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Growth, Trade, and Deindustrialization

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This paper shows that deindustrialization is explained primarily by developments that are internal to the advanced economies. These include the combined effects on manufacturing employment of a relatively faster growth of productivity in manufacturing, the associated relative price changes, and shifts in the structure of demand between manufactures and services. North-south trade explains less than one-fifth of deindustrialization in the advanced economies. Moreover, the contribution of north-south trade to deindustrialization has been mainly through its effects in stimulating labor productivity in northern manufacturing; it has had little enduring effect on the total volume of manufacturing output in the advanced economies. (JEL O1, O3, F1, F43)

The share of manufacturing employment has declined continuously for more than two decades in most advanced economies—a phenomenon that is referred to as deindustrialization. For instance, in the group of countries that are classified as "industrial countries" in the IMF's *World Economic Outlook*, the share of manufacturing employment declined from about 28 percent in 1970 to about 18 percent in 1994. The main issues of debate regarding deindustrialization are whether the secular decline in the share of manufacturing employment ought to be viewed with concern, and the extent to which this decline is caused by factors that are internal to the advanced economies, as opposed to external factors in the form of expanding economic linkages with the developing countries.

The early contributions in this area by Baumol (1967) and Fuchs (1968), which were later extended more systematically by Rowthorn and Wells (1987) and Baumol, Blackman, and Wolff (1989), argued that deindustrialization in advanced economies

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is not necessarily an undesirable phenomenon, but is essentially the natural consequence of the industrial dynamism exhibited by these economies. As the bulk of the workforce in advanced economies is employed in either manufacturing or services, the evolution of employment shares depends mainly on output and productivity trends in these two sectors. In most advanced economies, labor productivity has typically grown much faster in manufacturing than it has in services, while output growth has been about the same in each sector.[1] Thus, given the similarity of output trends in the two sectors, lagging productivity in the service sector results in this sector absorbing a rising share of total employment, while rapid productivity growth in manufacturing leads to a shrinking employment share for this sector.

This emphasis on differential productivity growth as the main cause of deindustrialization contrasts with Colin Clark's (1957) influential hypothesis that the evolution of employment structure during economic development is explained by a well-defined sequence of changes in the composition of demand. Clark's hypothesis essentially consisted of an extrapolation of Engel's law to the case of manufactures. He argued that—just as, in a poor country, the share of income spent on food declines as per capita income rises, while a growing share is spent on other items such as manufactured goods—as the country develops further, demand shifts increasingly toward services and the share of expenditure devoted to manufactures stabilizes and then ultimately falls. As a result, the employment share of manufacturing should also stabilize and eventually fall. Thus, according to Clark, deindustrialization in advanced economies would be a natural consequence of the shift in demand away from manufactures toward services.

More recent studies seeking to explain the declining share of manufacturing employment, such as for instance those by Sachs and Schatz (1994), Wood (1994 and 1995), and Saeger (1996), broadly concur with the importance assigned to "internal" factors in accounting for deindustrialization. They recognize, however, that "external" factors such as the growth of north-south trade may also have played a significant role in accelerating the decline of manufacturing employment. The role of external factors has been most vigorously stressed by Wood. He argues that manufactured imports from the developing countries are highly labor intensive, and displace many times more workers in the advanced economies than their dollar value would suggest. Thus, even a balanced increase in north-south trade will, under these conditions, reduce manufacturing employment in the north because the number of low-skill jobs lost in the import-competing industries will greatly exceed the new jobs created in the skill-intensive export sector.

The main aim of this paper is to assess the relative importance of the forces described by the various hypotheses that have been put forward to explain deindustrialization. The analytical framework used is an extension of the framework provided in Rowthorn and Ramaswamy (1997). The main findings of the current paper are that deindustrialization has been caused primarily by factors that are internal to the advanced economies—i.e., by the combined effects of the interactions among shifts in the pattern of demand between manufactures and services, the faster growth of productivity in

[1]For instance, between 1960 and 1994 output grew at roughly similar rates in manufacturing and services—annual growth rates of 3.6 and 3.8 percent respectively; in contrast, productivity in manufacturing during this period grew at an annual rate of 3.6 percent, while productivity in services grew at only 1.6 percent.

manufacturing as compared to services, and the associated fall in the relative price of manufactures. The regression analysis further indicates that north-south trade has, on average, contributed less than one-fifth to the relative decline of manufacturing employment in the advanced economies. Moreover, the results show that competition from low-wage producers has had little effect on the overall volume of manufacturing output in the advanced economies. The contribution of north-south trade to deindustrialization is shown to have been mainly through its effect in stimulating labor productivity in the manufacturing sector of the advanced economies—firms in the north appear to have responded to the competition from cheaper imports both by utilizing their labor more efficiently and by shifting production increasingly toward higher valued items.

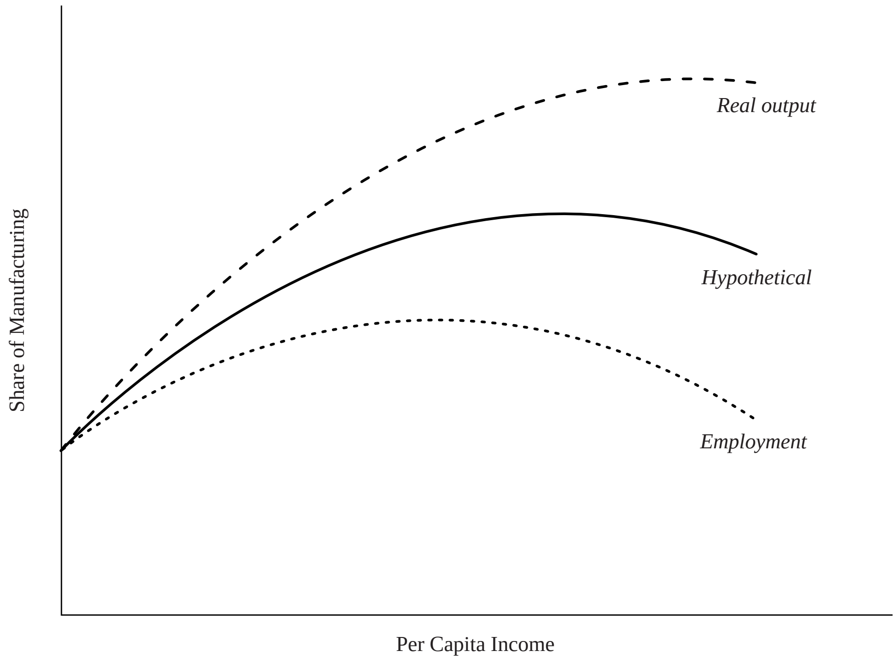
I. Deindustrialization: Some Conceptual Issues

Clark's account of structural change is notable for the weight it assigns to income elasticities of demand in explaining what happens to the output of manufacturing in the course of development. The income elasticity of demand for manufactures is high in poor countries, but low in rich countries, and this explains why the share of manufacturing in output and employment rises at first and falls later on. While there is some empirical basis for this hypothesis (see below), a purely demand-based explanation of deindustrialization is incomplete because it neglects the influence of productivity and prices on the structure of demand, and hence on output and employment. As noted above, labor productivity grows faster in manufacturing than it does in the economy as a whole, and hence the relative price of manufactured goods declines as the economy develops. This in turn encourages the substitution of manufactured goods for other items, especially those services whose relative cost is rising because of the relatively slower growth of productivity in those activities. In the earlier stages of development, the effect of such substitution is to boost the already rapid growth in demand for manufactures, while later on the substitution effect helps to stimulate an otherwise flagging demand for manufactured goods.

From a theoretical point of view, the effect of productivity growth on manufacturing employment is ambiguous. As noted above, on the one hand, the faster growth of productivity in this sector makes manufactured goods relatively cheap, thereby stimulating demand for them. On the other hand, less labor is required to manufacture any given volume of output. How these two influences net out in their effect on manufacturing employment is an empirical question that cannot be settled theoretically. As we shall see below, the evidence suggests that the labor-saving impact of faster productivity growth in the manufacturing sector outweighs the demand-creating effect of lower prices, so the net effect is to reduce the share of employment in this sector.

Figure 1 provides a schematic illustration of what happens to the manufacturing sector as per capita incomes rise. For convenience, units are chosen so that the shares of manufacturing in real output and in employment are initially the same. The curve labeled "hypothetical" shows how these shares would evolve if productivity growth were uniform across sectors and if relative prices were to remain unchanged through time. Under these conditions, the shares of manufacturing in real output and employment would remain equal, and their evolution would be determined solely by the income elasticity of demand for manufactures. The hypothetical curve is at first

Figure 1. Evolution of the Manufacturing Share



upward sloping because the income elasticity of demand for manufactures is greater than unity in the initial stages of economic development, and it later slopes downward when this elasticity falls below unity in the more advanced stages of economic development. In practice, neither output nor employment shares follows this hypothetical curve. Faster than average productivity growth in the manufacturing sector causes the relative price of manufactured goods to fall, thereby stimulating demand, raising their share in real output, and causing this share to follow a path indicated by the upper curve in the diagram. It also causes the amount of labor required per unit of manufacturing output to fall rapidly, so that the share of manufacturing in employment follows a much lower trajectory, which normally lies well below the hypothetical curve.

The above exposition assumes that the income elasticity of demand for manufactures is less than unity in advanced economies. How does one reconcile this with the findings of studies such as those of Summers (1985) and Falvey and Gemmel (1996) that services as a whole have an income elasticity of demand close to unity? The answer is as follows. In advanced economies, the share of manufactures in output and expenditure is small (and conversely, the share of services is large). Under these conditions, with an income elasticity of demand for services only marginally greater than unity, the income elasticity of demand for manufactures may be well below unity. For example, with an income elasticity of demand for services equal to 1.1, the income elasticity of demand for manufactures in the typical advanced economy will be around 0.7. This issue is explored in more detail in the appendix.

Regarding external factors, foreign trade can affect the internal structure of an economy in various ways. One involves international specialization between manufactures, and other goods and services. A country can become a “workshop” economy, generating a large trade surplus in manufactures that is used to help finance a substantial deficit in nonmanufactured items, such as food, fuels, or services. This is the situation in Germany or Japan, and was also true at one time of the United Kingdom. Alternatively, like Australia, Canada, or the United Kingdom today, a country may have a trade deficit in manufactures that is financed partly through the export of nonmanufactured items such as food, minerals, or services. Such trade patterns have obvious implications for the relative size of the manufacturing sector. Other things being equal, a more positive trade balance in manufactured goods implies a larger share of domestic manufacturing in output and employment.

A second avenue through which trade may affect the structure of employment in advanced economies is international specialization within manufacturing production. In recent decades, there has been an evolution in the division of labor whereby advanced economies of the north export skill-intensive manufactured goods in return for labor-intensive manufactures, such as clothing or toys, from developing countries in the south. To manufacture the former goods requires the employment of a modest number of skilled workers, whereas to produce the same value of labor-intensive goods would require the employment of a much greater number of unskilled workers. The effect of such trade should therefore be to reduce manufacturing employment in the north and to alter the skill composition of the manufacturing workforce. Low-wage imports may also reduce employment in the manufacturing sector of advanced economies by increasing competition and forcing firms to utilize their labor more efficiently. Note that aggregate statistics for the manufacturing sector make no distinction between a shift into higher value-added products and greater efficiency in the creation of existing products, and both will show up as an increase in labor productivity.

The above discussion describes the evolution of the manufacturing sector under the impact of rising incomes, differential productivity growth, relative price changes, and foreign trade. Superimposed on this evolution is the influence of other factors such as the share of fixed investment in total spending. Investment expenditure is skewed toward manufactured goods, such as machinery and building materials, so that a higher rate of investment will increase the share of manufactured goods in total demand, and thereby raise the share of manufacturing in real output and employment.

II. Econometric Estimations

To examine the above relationships empirically, we use annual data from a panel of 18 industrial countries over the period 1963–94, for which a total of 510 observations are available.[2] This sample was derived by dropping Ireland, Portugal, and Switzerland

[2]These countries are Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Italy, Japan, the Netherlands, New Zealand, Norway, Spain, Sweden, the United Kingdom, and the United States.

from the slightly larger sample of countries used in our previous study—Rowthorn and Ramaswamy (1997). Their exclusion was necessitated by the absence of sectoral data on prices, output, and productivity for these countries. The present sample also differs from the one used in our earlier study because the data now include observations for every year.[3]

The equations we estimate are of the following type:[4]

Productivity:

$$\log RELPROD = \alpha_0 + \alpha_1 \log Y + \textstyle\sum_{i>1} \alpha_i Z_i, \quad (1)$$

where *RELPROD* is relative labor productivity in manufacturing as compared to labor productivity in the economy as a whole, *Y* is per capita income, and the *Z*s are additional variables reflecting the influence of foreign trade and other factors.

Prices:

$$\log RELPRICE = \beta_0 + \beta_1 \log (RELPROD) + \textstyle\sum_{i>1} \beta_i Z_i, \quad (2)$$

where *RELPRICE* is the relative price of manufacturing goods as compared to the price of national output as a whole.

Output:

$$\log OUTSHARE = \gamma_0 + \gamma_1 \log Y + \gamma_2 (\log Y)^2 + \gamma_3 \log RELPRICE + \textstyle\sum_{i>3} \gamma_i Z_i, \quad (3)$$

where *OUTSHARE* is manufacturing value added as a share of real GDP.

With appropriate units of measurement, the following equation holds identically:

$$\log EMPSHARE = \log OUTSHARE - \log RELPROD, \quad (4)$$

where *EMPSHARE* is the share of manufacturing in total employment.

Eliminating the relative price variable from equation (3) and using the above identity, we obtain equations of the following type:

$$\log OUTSHARE = \delta_0 + \delta_1 \log Y + \delta_2 (\log Y)^2 + \textstyle\sum_{i>2} \delta_i Z_i; \quad (5)$$

$$\log EMPSHARE = \varepsilon_0 + \varepsilon_1 \log Y + \varepsilon_2 (\log Y)^2 + \textstyle\sum_{i>2} \varepsilon_i Z_i. \quad (6)$$

[3]Data on fixed capital formation, per capita income, output and prices are taken from the *OECD National Accounts*, supplemented as required by *OECD Historical Statistics*. Per capita income is converted to 1986 U.S. dollars by means of purchasing power parities in the IMF World Economic Outlook database. Employment series were taken from a variety of OECD sources, including *Historical Statistics*, *Labor Statistics*, and the *Intra-sectoral Data Base*. Trade statistics are drawn from the UNCTAD database, and our use of the term “developing country” accords with current United Nations practice. Thus, Singapore and Hong Kong SAR are classified as developing countries even though their per capita incomes are now among the world’s highest and despite the fact that they have been classified as advanced economies in the *World Economic Outlook* since May 1997. The term “manufactures” covers SITC sections 5 to 8 excluding division 68 (nonferrous metals).

[4]The appendix contains a simple model that motivates these equations.

The preceding discussion implies that coefficients have the following signs:

$$\alpha_1,\ \gamma_1,\ \delta_1,\ \varepsilon_1 > 0;\ \beta_1,\ \gamma_2,\ \gamma_3,\ \delta_2,\ \varepsilon_2 < 0. \tag{7}$$

As we shall see, the estimated coefficients satisfy these inequalities.

Most of the estimated equations include other variables in addition to those explicitly identified above. Dummy variables are used for individual countries to correct for international differences in measurement practices and other unexplained "fixed" effects. In some cases a time trend or time dummies are also included. To examine the influence of international trade on economic structure, we use two main variables, *TRADEBAL* and *LDCIMP*. The former is the overall trade balance in manufactured goods (total exports *minus* total imports); the latter is equal to manufactured imports from developing countries. Both are expressed as a percentage of GDP measured in U.S. dollars at purchasing power parity.[5]

The role of *TRADEBAL* is to capture the effect of overall manufacturing trade performance on the structure of employment. The variable *LDCIMP* is designed to capture the effects of competition from low-wage countries on labor productivity in northern economies. These effects include increased efficiency in activities that compete directly with low-wage producers, together with shifts in the composition of northern manufacturing toward higher value-added, skill-intensive, or capital-intensive activities. Such effects may occur even when trade is balanced between the north and the south, and are in addition to those north-south effects captured by the variable *TRADEBAL*.

Finally, there is the variable *FIXCAP*, which is gross domestic fixed capital formation expressed as a percent of GDP at constant prices. As noted earlier, the rationale for using this variable is that capital investment is manufacturing intensive, and a change in the rate of investment will therefore have a greater impact on the demand for manufactured goods than on the demand for the output of other sectors.

Regression Results: Productivity and Prices

Table 1 reports the results of pooled regressions in which the dependent variables are $\log Y$ and $\log RELPROD$. Both these variables have a strong upward trend, which accounts for the finding in regression equation (3) that rising per capita income is associated with increasing relative labor productivity in manufacturing. The variable *LDCIMP* is included to quantify the impact of low-wage imports on manufacturing productivity. In equation (4), the coefficient of this variable is quite large and highly significant. It implies that an increase of 1 percentage point in the ratio of low-wage imports to GDP will cause manufacturing productivity to rise by 8.5 percent as compared to productivity in the economy as a whole. To examine the robustness of this finding, we experimented with two other equations: (4AR), which corrects for first-order autocorrelation, and (5), which includes a time trend. In each case, the coefficient of *LDCIMP* turns out to be smaller than in the original formulation, but is still statistically significant.

[5]The conventional method is to normalize trade by dividing imports and exports by GDP converted to U.S. dollars at current exchange rates. This method is subject to major distortions caused by large exchange rate fluctuations, which may give the impression that large volume changes have occurred in imports and exports when this is not the case. The use of purchasing power parity (PPP) exchange rates helps to avoid this problem.

Table 1. Pooled Estimates of Relative Productivity and Prices, 1963–94

	Equation Number (in parentheses) and Dependent Variable					
	(1) log *Y*	(2) log *RELPROD*	(3) log *RELPROD*	(4) log *RELPROD*	(4AR) log *RELPROD*	(5) log *RELPROD*
Explanatory variables						
log *Y*	. . .	. . .	0.41**	0.30**	0.40**	–0.07
			(22.40)	(12.60)	(7.84)	(1.34)
YEARS	0.024**	0.012**	. . .	. . .	. . .	0.012**
	(60.37)	(27.26)				(8.41)
LDCIMP	. . .	. . .	. . .	0.085**	0.029**	0.028**
				(7.12)	(3.57)	(2.15)
Country dummies exist?	yes	yes	yes	yes	yes	yes
R^2	0.93	0.75	0.87	0.88	.022	0.77

Notes: The constant term is not reported. Absolute *t*-values are in parentheses. Two asterisks and one asterisk denote statistical significance at the 1 percent and the 5 percent level, respectively. The data sample consists of 18 OECD countries, for which a total of 510 observations are available. Equation (4AR) assumes an AR(1) error process. The prefix “log” denotes the natural logarithm. *Y* = per capita income in 1986 U.S. dollars at purchasing power parity. *RELPROD* = real value added per worker in manufacturing ÷ real value added per worker in the whole economy (index 1990 = 100). *LDCIMP* = imports of manufactures from developing countries (U.N. definition) as a percent of GDP at purchasing power parity. *YEARS* = years elapsed since 1963. There is a separate time dummy for each year except 1994 and a separate country dummy for each country except the United States.

Table 2. Pooled Estimates of Relative Prices, 1963–94

(Dependent variable = log RELPRICE)

	Equation Number	
	(6)	(7)
Explanatory variables		
Log *RELPROD*	–0.88**	–0.89**
	(36.91)	(28.97)
LDCIMP	. . .	–0.008
	. . .	(0.85)
Country dummies exist?	yes	yes
R^2	0.80	0.80

Notes: *RELPRICE* = implicit price of manufactures ÷ implicit price of GDP (index 1990 = 100). See also the notes to Table 1.

The determinants of relative prices are examined in Table 2. The coefficient of log *RELPROD* is large, negative, and highly significant, which is consistent with the notion that movements in labor productivity are the major factor influencing the behavior of relative prices. The coefficient of *LDCIMP* is close to zero and statistically insignificant, suggesting that competition from low-wage imports has had little enduring effect on domestic producer prices once we control for productivity. It may be that competition from such imports does affect producer prices by squeezing profit margins, but this effect must either be small or short lived, and manufacturers are probably able to restore their profit margins by becoming more efficient or shifting into higher value-added products.

Output

Table 3 analyzes how the share of manufacturing in real output is determined; three different equations are presented. Equation (8) is based on the standard OLS approach applied to the pooled sample containing all 510 observations. The residuals of this equation exhibit strong autocorrelation, which is largely eliminated in equation (8AR) by assuming an AR(1) error process. Equation (8AVG) is derived by grouping the original data by taking three-year averages centered on the years 1964, 1968, 1972, and so on. While this method sacrifices information, it has the advantage of largely eliminating autocorrelation without having to make explicit assumptions about the nature of the error process.[6]

[6]We experimented using country-specific autocorrelation coefficients, but these gave much the same results as in equation (9AR). We also experimented with lagged endogenous variables in the regression analysis, but the coefficients turned out to be very small and statistically insignificant. The *t*-values shown in Table 3 as well as the other tables are based on the conventional OLS estimates of significance, and are very similar to those obtained using White's correction for heteroscedasticity.

Table 3. Pooled Estimates of the Share of Manufacturing in Real Output, 1963–94

(Dependent variable = log OUTSHARE)

	Equation Number		
	(8)	(8AR)	(8AVG)
Explanatory variables			
Log *Y*	6.32**	5.01**	6.55**
	(13.63)	(3.95)	(7.02)
(Log *Y*)^2	–0.350**	–0.269**	–0.363**
	(13.82)	(4.00)	(7.09)
Log *RELPRICE*	–0.589**	–0.265**	–0.611**
	(18.37)	(6.14)	(9.82)
TRADEBAL	0.019**	0.004	0.020**
	(12.96)	(3.50)	(6.39)
LDCIMP	0.000	–0.009	–0.003
	(0.01)	(1.16)	(0.14)
FIXCAP	0.016**	0.007**	0.018**
	(11.71)	(5.89)	(6.16)
Country dummies exist?	yes	yes	yes
R^2	0.84	0.36	0.84
Turning point	$8,390	$10,983	$8,276

Notes: *OUTSHARE* = manufacturing value added as a percent of GDP at 1990 prices. Equation (8AR) assumes an AR(1) error process; equation (8AVG) is based on three-year averages centered on the years 1964, 1968, 1972, 1976, 1980, 1984, 1988, and 1992. *FIXCAP* = gross domestic fixed capital formation as a percent of GDP at 1990 prices. The turning point is the value of *Y* at which the dependent variable starts to fall with increasing *Y*. See also notes for Tables 1 and 2.

The key points to note in Table 3 are as follows. There is strong evidence of a hump-shaped relationship between log *OUTSHARE* and log *Y*. This implies that the income elasticity of demand for manufactures is well above unity when a country is poor, and falls below unity when a country becomes rich. This outcome is found no matter what method of estimation is used. Table 3 also shows the “turning point,” which is the level of per capita income at which the income elasticity of demand for manufactures is equal to unity. An interesting feature of these estimations is the coefficient on relative prices. In equations (8) and (8AVG), this coefficient is highly significant and is about 0.6, suggesting that the price elasticity of substitution between manufactures and nonmanufactures is in the region of 0.6.[7] In the case of equation (8AR), the price coefficient is less

[7]The coefficient of the regression equation indicates, strictly speaking, how the real expenditure share on manufacturing is affected by changes in relative prices. The appendix demonstrates that this coefficient is approximately equal to the elasticity of substitution between manufactures and nonmanufactures.

Table 4. Pooled Estimates of the Share of Manufacturing in Employment, 1963–94

(Dependent variable = log EMPSHARE)

	Equation Number			
	(9)	(9AR)	(9AVG)	(10)
Explanatory variables				
Log *Y*	11.78**	12.02**	11.65**	9.72**
	(22.14)	(8.70)	(10.92)	(18.31)
(Log *Y*)^2	–0.649**	–0.667**	–0.643**	–0.510**
	(22.39)	(8.97)	(11.01)	(17.05)
TRADEBAL	0.012**	0.000	0.015**	0.012**
	(7.11)	(0.14)	(4.16)	(5.88)
LDCIMP	–0.041**	–0.035**	–0.041	–0.041**
	(3.79)	(4.36)	(1.57)	(3.54)
FIXCAP	0.013**	0.008**	0.014**	0.002**
	(8.68)	(6.65)	(4.26)	(0.21)
Country dummies exist?	yes	yes	yes	yes
Time dummies exist?	no	no	no	yes
R^2	0.90	0.70	0.91	0.93
Turning point	$8,790	$9,421	$8,673	$13,846

Notes: *EMPSHARE* = employment in manufacturing as a percent of total employment. For other notes see Tables 1 and 2.

than half this value, but remains highly significant. Thus, while there is strong evidence that, as economies develop, the demand for manufactures is stimulated by their falling relative price, there is some uncertainty about the magnitude of this effect.

As expected, the real output share of manufactures is boosted by a positive manufacturing trade balance and by a high level of fixed capital formation, but the estimated size of these effects is lower when the *AR* version of the equation is used. In all output equations, the coefficient of *LDCIMP* is very small and insignificant, which is to be expected since this variable captures the impact of low-wage imports on productivity rather than output.

Employment

Tables 4 and 5 examine how the share of manufacturing employment is determined. The former table uses pooled data, while the latter uses cross-sectional data. There is strong evidence of a hump-shaped relationship, with the employment share of manufacturing rising in the earlier stages of economic development and falling back at high levels of per capita income. The estimated turning point varies somewhat between

Table 5. Cross-Sectional Estimates of the Share of Manufacturing in Employment

(Dependent variable = log EMPSHARE*)*

	Equation Number (In Parentheses), Year, and Number of Countries							
	(11) 1964 14	(12) 1968 15	(13) 1972 15	(14) 1976 16	(15) 1980 18	(16) 1984 18	(17) 1988 16	(18) 1992 16
Explanatory variables								
log *Y*	15.61**	14.59**	19.51**	22.15*	16.70	18.54	11.60	–1.09
	(5.18)	(3.30)	(2.65)	(2.21)	(1.55)	(1.58)	(1.07)	(0.09)
(Log *Y*)^2	–0.855**	–0.783**	–1.049**	–1.189*	–0.894	–0.990	–0.623	0.031
	(5.03)	(3.21)	(2.64)	(2.21)	(1.55)	(1.59)	(1.09)	(0.05)
TRADEBAL	0.019**	0.020**	0.021**	0.014**	0.014**	0.017**	0.018**	0.022**
	(4.24)	(3.67)	(4.03)	(3.33)	(3.20)	(2.80)	(3.80)	(3.61)
R^2	0.88	0.77	0.69	0.54	0.42	0.39	0.50	0.44
Turning point	$9,208	$11,094	$10,916	$11,108	$11,447	$11,645	$11,053	. . .
(Standard error)	($638)	($1,147)	($788)	($832)	($1,136)	($1,114)	($2,588)	. . .

Notes: Equations are estimated using data averaged over a three-year period centered on the year shown. For other notes, see Tables 1 to 4.

equations, with the cross-sectional equations yielding a somewhat higher turning point than the pooled equations. However, the latter are probably a better guide to the intertemporal process of structural change since they make use of time-series data for individual countries. They suggest a turning point of about $9,000 (1986 purchasing power parity) per capita, which most OECD countries had reached by 1970, and some well before. A number of East Asian economies have also reached or surpassed this point, and the share of manufacturing employment in most of them is now falling; thus the estimated turning point is consistent with the East Asian experience.[8]

As expected, fixed capital formation exerts a positive influence on manufacturing employment, but its impact varies between equations. There is also evidence that the overall trade balance in manufactures has a major impact on manufacturing employment. In equations (9) and (9AVG) the coefficient of *TRADEBAL* is quite large and statistically significant; this is also true of the cross-sectional estimates shown in Table 5. However, in the autoregressive formulation (9AR) the coefficient of *TRADEBAL* is small, which most likely reflects the fact that this variable plays a much greater role in explaining cross-country differences in the structure of employment than it does in explaining intertemporal developments.

The coefficient of the other trade variable, *LDCIMP*, differs somewhat in magnitude and significance between equations. Equations (9), (9AR), and (9AVG) use pooled data, and in all of these equations the coefficient of *LDCIMP* is negative and of similar size, although it is not always statistically significant. Interestingly, when additional dummies are included to allow for "fixed" time effects, the coefficient of *LDCIMP* increases in significance, indicating that this variable is not simply acting as a proxy for unidentified time effects. Note that in the cross-sectional regressions, the coefficients of *LDCIMP* are either small and insignificant or of the wrong sign. This suggests that although imports from the south have influenced the evolution of economic structure through time, they do not account for the large persistent differences in structure between countries. Such contrasts are explained primarily by the pattern of trade surpluses and deficits as reflected in the variable *TRADEBAL*.

III. Accounting for Deindustrialization

In this section we quantify the influence of the various factors responsible for the declining share of manufacturing employment in the industrial countries since 1970. For this purpose we use the regression results shown in Table 4. This table contains a number of equations, all of which yield unbiased estimates, so there is a question as to which is the most appropriate. Equation (9) has autocorrelated residuals, but yields plausible coefficients. Equation (9AR) has the advantage that the residuals are virtually uncorrelated, but the coefficient for *TRADEBAL* is implausibly low, whereas equation (9AVG) also has uncorrelated residuals but ignores much of the available information. We have chosen the estimates in equation (9) as the basis for the decompositions, but the results would have been virtually the same whichever equation was used.

[8]See Rowthorn and Ramaswamy (1997) for a more detailed discussion of the East Asian experience regarding deindustrialization.

Table 6 decomposes the changes in manufacturing employment into various components using the regression coefficients shown in equation (9). The headings in the table are self-explanatory with the exception of the component labeled "normal growth." This component covers all of the effects that would normally be associated with rising per capita income in a closed economy, and thus takes into account both the income elasticity of demand and the influence of normal productivity and price changes. It is estimated from the coefficients of log Y and (log Y)^2 in equation (9). Note that this component excludes the effect of abnormal price and productivity changes, in particular the abnormal productivity growth induced by competition from low-wage imports. The latter is included under the heading "north-south trade."

The main conclusion from our decomposition is that the bulk of deindustrialization since 1970 is due to internal factors. In most countries in our sample, between one-half and two-thirds of the relative decline of manufacturing employment is explained by the normal process of economic growth—via changing preference patterns, differential productivity growth, and associated price changes. In addition, there has been a substantial fall in the ratio of investment to GDP, which has helped to skew demand away from manufactured goods. Our calculations suggest that this has had quite a large impact on manufacturing employment in some countries, and on average accounts for about one-sixth of deindustrialization. For the average country in the sample, this is similar to the effect of north-south trade. Note that these findings do not depend on the specific equation used for our decomposition; similar results are obtained with equation (9AR) or (9AVG).

For most countries in the sample, our decomposition explains with reasonable accuracy what has happened to manufacturing employment since 1970. There is, however, a striking exception. As can be seen from Table 6, the residual for Japan is both large and positive, indicating that Japanese manufacturing employment has declined by much less than predicted. To understand what might be responsible for this anomaly, we examined the behavior of output, productivity, and prices over the period. The data indicate that the share of manufacturing in real output in Japan has risen substantially since 1970, whereas in most other countries this share has fallen. The unusual experience of Japan may be explained by the behavior of relative prices. Since 1970, profit margins have declined sharply in Japanese manufacturing industry, causing the relative price of manufactured goods to fall by far more than is predicted by productivity growth and by far more than in other industrial countries. This has stimulated the demand for manufactured goods in Japan, and helps to explain why the constant price share of manufactured goods in national production has risen since 1970, and hence why the share of manufacturing employment has fallen so little.

North-South Trade

We can also estimate the impact of north-south trade on the structure of employment in advanced economies. Suppose that manufactured exports to the south increase by 1 percent of GDP. According to equation (9), this will cause the number of people employed in manufacturing to rise by 1.2 percent. Conversely, if manufactured imports from the south increase by 1 percent of GDP, the result will be a 5.3 percent fall in the number of

Table 6. Explaining Deindustrialization, 1970–94

	Change in Share or Manufacturing Employment	Change Due to:						
		Normal growth	Investment	Total internal	North-south trade	Other trade	Total trade	Residual
Industrial countries	–8.7	–6.9	–1.5	–8.4	–1.6	0.1	–1.5	1.2
United States	–10.4	–7.8	–0.6	–8.4	–2.0	–0.5	–2.5	0.6
European Union	–9.5	–6.0	–2.0	–8.0	–1.6	0.2	–1.4	–0.1
Japan	–3.3	–8.0	–1.9	–10.0	–0.9	1.3	0.4	6.2

Notes: This table decomposes changes in the employment share of manufacturing. The estimates shown here are based on regression equation (9) in Table 4. The column showing the residuals includes the interaction effects due to the nonlinear (logarithmic) form of the estimated equation. "Normal growth" refers to the income effect estimated from the income coefficient in equation (9); it includes the effect of those productivity and price changes that are normally associated with rising incomes. It excludes the effect of abnormal price and productivity changes, in particular the effects of abnormal productivity growth arising from competition with low-wage countries. The latter is included under the heading "north-south trade."

manufacturing workers.[9] Thus, one dollar's worth of imports from the south destroys 4.4 times as many northern manufacturing jobs as are created by one dollar's worth of exports to the south. These figures indicate the origin of the "balanced trade effect," whereby imports from the south reduce manufacturing employment in the north even when they are matched by an equal value of northern exports.

Among the richer countries in our sample, gross imports from the south have eliminated manufacturing jobs equivalent in number to 1.5–4 percent of total employment. For the United States, the figure is 2.2 percent of total employment, and for the average country in our sample it is 1.9 percent. The corresponding estimates for the new manufacturing jobs created by exports to the south are 0.3 percent for the United States and 0.3 percent for the average country. Given that total employment in the countries of our sample is about 350 million, this suggests that about 7 million manufacturing jobs have been lost because of southern competition and about 1 million created by additional exports to the south. The net loss of 6 million jobs is less than one-fifth of manufacturing jobs lost because of deindustrialization since 1970, but the impact on unskilled workers and those with nontransferable skills is greater than this figure suggests. Thus, although deindustrialization is not primarily due to north-south trade, such trade is likely to have had a sizable impact on the demand for certain types of labor.

There are two main channels through which competition from low-wage producers can affect employment in northern manufacturing. The first is via its impact on total manufacturing output in the north; the second is through its impact on labor productivity. Our estimates suggest competition from low-wage producers has had little effect on the overall volume of manufacturing output in northern countries. In no country has there been a substantial change in the overall balance of manufacturing trade with the south, and the output regressions reported in Table 3 reveal little connection between aggregate manufacturing output and the volume of manufactured imports from the south. However, as we have seen in Table 1, there is evidence that low-wage competition has contributed to higher labor productivity in northern manufacturing. That is, in the face of low-wage competition, northern countries have responded, not by abandoning manufacturing as Brown and Julius (1994) have claimed, but by increasing labor productivity within the manufacturing sector. This has involved either increasing efficiency to produce more of the same kind of output per unit of labor, or switching to other types of manufactured goods where value-added per worker is higher.[10]

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[9]Note that these effects are expressed as a percentage of manufacturing employment (not of total employment). They are derived as follows. An increase of 1 percentage point in the ratio of northern manufactured exports to GDP implies a change of +1 unit in the variable *TRADEBAL*. According to equation (9), this will cause log *EMPSHARE* to change by +0.012, which is equivalent to a 1.2 percent increase in the number of manufacturing jobs. Conversely, suppose that the ratio of manufacturing imports from the south to GDP increases by 1 percentage point. This will cause the variables *TRADEBAL* and *LDCIMP* to alter by –1 and +1 unit, respectively. From equation (9), it follows that log *EMPSHARE* will change by (+0.012)*(–1) + (–0.041)*(+1) = –0.053, which implies a 5.3 percent fall in the number of manufacturing jobs. Note that, in the average OECD country, 5 percent of manufacturing jobs represent about 1 percent of total employment.

[10]This is a theme that has been stressed by Krugman in his popular writings. See Krugman (1996).

IV. Conclusion

The main conclusion of this paper is that deindustrialization is explained mainly by factors that are internal to the advanced economies—i.e., as a result of the interactions among changing preference patterns between manufactures and services, the faster growth of productivity in manufacturing as compared to services, and the associated relative decline in the price of manufactures. North-south trade has, on average, contributed less than 20 percent to the relative decline in manufacturing employment in the advanced economies. Moreover, the impact of north-south trade on deindustrialization has been mainly through its effect in stimulating labor productivity in the manufacturing sector of the advanced economies; it has had little effect on manufacturing output in the advanced economies. The decline in the ratio of investment to GDP in the advanced economies has also skewed demand away from manufacturing output. The decline in the investment ratio has caused almost one-sixth of total deindustrialization—which is roughly similar to the effect of north-south trade on deindustrialization.

APPENDIX

This appendix describes a simple model that motivates the regression equations used in the text. It also derives certain mathematical relationships between price elasticities and between income elasticities.

The Model

The model refers to a closed economy that is divided into three sectors: manufacturing, services, and agriculture. Measured at base-year prices, the output of these sectors is Y_m, Y_s, and Y_a, respectively, and total output is given by

$$Y = Y_a + Y_s + Y_m. \tag{A1}$$

We shall refer to Y as "real" output. The following equation is satisfied identically:

$$Y = C + I + B, \tag{A2}$$

where C, I, and B are consumption, investment, and the overall foreign trade balance (total exports minus total imports). All are measured at base-year prices.

The corresponding identity for manufacturing output is

$$Y_m = C_m + I_m + B_m. \tag{A3}$$

It follows that

$$\begin{aligned}\frac{Y_m}{Y} &= \frac{C_m}{C}\frac{C}{Y} + \frac{I_m}{Y} + \frac{B_m}{Y}\\ &= \frac{C_m}{C}\left(1 - \frac{B}{Y}\right) + \left(\frac{I_m}{I} - \frac{C_m}{C}\right)\frac{I}{Y} + \frac{B_m}{Y}.\end{aligned} \tag{A4}$$

This equation indicates that an increase in I/Y will raise the share of manufacturing if investment is more manufacturing intensive than consumption (i.e., $I_m/I > C_m/C$).

Assuming that total exports and imports are equal, which is approximately true for the countries in our sample, the above equation can be written as follows:

$$\frac{Y_m}{Y} = \frac{C_m}{C} + \left(\frac{I_m}{I} - \frac{C_m}{C}\right)\frac{I}{Y} + \frac{B_m}{Y}. \qquad \text{(A5)}$$

Measured at base-year prices, per capita income is given by

$$y = \frac{Y}{N}, \qquad \text{(A6)}$$

where N is population. Real consumption can be decomposed as follows:

$$C = C_a + C_s + C_m. \qquad \text{(A7)}$$

The share of each sector in total consumption is a function of per capita income and relative prices. Thus,

$$\frac{C_i}{C} = f_i\left(y,\ P_a/P_m,\ P_s/P_m\right) \qquad i = a,\ s,\ m, \qquad \text{(A8)}$$

where $f_m(.) = 1 - f_a(.) - f_s(.)$.

We assume that the income elasticity of demand for services is greater than one at all stages of development, while that of agricultural goods is less than one. Thus, if prices are held constant, the share of services in real consumption increases with per capita income, while that of agriculture falls. The decline in agriculture is especially rapid during the early stages of development. Figure A1 illustrates what these assumptions imply for the manufacturing sector. As the economy grows, both manufacturing and services initially increase their shares of real consumption at the expense of agriculture. However, this cannot continue indefinitely. As the share of agriculture shrinks, the scope for further shrinkage diminishes, and continued expansion in the service share must eventually be at the expense of manufacturing. At a certain point, the share of manufacturing in real consumption stabilizes and then begins to fall. Thus, for some y^*,

$$\begin{aligned} \frac{\partial f_m}{\partial y} &> 0 \qquad \text{for } y < y^* \\ &< 0 \qquad \text{for } y > y^*. \end{aligned} \qquad \text{(A9)}$$

We also assume that the share of manufacturing in total investment is a function of relative prices. Thus,

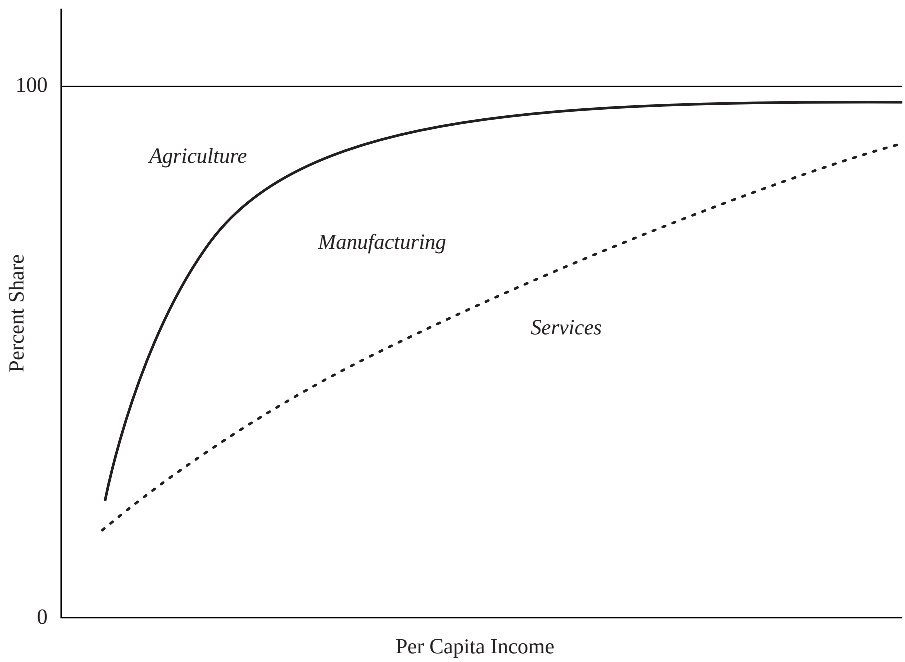
$$\frac{I_m}{I} = g_m\left(P_a/P_m,\ P_s/P_m\right). \qquad \text{(A10)}$$

Substituting in equation (A5) we obtain

$$\frac{Y_m}{Y} = f_m\left(y,\ P_a/P_m,\ P_s/P_m\right) + h_m\left(y,\ P_a/P_m,\ P_s/P_m\right)\frac{I}{Y} + \frac{B_m}{Y}, \qquad \text{(A11)}$$

where $h_m(.) = g_m(.) - f_m(.)$.

Figure A1. Sectoral Composition of Real Output



Productivity

Output per worker is assumed to satisfy the following equations:

$$\frac{Y}{L} = ce^{\theta t}$$

$$\frac{Y_m}{L_m} = c_m e^{\lambda\theta t + \phi M_1/Y} \qquad \lambda > 1, \tag{A12}$$

where c, c_m, θ, Φ, and λ are constants, and M_1 stands manufacturing imports from the south, measured at base-year prices. The exponential terms allow for the effects of both technical progress and capital accumulation. The model does not explicitly allow for capital accumulation since adequate data on these variables were not available for all of the countries in our sample over the whole period. Labor productivity increases faster in manufacturing than elsewhere in the economy, and manufactured imports from the south stimulate manufacturing productivity in the north by eliminating low-productivity activities and encouraging innovation.

Assuming that

$$\frac{L}{N} = constant, \tag{A13}$$

it follows that

$$\log\left(\frac{Y_m/L_m}{Y/L}\right) = constant + (\lambda - 1)\log y + \phi\frac{M_1}{Y}. \tag{A14}$$

Prices

The following mark-up equations are satisfied identically:

$$\Pi_m = \frac{P_m Y_m - W_m L_m}{W_m L_m}$$

$$\Pi = \frac{PY - WL}{WL}, \tag{A15}$$

where W,(W_m) denotes the wage rate per unit of labor and Π,(Π_m), the mark-up of price over average cost.

$$\log\left(\frac{P_m}{P}\right) = \log\left[\frac{W_m\left(1+\Pi_m\right)}{W(1+\Pi)}\right] - \log\left(\frac{Y_m/L_m}{Y/L}\right). \tag{A16}$$

Regression Analysis

The regression analysis reported in the text is based on the above model. Relative productivity is explained using the following version of equation (A14):

$$\log\left(\frac{Y_m/L_m}{Y/L}\right) = \alpha_0 + \alpha_1 \log y + \Sigma_{i>1}\alpha_i Z_i, \tag{1}$$

where the Zs are other dummy variables that might influence the profit margin, and the equation numbers (1, 2, . . .) refer to the equation numbering in the main text of this paper. Relative prices are explained using the following version of equation (A16):

$$\log\left(\frac{P_m}{P}\right) = \beta_0 + \beta_1 \log\left(\frac{Y_m/L_m}{Y/L}\right) + \Sigma_{i>1}\beta_i Z_i. \tag{2}$$

This version is in effect testing how far wage rates and the mark-up in manufacturing differ from the national average.

In equation (A11), the share of manufactures in real output depends on the relative price of manufactures compared to services and agriculture considered separately. In our regression analysis we use a simpler formulation, in which the demand for manufactures depends on the single relative price P_m/P. The specific functional form is as follows:

$$\log\left(\frac{Y_m}{Y}\right) = \gamma_0 + \gamma_1 \log Y + \gamma_2 (\log Y)^2 + \gamma_3 \log\left(\frac{P_m}{P}\right) + \Sigma_{i>3}\gamma_i Z_i. \tag{3}$$

Provided $\gamma_1 > 0$ and γ_2, $\gamma_3 < 0$, the demand for manufactures exhibits the required features. The income elasticity of demand is then greater than unity when Y is small, and less than unity for large Y. Moreover, a reduction in the relative price of manufactures increases the demand for such items.

Elasticity of Substitution

This subsection demonstrates that the price elasticity of substitution between manufactures and total output is approximately equal to the price elasticity of substitution between manufactures and nonmanufactures.

Measured at base-year prices, real output can be decomposed as follows:

$$Y = Y_m + Y_n, \tag{A17}$$

where n refers to all nonmanufacturing activities combined. The corresponding equation in current prices is

$$PY = P_m Y_m + P_n Y_n. \tag{A18}$$

In the base year, all prices are equal to unity and this equation coincides with the previous one. Define

$$\sigma_m = \frac{P_m/P}{Y_m/Y}\frac{\partial(Y_m/Y)}{\partial(P_m/P)} \tag{A19}$$

and

$$\sigma_{mn} = -\frac{P_m/P_n}{Y_m/Y_n}\frac{\partial(Y_m/Y_n)}{\partial(P_m/P_n)}. \tag{A20}$$

Note that σ_m is equal to $-\gamma_3$, the coefficient of $\log(P_m/P)$ in equation (3) of the main text, and σ_{mn} is the elasticity of substitution between manufactures and nonmanufactures.

We shall now consider how σ_{mn} and σ_m are related. The following equation can be easily derived:

$$\sigma_{mn} = -\frac{\sigma_m \dfrac{P}{P_n}\dfrac{Y_n}{Y}\dfrac{\partial(P_m/P)}{\partial(P_m/P_n)}}{\dfrac{\partial(Y_m/Y)}{\partial(Y_m/Y_n)}}. \tag{A21}$$

To convert this equation into a more useful form, let

$$\frac{Y_m}{Y_n} = h, \qquad \frac{P_m}{P_n} = z. \tag{A22}$$

From equations (A21) and (A22), it follows that

$$\frac{Y_m}{Y} = \frac{h}{1+h}, \qquad \frac{Y_n}{Y} = \frac{1}{1+h} \tag{A23}$$

$$\frac{P_m}{P} = \frac{z(1+h)}{1+zh}, \qquad \frac{P_n}{P} = \frac{1+h}{1+zh} \tag{A24}$$

$$\sigma_{mn} = -\frac{z}{h}\frac{\partial h}{\partial z}. \tag{A25}$$

Table A1. Relationship Between σ_m and σ_{mn}

h	z	σ_m	σ_{mn}
0.2	0.5	0.3	0.32
0.4	0.5	0.3	0.33
0.2	2.0	0.3	0.27
0.4	2.0	0.3	0.25
0.2	0.5	0.6	0.62
0.4	0.5	0.6	0.64
0.2	2.0	0.6	0.56
0.4	2.0	0.6	0.54

Moreover,

$$\begin{aligned}\frac{\partial(P_m/P)}{\partial(P_m/P_n)} &= \frac{\partial}{z}\left(\frac{z(1+h)}{1+zh}\right)\\ &= \frac{(1+h)+(1-z)z\dfrac{\partial h}{\partial z}}{(1+zh)^2}\end{aligned} \tag{A26}$$

and

$$\begin{aligned}\frac{\partial(Y_m/Y)}{\partial(Y_m/Y_n)} &= \frac{\partial}{\partial h}\left(\frac{h}{1+h}\right)\\ &= \frac{1}{(1+h)^2}.\end{aligned} \tag{A27}$$

Substituting in equation (A21) yields

$$\begin{aligned}\sigma_{mn} &= \frac{(1+h)\sigma_m}{(1+zh)+(1-z)h\sigma_m}\\ &= \sigma_m\left[1+\frac{(1-z)h(1-\sigma_m)}{(1+zh)+(1-z)h\sigma_m}\right].\end{aligned} \tag{A28}$$

This is the required formula linking the two elasticities of substitution.

In the base year, all prices are equal to unity, so that $z = 1$ and hence $\sigma_{mn} = \sigma_m$. More generally, σ_{mn} is approximately equal to σ_m if relative prices are similar to those in the base year, or if the share of manufacturing in real output is small, or if σ_m is close to unity.

Table A1 illustrates the implications of the above equation for values of h and z in the range covered by our sample of countries. It is clear that σ_{mn} and σ_m are very similar in magnitude. Thus, $-\gamma_3$ in equation (3) of the text can be used as an estimator of σ_{mn}.

Income Elasticity Formula

This subsection examines the relationship between the income elasticities of demand for manufactures and nonmanufactures.

Per capita output in base year prices is given by

$$Y = Y_m + Y_n, \tag{A29}$$

where Y_m and Y_n are the real per capita output of (expenditure on) of manufactures and nonmanufactures, respectively.

Income elasticities of demand are defined as follows:

$$\begin{aligned} \eta_m &= \frac{Y}{Y_m}\frac{\partial Y_m}{\partial Y} \\ \eta_n &= \frac{Y}{Y_n}\frac{\partial Y_n}{\partial Y}. \end{aligned} \tag{A30}$$

Differentiating equation (A29) with respect to Y, we find that

$$\begin{aligned} 1 &= \frac{Y_m}{Y}\eta_m + \frac{Y_n}{Y}\eta_n \\ &= \frac{Y_m}{Y}\eta_m + \left(1 - \frac{Y_m}{Y}\right)\eta_n, \end{aligned} \tag{A31}$$

which implies that

$$1 - \eta_m = -\left(\frac{Y}{Y_m} - 1\right)(\eta_n - 1). \tag{A32}$$

To illustrate the implications of this equation, suppose that $Y_m/Y = 0.20$ and that $\eta_n = 1.10$. In this case $\eta_m = 0.6$. Thus, the income elasticity of demand for nonmanufactures is close to unity, and the corresponding elasticity for manufactures is quite low. This is a direct result of the fact that the share of manufactures in total expenditure is small.

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