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De-industrialization and Emerging Market Economies

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This paper identifies a non-linear pattern of industrialization. A panel regression suggests that the manufacturing/GDP share reaches its peak when the developing country's GDP/capita reaches about 60% of the US GDP/capita, and that financial depth is associated with a higher manufacturing share. We provide an interpretation for the above findings in a global economy characterized by a traded manufacturing industry, where the number of varieties is endogenously determined, and non traded services. While de-industrialization would have occurred even in the absence of the emerging markets, their presence magnifies this process for the high-income countries.

I. Introduction

De-industrialization has been the experience of a growing number of countries. For example, Figure 1 plots the manufacturing/GDP share for Brazil, China, Japan and Korea (1970-1994). It is noteworthy that both Korea and Brazil's manufacturing share form an inverted U shape curve, rising initially, declining later. In contrast, Japan's share declined continuously throughout that time. China exhibits a strong surge in the aftermath of the liberalization during the seventies, followed by a tenuous decline. Among the four countries, Japan's GDP/Capita is the closest to that of the US, China is a relatively "young" tiger, whereas Korea may be viewed as a maturing "tiger". Figure 1 suggests an inverted U shape association between "catching up" with high income countries and the patterns of de-industrialization. We confirm this conjecture by fitting a quadratic regression explaining the manufacturing patterns of 80 countries, from 1970 to 1995. Table 1 summarizes the regression results for the case where the explanatory variables are the countries' relative GDP/capita (normalized by the US GDP/capita), the square of the countries' relative GDP/capita, and the financial depth. Our regression indicates that the manufacturing share reaches its peak when the developing country's GDP/capita reaches about 0.6 that of the US. In addition, we find that financial depth is associated with a higher manufacturing share.[1]

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1. The standard limitations of regression analysis apply - the partial correlations summarized in Table 1 are not indicating causality. The purpose of the paper is to propose a model providing an interpretation for the regularities summarized by the regression. It is also noteworthy that one expects a two way feedback between financial depth and the GDP/Capita, and the regression reported in the Table is not attempting to control for this

The purpose of this paper is to provide an interpretation for the above findings. A key insight into the problem is provided by the tendency for countries with higher productivity in tradable goods (compared with non-tradable goods) to have a higher price level. This observation was used to explain the international pattern of the real exchange rate by Balassa (1964), Samuelson (1964), and earlier by Harrod (1933). More recent affirmation of the Harrod-Balassa-Samuelson (HBS henceforth) effect include Asea and Mendoza (1994) and De Gregorio, Giovannini and Wolf (1994).[2] The data of the last 50 years has confirmed the long-run rise in the relative price of services, as well as the positive association between long-run tradable/non-tradable productivity growth differentials and the long run relative price of non tradable goods (see Baumol, Blackman and Wolf (1989) and De Gregorio *et al.* (1994)). This insight has been corroborated by Summers (1985), who found that the demand for services is indeed price inelastic, and that the income elasticity of the demand for services is one. The potential growth implications of these observations were pointed out earlier by Baumol (1967), who showed that the combination of inelastic demand for services, with a more rapid technological improvement in manufacturing, would lead to unbalanced growth. Consequently the share of services will increase overtime, the share of manufacturing will decline, dragging downwards the overall growth rate of the economy.

Following the above literature, we consider a global economy characterized by a traded manufacturing industry and non traded services. The manufacturing sector is composed of a large number of producers organized in a monopolistic competitive environment, as in Helpman-Krugman, where the number of varieties is endogenously determined. We assume Dixit-Stiglitz (1977) preferences for manufacturing varieties, and a CES aggregator of the utility from services and manufacturing. Our model is consistent with the patterns of de-industrialization of high income observed in the data. The pattern of the emerging markets is richer, as the share of manufacturing tends to increase early on, and declines later throughout the catching up process. Section II reviews the model, and Section III concludes.

II. The Model

Consider a world economy composed of 2 nations. The home economy is populated by agents whose utility at time i is

$$W_i = \sum_{t=i}^{\infty} \frac{U_t}{1+r} \tag{1}$$

where the period t utility is the aggregate of the utility from manufacturing (M) and services (S),

effect.

2. While the borderline between non-traded and traded goods is murky, one may assess the HBS hypothesis by utilizing the substantial overlap between non tradables and services, and between manufacturing and traded goods. This has been the research strategy adopted frequently.

$$U_t = \left[(M_t)^r + (S_t)^r\right]^{1/r} . \tag{2}$$

Following Baumol (1967) and Summers (1985), we assume that $r < 0$.[3] Manufacturing is characterized by differentiated products, of which $m(m^*)$ varieties are produced in the home (foreign) economy. These $m + m^*$ varieties are aggregated according to the Dixit-Stigitz utility,

$$M_t = \left[\sum_{n=1}^{m+m^*}(M_{t,n})^q\right]^{1/q} ; \ \ 0 \le \boldsymbol{q} \le 1 . \tag{3}$$

The preference structure is akin to Obstfeld and Rogoff (1996, Section 4.4) and Spilimbergo (1998).[4] To simplify exposition we suppress henceforth the time index t. The production of services is given by

$$S = L_s \tag{4}$$

where L_s workers are employed in services, which are assumed to be non-traded. The production of variety n at home requires both the periodic "maintenance cost" C_t (measured in labor units), and the employment of labor time

$$M_n = \frac{L_n}{a} \tag{5}$$

where L_n workers are employed in producing variety n, $1 \le n \le m$, and the constant a measures the marginal cost of manufacturing (in units of services). The foreign country is characterized by similar equations, where '*' denotes foreign values. We normalize the labor force in the home economy to 1, and in the foreign economy to h, and the price of services in the home economy to 1. The demand for services is (see the Appendix for derivation)

$$S = \frac{1}{1 + (P_m)^{\tilde{r}}} ; \ S^* = \frac{h}{1 + (P_m / P_s^*)^{\tilde{r}}} \tag{6}$$

3. Equation (2) implies that $\frac{S}{M}\frac{P_s}{P_m} = \left[\frac{P_m}{P_s}\right]^{\frac{1}{1-r} - 1}$, where the price of manufacturing and services is denoted by P_m, P_s, respectively. Hence, a drop in the relative price of manufacturing will reduce its share iff $r < 0$.

4. Spilimbergo (1998) considered a Ricardian global economy, focusing on the impact of trade on de-industrialization. The focus of our model is on de-industrialization induced by technological "catching up" of emerging markets. A key aspect of the catching up is that it leads to more homogeneous production patterns across countries. This observation induces us to model the supply side using the monopolistic competitive environment instead of the Ricardian approach.

where $\tilde{r} = r/(r-1)$. Recalling our assumption that $r < 0$, it follows that $1 > \tilde{r} > 0$.
The term P_m is the Dixit-Stiglitz manufacturing price index:

$$P_m = \left[m\{p_v\}^{-qs} + m^*\{p_v^*\}^{-qs}\right]^{-1/[sq]}, \quad s = 1/[1-q] \tag{7}$$

where $p_v; p_v^*$ are the prices of a representative variety in the home (foreign) economy, respectively. Applying the properties of monopolistic competition it follows that

$$P_m = \left[m\left\{\frac{a}{q}\right\}^{-qs} + m^*\left\{\frac{a^*P_s^*}{q}\right\}^{-qs}\right]^{-1/[qs]} \tag{7'}$$

The relative price of services is a weighted average of the relative manufacturing productivity (see the Appendix for further details):

$$\frac{P_s^*}{P_s} = \left\{\frac{C}{C^*}\right\}^{1-q}\left\{\frac{a}{a^*}\right\}^{q} \tag{8}$$

We close the system by noting that full employment implies (see the Appendix for derivation)

$$\begin{aligned} &a.\ \ 1 = \frac{mC}{1-q}\left[1+\{P_m\}^{-\tilde{r}}\right]; \\ &b.\ \ h = \frac{m^*C^*}{1-q}\left[1+\left\{\frac{P_m}{P_s^*}\right\}^{-\tilde{r}}\right] \end{aligned} \tag{9}$$

Equations (7)-(9) form a simultaneous system of four equations in four endogenous variables $[m, m^*, P_m, P_s^*]$. In the Appendix we show that the GDP shares of manufacturing, f, f^*, are

$$\begin{aligned} &a.\ \ f = \frac{1}{1+\{P_m\}^{-\tilde{r}}}; \\ &b.\ \ f^* = \frac{1}{1+\left\{\frac{P_m}{P_s^*}\right\}^{-\tilde{r}}} \end{aligned} \tag{10}$$

Suppose that the foreign country is less productive. We can apply our system to investigate the impact of a catching up process. To fix ideas, suppose that C^*, a^* drop at the same rate, $d\log\left[C^*\right] = d\log[a^*] < 0$. It can be verified that[5]

$$
\begin{aligned}
&\left.\frac{d\log m}{d\log a^*}\right|_{d\log a^* = d\log c^*} = \frac{[1 - t^*\tilde{r}]\,\tilde{r}\,t\,t_p^*}{sq + \tilde{r}[t\,t_p + t^* t_p^*]} > 0 \\
&\left.\frac{d\log m^*}{d\log a^*}\right|_{d\log a^* = d\log c^*} = -\frac{[1 - t^*\tilde{r}][\,\tilde{r}\,t\,t_p + sq]}{sq + \tilde{r}[t\,t_p + t^* t_p^*]} < 0
\end{aligned}
\tag{11}
$$

where $t_p; t_p^*; t; t^*$ are shares bounded between zero and one, defined by

$$
t_p = \frac{m\left\{\frac{a}{q}\right\}^{-qs}}{m\left\{\frac{a}{q}\right\}^{-qs} + m^*\left\{\frac{a^* P_s^*}{q}\right\}^{-qs}};\quad t_p^* = \frac{m^*\left\{\frac{a^* P_s^*}{q}\right\}^{-qs}}{m\left\{\frac{a}{q}\right\}^{-qs} + m^*\left\{\frac{a^* P_s^*}{q}\right\}^{-qs}}
$$

$$
t = \frac{(P_m)^{\tilde{r}}}{1 + (P_m)^{\tilde{r}}};\quad t^* = \frac{(P_m / P_s^*)^{\tilde{r}}}{1 + (P_m / P_s^*)^{\tilde{r}}}\ .
$$

Hence, the catching up process leads to the de-industrialization of the high income countries. It is noteworthy that, as long as the productivity growth rate of manufacturing exceeds that of services, the de-industrialization would have occurred even in the absence of international trade. Applying our model it can be verified that in autarky

$$
\begin{aligned}
&\left.\frac{d\log f}{d\log a}\right|_{d\log a = d\log c} = \frac{[1 - t]\,\tilde{r}\,s}{sq + \tilde{r}[1 - t]} > 0 \quad \text{and} \\
&\left.\frac{d\log P_m}{d\log a}\right|_{d\log a = d\log c} = \frac{s}{sq + \tilde{r}[1 - t]} > 0\ .
\end{aligned}
\tag{12}
$$

Hence, technological improvements in manufacturing would reduce the relative price of manufacturing, increasing the GNP share of services independently of international trade. Consequently, the catching up of the emerging markets magnifies the de-industrialization process.

Our analysis so far conveniently assumed that all countries can be aggregated into two blocks - high income and emerging markets. Some of the dynamics of de-industrialization, however, may be better understood in a more heterogeneous world, where the rank of

5. Similar analysis would apply if the catching up process reduces only one of these parameters.

emerging markets widens as new comers (like China in the eighties) enter the global economy. To appreciate this point we turn now to a simulation of our model. Equations (7') and (8) can be used to substitute for P_m, P_s^* in (9), resulting in two "full employment" equilibrium conditions, the solution of which gives m, m^*. Figure 2 plots values of foreign and domestic varieties that are consistent with these "full employment" equilibrium conditions. Curve HH (FF) corresponds to a configuration consistent with equilibrating the home (foreign) economy. The relative slope of the two curves follows from the assumption that the substitutability of services and manufacturing is below 1. Curves HH and FF in Figure 2 simulate the case where both the population of the foreign country and its productivity in manufacturing are half that of the home economy. The horizontal contours measure the manufacturing share in the home economy. In autarky (point I), the home economy producers about 17 varieties, and the share of manufacturing is about 0.32. Autarky will prevail either due to restrictions on trade, or in the case where the productivity of the foreign country is very low.[6] Free trade (or improvement in foreign productivity to the level in the simulation) reduces the number of varieties produced at home, and reduces the share of manufacturing to 0.31. Throughout the catching up, FF will shift rightwards. Curve F' F' corresponds to the case where the foreign economy caught up with the home economy, hence the productivity of both is identical (but the foreign country is half the size of the home economy). Note that throughout the catching up process the manufacturing share of the home economy will decline further, reaching about 0.30 at point III. The manufacturing share of the foreign country increases from about 0.16 at point II to 0.30 at point III.

Suppose now that, starting at the equilibrium depicted at point III, a third country takes off, engaging in "catching up." This will set in motion a process that induces further de-industrialization of the home economy, and the de-industrialization of the second country. To appreciate this point, note that at point III, the first two countries are identical (up to scale), hence we can aggregate them into one block, referred to as the industrialized block. For example, suppose that the labor force in the emerging country equals that of the block of industrialized nations, and its productivity is half the productivity of the first two countries. Figure 3 depicts the new global equilibrium. Curve DD depicts now the block of the first two countries, and NN depicts the new comer. The catching up of the new emerging country will induce further industrialization of the industrialized country, reducing the share of manufacturing from 0.3 in IV to 0.285 at point V.

III. Concluding Remarks

This paper focused on the factors explaining de-industrialization patterns. We showed that the catching up of emerging markets with the technological frontier of the high income countries induces de-industrialization of the high income countries. While de-industrialization would have occurred even in the absence of the emerging markets, the presence of emerging markets magnifies this process for the high income countries. The industrialization patterns

6. Equation (9) implies that a lower foreign productivity pushes curve FF leftwards, and autarky is approached as a^* and C^* increase.

of emerging markets is impacted by their ‘packing order’ in the catching up process. The entrance of new, low wages, emerging markets to the global arena (like China) may account for the de-industrialization of the more maturing emerging economies (like Korea). In closing the paper it is useful to note that our discussion refrains from welfare analysis. While it can be shown that our model of de-industrialization is welfare improving to all countries, this result is not robust to the details of the model, and may be reversed in the presence of learning by doing and technological spillover effects.

Appendix

This Appendix reviews the derivation of the key equations. Recall that we normalize the labor force in the home economy to 1, and in the foreign economy to h, and the price of services in the home economy to 1. The maximization problem facing the agent in the home economy is summarized by

$$\underset{\{M_n\}_{n=1}^{m+m^*};\, S}{MAX} \left[\left[(M)^r + (S)^r \right]^{1/r} + l \left\{ \sum_{n=1}^{m+m^*} p_n M_n + S - 1 \right\} \right] \tag{A1}$$

where l is the budget constraint’s La grange multiplier. A similar problem applies to the foreign country

$$\underset{\{M_n^*\}_{n=1}^{m+m^*};\, S^*}{MAX} \left[\left[(M^*)^r + (S^*)^r \right]^{1/r} + l^* \left\{ \sum_{n=1}^{m+m^*} p_n M_n^* + p_s^* S^* - h \right\} \right], \tag{A2}$$

Applying the first order conditions leads to (6), (7) and (7'). These conditions can be solved for the home and foreign demand of a representative variety

$$M_v = \frac{1}{P_m + (P_m)^{1/(1-r)}} \left(\frac{P_m}{p_v} \right)^s ; \quad M_v^* = \frac{h}{\dfrac{P_m}{p_s^*} + \left(\dfrac{P_m}{p_s^*} \right)^{1/(1-r)}} \left(\frac{P_m}{p_v} \right)^s \quad \text{where } s = 1/(1-q) \tag{A3}$$

Hence, the producer faces demand the elasticity of which is $s = 1/(1-q)$. The marginal costs of manufacturing at home and in the foreign country are

$$MC_v = a \, ; \quad MC_{v*}^* = a^* P_s^* \tag{A4}$$

from which we infer that

$$p_v = \frac{a}{q}; \quad p_{v*} = \frac{a^*}{q} P_s^* . \tag{A5}$$

Free entry into manufacturing implies that gross profits equal the fixed cost

$$\begin{aligned} &\left[M_v + M_v^*\right]\left[p_v - MC_v\right] = C; \\ &\left[M_{v*} + M_{v*}^*\right]\left[p_{v*} - MC_{v*}\right] = C^* P_s^* \end{aligned} \tag{A6}$$

Applying (A3)-(A5) to (A6), dividing the two resultant equations yields

$$\frac{P_s^*}{P_s} = \left\{\frac{C}{C^*}\right\}^{1-q} \left\{\frac{a}{a^*}\right\}^{q} . \tag{8}$$

Full employment in both countries implies that

$$\begin{aligned} &1 = S + \left[aM_v^s + C\right]m \\ &h = S^* + \left[a^* M_{v*}^{*s} + C^*\right]m^* \end{aligned} \tag{A7}$$

where M_v^s; M_{v*}^{*s} is the supply of the represented variety in the home and the foreign economy, respectively. Applying (A4)-(A6) it follows that

$$\begin{aligned} &M_v^s a\left(\frac{1}{q} - 1\right) = C \\ &M_v^{*s} a^* \left(\frac{1}{q} - 1\right) = C^* . \end{aligned} \tag{A8}$$

Note that the manufacturing output in the home and the foreign economy is

$$\begin{aligned} &mM_v^s p_v = mM_v^s \frac{a}{q} \\ &m^* M_v^{*s} p_v^* = m^* M_v^{*s} \frac{a^*}{q} P_s^* \end{aligned} \tag{A9}$$

Applying (A8) and (A9) we infer that the manufacturing output in the two economies is

$$mM_v^{s} p_v = mC\boldsymbol{s}$$

$$m^* M_v^{*s} p_v^* = m^* C^* \boldsymbol{s} P_s^* \tag{A9'}$$

Applying (A8) to (A7), collecting terms, we infer that

$$1 = S + mC\boldsymbol{s}$$

$$h = S^* + m^* C^* s\ . \tag{A10}$$

Using (6) to substitute for S, S^* in (A9) we infer

$$a.\ \ 1 = \frac{mC}{1-\boldsymbol{q}}\left[1+\{P_m\}^{-\tilde{r}}\right];$$

$$b.\ \ h = \frac{m^* C^*}{1-\boldsymbol{q}}\left[1+\left\{\frac{P_m}{P_s^*}\right\}^{-\tilde{r}}\right] \tag{9}$$

We close the Appendix with a review of the derivation of the manufacturing shares, (10). We illustrate the derivation of f^*. Similar steps explain the derivation of f.

Applying (A5) and (A8) to the definition of the manufacturing share it follows that

$$f^* = \frac{m^* p_v^* M_v^{*s}}{m^* p_v^* M_v^{*s} + S^* P_s^*} = \frac{1}{1+\dfrac{S^* P_s^*}{m^* p_v^* M_v^{*s}}} = \frac{1}{1+\dfrac{S^* \boldsymbol{q}}{m^* \dfrac{C^* \boldsymbol{q}}{a^*(1-\boldsymbol{q})} a^*}} = \frac{1}{1+\dfrac{S^*(1-\boldsymbol{q})}{m^* C^*}} \tag{A11}$$

Applying (A10) and (9) to the last equation we infer that

$$f^* = \frac{1}{1+\dfrac{S^*(1-\boldsymbol{q})}{m^* C^*}} = \frac{1}{1+\dfrac{\left[h - m^* C^* \dfrac{1}{1-\boldsymbol{q}}\right](1-\boldsymbol{q})}{m^* C^*}} = \frac{m^* C^*}{h(1-\boldsymbol{q})} = \frac{1}{1+\left\{\dfrac{P_m}{P_s^*}\right\}^{-\tilde{r}}}\ . \tag{A12}$$

References

Asea, P.K., and E. Mondoza (1994), "The Balassa-Samuelson Model: A General Equilibrium Appraisal," *Review of International Economics*, 2, October, 244-67.

Balassa, B. (1964), "A Purchasing Power Parity, a Reappraisal," *Journal of Political*

Economy, 72, December, 584-96.

Baumol, W. (1967), "Macroeconomics of Unbalanced Growth: The Anatomy of Urban Crisis," *American Economic Review*, 76(5), 415-426.

Baumol, W., S.A. Blackmand, and E. Wolf (1989), *Productivity and American Leadership, The Long View*, Cambridge, MA, MIT Press.

De Gregorio J., A. Giovannini, and H.C. Wolf (1994), "International Evidence on Tradables and Non-tradables Inflation," *European Economic Review*, 38, June, 1225-44.

Harrod, R.F. (1933), *International Economics*, London: James Nisbet and Cambridge Press.

Obstfeld, M., and K. Rogoff (1996), *Foundations of International Macroeconomics*, Cambridge, Mass. and London: MIT Press.

Samuelson, P.A. (1964), "Theoretical Notes on Trade Problems," *Review of Economics and Statistics*, 46, May, 145-54.

Spilimbergo (1998), "De-industrialization and Trade," *Review of International Economics*, 6(3), August, 450-60.

Summers, R. (1985), "Services in International Economy," in *Managing the Service Economy*, ed. by R. Inman, Cambridge University Press.

Table 1 Association Between Manufacturing GDP Share; The Relative GDP per Capita and Financial Depth, 1970-1995

Variable	Coef.	Std. Err.	t
$\frac{i\ GDP\ per\ Capita}{US\ GDP\ per\ Capita}$	28.31	2.22	12.77
$\left[\frac{i\ GDP\ per\ Capita}{US\ GDP\ per\ Capita}\right]^2$	−22.18	2.13	−10.41
Financial Depth	0.040	0.0076	5.26
Constant	14.15	0.34	41.8
$\bar{R}^2$	0.21		

Notes: Dependent variable is the manufacturing value added as % of GDP. Financial depth is Money and quasi money (M2) as a % of GDP.

$$\frac{i\ GDP\ per\ Capita}{US\ GDP\ per\ Capita} = \frac{\text{Country i GDP at market prices (constant 1987 US\$) per Capita}}{\text{US GDP at market prices (constant 1987 US\$) per Capita}}$$

Sources: Penn World Tables, Version 5.6a; Glen and Sumlinski (1995); Madarassy and Pfeffermann (1992); World Bank World Tables; IMF International Financial Statistics; Inter-American Development Bank; Barro (1991) data. The countries were chosen by date availability - Algeria, Argentina, Australia, Austria, Bangladesh, Belize, Bolivia, Brazil, Canada, Chile, China, Colombia, Costa, Rica, Cote, d' Ivoire, Cyprus, Denmark, Dominican, Republic, Ecuador, Egypt,, Arab, Rep., El, Salvador, Fiji, Finland, France, Germany, Ghana, Greece, Guatemala, Guyana, Haiti, Honduras, Hungary, Iceland, India, Indonesia, Iran,, Islamic, Rep., Ireland, Israel, Italy, Japan, Jordan, Kenya, Korea,, Dem., Rep., Korea,, Rep., Madagascar, Malawi, Malaysia, Mali, Malta, Mauritius, Mexico, Morocco, Nepal, Netherlands, New, Zealand, Nicaragua, Nigeria, Norway, Pakistan, Panama, Papua, New, Guinea, Paraguay, Peru, Philippines, Portugal, Seychelles, Singapore, South, Africa, Spain, Sri, Lanka, Sweden, Switzerland, Tanzania, Thailand, Tunisia, Turkey, United, Kingdom, United, States, Uruguay, Venezuela, Zimbabwe.

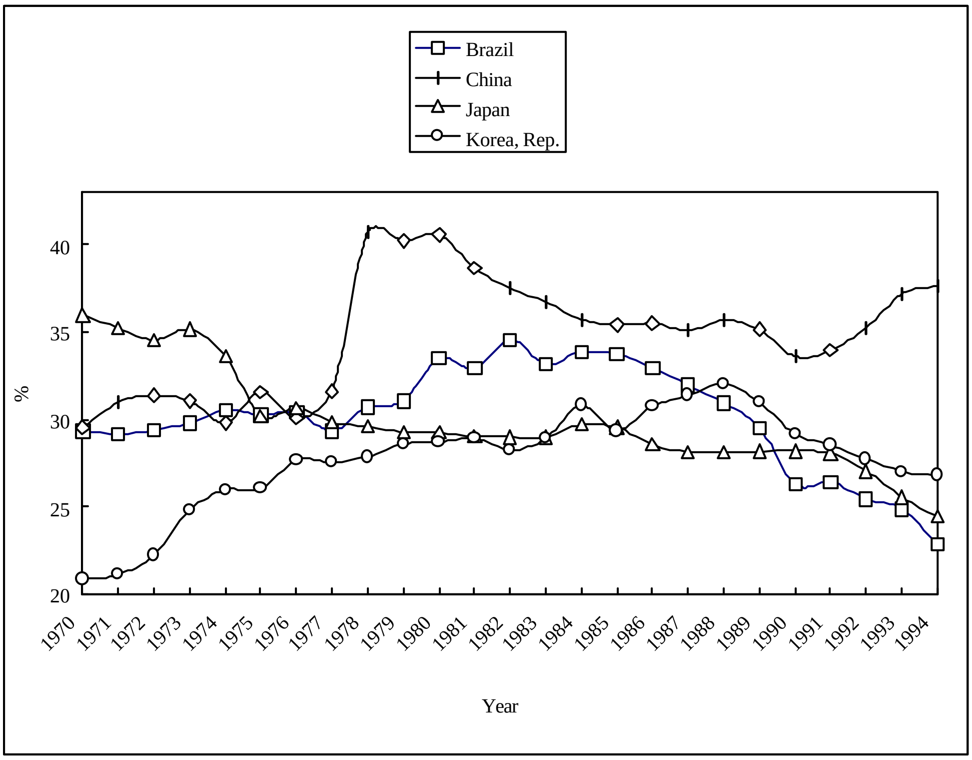

Figure 1 Manufacturing/GDP Share for Brazil, China, Japan and Korea, 1970-94

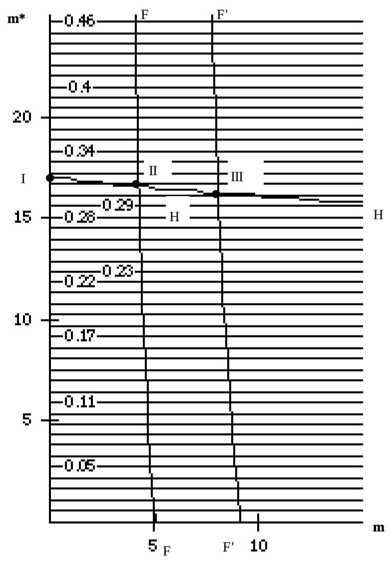

Figure 2

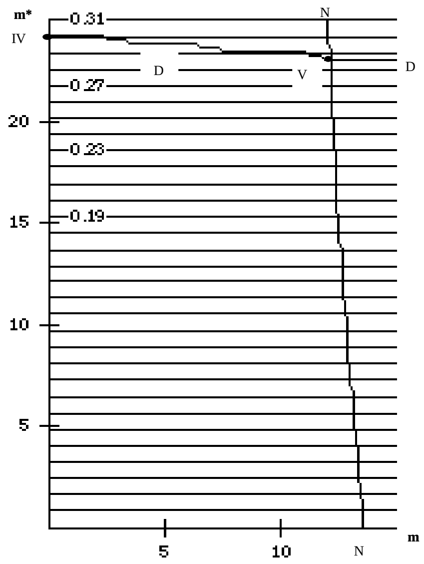

Figure 3

De-industrialization and Emerging Markets

The Figures were drawn for $q = 0.33$, $C = 1/80$; $r = -0.1$; $a = 1/10$; $L = 1$; $L^{*} = 0.5$.