

Premature deindustrialization

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Abstract I document a significant deindustrialization trend in recent decades that goes considerably beyond the advanced, post-industrial economies. The hump-shaped relationship between industrialization (measured by employment or output shares) and incomes has shifted downwards and moved closer to the origin. This means countries are running out of industrialization opportunities sooner and at much lower levels of income compared to the experience of early industrializers. Asian countries and manufactures exporters have been largely insulated from those trends, while Latin American countries have been especially hard hit. Advanced economies have lost considerable employment (especially of the low-skill type), but they have done surprisingly well in terms of manufacturing output shares at constant prices. While these trends are not very recent, the evidence suggests both globalization and labor-saving technological progress in manufacturing have been behind these developments. The paper briefly considers some of the economic and political implications of these trends.

Keywords Deindustrialization · Industrialization · Economic growth

JEL classification O14

1 Introduction

Our modern world is in many ways the product of industrialization. It was the industrial revolution that enabled sustained productivity growth in Europe and the United States for the first time, resulting in the division of the world economy into rich and poor nations. It was industrialization again that permitted catch-up and convergence with the West by a relatively smaller number of non-Western nations—Japan starting in the late Nineteenth century, South Korea, Taiwan and a few others after the 1960s. In countries that still remain mired in poverty,

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such as those in sub-Saharan Africa and south Asia, many observers and policy makers believe future economic hopes rest in important part on fostering new manufacturing industries.

Most of the advanced economies of the world have long moved into a new, post-industrial phase of development. These economies have been deindustrializing for decades, a trend that is particularly noticeable when one looks at the employment share of manufacturing. Employment deindustrialization has long been a concern in rich nations, where it is associated in public discussions with the loss of good jobs, rising inequality, and a potential decline in innovation capacity.¹ In terms of output, deindustrialization has been in fact less striking and uniform, a pattern that is obscured by the frequent reliance on value added measures at current rather than constant prices.

In the United States manufacturing industries' share of total employment has steadily fallen since the 1950s, coming down from around a quarter of the workforce to less than a tenth today. Meanwhile, manufacturing value-added (MVA) has remained a constant share of GDP at constant prices—a testament to differentially rapid labor productivity growth in this sector. In Great Britain, at the other end of the spectrum, deindustrialization has been both more rapid and thorough. Manufacturing's share of employment has fallen from a third in the 1970s to slightly above 10 % today, while real MVA (at 2005 prices) has declined from around a quarter of GDP to less than 15 %.² Across the developed world as a whole, real manufacturing output has held its own rather well once we control for changes in income and population, as I will show later in the paper.

The term deindustrialization is used today to refer to the experience mainly of these advanced economies. In this paper, I focus on a less noticed trend over the last three decades, which is an even more striking, and puzzling, pattern of deindustrialization in low- and middle-income countries. With some exceptions, confined largely to Asia, developing countries have experienced falling manufacturing shares in both employment and real value added, especially since the 1980s. For the most part, these countries had built up modest manufacturing industries during the 1950s and 1960s, behind protective walls and under policies of import substitution. These industries have been shrinking significantly since then. The low-income economies of Sub-Saharan Africa have been affected nearly as much by these trends as the middle-income economies of Latin America—though there was less manufacturing to begin with in the former group of countries.

Manufacturing typically follows an inverted U-shaped path over the course of development. Even though such a pattern can be observed in developing countries as well, the turning point arrives sooner and at much lower levels of income today. In most of these countries, manufacturing has begun to shrink (or is on course for shrinking) at levels of income that are a fraction of those at which the advanced economies started to deindustrialize.³ Developing countries are turning into service economies without having gone through a proper experience of industrialization. I call this “premature deindustrialization.”⁴

There are two senses in which the shrinking of manufacturing in low and medium income economies can be viewed as premature. The first, purely descriptive, sense is that these

¹ The bulk of R&D and patents originates from manufacturing. In Europe, for example, close to two-thirds of business R&D spending is done in manufacturing even though the sector is responsible for only 14–15 % of employment and value added in aggregate (Veugelers 2013, p. 8).

² These numbers come from Timmer et al. (2014), which is the principal data source I will use in the paper.

³ See also Amirapu and Subramanian (2015), who document premature deindustrialization within Indian states.

⁴ The term seems to have been first used by Dasgupta and Singh (2006), although Kaldor (1966) made much earlier reference to early deindustrialization in the British context. I am grateful to Andre Nassif for the Kaldor reference.

economies are undergoing deindustrialization much earlier than the historical norms. As I will show in Sect. 6, late industrializers are unable to build as large manufacturing sectors and are starting to deindustrialize at considerably lower levels of income, compared to early industrializers.

The second sense in which this is premature is that early deindustrialization may have detrimental effects on economic growth. Manufacturing activities have some features that make them instrumental in the process of growth. First, manufacturing tends to be technologically a dynamic sector. In fact, as demonstrated in Rodrik (2013), formal manufacturing sectors exhibit *unconditional* labor productivity convergence, unlike the rest of the economy. Second, manufacturing has traditionally absorbed significant quantities of unskilled labor, something that sets it apart from other high-productivity sectors such as mining or finance. Third, manufacturing is a tradable sector, which implies that it does not face the demand constraints of a home market populated by low-income consumers. It can expand and absorb workers even if the rest of the economy remains technologically stagnant. Taken together, these features make manufacturing the quintessential escalator for developing economies (Rodrik 2014). Hence early deindustrialization could well remove the main channel through which rapid growth has taken place in the past. My focus in the present paper is on documenting deindustrialization trends against the background of these considerations, rather than on examining their normative consequences.

I do spend some time to consider the underlying causes of these trends. I present a simple theoretical framework in Sect. 7 to help interpret the key empirical findings of the paper. Two important differences across country groups in particular need explanation. First, advanced countries as a group have managed to avoid output deindustrialization, unlike the bulk of developing countries. Second, among developing countries, Asian countries have experienced no output or employment deindustrialization. (Note that these patterns refer to outcomes after income and demographic trends are controlled for.) I do not attempt here a full-fledged causal explanation for the patterns. But the model is suggestive of the combinations of technology and trade shocks that can account for the observed heterogeneity. In brief, productivity improvements appear to have played the major role in the advanced economies, while globalization features more prominently in accounting for industrialization-deindustrialization patterns within the developing world.

The conventional explanation for employment deindustrialization relies on differential rates of technological progress (Lawrence and Edwards 2013). Typically, manufacturing experiences more rapid productivity growth than the rest of the economy. This results in a reduction in the share of the economy's labor employed by manufacturing as long as the elasticity of substitution between manufacturing and other sectors is less than unity ($\sigma < 1$). As I show in Sect. 7, however, under the same assumptions the output share of manufacturing moves in the opposite direction. To get both employment and output deindustrialization, we need to make additional assumptions: that the trade balance in manufactures becomes more negative or that there is a secular demand shift away from manufactures. (The math is worked out in Sect. 7.)

Since the more pronounced story in the advanced countries is employment rather than output deindustrialization, a technology-based story does reasonably well to account for the patterns there. Further, the evidence suggests that a particular type of technological progress, of the unskilled-labor saving type, is responsible for the bulk of the labor displacement from manufacturing (Sect. 5).

For developing countries, however, it is less evident that the technology argument applies in quite the same way. Crucially, the mechanism referred to above relies on adjustments in domestic relative prices. Differential technological progress in manufacturing depresses the

relative price of manufacturing. In the case where $\sigma < 1$, this decline is sufficiently large that it ensures demand for labor in manufacturing is lower in the new equilibrium. The big difference in developing countries is that they are small in world markets for manufactures, where they are essentially price takers. In the limit, when relative prices are fully determined by global (rather than domestic) supply-demand conditions, more rapid productivity growth in manufacturing at home actually produces industrialization, not deindustrialization – in terms of both employment and output (as the model of Sect. 7 shows). So the culprit for deindustrialization in developing countries must be found elsewhere.

The obvious alternative is trade and globalization. A plausible story would be the following. As developing countries opened up to trade, their manufacturing sectors were hit by a double shock. Those without a strong comparative advantage in manufacturing became net importers of manufacturing, reversing a long process of import-substitution.⁵ In addition, developing countries “imported” deindustrialization from the advanced countries, because they became exposed to the relative price trends originating from advanced economies. The decline in the relative price of manufacturing in the advanced countries put a squeeze on manufacturing everywhere, including the countries that may not have experienced much technological progress. This account is consistent with the strong reduction in both employment *and* output shares in developing countries (especially those that do not specialize in manufactures). It also helps account for the fact that Asian countries, with a comparative advantage in manufactures, have been spared the same trends.

In sum, while technological progress is no doubt a large part of the story behind employment deindustrialization in the advanced countries, in the developing countries trade and globalization likely played a comparatively bigger role.

The outline of the paper is as follows. In Sect. 2, I discuss the data, various measures of deindustrialization, and the inverse-U shaped relationship between industrialization and incomes. In Sects. 3 and 4, I document the patterns of deindustrialization over time and across different country groups. In Sect. 5, I look at employment deindustrialization, differentiating across different labor types. In Sect. 6, I make the concept of premature deindustrialization more precise. In Sect. 7, I develop an analytical framework within which the empirical results can be interpreted. In Sect. 8, I conclude.

2 The inverse U-shaped curve in manufacturing: data, measures and trends

I begin by providing some indicators of changes in global manufacturing activity in recent decades (Table 1). The data come from the United Nations and have globally comprehensive coverage but they go back only to 1970. The top panel of the table shows the global distribution of manufacturing output, while the lower panel shows shares of manufacturing in GDP for major regions. Two key conclusions stand out. First, there has been a significant relocation of manufacturing from the richer parts of the world (United States and Europe) to Asia, particularly China. Second, the share of manufacturing in GDP has moved differently in various regions, and not always in a manner that would have been expected a priori. Some low-income regions (sub-Saharan Africa and Latin America) have deindustrialized, while some high-income regions (namely the U.S.) have avoided that fate.

⁵ This echoes the concern in the voluminous literature on the Dutch disease, that developing countries with comparative advantage in primary products would experience a squeeze on manufacturing as they open up to trade. See Corden (1984), van Wijnbergen (1984), and Sachs and Warner (1999).

Table 1 Indicators of global manufacturing activity (in 2005 constant USD)

	World	United States	Western Europe	Latin America and Caribbean	Asia (excluding China)	China	Sub-Saharan Africa	Other
Shares in global MVA								
1970	1.00	0.26	0.24	0.06	0.15	0.00	0.01	0.27
1980	1.00	0.22	0.21	0.08	0.18	0.01	0.01	0.29
1990	1.00	0.21	0.19	0.06	0.24	0.02	0.01	0.26
2000	1.00	0.24	0.16	0.07	0.24	0.06	0.01	0.22
2010	1.00	0.20	0.13	0.06	0.26	0.16	0.01	0.18
2013	1.00	0.19	0.13	0.06	0.26	0.18	0.01	0.17
MVA share in GDP								
1970	0.17	0.13	0.22	0.20	0.16	0.09	0.14	
1980	0.16	0.12	0.20	0.20	0.16	0.16	0.15	
1990	0.16	0.12	0.19	0.19	0.19	0.18	0.15	
2000	0.17	0.13	0.18	0.19	0.19	0.29	0.13	
2010	0.18	0.13	0.18	0.17	0.21	0.36	0.11	
2013	0.18	0.13	0.18	0.16	0.20	0.36	0.11	

Source: Calculated from United Nations, <http://unstats.un.org/unsd/snaama/selbasicFast.asp>
 The UN does not provide manufacturing data for China for the period before 2005. Manufacturing is grouped under the aggregate “Mining, Manufacturing, Utilities (ISIC C-E)”.
 I have imputed manufacturing values for China by backward extrapolation of the manufacturing share in this aggregate

There are a variety of industrialization/deindustrialization measures in the literature. Some studies focus on manufacturing employment (as a share of total employment), while others use manufacturing output (MVA as a share of GDP). MVA shares in turn can be calculated at constant or current prices. Different measures yield different trends and results. For completeness I will use all three measures in this paper, denoting them as *manemp* (manufacturing employment share), *nommva* (MVA share at current prices), and *realmva* (MVA share at constant prices). I will focus in later sections on the real magnitudes *manemp* and *realmva*, as *nommva* conflates movements in quantities and prices which are best kept distinct when trying to understand patterns of structural change and their determinants.

My baseline results are based on data from the Groningen Growth and Development Center (GGDC, [Timmer et al. 2014](#)). These data span the period between the late 1940s/early 1950s through the early 2010s and cover 42 countries, both developed and developing. The major economies in Latin America, Asia, and sub-Saharan Africa are included alongside advanced economies. (For more details on the data set, see the Appendix.) Constant-price series are at 2005 prices.⁶ For robustness checks and further analysis, I will supplement this data with two other sources. The Socio-economic Accounts of the World Input-Output Database (Timmer 2012) provide a disaggregation of sectoral employment by three skill categories for 40, mainly advanced economies. And researchers at the Asian Development Bank have recently put together manufacturing employment and output series for a much larger group of countries using a variety of sources, including the ILO, U.N., and World Bank, though these data start from 1970 at the earliest ([Felipe and Rhee 2014](#)).⁷ I will combine these various sources on manufacturing with income and population data from [Maddison \(2009\)](#), updated using the World Bank's World Development Indicators. The income figures are at 1990 international dollars.

Figure 1 shows the simulated relationship between the three measures of industrialization and income per capita. The figure is based on a quadratic estimation using country fixed effects and controlling for population size and period dummies. (See Sect. 3 for the exact specification.) The curves are drawn for a “representative” country with the median population in the sample (27 million). Period and country effects are all averaged to obtain a typical relationship for the sample and full time span covered. The estimation results underlying the figure are shown in Table 2, cols. (1)–(3). The quadratic terms are statistically highly significant for all three manufacturing indicators. The share of manufacturing tends to first rise and then fall over the course of development.

However, the turning points differ significantly. In particular, *manemp* peaks much earlier than *realmva*. The employment share of manufacturing starts to fall past an income level of around \$6,000 (in 1990 US)\$, after having reached an estimated maximum close to 20%. Manufacturing output at constant prices peaks very late in the development process. The estimated income level at which it begins to fall is in fact higher than any of the incomes observed in the data set (above \$70,000 in 1990 US).⁸ As we shall see in Sect. 6, post-1990

⁶ The only exception is West Germany, for which there are no data after 1991 and constant-price series are at 1991 prices. Since all my regressions include country fixed effects, this difference in base year will be absorbed into the fixed effect for the country.

⁷ I am grateful to Jesus Felipe for making these data available to me.

⁸ These differences are statistically significant. The 95% confidence intervals for log incomes at which manufacturing shares peak, computed using the delta method, are as follows: *manemp* [8.45, 8.97]; *nommva* [8.79, 9.58], and *realmva* [10.16, 12.27]. The confidence interval for *manemp* (and *nommva*) does not overlap that for *realmva*. The series for *manemp* and *nommva* easily pass the [Lind and Mehlum \(2010\)](#) test for the presence of an inverse U-relationship in log GDP per capita, while *realmva* fails it because the extremum occurs outside the observed income range.

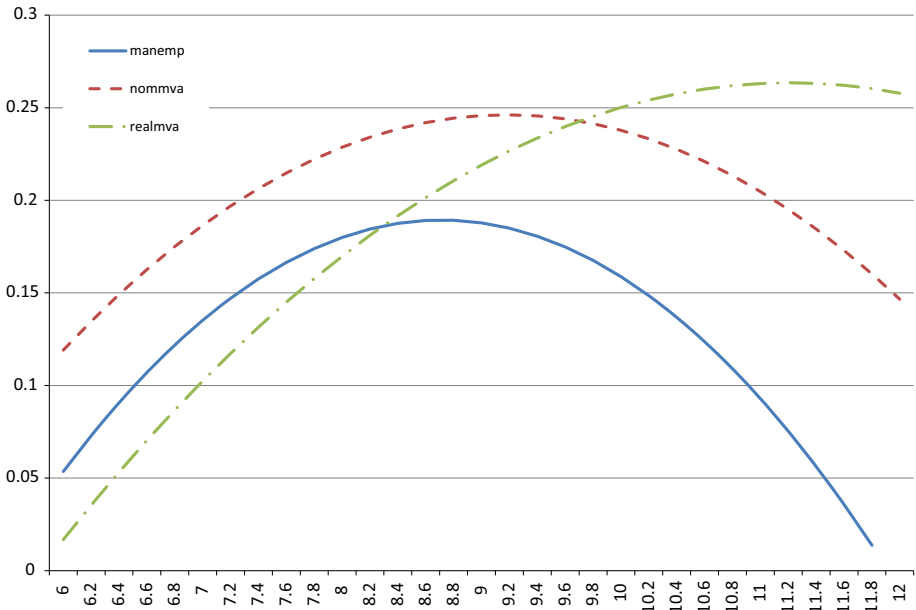


Fig. 1 Simulated manufacturing shares as a function of income (In GDP per capita in 1990 international dollars)

data indicate a much earlier decline, at less than half the pre-1990 income level. (Note that the peak shares themselves are less meaningful in the case of output, as they depend on the base year selected for converting current prices to constant prices.)

The literature focuses on two possible explanations for why manufacturing’s share eventually falls (Ngai and Pissarides 2004; Buera and Joseph 2009; Foellmi and Zweimuller 2008; Lawrence and Edwards 2013; Nickell et al. 2008). One is demand-based, and relies on a shift in consumption preferences away from goods and towards services. This on its own would not produce the timing difference in peaks, as a pure demand shift would have similar effects on manufacturing quantities (output and employment). The second explanation is technological, and relies on more rapid productivity growth in manufacturing than in the rest of the economy. As long as the elasticity of substitution is less than one, this produces a decline in the share of manufacturing employment, but not in the share of manufacturing output. We need a combination of supply- and demand-side reasons to explain both the decline in manufacturing’s share and the later turnaround in output compared to employment.

An added complication is that the effects of technology and demand shocks depend crucially on whether the economy is open to trade or not (Matsuyama 2009). For the moment, I leave these questions aside. I will develop the analytical results linking technology, demand, and trade to deindustrialization in Sect. 7.

As Fig. 1 shows, *nommva* also peaks much earlier than *realmva*, though not so early as *manemp*. The explanation for this difference has to do with relative price changes over the course of development. The relative price of manufacturing tends to decline as countries get richer, tending to depress the share of MVA at current prices. Figure 2 displays the pattern for four of the countries in our sample. The relative price of manufacturing has more than halved in the United States since the early 1960s. Great Britain has experienced a somewhat smaller decline. In South Korea, which has grown extremely rapidly, manufacturing’s relative price

Table 2 Baseline regressions

	Common sample			Largest sample		
	<i>manemp</i>	<i>nommva</i>	<i>realmva</i>	<i>manemp</i>	<i>nommva</i>	<i>realmva</i>
In population	0.115* (0.021)	0.142* (0.029)	-0.113* (0.028)	0.122* (0.021)	0.192* (0.027)	-0.039 (0.025)
In population squared	-0.000 (0.001)	-0.002* (0.001)	0.005* (0.001)	-0.001 (0.001)	-0.004* (0.001)	0.003* (0.001)
In GDP per capita	0.321* (0.027)	0.230* (0.031)	0.204* (0.025)	0.316* (0.026)	0.266* (0.031)	0.262* (0.027)
In GDP per capita squared	-0.018* (0.002)	-0.013* (0.002)	-0.009* (0.001)	-0.018* (0.002)	-0.014* (0.002)	-0.012* (0.002)
1960s	-0.029* (0.005)	-0.011*** (0.006)	-0.008 (0.005)	-0.018* (0.004)	-0.010*** (0.006)	-0.028* (0.007)
1970s	-0.044* (0.006)	-0.021* (0.007)	-0.004 (0.006)	-0.033* (0.005)	-0.014** (0.007)	-0.026* (0.008)
1980s	-0.066* (0.007)	-0.033* (0.008)	-0.011*** (0.007)	-0.054* (0.006)	-0.028* (0.008)	-0.034* (0.009)
1990s	-0.086* (0.009)	-0.052* (0.009)	-0.017** (0.008)	-0.074* (0.008)	-0.049* (0.009)	-0.040* (0.010)
2000s+	-0.117* (0.010)	-0.085* (0.010)	-0.035* (0.009)	-0.105* (0.009)	-0.085* (0.010)	-0.059* (0.011)
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Number of countries	42	42	42	42	42	42
Number of observations	1995	1995	1995	2209	2128	2302

Robust standard errors are reported in parentheses
 Levels of statistical significance: * 99%, ** 95%, *** 90%

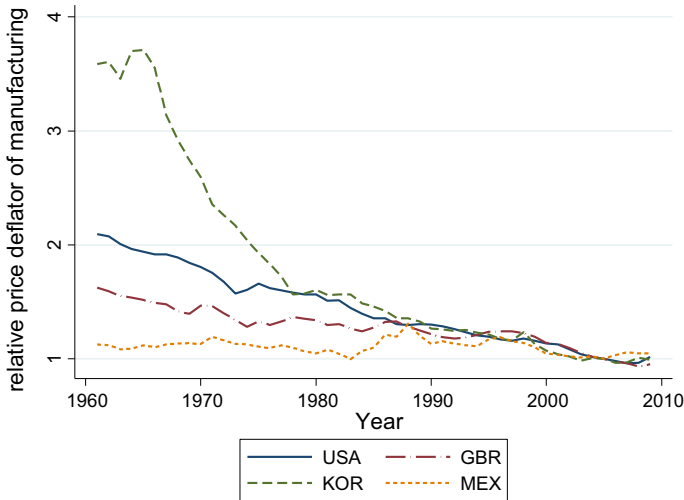


Fig. 2 Relative price trends

has come down by a whopping 250 %. In Mexico, meanwhile, relative prices have remained more or less flat.

These trends are also consistent broadly with a technology-based explanation for the manufacturing hump. More rapid productivity growth in manufacturing reduces the relative price of manufactured goods through standard supply-demand channels. This in turn causes *nommva* to reach an earlier peak than *realmva* as shown in Fig. 1.

3 Deindustrialization over time

As Fig. 1 makes clear, deindustrialization is the common fate of countries that are growing. My interest here is to check whether deindustrialization has been more rapid in recent periods. For this purpose, I use a basic specification that controls for the effect of demographic and income trends (with quadratic terms for log population, *pop*, and GDP per capita, *y*) as well as country fixed effects (D_i). The baseline regression looks as follows:

$$manshare_{it} = \beta_0 + \beta_1 \ln pop_{it} + \beta_2 (\ln pop_{it})^2 + \beta_3 \ln y_{it} + \beta_4 (\ln y_{it})^2 + \sum_i \gamma_i D_i + \sum_T \varphi_T PER_T + \epsilon_{it},$$

where *manshare* denotes one of our three indicators of industrialization. Country fixed-effects allow me to take into account any country-specific features (geography, endowments, history) that create a difference in the baseline conditions for manufacturing industry across different nations. My main focus is on trends over time, which are captured using period dummies (PER_T) for the 1960s, 1970s, 1980s, 1990s, and post-2000 years. (The post-2000 dummy covers the period 2000 through the final year in the sample, 2012.) The estimated coefficients on these dummies (φ_T) allow us to gauge the effects of common shocks felt by manufacturing in each of the time periods, relative to the excluded, pre-1960 years.

Table 2 shows two versions of the baseline results for each of our three measures of manufacturing industry, *manemp*, *nommva*, and *reamva*. Columns (1)–(3) are restricted to a common sample so that the results are directly comparable across the measures. Columns

(4)–(6) employ the largest sample possible. The common samples have 1995 observations, while the others range from 2128 to 2302.

The results for *manemp* and *nommva* are very similar across the two specifications. In both cases, we find a sizable and significant negative trend over time, larger for *manemp* than for *nommva*. Using the estimates from the common sample, the average country in our sample had a level of *manemp* that stood 11.7 percentage points lower after 2000 than in the 1950s, and 8.8 percentage points (0.117–0.029) lower than in the 1960s. The corresponding reductions for *nommva* are 8.5 and 7.4 % points, respectively.

The declines in *realmva* are smaller, and in the common sample show up significantly only for the post-1990 period. Depending on whether we use the common or largest sample, the post-2000 negative shock is 3.5–5.9 % points relative to the pre-1960 period.

Figure 3a–c provide a visual sense of the results. They plot the estimated coefficients for the period dummies, along with a 95 % confidence interval around them. The figures show a steady decrease over time in manufacturing shares after controlling for income and demographic trends. The decline is most dramatic for employment; it is less pronounced, but still evident after 1990 for real MVA. Manufacturing employment and activity have gone missing in a big way.

The samples in Table 2 provide good coverage across developed and developing regions, but the number of countries is limited to 42. To make sure that the results are representative of trends in other countries as well, I turn to the ADB dataset which includes a much larger group of countries (up to 87 for *manemp* and 124 for *nommva* and *realmva*). The limitation in this case is that coverage begins in 1970 (Felipe and Rhee 2014). So I include dummies for the 1980s, 1990s, and post-2000 years only, with the 1970s as the excluded period. Note that the ADB data set provides two alternative series for MVA, one using U.N. sources and the other using World Bank data. The results are presented in Table 3, and are quite similar to the previous ones.

Once again, the strongest downward trend over time is for *manemp*, a reduction of 6.5 % points compared to the 1970s. (This matches up well with the corresponding number of 7.3 % points (0.117–0.044) from Table 2.) The decline in *nommva* is 3.0 or 5.2 points over the 1970s, depending on which series is used. Finally, the decline for *realmva* is 0.9–2.4 points.

4 Deindustrialization in different country groups

We can obtain some insight about the causes of these trends by looking at deindustrialization patterns in different country groups separately. This is done in Tables 4, 5, and 6, for *manemp*, *nommva*, and *realmva*, respectively. In each table, the baseline regression is run for the following groups: (a) developed countries; (b) Latin American countries; (c) Asian countries; (d) sub-Saharan African countries; and (e) sub-Saharan African countries excluding Mauritius. Note that since there are no data for the 1950s for sub-Saharan Africa, the period dummies for that region start from the 1970s. Also, two of the countries our global sample (Egypt and Morocco) do not belong in any of these groups, so have been excluded from the group-level estimations.⁹

⁹ An alternative, and more efficient form of estimation would be to introduce periodXgroup dummies in a single, global regression. However, the results in Tables 4–6 suggest considerable heterogeneity in the estimated coefficients on population and income terms across groups. So allowing these coefficients to vary seems worth the price of potentially reduced power. Since the period dummies in the group-specific regressions are estimated tightly for the most part, the loss in efficiency does not appear to make much practical difference.

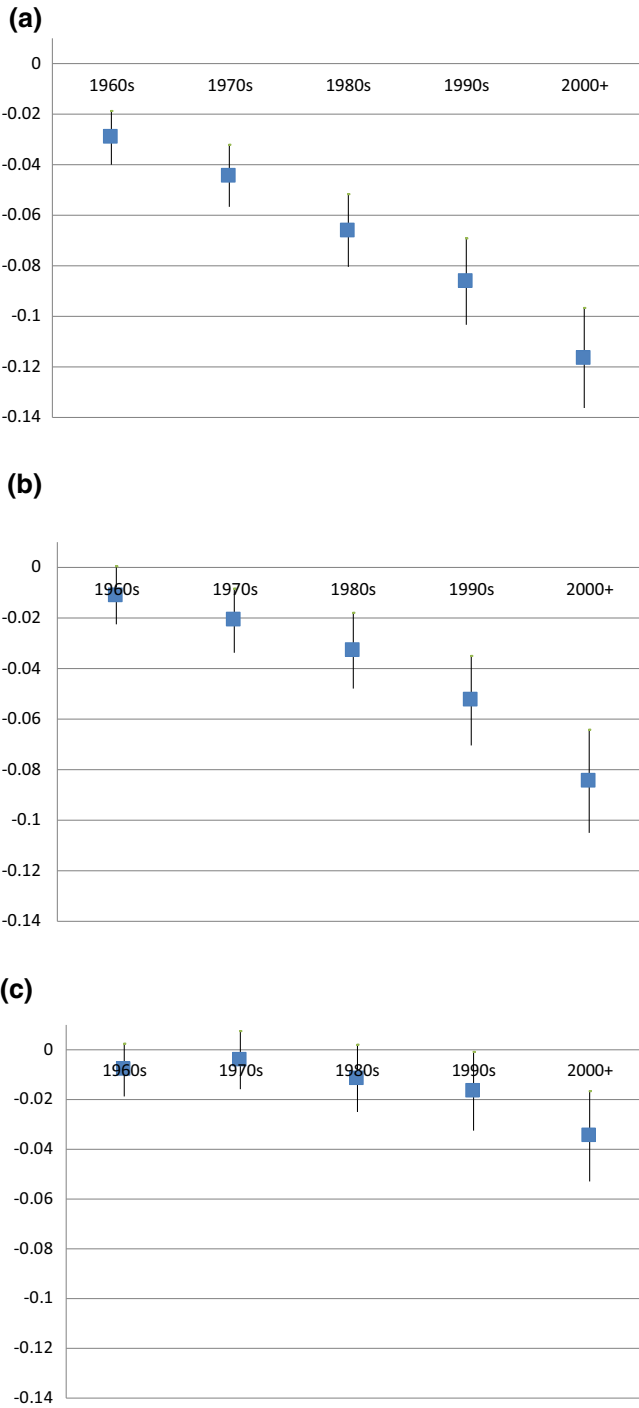


Fig. 3 Estimated period coefficients (with 95 % confidence intervals): **a** *manemp* **b** *nommva* **c** *realmva*

Table 3 Alternative data sets

	<i>manemp</i>		<i>nommva</i>		<i>realmva</i>	
	ADB/ILO	ADB/UN	ADB/UN	ADB/WB	ADB/UN	ADB/WB
ln population	0.196* (0.043)	0.194* (0.026)	0.260* (0.031)	0.008 (0.019)	0.008 (0.019)	-0.044 (0.029)
ln population squared	-0.004* (0.001)	-0.004* (0.001)	-0.007* (0.001)	0.001 (0.001)	0.001 (0.001)	0.002** (0.001)
ln GDP per capita	0.693* (0.052)	0.238* (0.016)	0.146* (0.019)	0.060* (0.015)	0.060* (0.015)	0.057* (0.017)
ln GDP per capita squared	-0.039* (0.003)	-0.013* (0.001)	-0.008* (0.001)	-0.002** (0.001)	-0.002** (0.001)	-0.002*** (0.001)
1980s	-0.023* (0.002)	-0.011* (0.002)	-0.002 (0.002)	-0.006* (0.001)	-0.006* (0.001)	0.000 (0.002)
1990s	-0.043* (0.004)	-0.029* (0.002)	-0.010* (0.003)	-0.016* (0.002)	-0.016* (0.002)	-0.003 (0.003)
2000s+	-0.065* (0.005)	-0.052* (0.003)	-0.030* (0.004)	-0.024* (0.003)	-0.024* (0.003)	-0.009** (0.003)
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Number of countries	87	124	119	124	124	112
Number of observations	1947	4378	3691	5070	5070	3312

Robust standard errors are reported in parentheses
 Levels of statistical significance: * 99%; ** 95%; *** 90%

Table 4 Country groups, *manemp*

	All countries	Developed countries	Latin America	Asia	Sub-Saharan Africa	Sub-Saharan Africa (excl. Mauritius)
ln population	0.122* (0.021)	-0.652* (0.122)	0.191* (0.032)	0.789* (0.102)	0.199* (0.019)	0.178* (0.014)
ln population squared	-0.001 (0.001)	0.017* (0.003)	-0.003* (0.001)	-0.025* (0.003)	-0.005* (0.001)	-0.004* (0.000)
ln GDP per capita	0.316* (0.026)	1.070* (0.088)	0.902* (0.071)	0.912* (0.071)	0.190* (0.024)	0.148* (0.018)
ln GDP per capita squared	-0.018* (0.002)	-0.057* (0.005)	-0.052* (0.004)	-0.051* (0.004)	-0.014* (0.002)	-0.011* (0.001)
1960s	-0.018* (0.004)	-0.004 (0.004)	-0.027* (0.004)	-0.003 (0.013)	n.a.	n.a.
1970s	-0.033* (0.005)	-0.021* (0.006)	-0.050* (0.006)	0.016 (0.016)	0.002 (0.004)	-0.003 (0.003)
1980s	-0.054* (0.006)	-0.052* (0.007)	-0.079* (0.008)	0.022 (0.019)	0.004 (0.007)	-0.021* (0.005)
1990s	-0.074* (0.008)	-0.072* (0.009)	-0.096* (0.010)	0.013 (0.022)	0.007 (0.012)	-0.033* (0.007)
2000s+	-0.105* (0.009)	-0.096* (0.010)	-0.131* (0.012)	0.004 (0.026)	0.007 (0.014)	-0.035* (0.008)
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Number of countries	42	10	9	11	11	10
Number of observations	2209	575	545	519	524	481

Robust standard errors are reported in parentheses
 Levels of statistical significance: * 99 %; ** 95 %; *** 90 %

Table 5 Country groups, *nommva*

	All countries	Developed countries	Latin America	Asia	Sub-Saharan Africa	Sub-Saharan Africa (excl. Mauritius)
In population	0.192* (0.027)	0.752** (0.309)	0.223* (0.046)	1.009* (0.081)	0.552* (0.049)	0.519* (0.045)
In population squared	-0.004* (0.001)	-0.016** (0.008)	-0.007* (0.001)	-0.029* (0.002)	-0.017* (0.001)	-0.014* (0.001)
In GDP per capita	0.266* (0.031)	1.024* (0.139)	0.308*** (0.157)	0.877* (0.054)	0.047 (0.061)	0.027 (0.056)
In GDP per capita squared	-0.014* (0.002)	-0.059* (0.008)	-0.016*** (0.009)	-0.050* (0.003)	-0.007 (0.005)	-0.006 (0.004)
1960s	-0.010*** (0.006)	-0.003 (0.007)	-0.001 (0.008)	0.008 (0.007)	n.a.	n.a.
1970s	-0.014** (0.007)	-0.035* (0.010)	-0.006 (0.010)	0.032* (0.010)	0.030* (0.005)	0.017* (0.005)
1980s	-0.028* (0.008)	-0.054* (0.011)	-0.002 (0.014)	0.036* (0.014)	0.029* (0.008)	-0.008 (0.009)
1990s	-0.049* (0.009)	-0.062* (0.013)	-0.010 (0.018)	0.033*** (0.018)	0.010 (0.010)	-0.050* (0.013)
2000s+	-0.085* (0.010)	-0.079* (0.015)	-0.039** (0.020)	0.032 (0.022)	-0.004 (0.012)	-0.079* (0.016)
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Number of countries	42	10	9	11	11	10
Number of observations	2128	451	498	576	565	512

Robust standard errors are reported in parentheses
 Levels of statistical significance: * 99 %; ** 95 %; *** 90 %

Table 6 Country groups, *realmva*

	All countries	Developed countries	Latin America	Asia	Sub-Saharan Africa	Sub-Saharan Africa (excl. Mauritius)
In population	-0.039 (0.025)	-4.564* (0.776)	0.263* (0.027)	0.251* (0.084)	0.062** (0.029)	0.053*** (0.031)
In population squared	0.003* (0.001)	0.113* (0.019)	-0.004* (0.001)	-0.011* (0.003)	-0.001 (0.001)	-0.000 (0.001)
In GDP per capita	0.262* (0.027)	0.778* (0.129)	-0.135** (0.059)	0.737* (0.040)	0.123* (0.025)	0.106* (0.024)
In GDP per capita squared	-0.012* (0.002)	-0.036* (0.008)	0.006*** (0.003)	-0.038* (0.003)	-0.009* (0.002)	-0.008* (0.002)
1960s	-0.028* (0.007)	-0.021*** (0.011)	-0.011* (0.004)	0.011*** (0.006)	n.a.	n.a.
1970s	-0.026* (0.008)	0.007 (0.015)	-0.017* (0.006)	0.027* (0.010)	0.017* (0.005)	0.012* (0.004)
1980s	-0.034* (0.009)	0.006 (0.018)	-0.052* (0.007)	0.034** (0.013)	0.015** (0.006)	-0.004 (0.006)
1990s	-0.040* (0.010)	0.013 (0.023)	-0.078* (0.008)	0.041** (0.017)	0.011 (0.009)	-0.022* (0.008)
2000s+	-0.059* (0.011)	0.021 (0.027)	-0.101* (0.010)	0.044** (0.020)	-0.003 (0.011)	-0.042* (0.010)
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Number of countries	42	10	9	11	11	10
Number of observations	2302	592	556	577	530	487

Robust standard errors are reported in parentheses
Levels of statistical significance: * 99 %; ** 95 %; *** 90 %

The results point to important regional differences. First, even though developed countries have experienced big losses in *manemp* and *nommva*, they have done surprisingly well in *realmva*. The estimated coefficients for the period dummies for *realmva* are in fact positive (but statistically insignificant) for the developed countries in recent decades (Table 6). This is to be compared with significant negative estimates for Latin America and Africa (once Mauritius is excluded). To be clear, this does not mean that the rich nations have not experienced reductions in real manufacturing output shares in GDP. It simply means that their experience can be well explained by income and demographic trends, with little unexplained (output) deindustrialization left to account for in recent decades.

The results for Asia are even more striking. Asia is the only region for which recent period dummies are not negative for *manemp* (once again, if Mauritius is excluded from the sub-Saharan sample). And the estimates for *realmva* in recent periods are actually positive and statistically significant. These results suggest that Asia has not only bucked the global trend in manufacturing employment, it has managed to maintain stronger manufacturing performance than would be expected on the basis of its income and demography.

The region that has done the worst is Latin America, which has the most negative recent-period effects for *manemp* and *realmva*. The effects for *nommva* are not as pronounced, suggesting that relative prices have not moved there against manufacturing nearly as much as in other regions. Finally, the estimates for sub-Saharan Africa depend heavily on whether Mauritius – a strong manufactures exporter – is included in the sample or not. Without Mauritius in the sample, sub-Saharan African countries emerge as large losers on all three measures of industrialization. Their output deindustrialization in recent decades looks especially dramatic in light of the strong showing for *realmva* in the 1970s (captured by a positive and significant coefficient for *dum1970s* in Table 6). Since sub-Saharan countries are still very poor and widely regarded as the next frontier of labor-intensive export-oriented manufacturing, these are quite striking findings.

The results with respect to Asia and the difference that the inclusion of Mauritius makes to the African performance strongly suggests that these variations in outcomes are related to patterns of comparative advantage, and, in particular, how well or poorly countries have done in global trade in manufactures. To test this idea, I divide our sample of countries into two groups: (a) manufactures exporters, and (b) non-manufactures exporters. I use two criteria to split the sample based on the composition of trade. The first classifies countries as manufactures exporters if the share of manufactures in exports exceeds 75 %, the second if the share of manufactures in exports exceeds the corresponding share in imports.

The results, shown in Table 7, support the comparative-advantage hypothesis. Regardless of the criterion used, the employment loss in manufactures exporters is smaller. Whereas the period effects for *realmva* are strongly negative and significant for manufactures non-exporters, they change sign and are occasionally significant for manufactures exporters. Regressions using ADB data, with broader country coverage, produce very similar results (Table 8). The period effects for *manemp* are not distinguishable between the two groups with this sample, but the *realmva* results show even stronger asymmetries.

In sum, the geographical patterns of deindustrialization seem closely linked to globalization. Our results apparently reflect the sizable shift in global manufacturing activity in recent decades towards East Asia, and China in particular, with both Latin America and sub-Saharan Africa among the developing regions as the losers (see Table 1). Countries with a strong comparative advantage in manufactures have managed to avoid declines in real MVA shares, and employment losses, where they have occurred, have been less severe. Interestingly, on the output side it appears that the brunt of globalization and the rise of Asian exporters has been borne by other developing countries, rather than the advanced economies. What is partic-

Table 7 Results by manufacturing specialization

	Non-manufactures exporters				Manufactures exporters			
	Manufactured exports < 75%		Share of manufactured exports < share of manufactured imports		Manufactured exports > 75%		Share of manufactured exports > share of manufactured imports	
	<i>manemp</i>	<i>realmva</i>	<i>manemp</i>	<i>realmva</i>	<i>manemp</i>	<i>realmva</i>	<i>manemp</i>	<i>realmva</i>
In population	0.202* (0.025)	0.146* (0.031)	0.174* (0.028)	0.130* (0.031)	0.326* (0.035)	0.034 (0.034)	0.444* (0.025)	0.184* (0.033)
In population squared	-0.003* (0.001)	-0.001*** (0.001)	-0.002** (0.001)	-0.001 (0.001)	-0.009* (0.001)	-0.002** (0.001)	-0.014* (0.001)	-0.007* (0.001)
In GDP per capita	0.172* (0.021)	0.314* (0.051)	0.161* (0.022)	0.314* (0.051)	0.704* (0.043)	0.645* (0.021)	0.772* (0.042)	0.627* (0.025)
In GDP per capita squared	-0.010* (0.001)	-0.018* (0.003)	-0.009* (0.001)	-0.017* (0.003)	-0.039* (0.003)	-0.033* (0.001)	-0.042* (0.003)	-0.032* (0.002)
1960s	-0.032* (0.004)	-0.055* (0.011)	-0.028* (0.004)	-0.057* (0.011)	-0.004 (0.006)	0.004 (0.003)	-0.002 (0.005)	0.007** (0.004)
1970s	-0.057* (0.005)	-0.070* (0.013)	-0.054* (0.005)	-0.073* (0.013)	-0.004 (0.008)	0.024* (0.005)	-0.002 (0.008)	0.030* (0.005)
1980s	-0.080* (0.006)	-0.087* (0.015)	-0.078* (0.006)	-0.091* (0.015)	-0.025* (0.009)	0.014** (0.007)	-0.020** (0.009)	0.022* (0.007)
1990s	-0.093* (0.007)	-0.097* (0.016)	-0.093* (0.008)	-0.101* (0.017)	-0.057* (0.011)	0.013 (0.008)	-0.050* (0.011)	0.019** (0.009)
2000s+	-0.120* (0.009)	-0.123* (0.018)	-0.123* (0.009)	-0.128* (0.019)	-0.089* (0.013)	0.012 (0.010)	-0.079* (0.013)	0.014 (0.011)
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of countries	26	26	26	26	16	16	16	16
Number of observations	1366	1426	1378	1425	843	876	831	877

Robust standard errors are reported in parentheses
 Levels of statistical significance: * 99%; ** 95%; *** 90%

Table 8 Results by manufacturing specialization (ADB/ILO/WB data)

	Non-manufactures exporters				Manufactures exporters			
	Manufactured exports < 75%		Share of manufactured exports < share of manufactured imports		Manufactured exports > 75%		Share of manufactured exports > share of manufactured imports	
	<i>manemp</i>	<i>realmva</i>	<i>manemp</i>	<i>realmva</i>	<i>manemp</i>	<i>realmva</i>	<i>manemp</i>	<i>realmva</i>
In population	0.130* (0.049)	-0.094** (0.040)	0.130* (0.046)	-0.131* (0.050)	-0.036 (0.130)	0.132** (0.053)	0.022 (0.1135)	0.116* (0.043)
In population squared	-0.002 (0.002)	0.004* (0.001)	-0.002 (0.002)	0.006* (0.002)	0.001 (0.004)	-0.005* (0.002)	-0.001 (0.003)	-0.004* (0.001)
In GDP per capita	0.525* (0.056)	0.065* (0.017)	0.528* (0.061)	0.078* (0.018)	0.825* (0.008)	0.173* (0.032)	0.817* (0.069)	0.102* (0.031)
In GDP per capita squared	-0.030* (0.003)	-0.003* (0.001)	-0.030* (0.003)	-0.004* (0.001)	-0.045* (0.005)	-0.008* (0.002)	-0.045* (0.004)	-0.003 (0.002)
1980s	-0.028* (0.003)	-0.008* (0.002)	-0.028* (0.003)	-0.007* (0.003)	-0.018* (0.003)	0.018* (0.003)	-0.019* (0.003)	0.010* (0.003)
1990s	-0.042* (0.004)	-0.016* (0.003)	-0.042* (0.004)	-0.013* (0.003)	-0.049* (0.005)	0.023* (0.005)	-0.049* (0.004)	0.009** (0.004)
2000s+	-0.066* (0.006)	-0.028* (0.004)	-0.066* (0.006)	-0.026* (0.0049)	-0.069* (0.007)	0.034* (0.006)	-0.071* (0.006)	0.015* (0.006)
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of countries	55	80	52	73	32	32	35	39
Number of observations	1058	2411	1028	2238	889	901	919	1074

Robust standard errors are reported in parentheses
 Levels of statistical significance: * 99 %; ** 95 %; *** 90 %

ularly striking is the magnitude of adverse employment effects in Latin America, which is even larger than in developed economies.

5 Employment deindustrialization by skill groups

As the results above make clear, deindustrialization shows up most clearly and in its strongest form in employment. The only countries that have managed to avoid a steady decline in manufacturing employment in recent decades (as a share of total employment) are those with a strong comparative advantage in manufacturing. The Socio Economic Accounts of the World Input-Output Database (WIOD, Timmer 2012) allow us to dig a bit deeper on the employment impacts. These data provide a breakdown of manufacturing employment by three worker types: low-skill, medium-skill, and high-skill. The data span the years 1995–2009 and include 40 countries, with the coverage biased heavily towards Europe. (For the list of countries included see the Appendix.)

I run essentially the same regression as before, with two differences. First, the dependent variable is manufacturing’s share of the economy’s total employment of workers of a particular skill type. Second, since the data start from 1995, I use annual dummies rather than decade dummies. (As before, there is a full set of country fixed effects.) This gives us three regressions, one for each skill type.

Figure 4 plots the estimated coefficients for the year dummies. The results are quite striking, in that virtually the entire reduction over time in employment comes in the low-skill category. Manufacturing’s share of low-skill employment has come down by 4 percentage points between 1995 and 2009, a decline that is statistically highly significant. The decline in medium-skill employment is miniscule by comparison, while manufacturing’s share of high-

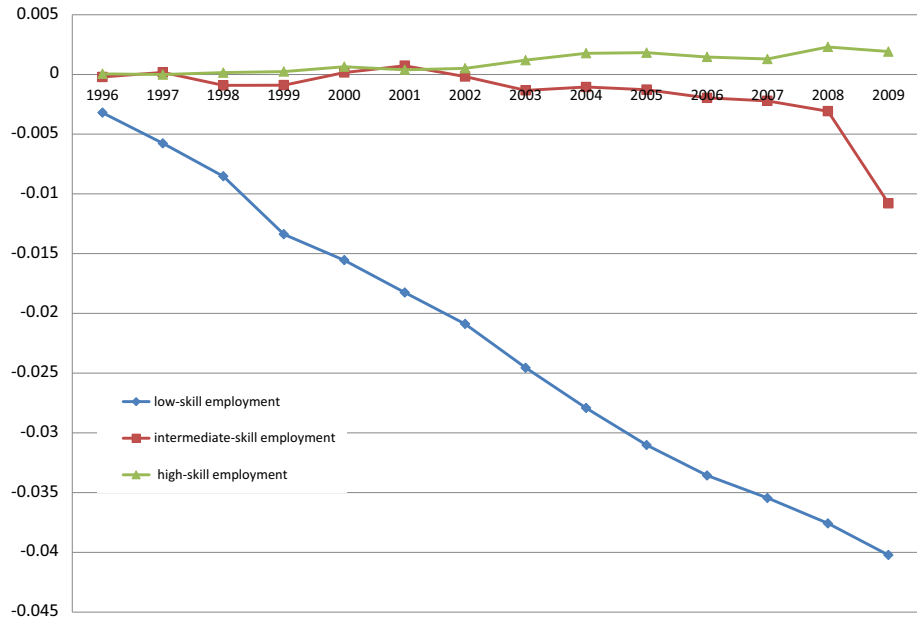


Fig. 4 Estimated year coefficients for employment of different skill types

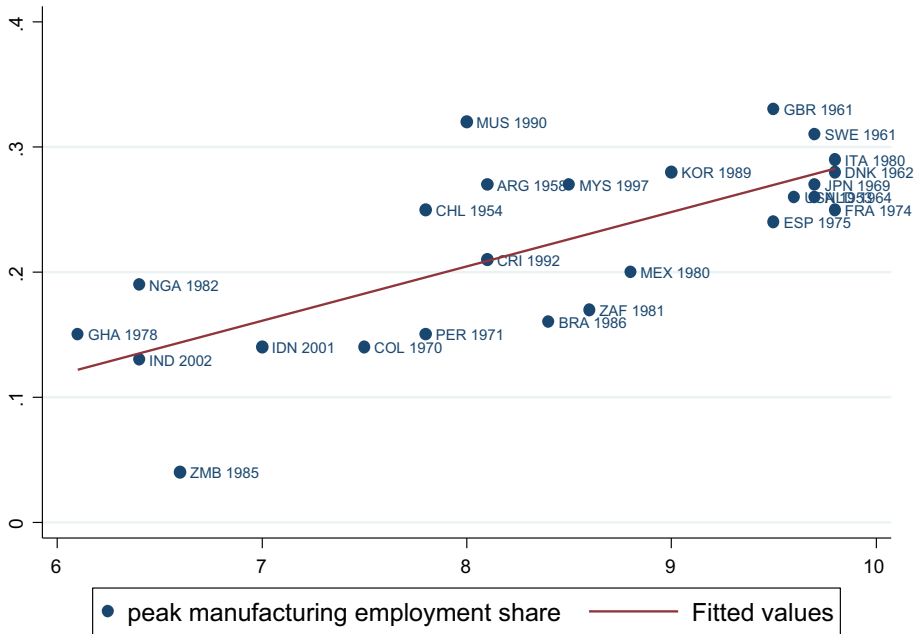


Fig. 5 Income at which manufacturing employment peaks (logs)

skill employment has actually slightly increased over the same period. The chart underscores in a dramatic fashion that it is low-skill workers who have borne the lion’s share of the impact of recent changes in trade and technology on manufacturing.

6 Premature deindustrialization

Our results so far suggest that late industrializers will reach peak levels of industrialization, as measured by *manemp* and *realmva*, that are quite a bit lower than those experienced by early industrializers. Let us denote these peak levels by *manemp** and *realmva**. There is evidence that suggests these peak levels are reached at lower levels of income as well. Denote that level of income by *y**. Our baseline regressions capture the downward shift in the manufacturing hump over time, but not the possibility that the curve may be moving closer to the origin as well.

Figure 5 suggests that *manemp** and *y** are in fact both lower for more recent industrializers. The figure displays *manemp* and *y* levels for the years of peak employment industrialization. (I have determined the turnaround years by looking at each country individually and identifying visually the year at which *manemp* begins to decline.) Compare the two sets of countries at the opposite ends of the chart. Industrialization peaked in Western European countries such as Britain, Sweden, and Italy at income levels of around \$14,000 (in 1990 dollars). India and many sub-Saharan African countries appear to have reached their peak manufacturing employment shares at income levels of \$700.¹⁰

Figure 5 represents a heuristic exercise that does not permit statistical testing. To check more systematically how the industrialization inverse U-curve has shifted over time, I run

¹⁰ For a similar chart, see Felipe and Rhee 2014.

Table 9 Regressions with interaction terms for post-1990

	<i>manemp</i>	<i>realmva</i>
ln population	0.166* (0.019)	-0.016 (0.025)
ln population squared	-0.005* (0.001)	0.001 (0.001)
ln GDP per capita	0.326* (0.018)	0.273* (0.029)
ln GDP per capita squared	-0.018* (0.001)	-0.013* (0.002)
ln GDP per capita X post-1990	0.031* (0.002)	0.015* (0.002)
ln GDP per capita squared X post-1990	-0.004* (0.000)	-0.002* (0.000)
Country fixed effects	Yes	Yes
Number of countries	42	42
number of observations	2209	2302

Robust standard errors are reported in parentheses

Levels of statistical significance: * 99%; ** 95%; *** 90%

regressions that drop the period dummies and interact the income and income squared terms with a dummy for the post-1990 period. Using the 1990 year as a break-point is somewhat arbitrary. But it ensures a sufficient number of observations on either side, and is also useful as a demarcation of the period in which globalization gathered speed. The results are shown in Table 9. The estimated coefficients on both interaction terms are statistically highly significant for *manemp* and *realmva* alike. Moreover, the signs confirm the pattern noted in Fig. 5.

Figures 6 and 7 plot the simulated industrialization levels against income for pre- and post-1990, based on the estimates in Table 9. We can see how the hump-shaped curves have moved closer to the origin in the latter period, in a particularly noticeable way for employment.¹¹ Using the same results, we can calculate *manemp** and *realmva**, and the corresponding point estimates for y^* for each sub-period. These are displayed in Table 10 and show dramatic differences. The table also shows 95% confidence intervals around the estimated y^* , computed using the delta method. The bands do not overlap in the case of *manemp*, indicating that the pre- and post-1990 difference is clearly statistically significant. The confidence intervals for *realmva* are much wider, so they prevent us from reaching as strong a conclusion for output.

To summarize, since 1990 countries have reached peak manufacturing employment and output shares at incomes that are around forty percent of the levels experienced before 1990. The employment effects are statistically highly significant. The output effects, which are almost equally large on average, are also quite heterogeneous across different country groups. So it is harder to reach a wholesale conclusion for *realmva* that pre- and post-1990 trends are statistically distinguishable.

7 Some analytics

To see how demand, technology, and trade shape the size of the manufacturing sector, I consider a simple two-sector model. The determinants of the inverse-U shaped pattern in manufacturing has been examined in the literature cited previously. My focus here is not on this per se, but on the forces behind the downward shift in manufacturing shares over time, as

¹¹ Amirapu and Subramanian (2015) present similar charts, using *industrial* employment data from the World Development Indicators.

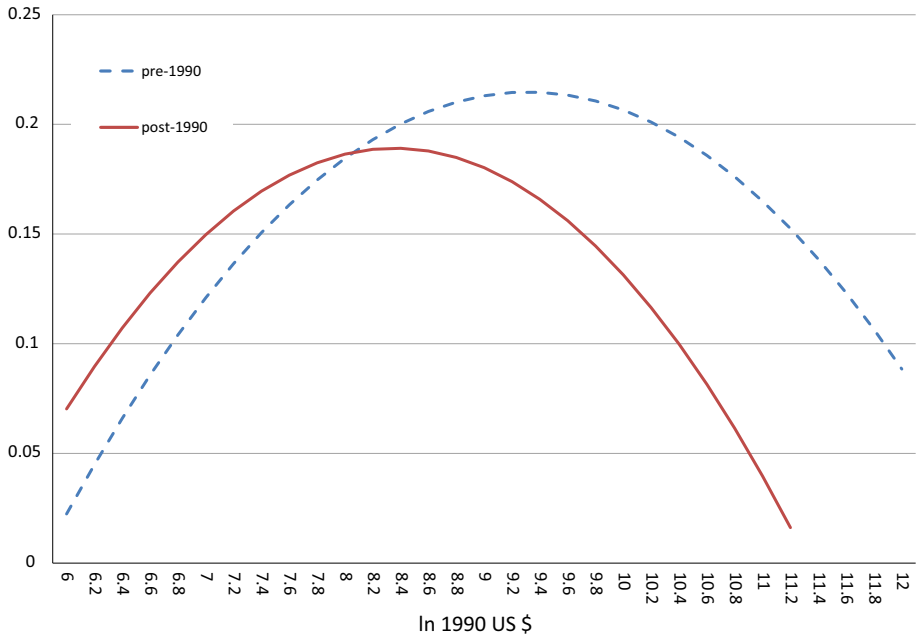


Fig. 6 Simulated manufacturing employment shares

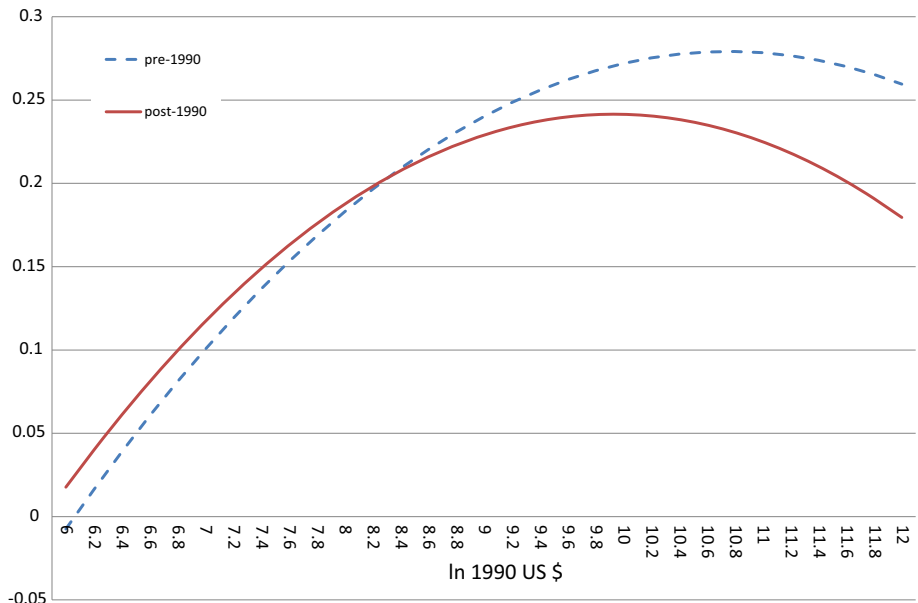


Fig. 7 Simulated manufacturing output shares (MVA/GDP at constant prices)

Table 10 Maximum industrialization levels, pre- and post-1990

	<i>manemp</i>		<i>realmva</i>	
	Pre-1990	Post-1990	Pre-1990	Post-1990
Maximum share	21.5 %	18.9 %	27.9 %	24.1 %
Reached at income level (GDP per capita, in 1990 international)\$	\$ 11,048	\$ 4273	\$ 47,099	\$ 20,537
95 % confidence interval	[8785, 14,017]	[3831, 4735]	[19,667, 112,081]	[12,429, 34,061]

Source: Author’s calculations; see text

documented previously. The model is barebones, and I claim no novelty for it. For the most part, it summarizes existing results in the literature. The framework’s main advantage is that it looks at the effects of different types of shocks on both employment- and output-based measures of industrialization. For more complete formal treatments of structural change, see Matsuyama (1992 and 2009), Ngai and Pissarides (2004), Buera and Joseph (2009), Foellmi and Zweimuller (2008), and Nickell et al. (2008).¹²

Let the economy be divided into manufacturing (*m*) and non-manufacturing (*n*), with a constant labor force fixed at unity. The share of employment in the manufacturing sector (*manemp*) is denoted by α . Production functions in the two sectors exhibits diminishing marginal returns to labor and are written as follows:

$$q_m^s = \theta_m \alpha^{\beta_m} \tag{1}$$

$$q_n^s = \theta_n (1 - \alpha)^{\beta_n}, \tag{2}$$

where q_m^s and q_n^s are the quantities supplied of manufactures and non-manufactures, respectively, θ_m and θ_n are parameters capturing the productivity of the two sectors, and β_m and β_n are technological constants between 0 and 1. The results in Sect. 5 provide strong hints of technological bias away from unskilled labor. But my focus here is on changes in the overall labor requirements in manufacturing rather than on substitution among different skill categories. The former is appropriately captured by shifts in the parameter θ_m .

It is convenient to represent the demand side in rates of change form, with a “hat” above a variable denoting proportional changes ($\hat{y} = dy/y$):

$$\hat{q}_m^d - \hat{q}_n^d = -\sigma (\hat{p}_m - \hat{p}_n), \tag{3}$$

where σ is the elasticity of substitution in consumption between the two goods. There are two goods-market clearing equations:

$$q_m^d + x = q_m^s \tag{4}$$

$$q_n^d = q_n^s, \tag{5}$$

where x stands for the net exports of the manufactured good. (For simplicity, I assume balanced trade in non-manufactures.) Labor is fully employed and mobile between the two

¹² For models of industrialization with increasing returns and inter-industry linkages, see also Rodríguez-Clare (1996), Venables (1996), and Rodrik (1996).

sectors. This gives us our final equation, which is the labor-market equilibrium equation:

$$\beta_m p_m \theta_m \alpha^{\beta_m - 1} = \beta_n p_n \theta_n (1 - \alpha)^{\beta_n - 1} \tag{6}$$

This equation equates the value marginal product of labor in the two sectors.

Since we can only determine relative prices, let's take the non-manufactured good to be the numeraire, fixing p_n at unity. We are left with seven endogenous variables: $\alpha, q_n^d, q_n^s, q_m^d, q_m^s, p_m$ and x . We would need an additional, global market-clearing equation to determine p_m and x simultaneously. This in turn requires modeling the rest of the world as well. Here I will take a short-cut and make one of two extreme assumptions. In one case, prices are determined endogenously by developments in the home economy and net trade flows are exogenous. In the second case, the economy is sufficiently small that it remains a price taker in world markets (so that x is endogenous and p_m is a parameter).¹³ These two characterizations are meant to capture the situations in the large developed and the developing countries, respectively.

Consider first the advanced economy case. Doing the comparative statics for the employment share of manufacturing, we get

$$d\alpha = \psi \left[\left(\frac{\sigma - \lambda}{\sigma} \right) \hat{\theta}_m - \left(\frac{\sigma - 1}{\sigma} \right) \hat{\theta}_n + \frac{1}{\sigma} \frac{dx}{q_m^d} \right], \tag{7}$$

where

$$\psi = \left[\frac{1}{\alpha} (1 - \beta_m) + \frac{1}{1 - \alpha} (1 - \beta_n) + \frac{1}{\sigma} \left(\frac{\lambda}{\alpha} \beta_m + \frac{1}{1 - \alpha} \beta_n \right) \right]^{-1} > 0$$

and

$$\lambda = \frac{q_m^s}{q_m^d}.$$

A lower trade surplus, or bigger trade deficit, in manufacturing ($dx < 0$) results in a smaller employment share in manufacturing, which is not surprising. Note that a reduction in x is formally analogous to an adverse demand shock for manufactures, such as a secular shift in demand towards services and other non-manufactures. In both cases, the manufacturing sector shrinks.

The relationship between technological progress ($\hat{\theta}_m, \hat{\theta}_n$) and α , on the other hand, depends critically on the size of the elasticity of substitution in demand between manufactures and non-manufactures. Suppose for the moment that net trade in manufactures is small so that $\lambda \approx 1$. Then if demand is inelastic ($\sigma < 1$), α is decreasing in technological progress in manufactures ($\hat{\theta}_m$) and increasing in technological progress in non-manufactures ($\hat{\theta}_n$). More rapid TFP growth in manufacturing, which is the usual case, results in employment deindustrialization. Intuitively, the technological progress-induced reduction in the relative price of manufacturing does not spur demand for manufactures sufficiently, so that the net result is a squeeze in manufactures employment. These results are reversed when demand is elastic ($\sigma > 1$). This is the same as the finding in [Ngai and Pissarides \(2004\)](#).¹⁴

¹³ I assume that manufactures are the only goods that are traded. In reality, many services are also traded, and the share that crosses national borders has increased over time. Still, even though services dominate the domestic economy, they amount to less than a quarter of global trade. For measurement and other issues posed by trade in services, see World Trade Organization (WTO 2010).

¹⁴ [Baumol and Bowen \(1965\)](#) and [Baumol \(1967\)](#) are the classic works that looked at the consequences of lower productivity growth in services relative to manufactures.

The effect of technological progress in manufacturing, however, is also mediated through λ , the ratio of supply to demand in manufacturing. This is something that has not been emphasized in the earlier literature, which typically assumes a closed economy. Consider the case where a country is a large net importer of manufactures ($\lambda \ll 1$). As can be seen from (7), as long as $\sigma - \lambda > 0$ the coefficient that multiplies $\hat{\theta}_m$ is positive. This is possible even when $\sigma < 1$ and demand for manufactures is inelastic. So we have a reversal of the result that inelastic demand and rapid technological progress in manufacturing produce (employment) deindustrialization.

The intuition behind this is as follows. The lower the share of domestic supply in total consumption, the smaller the effect of TFP in domestic manufactures on relative prices. When manufacturing experiences rapid productivity growth, it experiences less decline in relative prices (compared to a country where domestic supply is a large share of domestic consumption). Consequently, domestic output and employment are larger in equilibrium. In the limit, when technological progress has no effect on domestic relative prices, manufacturing employment is always boosted by TFP growth in manufactures. This is indeed the case in our other benchmark example, a small open economy which takes its relative prices from world markets.

Before we turn to that case, however, let us also look at the output share of manufacturing and how it is affected by trade and technology. Denote the real value added share of manufacturing (*realmva*) by α_q :

$$\alpha_q = \frac{q_m^s}{q_m^s + q_n^s}.$$

We can now relate output-deindustrialization ($d\alpha_q$) to employment deindustrialization ($d\alpha$) as follows:

$$d\alpha_q = \alpha_q (1 - \alpha_q) \left[\hat{\theta}_m - \hat{\theta}_n + \left(\frac{1}{\alpha} \beta_m + \frac{1}{1 - \alpha} \beta_n \right) d\alpha \right]. \tag{8}$$

This shows that when the main shock comes from trade or demand (with $\hat{\theta}_m = \hat{\theta}_n = 0$), the two measures of industrialization always move in the same way. However, when employment deindustrialization is due to differential TFP growth in manufacturing ($\hat{\theta}_m - \hat{\theta}_n > 0$), it is possible for the output share of manufacturing to move very little, or even to increase.

To see this in greater detail, consider the case where the economy does not trade at all so that $\lambda = 1$. In this case, the output share of manufacturing must in fact rise. We can read this off readily from the demand-side relationship (3). Differential productivity growth in manufacturing depresses the relative price of manufacturing, and this implies $\hat{q}_m^d = \hat{q}_m^s > \hat{q}_n^d = \hat{q}_n^s$, and therefore $d\alpha_q > 0$. Or, substituting (7) into (8) and solving, we get:

$$d\alpha_q = \alpha_q (1 - \alpha_q) \left\{ \frac{\left(\frac{\sigma}{\sigma - 1} \right)}{\left(\frac{\sigma}{\sigma - 1} \right) - [(1 - \alpha) \beta_m + \alpha \beta_n]} \right\} (\hat{\theta}_m - \hat{\theta}_n).$$

Since the term in curly brackets is positive when $\sigma < 1$, α_q must move in the same direction as differential productivity growth in manufacturing. This establishes that in an economy where trade plays a small role, rapid technological progress in manufacturing produces employment deindustrialization, but not output deindustrialization.

Let us look now at the small-open economy case. For this case, we treat price changes parametrically and take x to be endogenous. The comparative statics yields:

$$d\alpha = \left[\frac{1}{\alpha} (1 - \beta_m) + \frac{1}{1 - \alpha} (1 - \beta_n) \right]^{-1} \left[\hat{p}_m + \hat{\theta}_m - \hat{\theta}_n \right]. \quad (9)$$

Technological progress in manufacturing now has an unambiguously positive effect on α . Technological progress in non-manufacturing has an unambiguously negative effect. And an increase in the relative price of manufacturing works just like technological progress in manufacturing. Moreover, the result does not depend on σ or its magnitude, as trade has the effect of de-linking the supply side of the economy from the demand side. For the same reason, adverse domestic demand shocks would not produce deindustrialization in the small open economy; domestic producers can sell the surplus output on world markets. As Matsuyama (2009) has previously emphasized, the relationship between productivity growth and industrialization depends crucially on whether we treat prices to be determined domestically or in the global economy.¹⁵

This last set of results is important in interpreting the experience of developing countries that have experienced rapid deindustrialization. These countries tend to be small in global markets for manufacturing, so we can take them as price takers. What equation (9) shows is that employment deindustrialization in those countries cannot have been the consequence of differentially rapid TFP growth in manufacturing at home. That kind of technological progress would have fostered industrialization, rather than the reverse. In this respect, developing countries are quite different from the advanced countries where there is considerable evidence that domestic technological progress was the culprit.

As price takers, however, these developing countries may have “imported” deindustrialization from the abroad. Most countries in Latin America undertook significant trade liberalizations in the second half of the 1980s and early 1990s, transforming themselves into open economies. Many countries in Sub-Saharan Africa experienced trade opening as well around the same time. As (9) shows, a decline in the relative price of manufactures ($\hat{p}_m < 0$) – the result of technological progress elsewhere, the rise of China, domestic trade liberalization, or all three – would have had the same effect as technological regress at home in manufacturing. Even with more rapid TFP growth in manufacturing (compared to non-manufacturing), these countries would find themselves deindustrializing in employment terms.

Putting it differently, employment industrialization in the developing world requires more than differentially rapid TFP growth in manufacturing. It requires that the productivity growth differential between manufacturing and non-manufacturing also exceed the decline in manufactures’ relative prices on world markets. Our empirical results suggest that only very few developing countries managed this feat consistently.

The configuration of analytical results under different assumptions about economic closure and the nature of the shocks is summarized in the table below.

¹⁵ Matsuyama (2009) shows that cross-country results have to be interpreted with caution when economies are globally integrated. In particular, faster productivity gains need not be correlated with more rapid decline in manufacturing across countries, even if productivity change is globally responsible for manufacturing’s decline. See also Uy et al. (2013) which develops a model with productivity and trade cost shocks under various assumptions about demand, and uses it to explain South Korea’s pattern of structural change. The authors find that non-homothetic demand, more rapid productivity growth in manufacturing, and the decline in manufacturing trade costs do a good job of explaining structural change, with the exception of the decline in manufacturing after 1990.

Effects of trade, technology, and demand on different measures of industrialization

A. "Closed" economy (with $\sigma < 1$)

Effect on:	Technology shock: $\hat{\theta}_m - \hat{\theta}_n > 0$	Trade shock: $dx < 0$	Adverse domestic demand shock on manufacturing
<i>manemp</i> ($d\alpha$)	–	–	–
<i>realmva</i> ($d\alpha_q$)	+	–	–

B. Small open economy

Effect on:	Technology shock: $\hat{\theta}_m - \hat{\theta}_n > 0$	External price shock: $\hat{p}_m < 0$	Adverse domestic demand shock on manufacturing
<i>manemp</i> ($d\alpha$)	+	–	0
<i>realmva</i> ($d\alpha_q$)	+	–	0

These are all ceteris paribus results, for the case where each country can be treated individually. We need to exercise care in interpreting them when technology (or demand) shocks occur in many countries simultaneously (requiring us to explicitly endogenize trade volumes and relative prices on world markets). Consider the consequences of technological progress in manufacturing that takes place in both developed and developing countries. As long as the (global) supply of manufactures exceeds supply of non-manufactures at unchanged prices, the consequence is that $\hat{p}_m < 0$ for all countries. Those countries which have experienced less technological progress in manufacturing will see their manufacturing industries suffer declines in output, even though productivity has increased. When TFP growth in manufacturing is global, only those countries with the more rapid TFP growth will avoid deindustrialization. So for Latin America or Africa to experience industrialization as open economies, they must have had TFP growth in manufacturing that was faster than in the rest of the world, which evidently did not happen.

Finally, we can use this framework also to interpret the consequences of resource rents and related Dutch-disease issues in open economies. Many Latin American and African countries have experienced booming primary sectors as a consequence of resource discoveries and a rise in commodity price. In the present model a resource boom would manifest itself as an increase in productivity growth and/or prices in non-manufacturing (relative to manufacturing, in both cases). The effects for small open economies can be read off the first two columns in part B of the table above: the economy suffers both employment and output deindustrialization. Effectively, resource booms magnify the deindustrializing consequences that trade has on countries with comparative advantage in primary products.¹⁶

8 Concluding remarks: implications and consequences

One way to understand the transformation in global manufacturing documented here is to consider the analogy of a closed economy with three regions: a high-income region that is already industrialized, and two low-income regions, one with a strong comparative advantage

¹⁶ Aid inflows operate similarly to resource booms in so far as they drive up the price of non-traded goods, and reduce the relative price of manufactures. For an examination of these issues in the Sub-Saharan African and Latin American contexts, respectively, see Rajan and Subramanian (2011) and Palma (2014).

(or head start) in manufacturing and the other without.¹⁷ The economy experiences two shocks: (low-skill) labor-saving technological progress and decline in transport/transaction costs among regions. We would then observe the following patterns: (i) a sharp decline in manufacturing employment in the high-income region, with the impact on manufacturing output (at constant prices) depending on the balance between technology (positive) and trade (negative) shocks; (ii) an increase in output and (possibly) employment in the low-income region with the comparative advantage (or head start) in manufactures; and (iii) a decline in both output and employment in the other low-income region. These consequences broadly capture the trends we have seen in the advanced economies, Asian manufactures exporters, and other developing economies, respectively.

How concerned should low- and middle-income countries be about their “premature” deindustrialization? The previous section treated productivity growth as exogenous, to examine its consequences for industrialization under different economic structures. But there is a reverse channel of causation as well, especially in developing countries, which goes from industrialization to economy-wide productivity. In low-income settings, the movement of workers from the countryside to urban factories where their productivity tends to be much higher is an important source of productivity growth. Industrialization contributes to growth both because of this reallocation effect and because manufacturing tends to experience relatively stronger productivity growth over the medium to longer term. In fact, organized, formal manufacturing appears to exhibit unconditional convergence, which makes it a potent engine of growth (Rodrik 2013, 2014).¹⁸ From this perspective, premature deindustrialization is not good news for developing nations. It blocks off the main avenue of rapid economic convergence in low-income settings.¹⁹

The consequences are already visible in the developing world. In Latin America, as manufacturing has shrunk informality has grown and economy-wide productivity has suffered. In Africa, urban migrants are crowding into petty services instead of manufacturing, and despite growing Chinese investment there are as yet few signs of a significant resurgence in industry. McMillan and Rodrik (2011) analyze employment patterns in a broad cross-section

¹⁷ I am grateful to an anonymous referee who suggested the closed-economy analogy.

¹⁸ Young (November 2013 and forthcoming) raises some important questions about gaps in inter-sectoral productivity and in manufacturing versus nonmanufacturing productivity growth, arguing that these gaps may be due to selection based on unobserved worker skills. To the extent that manufacturing is more productive because it employs the more capable workers, it loses its “specialness.” In particular, more labor absorption in manufacturing would not raise economy-wide productivity, as marginal workers drawn into manufacturing would be of the lower-productivity type. Even if selection effects are present, however, it is not clear they can explain why manufacturing industries that are further away from the frontier experience more rapid labor productivity growth (as in Rodrik 2013). A recent paper by Franck and Galor (2015) suggests early industrialization may have adverse long-run effects, within a country: these authors find that regions in France that adopted industrial technology earlier eventually ended up with lower incomes and human capital levels. It is not clear what the implications of such results to growth patterns across countries are, however. France is a post-industrial country, and the cross-region findings are conditional on industrialization and within-country convergence having taken place.

¹⁹ A full welfare evaluation of the trends discussed in this paper must take into account other effects in addition to the foregone productivity gains due to premature deindustrialization. For developing countries that are net importers of manufactures, the global reduction in the relative price of manufactures due to technological progress in advanced countries represents a terms-of-trade benefit and a (static) welfare gain. (For developing countries that are net exporters of manufactures, there is a corresponding terms-of-trade loss.) The fall in manufacturing prices may also reduce the cost of capital-goods in developing countries, and thereby spur investment. Where private investment is sub-optimal due to credit-market or other failures, this would represent an additional source of welfare gain. It is in principle possible to attach some quantitative magnitudes for representative countries to each one of these effects, using the results here and in Rodrik (2013). However, such an effort would take this paper too far afield, and I leave it to future work.

of developing economies and find that labor has been moving in the wrong direction in Latin America and Africa – to low productivity services and away from high productivity activities such as manufacturing. So structural change has ended up being growth-reducing in these countries in recent decades, unlike the 1950-75 period during which it made a strong positive contribution to growth (see also [de Vries et al. 2013](#), and [McMillan et al. 2014](#)).²⁰

There has been no lack of growth in the developing world since the mid-1990s. But outside of Asia and the small group of manufactures exporters, the evidence (cited in the previous paragraph) shows that this growth has not been driven by the traditional mechanism of industrialization. Many of the growth booms appear to have been driven by capital inflows, external transfers, or commodity booms, raising questions about their sustainability.²¹

In the absence of sizable manufacturing industries, these economies will need to discover new growth models. One possibility is services-led growth. Many services, such as IT and finance, are high productivity and tradable, and could play the escalator role that manufacturing has traditionally played. However, these service industries are typically highly skill-intensive, and do not have the capacity to absorb—as manufacturing did—the type of labor that low- and middle-income economies have in abundance. The bulk of other services suffer from two shortcomings. Either they are technologically not very dynamic. Or they are non-tradable, which means that their ability to expand rapidly is constrained by incomes (and hence productivity) in the rest of the economy.

None of this implies that developing countries have to stagnate. As I discuss in [Rodrik \(2014\)](#), moderate growth is possible through improved fundamentals—better institutions and growing stocks of human capital, skills, and knowledge. The advanced countries themselves have been able to grow at rates between 1.5 and 2 % per annum despite declining manufacturing. But catching up with the frontier requires growth rates higher than these. Sustained, rapid convergence on the part of developing economies has historically required industrialization, except for a very few resource-rich economies.²²

The political consequences of premature deindustrialization are more subtle, but could be even more significant. Historically, industrialization played a foundational role in Western Europe and North America in creating modern states and democratic politics. The labor movement, a product of industrialization, led demands for the expansion of the franchise, and eventually the creation of the welfare state. It was the bargain between elites and organized labor that enabled the development of democracy ([Acemoglu and Robinson 2009](#)). The weakness of organized labor in today’s developing societies is likely to foster different paths of political development, not necessarily friendly to liberal democracy. In particular, the

²⁰ It is possible that these trends will be reversed, as manufacturing migrates from Asia to low-wage countries. Anecdotal evidence (e.g. the rise of Chinese manufacturing investment in countries such as Ethiopia and Rwanda) as well as some of the more systematic evidence in [McMillan et al. \(2014\)](#) suggest that manufacturing may have a renewal of sorts in Sub-Saharan Africa. But the fact that we rarely see double humps in the manufacturing curve should make us skeptical of this eventuality.

²¹ On Africa, for example, see [African Center for Economic Transformation \(2014\)](#), which emphasizes the need for productive diversification and structural transformation if recent growth rates are to be sustained.

²² I show in [Rodrik \(2014\)](#) that the vast majority of the countries that experienced growth rates of 4.5 percent or more for at least three decades are those that underwent rapid industrialization. The list is composed essentially of two categories of countries: some in the European periphery during the 1950s and 1960s (e.g., Spain, Portugal, Israel), and some in East Asia since the 1960s (e.g., South Korea, Taiwan, Malaysia). The exceptions are some small, but resource-rich countries (e.g., Botswana, Oman, Equatorial Guinea), many of which experienced reversals eventually. In that paper, I propose a framework that distinguishes between two channels of growth, with overlapping but distinct requirements: a “fundamentals” channel that relies on the accumulation of economy-wide skills and institutional capabilities, and a “structural transformation” channel that relies on industrialization. I argue that slow-to-moderate growth is possible with the former, but that rapid convergence requires the latter.

substitution of identity or ethnic cleavages for class cleavages as the central loci of politics may spawn “electoral” or “illiberal” democracies. We present a formal model in [Mukand and Rodrik \(2015\)](#) which suggests precisely that.

Such considerations are necessarily speculative. Nevertheless, whatever the specific consequences, premature deindustrialization suggests the future of today’s developing countries will be unlike the past of today’s advanced societies—neither economically nor politically.

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Appendix

Country and variable coverage in the GGDC 10-Sector Database

Acronym	Country	Value added in current prices	Value added in constant prices	Employment by sector
Sub-Saharan Africa				
BWA	Botswana	1964–2010	1964–2010	1964–2010
ETH	Ethiopia	1961–2010	1961–2010	1961–2010
GHA	Ghana	1960–2010	1960–2010	1960–2010
KEN	Kenya	1960–2010	1964–2010	1969–2010
MWI	Malawi	1960–2010	1966–2010	1966–2010
MUS	Mauritius	1960–2010	1970–2010	1970–2010
NGA	Nigeria	1960–2010	1960–2010	1960–2011
NGA(alt)	Nigeria (2014 GDP revision)	2010–2013	2010–2013 (in 2010 prices)	
SEN	Senegal	1960–2010	1970–2010	1970–2010
ZAF	South Africa	1960–2010	1960–2010	1960–2010
TZA	Tanzania	1960–2010	1960–2010	1960–2010
ZMB	Zambia	1960–2010	1965–2010	1965–2010
North Africa				
EGY	Egypt	1960–2013	1960–2012	1960–2012
MOR	Morocco	1970–2012	1960–2012	1960–2012
Asia				
CHN	China	1952–2011	1952–2010	1952–2011
HKG	Hong Kong	1970–2011	1974–2011	1974–2011
IND	India	1950–2012	1950–2012	1960–2010
IDN	Indonesia	1966–2012	1960–2012	1961–2012
JPN	Japan	1953–2011	1953–2011	1953–2012
KOR	South Korea	1953–2011	1953–2011	1963–2011
MYS	Malaysia	1970–2011	1970–2011	1975–2011

Acronym	Country	Value added in current prices	Value added in constant prices	Employment by sector
PHL	Philippines	1971–2012	1971–2012	1971–2012
SGP	Singapore	1970–2012	1960–2012	1970–2011
TWN	Taiwan	1951–2012	1961–2012	1963–2012
THA	Thailand	1951–2011	1951–2011	1960–2011
Latin America				
ARG	Argentina	1950–2011	1950–2011	1950–2011
BOL	Bolivia	1958–2011	1950–2011	1950–2010
BRA	Brazil	1990–2011	1950–2011	1950–2011
CHL	Chile	1950–2011	1950–2011	1950–2012
COL	Colombia	1950–2011	1950–2011	1950–2010
CRI	Costa Rica	1950–2011	1950–2011	1950–2011
MEX	Mexico	1950–2011	1950–2011	1950–2012
PER	Peru	1950–2011	1950–2011	1960–2011
VEN	Venezuela	1960–2012	1950–2012	1950–2011
North America				
USA	United States of America	1947–2010	1947–2010	1950–2010
Europe				
DEW	West Germany	1968–1991	1950–1991 (1991 prices)	1950–1991
DNK	Denmark	1970–2011	1947–2009	1948–2011
ESP	Spain	1970–2011	1947–2009	1950–2011
FRA	France	1970–2011	1950–2009	1950–2011
GBR	United Kingdom	1960–2011	1949–2009	1948–2011
ITA	Italy	1970–2011	1951–2009	1951–2011
NLD	The Netherlands	1970–2011	1949–2009	1950–2011
SWE	Sweden	1970–2011	1950–2009	1950–2011

Source Timmer et al. (2014). See <http://www.rug.nl/research/ggdc/data/10-sector-database>

Countries included in the Socio Economic Accounts of the World Input-Output Database (WIOD)

Austria, Germany, Netherlands, Canada, China, Belgium, Greece, Poland, United States, India, Bulgaria, Hungary, Portugal, Japan, Cyprus, Ireland, Romania, South Korea, Czech Republic, Italy, Slovak Republic, Australia, Denmark, Latvia, Slovenia, Brazil, Taiwan, Estonia, Lithuania, Spain, Mexico, Turkey, Finland, Luxembourg, Sweden, Indonesia, France, Malta, United Kingdom, Russia.

Source Timmer (2012), latest update available at http://www.wiod.org/protected3/data/update_sep12/SEA%20Sources_June2014.pdf.

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