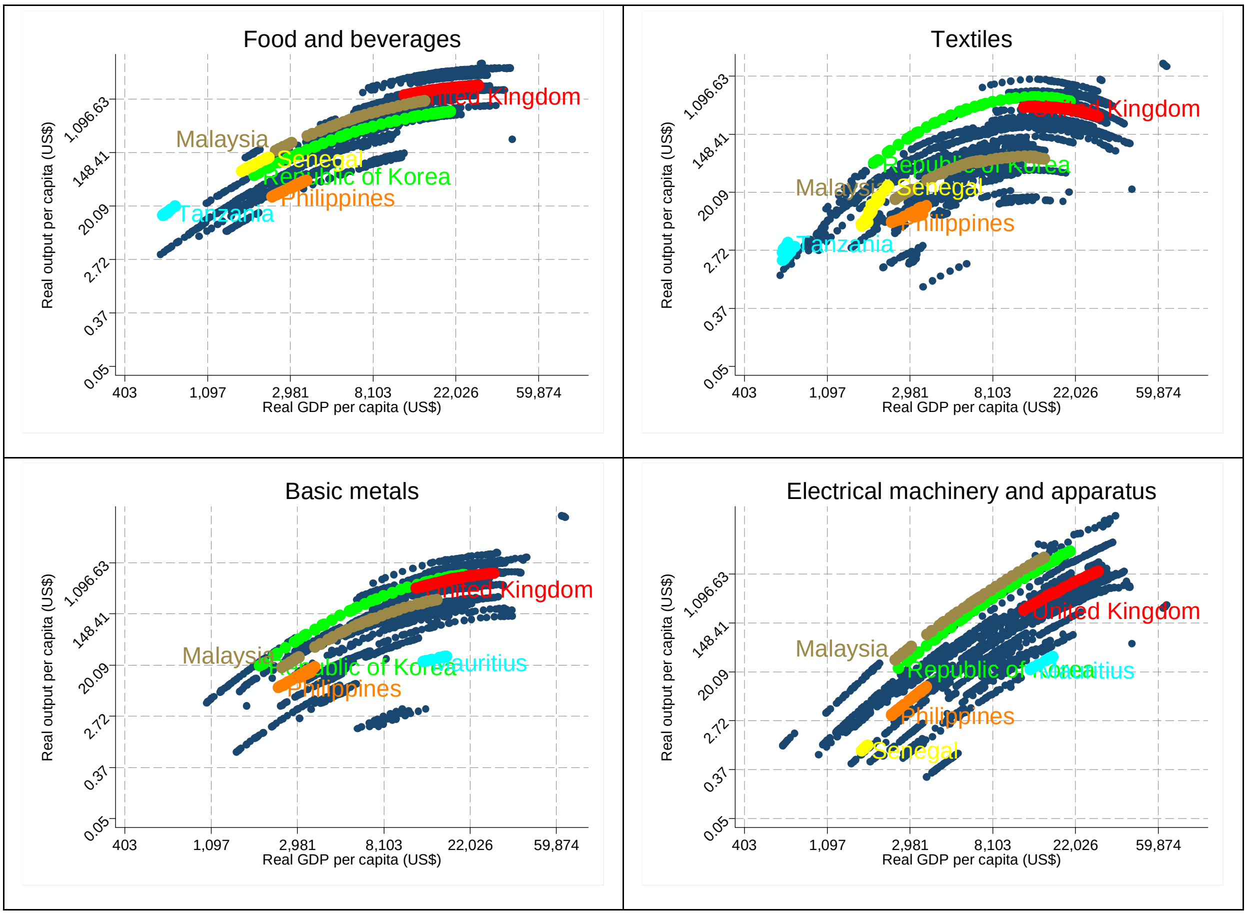
Table 10 Regression estimations based on equation 6 (FE estimation) for small and large countries

ISIC	*Size*	*C*	*GDPPC*	*GDPPC²*	*POPD*	*RPC*	$\overline{R}^2$	*N*
Food and beverages	Small	-38.0320***	8.3221***	-0.4134***	0.0655	0.1795*	0.9605	1093
	Large	-9.9922***	4.6471***	-0.2078***	-0.0308	-0.9872***	0.9791	960
Tobacco	Small	-33.0087***	7.0885***	-0.3619***	-0.0316	0.1681	0.9483	1015
	Large	-12.6817***	5.8740***	-0.2999***	-0.2224***	-1.3102***	0.9746	906
Textiles	Small	-78.9587***	17.7249***	-0.9324***	-0.4838***	0.2440	0.9207	1189
	Large	-42.5235***	8.9678***	-0.4504***	-0.8034***	0.4191	0.9368	996
Wearing apparel	Small	-77.0230	19.0149***	-1.0151***	-0.2632**	-0.3449*	0.9427	1225
	Large	-53.1432***	11.5903***	-0.5846***	-1.4111***	0.1969	0.9369	967
Wood products	Small	-77.7955***	16.7589***	-0.8738***	-0.5722***	0.9960***	0.9443	1204
	Large	-23.9815***	5.3193***	-0.2645***	-0.6037***	0.3934	0.9730	921
Paper	Small	-43.8634***	8.6427***	-0.3961***	-0.3108***	0.2455*	0.9593	1152
	Large	-10.4649**	4.1149***	-0.1559***	-0.5223***	-0.9793**	0.9779	913
Printing and publishing	Small	-23.3969***	4.6667***	-0.1972***	0.2649***	-0.1758	0.9710	1105
	Large	-11.7423*	2.5483***	-0.0851**	-0.5301***	0.1956	0.9600	900
Coke and refined petroleum	Small	-33.6153**	7.2100***	-0.3370**	0.1622	0.2725*	0.9353	585
	Large	-27.4696	6.9804***	-0.3317***	-0.0011	-0.2546	0.9772	733
Chemicals	Small	-27.2727***	5.4923***	-0.2067***	0.5435***	-0.1518	0.9490	1093
	Large	-10.6859***	2.1952***	-0.0468*	0.3744***	-0.4227	0.9747	894
Rubber and plastic	Small	-51.3233***	9.7551***	-0.4706***	0.4413***	0.2055	0.9572	1066
	Large	-10.4101**	2.1995***	-0.0553*	0.2637***	-0.0648	0.9701	909
Non-metallic minerals	Small	-71.9746***	15.4303***	-0.7821***	-0.3010***	0.3863***	0.9498	1107
	Large	-25.4666***	7.0395***	-0.3413***	0.1873**	-0.8392**	0.9762	946
Basic metals	Small	-56.7309***	11.7295***	-0.5690***	-0.2525*	0.4592***	0.9695	811
	Large	-8.8013*	5.8751***	-0.2685***	0.2013	-2.4089***	0.9646	773
Fabricated metals	Small	-33.0976***	5.8352***	-0.2613**	0.3600***	0.4597**	0.9414	1020
	Large	-19.1648	5.5073***	-0.2382***	-0.3431**	-0.6330	0.9615	870
Machinery and equipment	Small	-52.1274***	10.1634***	-0.4705***	0.2337	-0.0407	0.9738	1044
	Large	-21.5122**	-1.9679*	0.2117***	-0.0993	3.1001***	0.9392	935
Electrical machinery and apparatus	Small	-67.3694***	14.4515***	-0.6501***	-0.2397*	-0.1962	0.9670	1102
	Large	-9.7360	5.3117***	-0.1905***	0.1522	-2.2172***	0.9569	955
Precision instruments	Small	-47.8662***	7.9737***	-0.3640***	0.5143**	0.8602***	0.9758	869
	Large	-32.4229***	5.6295***	-0.2131***	-0.5628***	0.1799	0.9726	785
Motor vehicles	Small	-54.3805***	12.1714***	-0.5954***	-0.4890***	-0.4507**	0.9598	1061
	Large	-11.7722	3.2806***	-0.0827	-0.8033***	-0.1311	0.9273	938
Furniture, n.e.c.	Small	-90.9426***	20.0021***	-0.9989***	-1.9994***	0.3159	0.9086	936
	Large	-21.2680***	4.8854***	-0.2252***	-0.3395**	-0.3185	0.9727	803
* p<0.05, ** p<0.01, *** p<0.001						Average: small	0.9519	
						Average: large	0.9628	

Source: Calculated by authors based on regression estimations for small and large countries (equation 6).

Based on regression equation 6 for all countries (estimation not included in the chapter), we constructed scatter graphs in Figure 3, which illustrate the deviations from the average pattern.

Figure 3 Scatter graph with country dummies



Source: Developed by authors based on regression estimations for all countries (equation 6).

For the subsequent analysis of growth patterns, we use the results from Table 10.

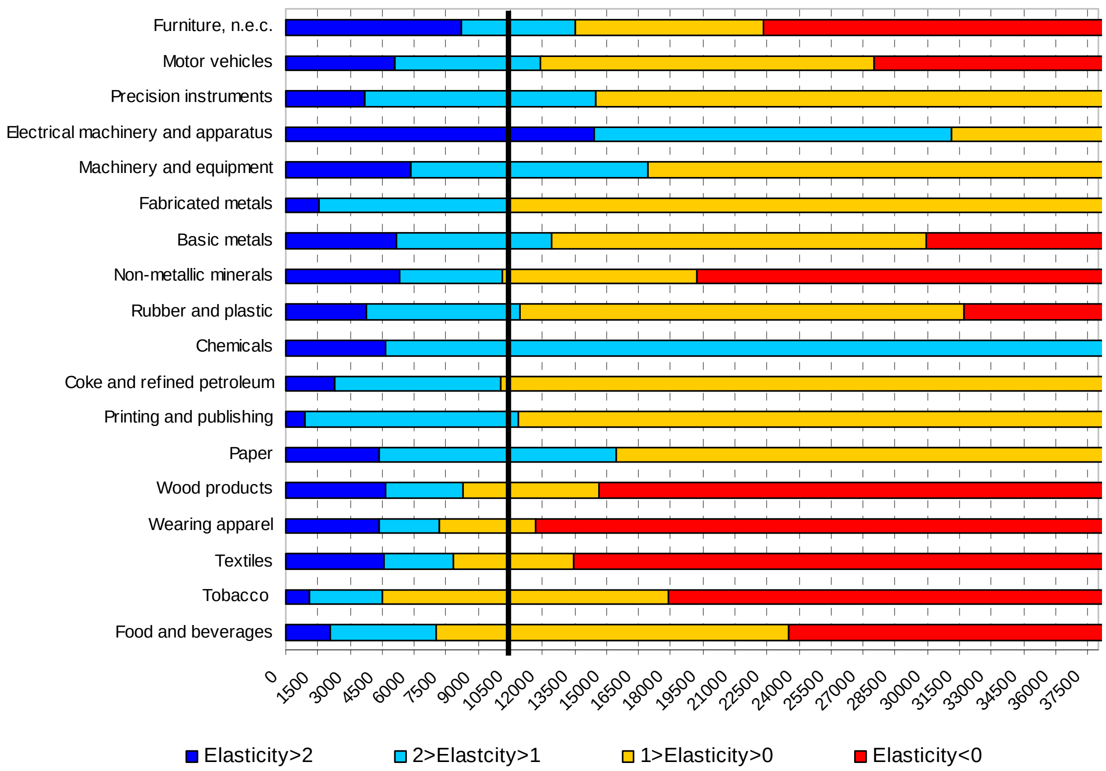
4.2. Growth patterns

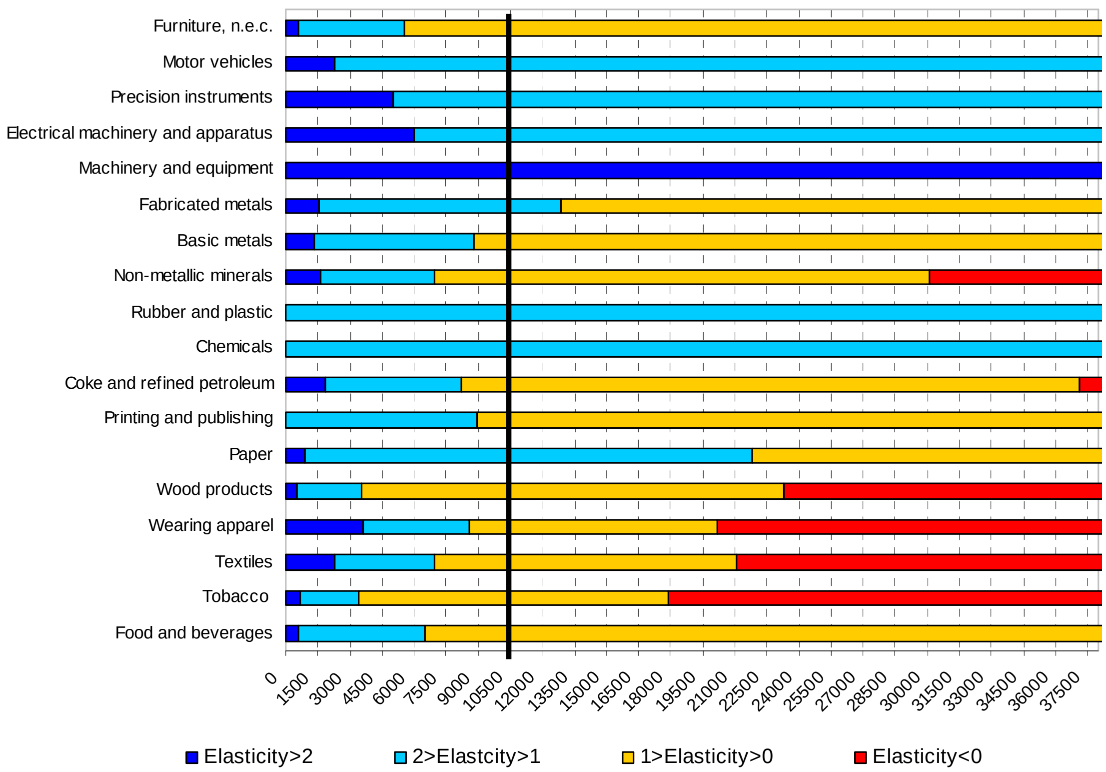
Chenery's original estimation (1960) included countries with a GDP per capita of up to USD 9,300 (USD 1,300 in 1960 prices). Figure 1 indicates that the pattern of industrial development is indeed more or less linear up to such a low income level. This could be the reason why the linear model of Chenery (1960) resulted in relatively high adjusted R-squares, which convinced him that the model could be considered for assessing patterns of industrial development. The availability of long-term time series and diverse cross-section data with income per capita including both low income and high income economies, enables one to present more accurate patterns of industrial development which reveal when and how output per capita began slowing down before decreasing.

Figure 4 depicts the growth/decline of 18 manufacturing sectors in relation to GDP for small and large countries. Regression results from Table 5 combined with the figure allow us to determine different stages of development for individual sectors. In the development cycle captured here, most sectors do not seem to reach clear-cut peaks for both country groups, yet nearly all of them begin to experience declining trends in the growth of output per capita. Based on regression results, we calculated four different elasticity thresholds for output per capita in relation to GDP per capita. The first stage is characterized by the rapid growth of output per capita with an elasticity larger than 2. At this stage, a 10 percent growth in GDP per capita would result in a more than 20 percent growth rate of output per capita. At the second stage, output per capita grows with an elasticity of between 2 and 1; at the third stage, between 1 and 0 in which output still grows but less than the growth rate of the whole economy; and at the fourth stage, with an elasticity smaller than 0. Sectoral output reaches its peak when elasticity reaches zero and subsequently begins to decline.

These differences between small and large countries become obvious when we analyze them in conjunction with the income effect. The first diagram in Figure 4 illustrates that 10 sectors will reach their peak in the development cycle captured in this chapter and then start to decline. The exceptions are ***Printing and publishing***, ***Chemicals***, ***Fabricated metals***, ***Electrical machinery and apparatus***, ***Paper***, ***Coke and petroleum***, ***Machinery and equipment***, and ***Precision instruments***. The sectors that reach their peak relatively early are ***Food and beverages***, ***Tobacco***, ***Textiles***, ***Wearing apparel***, and ***Wood products.*** Despite this, one cannot neglect the potential of many of these sectors, especially at the early stages of development. We see a rather different picture when looking at the second diagram in Figure 4, which shows the sectoral trends for large countries, where only seven sectors reach their peak within this GDP per capita range. Sectors such as ***Tobacco***, ***Textile***, ***Wearing apparel***, and ***Wood products*** also reach their peak at earlier stages of development in comparison to other sectors within the group of large countries, but later than small countries. Specifically, sectors such as ***Chemicals***, ***Rubber and plastic***, ***Machinery and equipment***, ***Electrical machinery and apparatus***, ***Precision instruments***, and ***Motor vehicles*** show impressive growth rates until a very late stage of development.

Figure 4 Sectoral elasticities for small and large countries





Source: Developed by authors based on regression estimations in Table 10.

Contrary to popular belief and some evidence, the output of the ***Food and beverages*** sector does not show a declining trend for all countries within a group (results of which are not presented in this chapter), and reaches its peak at USD 37,839, which comes at a relatively late stage of development. Earlier studies (Chenery, 1960: 633; Chenery and Taylor, 1968: 409; Maizels, 1968) estimated that the income elasticity of demand for this sector was around or less than 1).

Our results indicate that the sector grows with an elasticity of more than 2 until a GDP per capita of about USD 1,061. After reaching a GDP per capita of approximately USD 6,337, the sectoral output still grows more than the economy, but at a decreasing rate until reaching its peak. A similar development can also be observed in Figure 4 for both small and large countries. For small countries, the ***Food and beverages*** sector only starts declining at a GDP per capita of around USD 25,000: It grows with an elasticity of more than 2 until the GDP per capita reaches around USD 2,500 and an elasticity of more than 1 until the GDP per capita is around USD 7,500 US. For large countries, this sector does not reach its peak in the GDP range used here.

One important difference that was already addressed in the previous section is the difference between small and large countries at early stages of development. We used a dividing line of USD 9,000 in both diagrams. Up until this point, small countries in particular show an impressive growth rate across all sectors, which grow with an elasticity of more than 2 until a GDP per capita of approximately USD 4,500 – 5,000 is attained. Large countries, on the other hand, do not grow across sectors as fast as small countries until this point, but based on the graphs in Figures 1 and 4, we observe that their growth trajectories are more sustainable in the long-run and decline (if they decline) at later stages of development. This has important policy implications which we elaborate in more detail in the final paragraph.

5. Sectoral typology and policy implications

In this summary of the above discussion, the development of the sectors is classified in the following tables by their stage and growth potential. The stage of development is divided into "early", "middle", and "late" based on the peak period of the sectoral share in the economy. The columns of the tables list three development potentials.[9] The letters in parentheses, p and r,

[9] A sector is classified under "sustained growth" if it is estimated to pass the output per capita level of USD 1,000 during its development. If the sector is projected to reach a level of between USD 150 and 1,000, it is listed under "temporary growth" The sectors which most likely will not reach an output level of USD 150 are listed under "low growth." The sectors in italics are those whose country-specific characteristics account for 30% or more (i.e., the income level accounts for less than 70%) of the

indicate that population density and natural resource endowment, respectively, either have positive (+) or negative (-) effects on the development of the sector.

Table 11 Sector classifications by stage of development and growth for small countries

	Sustained growth	*Temporary growth*	*Low growth*
Early sectors	Food and beverages (+r)	Textiles (-p) Wearing apparel (-p, -r)	Tobacco Wood products (-p, +r)
Middle sectors		Coke and petroleum refining (+r) Non-metallic minerals (-p, +r) Basic metals (-p, +r)	Motor vehicles (-p, -r) Furniture and others (-p)
Late sectors	Chemicals (+p) Electrical machinery (-p)	Paper and paper products (-p, +r) Printing and publishing (+p) Rubber and plastic (+p) Fabricated metals (+p, +r) Machinery and equipment	Precision instruments (+p, +r)

Table 12 Sector classifications by stage of development and growth for small countries

	Sustained growth	*Temporary growth*	*Low growth*
Early sectors	Food and beverages (-r) Chemicals (+p)	Non-metallic minerals (+p, -r) Coke and petroleum refining Precision instruments (-p)	
Middle sectors	Machinery and equipment (+r)	Wearing apparel (-p) Textiles (-p) Basic metals (-r)	Tobacco (-p, -r)
Late sectors	Electrical machinery (-r) Motor vehicles (-p)	Paper and paper products (-p, -r) Printing and publishing (-p) Rubber and plastic (+p) Fabricated metals (-p)	Wood products (-p) Furniture and others (-p)

A comparison between Tables 11 and 12 shows that small countries have a limited number of sectors with high development potential (sustained growth), and country-specific effects tend to exert a high influence on a large number of sectoral developments, indicating higher uncertainty in their path towards industrialization. In the early stage of development, the food and beverages sector plays an important role in small countries, and depending on their population density and

explanation of the sectoral development pattern. Therefore, there is a high degree of uncertainty in their development relative to the sectors in black.

resource endowment, the countries have to support industrialization with other sectors, preferably with sectors of “temporary growth” instead of “low growth.” In any case, other than for the food and beverages sector, the development of the early sectors is highly dependent on country-specific factors, which implies that the countries need to consider policy, institutional, and other necessary conditions to successfully develop these early sectors.

Among sectors which peak in the next stage of economic development, only the non-metallic minerals sector can, with high certainty, be expected to develop along with the income increase in small countries. Given there is no sector of “sustained growth” in this stage and the uncertainty of other sectors’ development, small countries will continue to face the precarious situation where they have to make special efforts to identify sectors which are appropriate for their country characteristics rather than leaving industrialization to develop spontaneously through market force.

As the GDP per capita of small countries reaches a substantially high level, say, more than USD 10,000 US, the sectors listed in the late sectors in Table 11 should come to play a major role in the country’s economy. In other words, without a successful transformation of manufacturing industries to establish those late sectors, it is unlikely that small countries will reach the high income level. Hence, for their successful industrialization, small countries need to nurture the development of the late sectors long before the “late” stage has been attained. Among the late sectors, especially the chemical and electrical machinery sectors will be important for the country’s economy, as they are likely to sustain their growth even once most of the other sectors begin declining at a very high income level. Small countries with a relatively high population density have a higher likelihood of developing the chemical rather than the electrical machinery sector, and the opposite is true for countries with a low population density.

In contrast to small countries, manufacturing sectors in large countries develop with a higher degree of certainty along with the rise of income, because the income level generally explains 80 per cent of the sectors’ output variations, except for the wearing apparel and coke and petroleum refining sectors. Large countries have more sectors of “sustained growth” and fewer sectors of “low growth” than small countries, and each stage of development has at least one sector of “sustained growth”, which would make the manufacturing transformation smoother.

In this regard, rather than providing special support tailored to the unique needs of each sector, it is probably more effective if large countries focus on removing obstacles to the working of the market and provide functional support for educational, skill, and institutional development. One caveat to large countries is the importance of adequately managing their natural resources if endowed with a relatively high level of natural resources. Due to the many sectors with an –r sign next to them in Table 12, regardless of the level of population density (as shown in Figure 2), the manufacturing development in large countries with a higher level of natural resource endowment tends to lag. There are exceptions such as Canada and Mexico which despite their relatively high natural resource endowment have industrialized their economies. Large countries with similar conditions can learn from these and other successful examples.

The sectoral typology together with changes in sectoral elasticities in Figure 4 indicates when, how fast, how far, and how reliably manufacturing industries develop in countries with different geographic and demographic characteristics. The analysis of such information reveals that certain paths of manufacturing development are preferable over others depending on country characteristics, and there seems to be room for industrial planning, policy, and coordination for successful industrialization.

Overall, the manufacturing development in small countries begins later than in large ones. However, once the former's manufacturing industries take off, they tend to grow faster than those of large countries during most of the middle income stage before large countries once again surpass small countries in terms of the output per capita of manufacturing industries. Thus, small countries experience a relatively rapid growth and decline of the manufacturing industries while large countries are likely to undergo a slow but more sustainable growth. These development patterns are likely attributable to the differences in weight of exports as a source of demand for their manufacturing products. The heavier reliance of small countries on external markets allows a rapid expansion of their manufacturing industries, which is disproportionate to the country's size, when they have comparative advantages in the manufacturing industries. However, this leads to rapid declines once they lose these advantages in the international markets, which occurs between USD 7,500 and 12,000 GDP per capita, as their small domestic market cannot meet the significant source of the demand to sustain their manufacturing industries. On the other hand, due to the importance of the domestic market as a source of demand, manufacturing industries in large countries develop more commensurate to the country's economic growth. The large domestic market gives the manufacturing industries the scale advantage and extends the period of their development. The larger share of the domestic market as a source of demand functions as a buffer against the loss of competitiveness in the international market, allowing continued operation and even occasional growth along with the expansion of the domestic economy.

These general patterns of manufacturing development reveal that relative to large countries, small ones need more detailed strategies for their manufacturing development, accompanied by contingency plans, and must carefully manoeuvre the manufacturing transformation from one growth sector to another based on an understanding of their development patterns. This proposition is based on the three findings of the paper. First, as described above, windows of opportunity for manufacturing development are only open for a relatively short period of time for small countries. As Figure 1 shows, the output trend lines of small countries are often more curvilinear. Figure 4 attests that once the rapid growth period ends (when the elasticity becomes less than 2, but greater than 1), most sectors will reach the stage of relative decline (in which the elasticity becomes less than 1) faster than those of large countries.

Secondly, as the comparison of Tables 11 and 12 indicates, there are a larger number of sectors in small countries whose output changes are better explained by country-specific characteristics. This implies that the universal effect of income level is a less reliable determinant for sectoral output levels (on average, 0.64 R-square for small countries versus 0.8 R-square for large countries). It is, therefore, more important for small countries than for larger ones to make efforts to investigate how their country characteristics are likely to work as an advantage or disadvantage for the development of sectors they would like to establish and, if necessary, how they can create conducive conditions for such a development.

Finally, as the above sectoral typology demonstrates, the fact that small countries have fewer "sustained growth" and more "low growth" sectors means that their paths of industrialization have to be supported by shifting from one temporary growth sector to another, perhaps by proactively facilitating manufacturing transformation. For small countries, food and beverages, chemicals, and/or electrical machinery represent cornerstones for sustained industrialization to achieve a high level of GDP per capita. While understanding the importance of these sectors and supporting their development early on, the chemicals and electrical machinery sectors will only have significant weight in the economy at a later stage of industrialization. To bridge the early to late stages, even very small countries would need to have at least a couple of successful manufacturing industries to sustain the industrialization process.

For example, if a small resource-poor country is to strategically support industrialization—though a rigorous country assessment is necessary—Table 11 is particularly useful, as it demonstrates that the country probably has a better chance to succeed in the development of textile and/or wearing apparel in addition to the food and beverages sector, rather than in coke and petroleum refining, in the basic metal sectors or those listed under “low growth.” However, both the textile and wearing apparel sectors’ growth rate will slow down relatively fast after the end of the rapid growth period at a GDP per capita of around USD 4,500 and reach a period of relative decline (with a growth rate of less than the GDP per capita growth) at a per capita income of about USD 7,500. Thus, small countries need to foster the emergence, if not successful establishment, of middle or late sectors long before they reach a per capita income of roughly USD 7,500. As these descriptions suggest, understanding the general characteristics of the manufacturing sectors such as their timing, speed, and length of development and the country conditions conducive for their growth, will provide policy makers with a rough benchmark of a country’s long-term manufacturing transformation and help them elaborate policies to support industrialization.

6. Conclusion

Chenery and other authors made a seminal contribution to the conceptualization of factors that affect structural change. Their empirical studies, however, usually focused on a) the universal effect of income on structural change, mostly at a broad aggregation of a three-sector classification, paying little attention to b) the effects of given country characteristics over which the government has little or no control, and c) other country-specific effects. Building on their conceptual framework, this paper first improved the measure to account for the income effect on manufacturing transformation. Level of income explained most of the output variations for the sectors of large countries, but its explanatory power is lower for small countries, albeit the most important determinant of their sectoral development, accounting for two-third of the variations on average. This study also showed the extent to which b) explains manufacturing development and how such characteristics influence individual sectoral developments. Factor b) accounts for a relatively small part of the output variations; however, their combined effects seem to produce certain patterns of sectoral development as evidenced in the clustering of countries with similar characteristics in Figure 2. In addition, this paper measured the extent of c)’s influence and graphically illustrated the role country-specific effects play in sectoral output levels. On average, country-specific effects explain roughly one-third of sectoral development patterns for small countries, while such effects influence large countries to a much lesser extent. In short, a detailed analysis on a) and b) and their combined information allowed us to present the patterns of manufacturing transformation before the influence of country-specific effects, which can be used as benchmarks for monitoring manufacturing development and for policy formulation purposes.

The in-depth analysis at the disaggregated level of the manufacturing industry revealed the basic characteristics of manufacturing sectors with regard to their timing, speeds, and stages of development. The corollaries of this study will naturally lead us to investigate what constitutes the c), country-specific effects, in our future research.

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Printed in Austria
V.11-81308—March 2011—260

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