MANUFACTURING MATTERS… BUT IT'S THE JOBS THAT COUNT

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and Changyong Rhee

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ABSTRACT

This paper asks, first, whether today's developing economies can achieve high-income status without first building large manufacturing sectors. We find that practically every economy that enjoys a high income today experienced a manufacturing employment share in excess of 18%–20% sometime since the 1970s. Manufacturing output share thresholds are much poorer predictors of rich-country status than their employment counterparts. This motivates us to ask whether it is becoming more difficult to sustain high levels of manufacturing activity. We find that the maximum expected employment share for a typical developing economy has fallen to around 13%–15%, and that deindustrialization in employment sets in at much lower income per capita levels of $8,000–$9,000, than it once did. Neither manufacturing output shares, nor the level of income at which they decline have fallen as obviously. These results are consistent with the idea that industrialization in employment terms has been more important for eventual prosperity than has industrialization in output terms; and that high manufacturing employment shares are becoming more difficult to sustain as incomes rise. This suggests that the path to prosperity through industrialization may have become more difficult.

Keywords: industrialization, inverted U-shape, manufacturing

JEL Classification: O14

I. INTRODUCTION

This paper asks two complementary questions. First, whether today's developing economies can achieve high-income status without first building large manufacturing sectors; and second, whether it is becoming more difficult to sustain high levels of manufacturing activity. These are relevant questions because a long tradition in development economics holds that manufacturing is the *engine of growth* (Kaldor 1966; Chenery, Robinson, and Syrquin 1986). However, as we discuss below, there is a growing perception that economies are finding it more difficult to sustain high levels of manufacturing output and employment while simultaneously increasing wages.

The relevance of manufacturing for economic growth derives from the fact that faster growth in manufacturing generates faster growth in productivity in other sectors of the economy. Manufacturing draws resources from traditional sectors of the economy, often without significantly reducing output in these sectors. Channeling these resources into manufacturing is beneficial because manufactured goods have high income elasticities of demand, and because many manufacturing activities are produced under economies of scale. Moreover, manufacturing has a potential for productivity catch-up that is unmatched by most services.[1] Along these lines, recent research confirms that manufacturing is key for economic development. Rodrik (2013a) shows that manufacturing exhibits unconditional convergence in labor productivity—industries that start farther away from the labor productivity frontier experience significantly faster productivity growth even without conditioning on variables, such as domestic policies, human capital, geography, or institutional quality. Economies with higher manufacturing employment shares should therefore grow faster. See also Amable (2000), Fagerberg (2000), Peneder (2003), Rodrik (2009), Szirmai (2012), Szirmai and Verspagen (2011), and UNIDO (2013).

For these reasons, many national governments have targeted manufacturing in their development plans. For example, India's 2011 National Manufacturing Policy aims at raising the share of manufacturing in gross domestic product (GDP) to 25% and calls for setting up manufacturing zones to create 100 million manufacturing jobs. The Philippines is also developing a comprehensive manufacturing road map, and Indonesia passed a new Industry Law in early 2014. Developed economies like the United States (US), Australia or the members of the European Union, are also interested in industrializing, or rather, in reindustrializing after decades of deindustrializing (Helper, Krueger, and Wial 2012; Felipe, forthcoming 2015).

As noted above, however, there is a growing perception that, in recent times, it has become more difficult for economies to sustain high levels of manufacturing output and employment while simultaneously increasing wages and living standards (Rodrik 2009). This difficulty has been attributed to at least two forces. First, the internationalization of supply chains and increased international competition are making the location of manufacturing activity more sensitive to wage improvements, other things equal (Hasan, Mitra, and Ramaswamy 2007; Rodrik 1997). This phenomenon tends to reduce manufacturing output and employment levels more in high-wage, high-income economies, than in their poorer counterparts. To the extent that manufacturing output and employment shares tend to increase with income per capita when incomes are low, and then to decrease with incomes, following an inverted U-shape, this force should cause the per capita income level at which manufacturing employment and output shares peak to decline. However, to the extent that economies that experience rising wages can substitute capital for labor, this shift should be more apparent in employment than in output shares.

[1] See the *Symposium on Kaldor's Growth Laws*, published in the Journal of Post Keynesian Economics (1983).

Second, it has long been accepted that technological change has placed downward pressure on the sector's demand for less-skilled workers (Berman, Bound, and Griliches 1994; Berman, Bound, and Machin 1998; Goldin and Katz 2009), and there is now growing concern that technological change and the efficiencies that derive from globalized mass production are generally labor displacing (Cowen 2013; Brynjolfsson and McAffee 2014). Faster rates of labor-displacing technological change in manufacturing than in other sectors should push manufacturing employment shares down relative to manufacturing output shares. Rodrik (2013b, p. 52) has echoed this sentiment, "Technological changes are rendering manufacturing more capital and skill intensive, reducing the employment elasticity of industrialization and the capacity of manufacturing to absorb large volumes of unskilled labor from the countryside and from the informal sector." Together, these hypothesized forces make us wonder whether the rapid manufacturing-driven growth experienced by the Republic of Korea, Singapore, or Taipei,China, remains possible elsewhere. If it has become less likely, is there any evidence of an alternative path to prosperity?

This paper, therefore, answers two sets of questions. First, are there relevant examples of economies that are rich today but did not attain large manufacturing sectors at some point in their past? Are there economies that did not achieve large manufacturing sectors and became rich anyway? And has manufacturing employment or manufacturing output been more relevant to eventual prosperity? Second, is it indeed the case that high manufacturing employment and output shares are becoming more difficult to sustain? Specifically, if, as hypothesized, economies are experiencing a combination of increasing international competition for manufacturing jobs and rising labor productivity in manufacturing relative to other sectors, we should expect: (H1) peak manufacturing employment shares to decline; and (H2) both employment and output shares to peak at lower and lower income levels over time. Moreover, to the extent that economies can switch to more capital-intensive products and techniques as incomes rise, and to the extent that labor productivity increases drive manufacturing employment down, (H3) both trends (i.e., H1 and H2) should be more apparent in employment than in output shares. The paper tests these three hypotheses.

To shed light on these issues, we compile a carefully cleaned data set on manufacturing employment shares for 52 economies that is consistent over time. Reliable data on manufacturing employment shares over time have been available for a relatively small set of economies, most of which have, at some point in their history, supported high levels of manufacturing employment. It is therefore unknown, even as a historical fact, whether economies that failed to generate a large number of manufacturing jobs actually fared worse than those that did generate such jobs. We also have output share data for these same economies and for a further 83 economies. These data sets permit us to test whether there are particular thresholds in manufacturing employment and output that high-income economies have tended to cross. Our main contributions to the literature are two novel findings. First, that manufacturing employment is a better predictor of prosperity than manufacturing output; and second, that economies are finding more difficult to sustain high manufacturing employment shares (but not output shares) as their incomes rise.

Table 1 shows the peak and current manufacturing employment and output shares for a group of advanced and developing economies. Employment shares in advanced economies peaked earlier and at significantly higher levels than in developing economies. Current employment shares, on the other hand, are slightly lower in advanced economies. Peak output shares, in contrast, have not fallen nearly as much.

Table 1: Peak and Current Manufacturing Shares, Selected Economies
(Ordered by year of peak manufacturing employment share)

	Employment Shares (%)				Output Shares (%)			
	Peak		Latest		Peak		Latest	
	Year	Level	Year	Level	Year	Level	Year	Level
United Kingdom	1970	34.7	2008	12.0	1970	28.9	2010	10.7
United States	1970	26.4	2009	10.4	1972	23.8	2010	12.9
Argentina	1970	22.6	2005	11.5	1976	38.7	2010	20.5
Philippines	1971	11.3	2008	8.6	1973	28.9	2008	21.4
Japan	1973	27.5	2008	18.4	1973	32.4	2010	19.4
Brazil	1986	16.4	2007	13.4	1980	33.3	2010	16.2
Korea, Republic of	1989	27.8	2008	16.8	2010	30.3	2010	30.3
Mexico	1990	20.0	2008	16.9	1988	23.2	2010	18.3
India	2001	14.8	2005	13.6	1995	18	2010	14.7
Indonesia	2002	12.9	2008	12.0	1997	29.4	2010	24.8
China, People's Republic of	2010	16.9	2010	16.9	1978	40.5	2010	29.6

Notes: Peak shares are calculated as 7-year (centered) moving averages from 1970 to 2010. The peak is the highest of all these moving averages.
Source: Authors' calculations.

The remainder of the paper is structured as follows: Section II briefly describes our data set. Section III uses cross-sectional data to show that there is a strong positive relationship between the maximum manufacturing employment share that an economy achieved in the last 40 years and its per capita GDP today. We also test hypotheses H1, H2 and H3 through inter-country comparisons. Motivated by one key finding in Section III, Section IV asks whether all rich economies industrialized, and whether all economies that industrialized are rich. In Section V, we use panel data regressions to examine trends in manufacturing employment and output shares, and test whether our three hypotheses hold within economies over time. Section VI is dedicated to interpretation, caveats, and conclusions.

II. DATA

Our data on manufacturing employment shares come from a variety of sources, some of them spliced together. Data for four of our 52 economies come solely from the Organisation for Economic Co-operation and Development (OECD) Stan database, and data for another four come solely from the Groningen Growth Development Center (GGDC). We calculated the PRC's shares directly from the Census.[2] The remaining economies all utilize data from the International Labour Organization's (ILO's) LABORSTA database. LABORSTA often provides multiple estimates for the same economy and time period, differentiated by source, sampling restrictions, and sector classification systems. We have carefully selected the series to achieve maximum consistency, and cleaned these data meticulously, as explained in Appendix A. Data from a further 17 economies come from LABORSTA alone. However, in some cases, the LABORSTA series begin late into our sample period or end early.

[2] We opted for the PRC's census over data from the Statistical yearbooks, because the yearbook data are considered less reliable (Li and Gibson 2013), and do not cover the rural sector post-2003.

Where this is the case, we impute earlier and later employment shares using growth rates derived from the OECD Stan database (12 economies) or the GGDC data (six economies). For a further eight economies, we use GGDC data and fill in the gaps using growth rates calculated from LABORSTA. Prior to splicing series together, we corroborated that, for the common periods (i.e., periods when two sources provided data), the correlation between the two series was above 0.9. The list of sources for employment shares used for each economy is provided in Appendix A.

Manufacturing output shares are from the United Nations (UN) Statistics Division (SD). They capture the sector's share in value added, measured in current dollars. These data were sufficiently complete for an additional 83 economies. The UN does not provide output share data for the People's Republic of China (PRC) and Taipei,China, and so we obtained these value-added shares from the World Bank's current price series. While this series is slightly less comprehensive than the UN's, the correlation between the two series across time and economies is 0.94.

In sum, we have output share data for 135 economies, out of which we have sufficient employment share data for 52. Sufficient, in this case, means that we have at least five observed employment shares for the economy, including one as far in the past as the early 1980s and one in the new millennium. On average, each economy has 34 observed employment shares. Appendix A also provides the number of observed employment shares, and earliest and latest dates of these observations for each economy. On average, the 52 economies with sufficient employment data had higher incomes both during 2005–2010 and in the year the manufacturing output share peaked, than the 83 economies without sufficient employment data. They also have bigger populations, higher peak manufacturing output shares and experienced their peak manufacturing output share earlier. Appendix A contains the details.

We also draw upon the following series: per capita GDP in 2005 constant dollars (WDI); population (UNSD); and years of schooling in the population aged 15 and above (Barro and Lee 2010). Missing observations on these variables (other than those at the start and end of the time series) are filled in through log-linear interpolation.

As we discuss in Appendix B, small island economies are quite different structurally to larger, non-island nations. They have lower output shares, and structural endowments (land, demographics) are much more important for explaining the behavior of output shares in small island nations than in other nations. Data from small island nations are also often incomplete. We therefore exclude all island economies with a 1990 population of less than one million from our sample. We also exclude nations that have split up or unified over the course of our sample to ensure meaningful analysis.

We subjected the panel data set of output shares used in Section V to yet further cleaning procedures. We dropped observations of output shares if the UN and World Bank's estimates of current price output shares for that economy and year differed by more than 1 percentage point and by a factor at least 30%; and for those observations lacking estimates from the World Bank, if the UN constant and current price shares differ by more than 1 percentage point and a factor of at least 50%. This restricts the sample to observations in which we have greater confidence.

Finally, we note that we may have underestimated recent manufacturing employment and output shares due to the unbundling of many production processes that used to be included in manufacturing but now are part of services.[3] This does raise the possibility that we have overestimated the rate at which manufacturing activity has declined. We are nevertheless quite confident that much of the recent difficulty with sustaining manufacturing activity that we document is real. We consider these arguments in the concluding section after presenting our empirical results.

III. CROSS-SECTIONAL EVIDENCE ON THE IMPORTANCE AND FEASIBILITY OF ATTAINING HIGH MANUFACTURING EMPLOYMENT SHARES

This section uses cross-sectional data to show a key result of this paper, namely, that there is a strong positive relationship between the maximum manufacturing employment share that an economy achieved in the last 40 years and its per capita GDP today. This result does not hold as strongly for manufacturing output shares. We also test the three hypotheses motivated in the introduction: (H1) manufacturing employment shares have declined over time, (H2) the income levels at which employment and output shares peak have declined over time, and (H3) these two trends are more acute for employment than for output shares. The trends discussed here will be analyzed in detail in Sections IV and V.

Figure 1 shows that there is a positive and statistically significant relationship between economies' income per capita in 2005–2010 and the peak historical manufacturing employment share. The relationship with output shares is also positive, but much noisier. This is our first indication that manufacturing employment is more important than manufacturing output as a determinant of eventual prosperity. Manufacturing shares are calculated as 7-year moving averages from 1970 to 2010, and the peak is the highest of all these moving averages. There are economies that achieved shares of over 30%, with Hong Kong, China hitting over 40%; and economies that attained much lower shares.

Regression 1 in Panel A of Table 2 shows that economies that achieved high peak employment shares in the past are richer today. Indeed, controlling for the peak manufacturing employment shares, peak manufacturing output shares are statistically insignificant. A 1 percentage point difference in the peak manufacturing employment share is associated with a final per capita GDP that is 13% higher. Regression 2 shows that the slope of the best fit line in Figure 1 is statistically significant, while Regression 3 shows that, on their own, peak manufacturing output shares have very little explanatory power (note the much lower R-squared statistic). These regressions suggest that the industrialization process predicts future prosperity only insofar as it generates manufacturing jobs. Regression 4 adds the value of EXPY in the year the employment share peaked. EXPY is a proxy measure for the sophistication of an economy's export mix calculated using product (not services) data, and known to be a solid predictor of an economy's subsequent export performance (Hausmann, Hwang, and Rodrik

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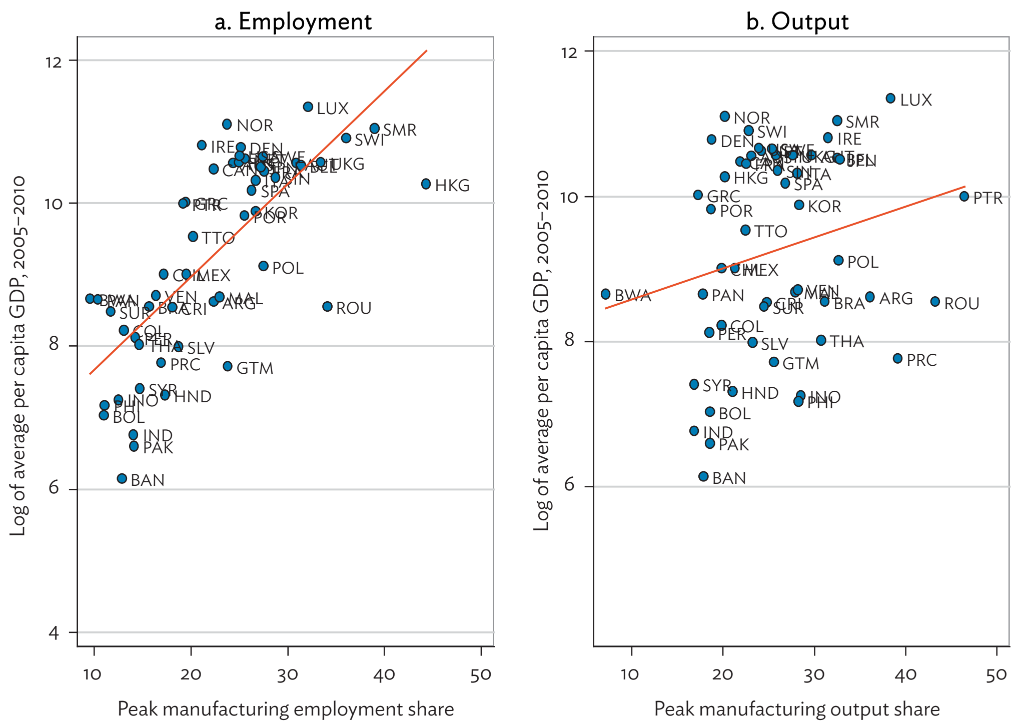
[3] Many manufacturing companies are outsourcing non-core operation (e.g., marketing, warehousing, transport, information technology) and many manufactured products are increasingly bundled with a host of services (e.g., after-sales services, such as extended warranties, repair services, telephone help-lines). This has been a process where manufacturing firms have shed many of their services functions to increase efficiency. They appear in the National Accounts as "producer services," separate from manufacturing. These outsourced service firms produce for manufacturing firms, i.e., without these services, the products would not reach consumers. All these services could perhaps be considered as part of manufacturing. These interconnections between manufacturing and services are well known, but are not properly estimated and accounted for in the statistics. Precise estimates require industry and country-specific data, most often not available.

2007). As expected, what an economy- exports matters; but even with this correction, manufacturing employment is still strongly related to future prosperity.

Figure 1: Peak Manufacturing Employment and Subsequent Prosperity



Notes: X-axis shows the level at which the 7-year moving average of the manufacturing employment and output shares peaked between 1970 and 2010. The dates of these peaks vary across countries. See Appendix Table A.3 for the definition of the codes.
Source: Authors' calculations.

We will show in Section IV that high manufacturing shares have, as a historic fact, been a pre-condition for eventual prosperity; and that output shares do not have this property.

Table 2: Regressions Corresponding to Figures 1, 2, and 3

A. Determinants of log per capita GDP in 2005–2010 (52 economies)								
	(1)		(2)		(3)		(4)	
Peak manufacturing employment share	0.133***	(0.022)	0.130***	(0.020)			0.103***	(0.026)
Peak manufacturing output share	-0.009	(0.026)			0.042*	(0.025)		
EXPY at time of peak manufacturing share							0.167***	(0.052)
Constant	6.529***	(0.670)	6.371***	(0.450)	8.160***	(0.692)	4.714	(0.512)

continued on next page

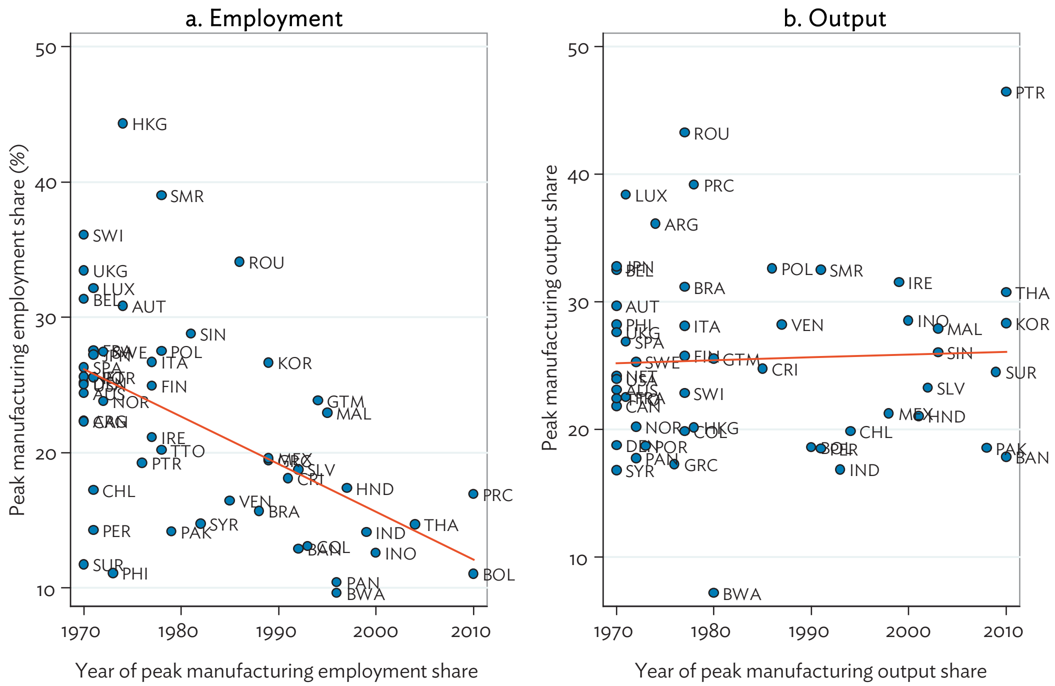
Table 2 continued

Sample size	52		52		52		43
R-squared	0.536		0.535		0.049		0.693
B. Peak employment shares fell over time, peak output shares did not							
	Peak Manufacturing Employment Share		Peak Manufacturing Output Share				
	(1)		(2)		(3)		
Year of peak employment share	-0.351***	(0.064)					
Year of peak VA share			0.023	(.076)	-.044	(.067)	
Constant	718.296***	(127.375)	-19.484	(149.84)	107.64	(132.75)	
Sample size	52		52		135		
R-squared	0.274		0.002		0.004		
C. GDP per capita at the time that the economy's manufacturing sector achieves its peak share of:							
	Employment		Output				
	(1)		(2)		(3)		
Year of peak share	-0.063***	(0.010)	-0.025*	(0.013)	-0.014	(0.011)	
Constant	132.57***	(19.93)	58.60**	(26.72)	35.83	(22.43)	
Sample size	52		52		135		
R-squared	0.368		0.068		0.013		

GDP = gross domestic product, VA = value added.
Notes: ***, **, and * indicate significance at the 1%, 5%, and, 10 % levels, respectively. Figures in parentheses are robust standard errors.
Source: Authors' calculations.

Figure 2 shows the relationship between the peak manufacturing employment and output shares and the years these peaks were reached. It shows that peak employment shares have fallen over time, with peaks averaging around 25% and often exceeding 30% until the mid-1980s, averaging 20% and rarely crossing 30% until the mid-1990s, and peaks below 20% during the last 15 years. This result confirms H1 above. On the other hand, peak output shares have not fallen, thus confirming H3 above. The first two regressions in Panel B of Table 2 confirm these findings. The third regression shows that output shares have not fallen even when we expand the analysis to include economies that do not have good employment shares. These results indicate that while it has not become more difficult to attain a high manufacturing output share, the manufacturing employment shares that are achievable have declined.

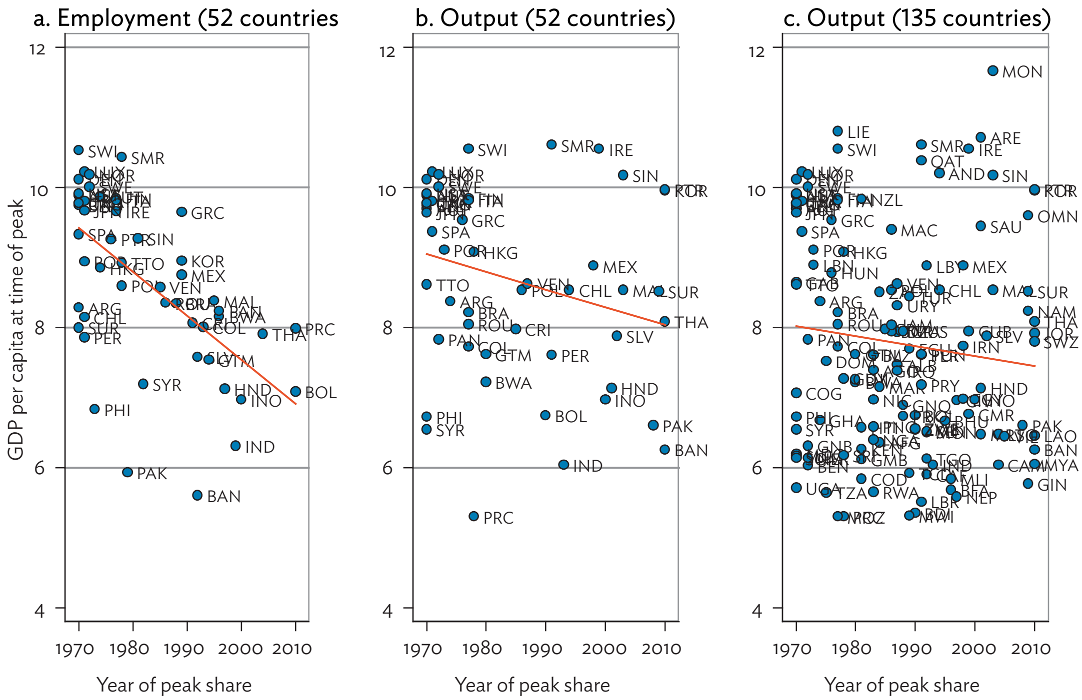
Figure 2: Peak Manufacturing Employment and Output Shares in Time



Notes: X-axis shows the year that the 7-year moving average of the manufacturing sector's employment and output shares peaked between 1970 and 2010. Y-axis shows the per capita income that year. See Appendix Table A.3 for the definition of the codes.
Source: Authors' calculations.

Figure 3 and the regressions in Panel C of Table 2 show the relationship between GDP per capita at the time of the peak and the year the peak was reached. As hypothesized in H2 and H3, GDP per capita at the time that employment peaked declines fast over time, while GDP per capita at the time that output peaked declines more slowly or does not decline significantly (depending on the sample). As in panels A and B, regressions involving employment shares have much greater predictive power than those that only involve output shares (higher R-squared).

Figure 3: Per Capita GDP at the Time of Peak Manufacturing Shares in Employment and Output



Notes: X-axis shows the year that the 7-year moving average of the manufacturing sector's employment and output shares peaked between 1970 and 2010. Y-axis shows the level at which they peaked. See Appendix Table A.3 for the definition of the codes.
Source: Authors' calculations.

In summary, these results confirm that achieving high manufacturing employment shares is a key determinant of subsequent prosperity; and that there are strong headwinds facing manufacturing employment that are likely to constrain economies' ability to achieve high incomes through industrialization.

IV. ARE INDUSTRIALIZED COUNTRIES RICH?

Motivated by the findings above, in particular by the positive relationship between income per capita and the peak manufacturing employment shares (Figure 1, and Panel A of Table 2), we investigate here whether all rich economies industrialized, and whether all economies that industrialized are rich. We do this by asking whether there are thresholds for manufacturing output and employment shares that distinguish rich from non-rich economies.

We classify an economy as "rich" if its average per capita GDP during 2005–2010 exceeds some cutoff. A cutoff of $12,000 in 2005 prices (not PPP corrected) is a convenient benchmark, corresponding roughly to the World Bank's definition of a high-income economy. Using this cutoff, exactly half of the 52 economies for which we have employment data are rich. We will also see what happens if we use different cutoffs. We will similarly propose that economies have "industrialized in employment" if their manufacturing employment shares crossed a particular threshold at any point between 1970 and 2010. Industrialization in output is defined analogously.

We experiment with multiple thresholds for manufacturing shares. For a given income cutoff and threshold manufacturing share, we will conclude that industrialization (I) has been *necessary* for becoming rich (R) if we observe in the data that all rich economies industrialized (i.e., no industrialization, no high income; Pr(R|~I)=0); and we will say that it is a *sufficient* condition if we observe that all economies that have industrialized are rich (i.e., industrialization guarantees rich-country status; Pr(R|I)=1). We will also select, for each income cutoff, the threshold manufacturing share that gives us the most separation between rich and non-rich economies (i.e., the level of I—manufacturing share, that maximizes $\Delta \equiv$ Pr(R|I) - Pr(R|~I)). The higher this difference is, the more powerful the manufacturing share becomes as a predictor of eventual prosperity. If crossing some manufacturing share threshold is both necessary and sufficient for being rich (i.e., Pr(R|I) - Pr(R|~I)=1), the set of industrialized economies and rich economies would coincide, a situation that would correspond to the traditional usage of the term "industrialized nation." We will examine these relationships separately for employment- and output-based definitions of industrialization. We emphasize that we use the terms "probability," "necessary," and "sufficient" strictly to describe historical data, and not as statements of what is theoretically possible. We will return to the implications of our results for economies' future prospects in Section VI.

Table 3 shows Pr(R|I) in the top panel and Pr(R|~I) in the bottom panel, calculated using employment shares (using data for 52 economies). The first column in each panel gives the percentage of economies that have reached the income per capita shown in each row (e.g., 57.7% of the economies achieved incomes over $6,000). The last row in the top and bottom panels, respectively, provide the percentage of economies that did and did not cross the threshold manufacturing share indicated in each column (e.g., 65.4% of the 52 economies reached a peak manufacturing employment share of 18%, and the other 34.6% did not). We have also marked in boldface the cells within each row corresponding to the employment threshold that maximizes Pr(R|I) - Pr(R|~I) for the income level in that row. For example, for a per capita income of $12,000 this difference is maximized at a threshold of 18% (Pr(R|I) - Pr(R|~I)=0.765-0=0.765, which is the largest difference for that income level.

These figures indicate that having crossed an 18% employment threshold between 1970 and 2010 is necessary for achieving $12,000 per capita income today (Pr(R|~I)=0); and having achieved this share fairly strongly predicts being a rich economy today (Pr(R|I)=0.765<1). Table 3 indicates that a 16% threshold is optimal for separating the economies that have and have not crossed $6,000; 18% is optimal for $8,000–$22,000; and 20% is optimal for $24,000–$30,000. In all but one of these cases, achieving the employment share threshold is necessary for crossing the income cutoff; no economy that failed to cross 16% (18%; 20%) achieved a per capita income of $6,000 ($8,000–$22,000; $24,000–$30,000). Achieving these threshold shares is not sufficient for crossing any income cutoff. However, the top panel does reveal that 90.9%–95.5% of economies that attained 24% manufacturing employment shares did reach $6,000–$18,000 per capita income. The takeaway is, therefore, that peak manufacturing employment shares in excess of 18%–20% strongly predict that an economy is rich; while peak shares below this threshold are near perfect predictors that an economy is not rich (i.e., manufacturing employment is necessary for becoming rich). Achieving employment shares of roughly 18%–20% is, therefore, a fairly good definition of industrialization.

Table 3: Probabilities of Being Rich, Conditional on Achieving Manufacturing Employment Share Thresholds

A. Probability that an economy has crossed per capita GDP threshold, given that it crossed the manufacturing employment share threshold

Per capita GDP threshold	*Probability that GDPPC > threshold*	Manufacturing Employment Share Threshold										
		10	12	14	16	18	20	22	24	26	28	30
6K	*0.577*	0.588	0.638	0.682	**0.789**	0.824	0.862	0.852	0.955	0.938	0.889	0.875
8K	*0.558*	0.569	0.617	0.659	0.763	**0.824**	0.862	0.852	0.955	0.938	0.889	0.875
10K	*0.500*	0.510	0.553	0.591	0.684	**0.765**	0.828	0.815	0.909	0.875	0.889	0.875
12K	*0.500*	0.510	0.553	0.591	0.684	**0.765**	0.828	0.815	0.909	0.875	0.889	0.875
14K	*0.481*	0.490	0.532	0.568	0.658	**0.735**	0.793	0.815	0.909	0.875	0.889	0.875
16K	*0.481*	0.490	0.532	0.568	0.658	**0.735**	0.793	0.815	0.909	0.875	0.889	0.875
18K	*0.481*	0.490	0.532	0.568	0.658	**0.735**	0.793	0.815	0.909	0.875	0.889	0.875
20K	*0.442*	0.451	0.489	0.523	0.605	**0.676**	0.724	0.741	0.818	0.813	0.889	0.875
22K	*0.423*	0.431	0.468	0.500	0.579	**0.647**	0.724	0.741	0.818	0.813	0.889	0.875
24K	*0.404*	0.412	0.447	0.477	0.553	0.618	**0.724**	0.741	0.818	0.813	0.889	0.875
26K	*0.404*	0.412	0.447	0.477	0.553	0.618	**0.724**	0.741	0.818	0.813	0.889	0.875
28K	*0.385*	0.392	0.426	0.455	0.526	0.588	**0.690**	0.704	0.773	0.750	0.889	0.875
30K	*0.365*	0.373	0.404	0.432	0.500	0.559	**0.655**	0.667	0.727	0.688	0.778	0.750
Probability that manufacturing share > threshold		*0.981*	*0.904*	*0.846*	*0.731*	*0.654*	*0.558*	*0.519*	*0.423*	*0.308*	*0.173*	*0.154*

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Table 3 continued

B. Probability that an economy has crossed per capita GDP threshold, given that it has not crossed the manufacturing employment share threshold

Per capita GDP threshold	*Probability that GDPPC > threshold*	Manufacturing Employment Share Threshold										
		10	12	14	16	18	20	22	24	26	28	30
6K	*0.577*	0.000	0.000	0.000	**0.000**	0.111	0.217	0.280	0.300	0.417	0.512	0.523
8K	*0.558*	0.000	0.000	0.000	0.000	**0.056**	0.174	0.240	0.267	0.389	0.488	0.500
10K	*0.500*	0.000	0.000	0.000	0.000	**0.000**	0.087	0.160	0.200	0.333	0.419	0.432
12K	*0.500*	0.000	0.000	0.000	0.000	**0.000**	0.087	0.160	0.200	0.333	0.419	0.432
14K	*0.481*	0.000	0.000	0.000	0.000	**0.000**	0.087	0.120	0.167	0.306	0.395	0.409
16K	*0.481*	0.000	0.000	0.000	0.000	**0.000**	0.087	0.120	0.167	0.306	0.395	0.409
18K	*0.481*	0.000	0.000	0.000	0.000	**0.000**	0.087	0.120	0.167	0.306	0.395	0.409
20K	*0.442*	0.000	0.000	0.000	0.000	**0.000**	0.087	0.120	0.167	0.278	0.349	0.364
22K	*0.423*	0.000	0.000	0.000	0.000	**0.000**	0.043	0.080	0.133	0.250	0.326	0.341
24K	*0.404*	0.000	0.000	0.000	0.000	0.000	**0.000**	0.040	0.100	0.222	0.302	0.318
26K	*0.404*	0.000	0.000	0.000	0.000	0.000	**0.000**	0.040	0.100	0.222	0.302	0.318
28K	*0.385*	0.000	0.000	0.000	0.000	0.000	**0.000**	0.040	0.100	0.222	0.279	0.295
30K	*0.365*	0.000	0.000	0.000	0.000	0.000	**0.000**	0.040	0.100	0.222	0.279	0.295
Probability that manufacturing share < threshold		*0.019*	*0.096*	*0.154*	*0.269*	*0.346*	*0.442*	*0.481*	*0.577*	*0.692*	*0.827*	*0.846*

GDP = gross domestic product, GDPPC = gross domestic product per capita.
Source: Authors' calculations.

Table 4 provides the same information for manufacturing output shares (data for 135 economies). Results indicate that a 22% manufacturing output share achieves maximal separation for all income levels (except for $28,000, where 20% fares slightly better). However, the separation is very poor. The largest observed value for Pr(R|I) - Pr(R|~I) is only 0.296, occurring at an output share threshold of 22% and an income cutoff of $6,000. In contrast, for employment shares, the largest observed value is 0.789, at an employment threshold of 16% and the same $6,000 income cutoff. Unsurprisingly, then, the table also shows that industrialization in output is not sufficient to achieve a high income per capita, as no output share cutoff guarantees that an economy crosses any income threshold; and that it is not necessary either, that is, failure to cross a given output share threshold does not ensure failure to become rich.

When we restrict the output sample to the 52 economies for which we have employment data (table available on request), the separation improves, but it is still not as good as it is for employment shares. The values of Pr(R|I) - Pr(R|~I) now range from 0.41 to 0.59; the result that industrialization in output is not sufficient to become rich remains; but now we find that industrialization in output is necessary to cross one income threshold: no economy with a peak manufacturing share of 18% or lower crossed $22,000 per capita income. Compared with the results in Tables 3 and 4, this suggests that output shares are not particularly good predictors of which small economies (many of which lack employment data) will be rich; that output shares provide some signal in the economies in our employment sample; and that employment shares are much better predictors of eventual prosperity than output shares.

How do the findings in this analysis classify economies? To see this, we return to the $12,000 cutoff for being rich and separately pick employment and output share thresholds that provide maximal separation between rich and poor economies in our 52-economy sample, that is, 18% for employment, and 22% for output. Table 5 categorizes economies by their industrialization status in employment and output using these thresholds, and highlights the rich economies in bold. Although the threshold for output shares is higher than the threshold for employment shares, these thresholds classify exactly the same number of economies (34) as industrialized in output and employment, respectively. This indicates that the horse-race we are about to run between employment and output shares is fair. We find that all high-income economies have industrialized in employment, but six high-income economies (Canada; Denmark; Greece; Hong Kong, China; Norway; and Portugal) did not industrialize in output. Indeed, if we restrict attention to those that have industrialized in employment, those that did not industrialize in output are more likely to be rich than those that did (6/7 > 20/27). Clearly, if we were to select one target, it would be employment shares, not output shares.

Summing up, this analysis indicates that achieving some critical output share has generally been neither necessary nor sufficient for achieving high-income status. On the other hand, achieving a manufacturing employment share of 18%–20% has been almost sufficient and absolutely necessary (in the statistical sense) for achieving high-income status.

Table 4: Probabilities of Being Rich, Conditional on Achieving Manufacturing Output Share Thresholds (135 economies)

A. Probability that an economy has crossed per capita GDP threshold, given that it crossed the manufacturing output share threshold

Per capita GDP threshold	*Probability that GDPPC > threshold*	Manufacturing Output Share Threshold										
		10	12	14	16	18	20	22	24	26	28	30
6K	*0.333*	0.342	0.362	0.371	0.398	0.436	0.484	**0.520**	0.500	0.500	0.522	0.438
8K	*0.304*	0.316	0.333	0.340	0.375	0.410	0.452	**0.480**	0.450	0.433	0.435	0.438
10K	*0.274*	0.291	0.305	0.309	0.341	0.372	0.419	**0.460**	0.425	0.400	0.391	0.375
12K	*0.267*	0.282	0.295	0.299	0.330	0.359	0.403	**0.440**	0.400	0.367	0.391	0.375
14K	*0.252*	0.265	0.286	0.289	0.318	0.346	0.387	**0.420**	0.400	0.367	0.391	0.375
16K	*0.237*	0.256	0.286	0.289	0.318	0.346	0.387	**0.420**	0.400	0.367	0.391	0.375
18K	*0.237*	0.256	0.286	0.289	0.318	0.346	0.387	**0.420**	0.400	0.367	0.391	0.375
20K	*0.222*	0.239	0.267	0.268	0.295	0.321	0.371	**0.400**	0.375	0.333	0.348	0.375
22K	*0.215*	0.231	0.257	0.258	0.284	0.308	0.355	**0.380**	0.350	0.300	0.304	0.313
24K	*0.207*	0.222	0.248	0.247	0.273	0.308	0.355	**0.380**	0.350	0.300	0.304	0.313
26K	*0.207*	0.222	0.248	0.247	0.273	0.308	0.355	**0.380**	0.350	0.300	0.304	0.313
28K	*0.193*	0.205	0.229	0.227	0.250	0.282	**0.323**	0.340	0.300	0.267	0.304	0.313
30K	*0.185*	0.197	0.219	0.216	0.239	0.269	0.306	**0.340**	0.300	0.267	0.304	0.313
Probability that manufacturing share > threshold		*0.867*	*0.778*	*0.719*	*0.652*	*0.578*	*0.459*	*0.370*	*0.296*	*0.222*	*0.170*	*0.119*

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Table 4 continued

B. Probability that an economy has crossed per capita GDP threshold, given that it has not crossed the manufacturing output share threshold

Per capita GDP threshold	*Probability that GDPPC > threshold*	Manufacturing Output Share Threshold										
		10	12	14	16	18	20	22	24	26	28	30
6K	*0.333*	0.278	0.233	0.237	0.213	0.193	0.205	**0.224**	0.263	0.286	0.295	0.319
8K	*0.304*	0.222	0.200	0.211	0.170	0.158	0.178	**0.200**	0.242	0.267	0.277	0.286
10K	*0.274*	0.167	0.167	0.184	0.149	0.140	0.151	**0.165**	0.211	0.238	0.250	0.261
12K	*0.267*	0.167	0.167	0.184	0.149	0.140	0.151	**0.165**	0.211	0.238	0.241	0.252
14K	*0.252*	0.167	0.133	0.158	0.128	0.123	0.137	**0.153**	0.189	0.219	0.223	0.235
16K	*0.237*	0.111	0.067	0.105	0.085	0.088	0.110	**0.129**	0.168	0.200	0.205	0.218
18K	*0.237*	0.111	0.067	0.105	0.085	0.088	0.110	**0.129**	0.168	0.200	0.205	0.218
20K	*0.222*	0.111	0.067	0.105	0.085	0.088	0.096	**0.118**	0.158	0.190	0.196	0.202
22K	*0.215*	0.111	0.067	0.105	0.085	0.088	0.096	**0.118**	0.158	0.190	0.196	0.202
24K	*0.207*	0.111	0.067	0.105	0.085	0.070	0.082	**0.106**	0.147	0.181	0.188	0.193
26K	*0.207*	0.111	0.067	0.105	0.085	0.070	0.082	**0.106**	0.147	0.181	0.188	0.193
28K	*0.193*	0.111	0.067	0.105	0.085	0.070	**0.082**	0.106	0.147	0.171	0.170	0.176
30K	*0.185*	0.111	0.067	0.105	0.085	0.070	0.082	**0.094**	0.137	0.162	0.161	0.168
Probability that manufacturing share < threshold		*0.133*	*0.222*	*0.281*	*0.348*	*0.422*	*0.541*	*0.630*	*0.704*	*0.778*	*0.830*	*0.881*

GDP = gross domestic product, GDPPC = gross domestic product per capita.
Source: Authors' calculations.

Table 5: Economies Categorized by Industrialization in Output and Employment

		Employment Share Relative to 18%	
		Not Industrialized (0/18 economies are rich)	Industrialized (26/34 economies are rich)
Output Share Relative to 22%	Not Industrialized (6/18 economies are rich)	Bangladesh, Bolivia, Botswana, Chile, Colombia, Honduras, India, Pakistan, Panama, Peru, Syria (0/11 economies are rich)	**Canada**, **Denmark**, **Greece**, **Hong Kong, China**, Mexico, **Norway**, **Portugal** (6/7 economies are rich)
	Industrialized (20/34 economies are rich)	Brazil, People's Republic of China, Indonesia, Philippines, Suriname, Thailand, Venezuela (0/7 economies are rich)	Argentina, **Australia**, **Austria**, **Belgium**, Costa Rica, El Salvador, **Finland**, **France**, Guatemala, **Ireland**, **Italy**, **Japan**, **Republic of Korea**, **Luxembourg**, Malaysia, **Netherlands**, Poland, **Puerto Rico**, Romania, **San Marino**, **Singapore**, **Spain**, **Sweden**, **Switzerland**, **Trinidad and Tobago**, **United Kingdom**, **United States** (20/27 economies are rich)

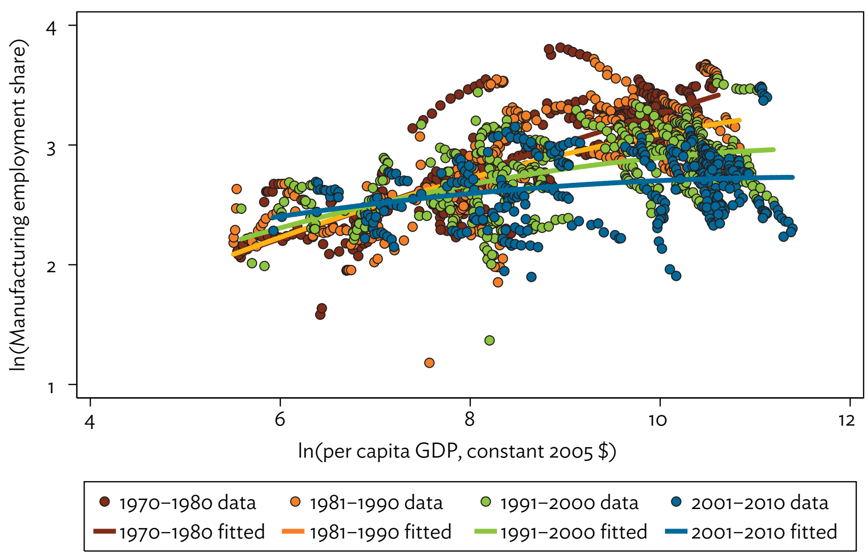
GDPPC = gross domestic product per capita.
Note: In bold if GDPPC during 2005–2010 exceeds $12,000.
Source: Authors.

V. HAS IT BECOME MORE DIFFICULT TO ACHIEVE HIGH MANUFACTURING SHARES?

This section turns to panel data to deepen the analysis in Figures 2 and 3, and panels B and C of Table 2. Specifically, the section asks whether it has become more difficult to achieve high manufacturing shares over time.

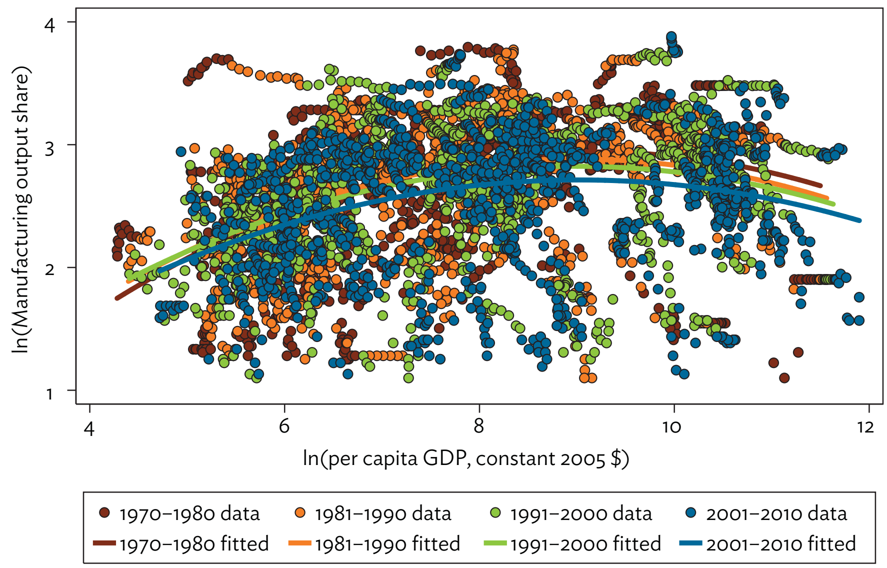
Figures 4 and 5 show scatterplots of logged manufacturing employment and output shares against logged per capita GDP, with quadratic best fit lines produced separately by decade. Each graph involves multiple observations from each economy. As can be seen, the employment and output shares expected at each income level have generally fallen. Also, as expected, the fall in predicted employment shares is deeper than the fall in predicted output shares.

Figure 4: Manufacturing Employment Share versus Per Capita GDP, Variables in Natural Logarithms



Source: Authors' calculations.

Figure 5: Manufacturing Output Share versus Per Capita GDP, Variables in Natural Logarithms



Source: Authors' calculations.

These two graphs also allow us to examine the hypothesis that manufacturing shares follow an inverted U-shape vis-à-vis income per capita. The inverted U-shape is an old idea that goes back to the pioneering work of Chenery (1960) and Kuznets (1966), among others. While Figure 5 confirms this result, Figure 4 is more interesting. Pooling economies and years within decades, we see no general trend for manufacturing employment shares to decline with income, during the 1970s, 1980s or 1990s, even at high incomes. However, the concavity of this profile increases with each decade, to the point that there is actually a peak expected employment share by the 2000s at a per capita income of around $13,000.

The regression lines in Figures 4 and 5 are partly identified of differences between economies. They are not representative of economies' trajectories over time. For example, the apparently constant upward trajectory of manufacturing employment shares with income in the first three decades of our sample might simply reflect the fact that the original OECD economies were richer and more industrialized than the developing economies during this period. In this case, the results offer little insight into whether developing economies would have been able to continually increase their manufacturing shares as they became richer. Therefore, they would not provide the right comparisons for analyzing the structural possibilities that economies have faced, or for testing the three hypotheses generated by the discussion in the introduction to the paper. That task is better accomplished by comparisons within economies over time. This requires regressions with country fixed effects.

We therefore estimate logarithmic regressions of output (Y) and employment (L) manufacturing shares ($LS_{Y,L}^{M}$) on income per capita (*LGDPPC*) and income per capita squared as well as a time trend (T), and the interaction between the time trend and income per capita. This specification embeds the three hypotheses we motivated in the introduction. Specifically, the time trend allows us to test whether manufacturing shares, conditional on income levels, have declined over time (H1); and, where the inverted U-shape is confirmed, whether expected peak shares have fallen.

The interaction between time and log income per capita allows us to test whether the income per capita at which the manufacturing share peaks has declined over time (H2). Comparing the results for the employment and output share regressions allows us to test whether these trends are more readily observed in employment than in output shares (H3). For the reasons just explained, we introduce country fixed effects, which would reflect, for example, differences in geography, institutions, and history. Some specifications also control for population (*LPOP*) and education levels (EDU), whose level effects are subsumed in the fixed effects (FE), but whose growth rates vary considerably across economies. Therefore, the regression estimated is:[4]

$$LS_{Y,L}^{M} = c + a_1 LGDPPC + a_2 (LGDPPC)^2 + a_3 T + a_4 (T * LGDPPC) + a_5 LPOP + a_6 EDU + \sum FE + \varepsilon_t$$

Acknowledging the likely two-way causal relationship between contemporary income and industrialization levels, and in keeping with the tradition in this literature, we treat the regression results as descriptive—they capture the likely joint trajectories of income and manufacturing shares.

Employment shares

Regression results for employment shares are shown in Table 6. The coefficients of the linear term are all positive and those of the squared income term are all negative, indicating that the employment share follows an inverted U-shape with respect to income per capita. To assess whether the relationship slopes up, down, or both over the relevant range of incomes, the table also provides the per capita GDP at which the share is estimated to peak in each specification (i.e., the inflection point of the inverted U). Actual per capita incomes among our set of 135 economies range from $143 (Democratic Republic of Congo) to $132,624 (Monaco) in 2010. In the subsample for which we have employment data, they range from $524 (Bangladesh) to $81,388 (Luxembourg). The peak manufacturing employment shares predicted for a "typical" economy are provided at the bottom. A typical economy is one with an average intercept term. When no fixed effects are used, all economies are assumed to be "typical."

Regressions (1)–(4) are introduced to examine the role of fixed effects, and to assess whether the inverted U-shape has shifted to the left. The regression in column (5) is our preferred specification, because it allows country fixed effects, interactions between income and time, and controls for log population (normalized to have a mean of zero) and its square. Population growth is driven by many factors other than the structure of production; but, by providing a growing market for manufactured goods, it can exert a strong effect on the size of the industrial sector. Post-estimation results indicate that larger populations are conducive to higher manufacturing employment shares, until a population level of 182 million. This seems entirely reasonable given that manufacturing is an increasing-returns-to-scale activity that produces tradable goods subject to transport costs (Krugman 1991).

Our first major finding is that country fixed effects matter. Table 6 includes the standard deviation of the country fixed effects, in order to examine how much inter-country variation in manufacturing employment shares is not explained by our independent variables. These show that proclivities to manufacturing employment vary widely across economies. Comparisons of R-squared statistics between regressions with fixed effects (3 and 4) and their counterparts without fixed effects

[4] See Rowthorn and Ramaswamy (1997, 1998), Nickell, Redding, and Swaffield (2008), Bah (2011), or Dabla-Norris et al. (2013), who use frameworks similar to ours to study related questions on structural transformation.

(1 and 2), indicate that around 75% of the variation in manufacturing employment shares that is not explained by income levels is captured by country-specific factors (country fixed effects). Comparing (3) to (1) and (4) to (2), shows that the per capita incomes at which manufacturing employment is estimated to peak declines enormously when fixed effects are introduced. Thus, today's industrializing economies should not base their assessments of the feasibility of industrializing in employment on the experiences of earlier industrializers. Such comparisons, which are captured by the regressions without country fixed effects, are misleading.

The second finding is a clear confirmation of H1, i.e., manufacturing employment shares have declined over time. This is apparent from the decline in the peak employment share expected by a typical economy as well as the negative and statistically significant derivatives of the shares with respect to the year (not shown—any positive coefficients on the year are more than compensated by the negative coefficients on the interaction between the year and log per capita GDP).

Third, the results also confirm H2, i.e., manufacturing employment peaks at lower levels of per capita income over time. The coefficient on the interaction between per capita GDP and income is negative and highly significant, and (in regression 5) the income level of peak manufacturing employment fell from $33,994 in 1970, to $9,576 in 2010. Thus, deindustrialization sets in sooner than in the past.

Table 6: Regressions of (Log) Manufacturing Employment Shares over Time and across Economies

	(1)		(2)		(3)		(4)		(5)		(6)	
Year	-0.012***	(0.001)	0.047***	(0.003)	-0.010***	(0.001)	0.035***	(0.004)	0.025***	(0.006)	0.010	(0.007)
Log GDP per capita x Year			-0.007***	(0.000)			-0.005***	(0.000)	-0.004***	(0.001)	-0.003***	(0.001)
Log GDP per capita (LGDPPC)	0.681***	(0.067)	0.470***	(0.063)	2.529***	(0.127)	1.150***	(0.188)	1.432***	(0.218)	1.599***	(0.234)
LGDPPC squared	-0.030***	(0.004)	-0.010**	(0.004)	-0.140***	(0.007)	-0.051***	(0.011)	-0.069***	(0.013)	-0.082***	(0.014)
Log-population									0.115	(0.061)	0.038	(0.057)
Log-population squared									-0.023**	(0.008)	-0.012	(0.008)
Years of schooling (Population aged 15+)											0.084***	(0.009)
Constant	-0.586*	(0.281)	-0.307	(0.258)	-8.155***	(0.616)	-3.034***	(0.776)	-4.035***	(0.889)	-4.426***	(0.954)
Country fixed effects?	No		No		Yes		Yes		Yes		Yes	
Standard deviation of fixed effects					0.324		0.235		0.378		0.289	
Sample size	1,747		1,747		1,747		1,747		1,747		1,654	
R-squared	0.453		0.517		0.868		0.878		0.880		0.877	
Per capita GDP at peak (std. error) during:												
Full sample period	$84,758	($31,369)			$8,437	($907)						
1970			$11.6 billion	($6.4 billion)			$75,763	($55,437)	$33,994	($15,581)	$17670	($5,646)
1990			$16.4 million	($49.6 million)			$27,155	($12,227)	$18,211	($5,453)	$11,987	($2,580)
2010			$23,320	($14,920)			$9,733	($2,575)	$9,756	($2,131)	$8,132	($1,437)
Peak employment share expected by a "typical" economy in:												
1970	26.6%	(0.74%)	169.9%	(142.01%)	26.5%	(0.48%)	30.8%	(3.35%)	31.0%	(1.90%)	31.0%	(1.19%)
1990	20.8%	(0.50%)	31.1%	(7.46%)	21.9%	(0.28%)	20.1%	(0.66%)	21.6%	(0.79%)	20.4%	(0.73%)
2010	16.3%	(0.43%)	13.6%	(5.25%)	18.1%	(0.34%)	14.6%	(0.38%)	15.9%	(0.82%)	13.8%	(0.73%)

Notes: *, **, and *** capture significance at the 5%, 1%, and 0.1% levels, respectively. Standard errors are robust.
Source: Authors' calculations.

Table 7 shows the country fixed effects derived from Regression 5 and the year the manufacturing employment shares peaked. The fixed effects, correcting for income and population, show whether a nation "punches above its weight" in sustaining manufacturing employment shares. The table also includes the median year of peak industrialization in each group of economies, and the population-weighted average of the country fixed effects. The dates show that manufacturing employment typically peaked earliest in high-income economies, followed by Latin American and Caribbean (LAC) nations, while Asia is peaking late. The fixed effects reveal that, on average, Asian economies have sustained higher manufacturing employment shares than "expected," while high-income and Latin American and Caribbean economies have typically sustained lower shares. These regional comparisons are the exact inverse of what we would have expected if the date of industrialization had been the only factor determining the manufacturing share that could be sustained. If that were the case, Asian economies, being late industrializers, should be at a relative disadvantage. This suggests that there is indeed something different about Asian economies that permitted them to sustain high levels of manufacturing employment. Policy differences are one possibility.

One relatively easy-to-quantify possibility, given the East Asian experience, is education. To examine this, regression (6) in Table 6 adds a correction for years of schooling, which also enters positively, indicating that an educated population is helpful for sustaining manufacturing employment. Consistent with this, the unexplained inter-country variation in manufacturing employment shares (the standard deviation of the fixed effects) falls significantly when education is introduced as an explanatory variable.

The fixed-effects regressions in Table 6 (regressions 4–6) show that the maximum expected employment share for a typical economy has fallen to around 13%–16%. Together with the empirical definition of industrialization we derived earlier (i.e., that industrialized economies achieved manufacturing employment shares in excess of 18%–20%, a level that almost every now-rich country achieved at some point), this suggests that the path to prosperity through manufacturing employment may have become more difficult.

Output shares

Table 8 presents the analogous regressions for output shares (with 135 economies). Results confirm the importance of including fixed effects in the analyses of possible manufacturing output shares—fixed effects have high explanatory power and reduce the per capita GDP at which manufacturing output shares are estimated to peak by roughly an order of magnitude. This is qualitatively similar to the behavior of employment shares. Also, as with employment, large output shares are easier to sustain in more educated and populous economies.

However, there are major differences between the behavior of employment and output shares. Regardless of whether country fixed effects are included or not, deindustrialization in output sets in at a lower income (roughly $2,000) than does deindustrialization in employment. This may reflect the effects of Cost Disease (Baumol 2012), wherein higher incomes are accompanied by higher manufacturing labor productivity, and services that become expensive relative to manufactured goods. This further reduces the gradient of manufacturing output shares with respect to incomes.

Table 7: Country Fixed Effects (Employment Share Regression 5) and Year of Peak Manufacturing Employment

Economy/Region	Fixed Effect	Peak Date	Economy/Region	Fixed Effect	Peak Date	Economy/Region	Fixed Effect	Peak Date
High-income economies	-0.032	1971	Latin America and Caribbean	-0.031	1989	Asia	0.096	1992
Australia	-0.321	1970	Argentina	-0.170	1970	Bangladesh	0.238	1992
Austria	0.251	1974	Bolivia	-0.117	2010	China, People's Republic of	0.129	2010
Belgium	0.062	1970	Brazil	-0.424	1988	Hong Kong, China	0.220	1974
Canada	-0.328	1970	Chile	-0.179	1971	India	0.259	1999
Denmark	0.089	1970	Colombia	-0.434	1993	Indonesia	-0.130	2000
Finland	0.152	1977	Costa Rica	0.099	1991	Korea, Republic of	-0.017	1989
France	-0.135	1971	El Salvador	0.202	1992	Malaysia	0.052	1995
Greece	-0.182	1989	Guatemala	0.128	1994	Pakistan	0.230	1979
Ireland	0.080	1977	Honduras	0.216	1997	Philippines	-0.308	1973
Italy	-0.010	1977	Mexico	-0.205	1989	Singapore	0.386	1981
Japan	-0.064	1971	Panama	-0.309	1996	Thailand	-0.342	2004
Luxembourg	0.658	1971	Peru	-0.385	1971			
Netherlands	-0.178	1970	Suriname	-0.117	1970	Other	0.003	1984
Norway	-0.041	1972	Trinidad and Tobago	-0.083	1978	Botswana	-0.425	1996
Portugal	0.146	1971	Venezuela, Bolivarian Republic of	-0.353	1985	Poland	0.108	1978
Puerto Rico	-0.078	1976				Romania	0.372	1986
San Marino	2.247	1978				Syrian Arab Republic	0.083	1982
Spain	-0.098	1970						
Sweden	0.043	1972						
Switzerland	0.214	1970						
United Kingdom	-0.109	1970						
United States	-0.325	1970						

Note: We provide median dates of peak manufacturing employment share (unweighted) in each region, and population-weighted average fixed effects for each region.
Source: Authors' calculations.

Table 8: Regressions of (Log) Manufacturing Output Shares over Time and across Economies

	(1)		(2)		(3)		(4)		(5)		(6)	
Year	-0.012***	(0.001)	-0.004	(0.003)	-0.002**	(0.001)	-0.005*	(0.003)	-0.013***	(0.003)	-0.009**	(0.003)
Log GDP per capita x Year			-0.001	(0.001)			0.001	(0.000)	0.001	(0.000)	-0.000	(0.000)
Log GDP per capita (LGDPPC)	0.774***	(0.050)	0.775***	(0.050)	1.537***	(0.090)	1.604***	(0.120)	1.490***	(0.124)	1.639***	(0.119)
LGDPPC squared	-0.042***	(0.003)	-0.042***	(0.003)	-0.103***	(0.007)	-0.109***	(0.010)	-0.098***	(0.010)	-0.107***	(0.009)
Log population									0.352***	(0.066)	0.284***	(0.049)
Log population squared									-0.027***	(0.006)	-0.026***	(0.006)
Years of schooling (Population aged 15+)											0.022**	(0.008)
Constant	-0.646***	(0.197)	-0.674***	(0.197)	-2.791***	(0.311)	-2.956***	(0.367)	-2.55***	(0.367)	-3.230***	(0.386)
Country fixed effects?	No		No		Yes		Yes		Yes		Yes	
Standard deviation of fixed effects					0.709		0.726		0.912		0.546	
Sample size	4,789		4,789		4,789		4,789		4,789		4,071	
R-squared	0.098		0.098		0.837		0.837		0.843		0.823	
Per capita GDP at peak during:												
Full sample period	$9,404	($980)			$1,711	($234)						
1970			$10,571	($2,125)			$1,582	($249)	$2,043	($475)	$2,049	($308)
1990			$9,599	($1,096)			$1,652	($231)	$2,160	($472)	$2,015	($280)
2010			$8,715	($1,121)			$1,725	($218)	$2,284	($476)	$1,980	($267)
Peak employment share expected by a "typical" economy in:												
1970	18.5%	(0.53%)	18.5%	(.53%)	18.8%	(0.44%)	19.1%	(0.66%)	22.8%	(0.64%)	22.3%	(0.69%)
1990	16.1%	(0.21%)	16.1%	(0.21%)	18.2%	(0.51%)	18.5%	(0.72%)	18.9%	(0.70%)	18.3%	(0.77%)
2010	14.0%	(0.37%)	14.0%	(0.37%)	17.6%	(0.62%)	18.0%	(0.81%)	15.7%	(1.00%)	15.0%	(0.95%)

Notes: *, **, and *** capture significance at the 5%, 1%, and 0.1% levels, respectively, using robust standard errors. Numbers in parentheses are standard errors.
Source: Authors' calculations.

We find that, compared with the employment shares, the log output shares expected at any income level have drifted down much more slowly. The resulting decline of employment shares relative to output shares is exactly what we would expect to see if rates of labor-saving technological change have been higher in manufacturing than in the rest of the economy. With respect to H2, we likewise find that the per capita income at which output shares peak has not decreased significantly. This, in combination with the fact that the income level at which manufacturing employment peaks has fallen, is consistent with the possibility that economies substituted capital-intensive for labor-intensive manufacturing activities as incomes rose. Together, these results confirm that sustaining manufacturing output is becoming somewhat more difficult, and that rising incomes do not weigh heavily on the output levels that economies can sustain. The real problem economies face is with sustaining manufacturing employment. Thus, they confirm H3.

VI. INTERPRETATION AND CONCLUSIONS

We have explored thoroughly the relationships between economic prosperity and manufacturing output and employment shares. We have shown that all economies that are rich today have, at some point in the last 40 years, enjoyed high manufacturing employment shares; while only a few economies that attained high manufacturing employment shares are not rich economies. Manufacturing employment has therefore been, as a matter of historical record, necessary but not sufficient for eventual prosperity. This is quite consistent with two points demonstrated by Rodrik (2013a). First, that economies that create many manufacturing jobs grow faster because manufacturing has an "escalator" quality—labor productivity in manufacturing industries rises rapidly towards the global frontier. Second, this is insufficient to ensure that poorer economies will grow faster than richer economies because manufacturing constitutes a relatively small share of total employment.

Our second contribution is to show that manufacturing employment shares have fallen, and now go into decline at lower levels of per capita income than they once did. Therefore, the fraction of national workforces for which manufacturing serves as an escalator has declined, even in low-income economies. Once again, manufacturing output shares do not display these trends as strongly. Taken literally, these results would appear to highlight the maintenance of manufacturing employment as one of the most important and difficult challenges that developing economies face today.

Of course, these results cannot be taken literally without a clear understanding of the causal mechanisms that drive them. We have shown that the data are consistent with explanations involving two forces: rising own-price elasticities of manufacturing labor demand, and labor productivity that rises faster in manufacturing than in non-manufacturing activities. However, two other alternative explanations need to be considered.

One is that, the result is purely mechanical. Suppose, in contrast to our story, that global labor productivity in manufacturing and in other sectors grew at the same pace, and that the growth rates of manufacturing outputs and of other products were identical. It follows that global manufacturing employment shares would have remained constant.[5] In this case, recent small increases in national manufacturing employment shares in some populous developing economies (e.g., the PRC, India)

[5] Aggregating across developing economies, Haraguchi (2014) finds that: (i) manufacturing's share in total output (added up across economies) has not changed since the 1970s, hovering around 20%–23%; and (ii) the aggregate manufacturing employment share increased since 1970.

would have to be accompanied by large declines in the corresponding shares in economies with smaller populations. While we are confident that the large populations of recent industrializers are part of the story, the relatively small movements in manufacturing output shares are not consistent with this purely mechanical explanation. If our results for employment shares were entirely driven by the Southward migration of manufacturing activity, output shares should have moved along with employment shares.

Another possibility is that, we are simply capturing the increased outsourcing of manufacturing-related services activity to dedicated service companies.[6] Again, it seems likely that this explains part of the declines in measured manufacturing shares, but not all of them. After all, this classification problem should afflict manufacturing output shares as well, and yet, these have not shifted downwards very fast, or leftwards at all. Finally, it is worth noting that if we add UNIDO's (2013) estimate of outsourced or manufacturing-related jobs to our figures, manufacturing employment shares would increase by around 20%. If we apply this increase to developing and developed economies alike, many low and middle-income economies would still fail to reach the 18%–20% manufacturing employment share threshold (e.g., Bangladesh, Indonesia, the Philippines, and most economies in the Middle East and North Africa, Central Asia, and Central America).

Two final comments, offered in closing. First, why is it that manufacturing employment shares have much clearer relationships with concurrent and subsequent income levels than output shares? One possibility is that output shares are influenced by the price of manufactured relative to non-manufactured outputs, which vary with incomes and across economies. We have already argued that these relative price differences may explain why output shares peak at lower incomes than employment shares. Variations in this relative price may also confound efforts to identify relationships with output shares.

Second, with the scope for manufacturing growth limited by the structural forces we have identified as well as by the increasing awareness of the high carbon footprint of many industries, and the possibility of restrictions on carbon emissions to avoid the negative effects of climate change (Gutowski 2007, Stern 2007), we need to consider whether economies can get rich by shifting to services without achieving high manufacturing employment shares. While it is impossible to rule out this possibility (given the growing array of new services and service-delivery modes, some of which appear to have rather high economies of scale (e.g., Maroto-Sánchez and Cuadrado-Roura 2009), Section IV demonstrates there are not yet any examples of economies that have done so successfully.

[6] UNIDO (2013) reckons that manufacturing employment is underestimated because informal manufacturing jobs and jobs in manufacturing-related services are not properly counted. UNIDO has estimated the latter worldwide for 1970–2009. In 2009, the number of these jobs was 95 million, or almost half of the direct formal jobs globally in manufacturing, and that 32 million of these jobs were in developed economies. We have spoken with UNIDO staff about how these jobs were estimated and their reliability. UNIDO has advised that their estimates are a first approximation that can certainly be used, but with great caution.

APPENDIX A: EMPLOYMENT DATA

The cleaning of the ILO's LABORSTA data proceeded as follows. We began with the full LABORSTA database. In any given economy and year, these data can include estimates from more than one source, and the sources may use different sectoral classifications. From this, we kept observations collected according to the International Standard Industrial Classification, versions 2, 3, or 4, and dropped the others. We then dropped sources that exclude major sections of the workforce (e.g., rural residents, agricultural workers). In those instances where employment levels in some sectors were missing, but could be inferred from total employment and employment in other sectors, we filled in the blanks and checked to see whether this yielded discontinuities in the series. Where discontinuities were observed, the series corresponding to that economy and source were dropped.

After these adjustments, some economies still had multiple sources in some years. For these economy-year pairs with overlapping series, we opted to use the longest continuous series. When the series had the same length, we chose the one that used ISIC revision 2. The final series were checked graphically for anomalies.

Table A.1: List of Economies by Source

LABORSTA only	Bangladesh, Botswana, El Salvador, Guatemala, Honduras, Pakistan, Panama, Poland, Portugal, Puerto Rico, Romania, San Marino, Suriname, Switzerland, Syria, Trinidad and Tobago, United Kingdom
OECD only	Belgium, Denmark, France, Ireland,
GGDC only	Argentina, Bolivia, India, Peru
LABORSTA + OECD growth rate	Australia, Austria, Canada, Finland, Greece, Italy, Luxembourg, Netherlands, Norway, Spain, Sweden, United States
LABORSTA + GGDC growth rate	Chile; Costa Rica; Hong Kong, China; Japan; Republic of Korea; Malaysia
GGDC + LABORSTA growth rate	Brazil, Colombia, Indonesia, Mexico, Philippines, Singapore, Thailand, Venezuela
National Census	People's Republic of China

Source: Authors.

Table A.2: Coverage of Manufacturing Employment Shares

Economy	# of Obs.	Earliest Obs.	Latest Obs.	Economy	# of Obs.	Earliest Obs.	Latest Obs.
Argentina	36	1970	2005	Korea, Republic of	39	1970	2008
Australia	38	1971	2008	Luxembourg	40	1970	2009
Austria	34	1976	2009	Malaysia	34	1975	2008
Bangladesh	9	1984	2005	Mexico	39	1970	2008
Belgium	40	1970	2009	Netherlands	40	1970	2009
Bolivia	38	1970	2007	Norway	40	1970	2009
Botswana	7	1985	2006	Pakistan	36	1973	2008
Brazil	38	1970	2007	Panama	35	1970	2008
Canada	39	1970	2008	Peru	36	1970	2005
Chile	39	1970	2008	Philippines	38	1971	2008
China, People's Republic of	6	1982	2010	Poland	28	1981	2008
Colombia	39	1970	2008	Portugal	35	1974	2008
Costa Rica	39	1970	2008	Puerto Rico	39	1970	2008
Denmark	40	1970	2009	Romania	37	1970	2008
El Salvador	20	1975	2007	San Marino	29	1978	2008
Finland	40	1970	2009	Singapore	39	1970	2008
France	39	1970	2008	Spain	40	1970	2009
Greece	29	1981	2009	Suriname	25	1973	2004
Guatemala	7	1981	2006	Sweden	40	1970	2009
Honduras	29	1970	2007	Switzerland	32	1970	2008
Hong Kong, China	32	1974	2005	Syrian Arab Republic	15	1970	2007
India	35	1971	2005	Thailand	39	1970	2008
Indonesia	39	1970	2008	Trinidad and Tobago	26	1970	2008
Ireland	40	1970	2009	United Kingdom	39	1970	2008
Italy	40	1970	2009	United States	40	1970	2009
Japan	39	1970	2008	Venezuela, Bolivarian Republic of	36	1970	2005

Source: Authors.

Table A.3: List of Codes for Each Economy

Economy	Code	Economy	Code
Afghanistan	AFG	Finland	FIN
Albania	ALB	France	FRA
Algeria	DZA	Gabon	GAB
Andorra	AND	Gambia, The	GMB
Angola	AGO	Ghana	GHA
Argentina	ARG	Greece	GRC
Australia	AUS	Guatemala	GTM
Austria	AUT	Guinea	GIN
Bangladesh	BAN	Guinea-Bissau	GNB
Belgium	BEL	Guyana	GUY
Belize	BLZ	Haiti	HTI
Benin	BEN	Honduras	HND
Bhutan	BHU	Hong Kong, China	HKG
Bolivia	BOL	Hungary	HUN
Botswana	BWA	India	IND
Brazil	BRA	Indonesia	INO
Bulgaria	BGR	Iran, Islamic Republic of	IRN
Burkina Faso	BFA	Iraq	IRQ
Burundi	BDI	Ireland	IRE
Cambodia	CAM	Italy	ITA
Cameroon	CMR	Jamaica	JAM
Canada	CAN	Japan	JPN
Central African Republic	CAF	Jordan	JOR
Chad	TCD	Kenya	KEN
Chile	CHL	Korea, Democratic People's Republic of	PRK
China, People's Republic of	PRC	Korea, Republic of	KOR
Colombia	COL	Lao People's Democratic Republic	LAO
Congo, Democratic Republic of the	COD	Lebanon	LBN
Congo, Republic of the	COG	Lesotho	LSO
Costa Rica	CRI	Liberia	LBR
Cote d'Ivoire	CIV	Libya	LBY
Cuba	CUB	Liechtenstein	LIE
Denmark	DEN	Luxembourg	LUX
Djibouti	DJI	Macau, China	MAC
Dominican Republic	DOM	Madagascar	MDG
Ecuador	ECU	Malawi	MWI
Egypt, Arab Republic of	EGY	Malaysia	MAL
El Salvador	SLV	Mali	MLI
Equatorial Guinea	GNQ	Mauritania	MRT

continued on next page

Table A.3 continued

Economy	Code	Economy	Code
Mauritius	MUS	Saudi Arabia	SAU
Mexico	MEX	Senegal	SEN
Monaco	MON	Sierra Leone	SLE
Mongolia	MON	Singapore	SIN
Morocco	MAR	Somalia	SOM
Mozambique	MOZ	South Africa	ZAF
Myanmar	MYA	Spain	SPA
Namibia	NAM	Sri Lanka	SRI
Nepal	NEP	Suriname	SUR
Netherlands	NET	Swaziland	SWZ
New Zealand	NZL	Sweden	SWE
Nicaragua	NIC	Switzerland	SWI
Niger	NER	Syrian Arab Republic	SYR
Nigeria	NGA	Tanzania	TZA
Norway	NOR	Thailand	THA
Oman	OMN	Togo	TGO
Pakistan	PAK	Trinidad and Tobago	TTO
Panama	PAN	Tunisia	TUN
Papua New Guinea	PNG	Turkey	TUR
Paraguay	PRY	Uganda	UGA
Peru	PER	United Arab Emirates	ARE
Philippines	PHI	United Kingdom	UKG
Poland	POL	United States	USA
Portugal	POR	Uruguay	URY
Puerto Rico	PTR	Venezuela, Bolivarian Republic of	VEN
Qatar	QAT	Viet Nam	VIE
Romania	ROU	Zambia	ZMB
Rwanda	RWA	Zimbabwe	ZWE
San Marino	SMR		

Sources: World Bank and Asian Development Bank.

Table A.4: Economies with Employment Share Data Are Different

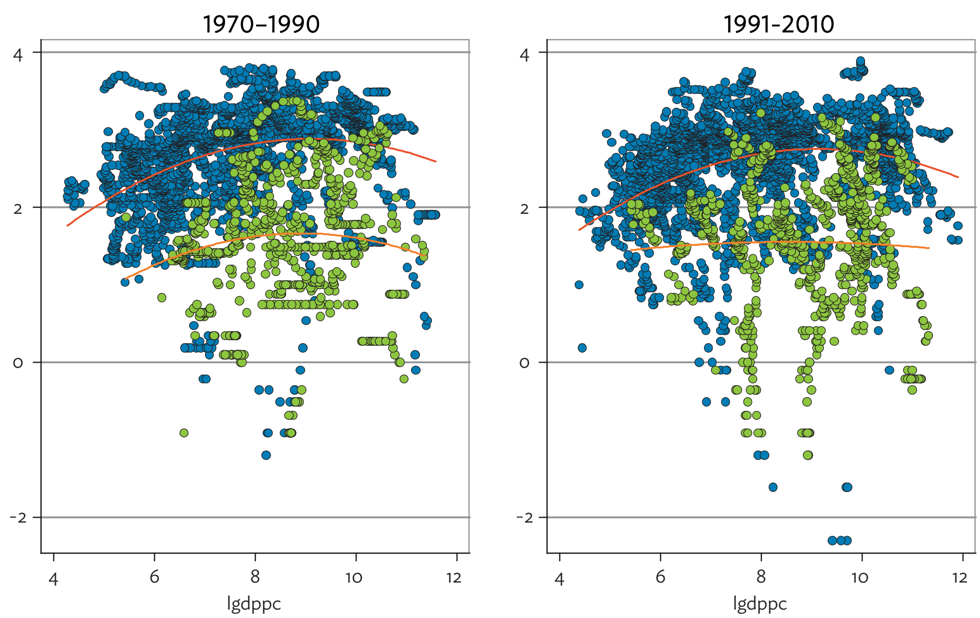
	With Employment Data (52 economies)	With or Without Employment Data (135 economies)
Mean per capita GDP (2005–2010)	$21,200	$7,466
Mean per capita GDP at time of peak manufacturing output share	$11,607	$5,277
Mean population over the sample period.	76.8 million	11.6 million
Mean manufacturing output share in year of peak	25.5%	16.2%
Median year of manufacturing output share peak	1977	1988

Source: Authors' calculations.

APPENDIX B: DIFFERENCES BETWEEN SMALL ISLAND NATIONS AND OTHER NATIONS

We began by examining the distribution of output shares with respect to log per capita income. The data in Figure B1 are raw. They have not been corrected for exogenous determinants. While an inverted U-shape is observed for non-small island nations in both time periods, no evidence of an inverted U-shape appears for small island nations in the latter 20 years of our sample. Small island nations are also clearly different, in that they have lower manufacturing output shares than other economies.

Figure B1: All Economies, Split by Small Island, No Corrections

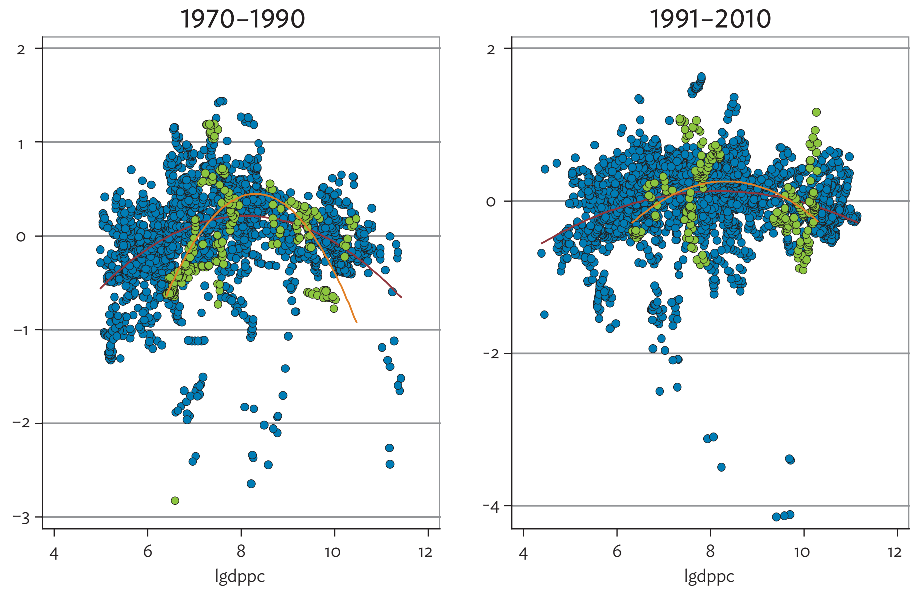


Notes: Green dots are island nations. Blue dots are non-island nations.
Source: Authors' calculations.

Next, to examine these structural issues further, we regressed the output shares on the year, year-squared, and several structural features. These are: natural resource exports as a share of total exports in 1990, log population, log per capita land endowment, the share of land that is usable for agriculture, and the ratios of retirees and young people to the working-age population. Results are available on request. The key differences between small island nations and other nations are: (i) small island nations have a lower intercept (smaller manufacturing shares, other things equal), suggesting that manufacturing activity is hard to sustain in more remote economies; and (ii) while natural resource intensity reduces manufacturing output in other nations, it increases it in islands, again suggesting that island nations without natural resources of their own find it difficult to sustain manufacturing.

Finally, figure B2 graphs the residuals from these regressions against log per capita GDP. With these corrections for underlying structural features firmly in place, we now see much clearer evidence of an inverted U with respect to per capita income for island nations. All these results suggest that per capita GDP has been a relatively less important determinant of manufacturing output shares in island nations, but that structural factors have been relatively important. To avoid complications, we therefore do not include them in our analysis.

Figure B2: All Economies, Split by Small Island, Structural Corrections



Notes: Green dots are island nations. Blue dots are non-island nations.
Source: Authors' calculations.

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United Nations Industrial Development Organization (UNIDO). 2013. Industrial Development Report 2013. Sustaining Employment Growth: The Role of Manufacturing and Structural Change.

Manufacturing Matters… but It's the Jobs That Count

Practically every economy that enjoys a high income today experienced a manufacturing employment share in excess of 18%–20% sometime since the 1970s. Manufacturing output share thresholds are much poorer predictors of rich-country status. We also find that the maximum expected employment share for a typical economy has fallen to around 13%–15%. Industrialization in employment has been more important for eventual prosperity than industrialization in output; and high manufacturing employment shares are becoming more difficult to sustain as incomes rise. Our findings suggest that the path to prosperity through industrialization may have become more difficult.

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