Pattern of structural change – Analysis of the Industrial sector in Developing countries

Standard economic theory tells us that industrialization follows an inverted-U shaped path along levels of income. As incomes grow, economies transition from agriculture-dominated economies to industry-dominated economies and finally to service dominated economies. The basic economic logic behind this is as follows. As incomes grow beyond a certain level, Engel's curve states that a greater proportion of income is then devoted to the products of the service sector and less to those of the manufacturing sector. As the proportion of demand falls, relative price of manufactured goods must fall too. Also, this has linkage effects onto the supply side as it implies that producers now shift their focus to the service sector. Thus, both the share of expenditure spent on manufactured goods as well as the share of manufactured goods in total value-added fall because of the lower proportionate demand of manufactured goods as incomes rise.

De-industrialization refers, crudely, to a falling importance of the industrial sector in general and the manufacturing sector. There are several ways in which deindustrialization has been defined in the literature – around levels or shares of manufacturing output in current or constant prices, around manufacturing employment, around exports or around a combination of these. The most common of these definitions are where deindustrialization is defined as a falling share of manufacturing in total employment (Singh 1977, Rowthorn and Ramaswamy 1999, Dasgupta and Singh 2006) and as a falling share of manufacturing in total output (Tregenna 2009).

To conceptualise de-industrialization for the purpose of our study, let us look at each of these one by one:

- Share of manufacturing output in total GDP at current prices - When we think about de-industrialization as a falling share of manufacturing output in total GDP at current prices, it doesn't necessarily signify a falling importance of the manufacturing sector because a falling share at current prices may also result from a proportional fall in the price index of manufacturing goods as compared to the general price level. One reason why this may happen is because of rising productivity and hence cost-effectiveness.
- Share of manufacturing output at constant prices - When we look at the share of manufacturing output at constant prices, we are doing away with the price effect and hence are looking at what is happening in real terms. This may be one of the potential definers of de-industrialization.
- Share of manufacturing employment in total employment - When we look at the share of manufacturing employment in total employment, it may reflect one of the following – either a falling share of manufacturing employment resulting from a shrinkage in manufacturing activity or a falling share of manufacturing employment resulting from a rise in labor productivity which effectively means that the same/higher output is being produced with lower labor.

	Share in real output (Change in)		**Share in nominal output (change in)**	
Share in employment (change in)	Positive	Negative	Positive	Negative
Positive	*Industrial growth*	*Falling productivity*	*Industrial growth*	*Can't say!*
Negative	*Rising Productivity*	*De-industrialization*	*Rising productivity*	*Can't say!*

In the above table, a falling share of nominal manufacturing output doesn't unambiguously imply de-industrialization even when combined with a negative change in the manufacturing share of employment because given the empirical tendency for productivity to rise faster in manufacturing than in other sectors, there is a tendency for relative prices of manufacturing to fall as a result. Since the nominal values include the price effect, it is not clear at the outset whether a fall in such a value is because of the price fall or because of a fall in real output. Thus, in order to conclusively say that de-industrialization in the sense of a falling importance of the manufacturing sector is taking place, we need to look at at-least two things in conjunction, with the constant/falling share of manufacturing value added in real terms being a necessary condition. The share of manufacturing output in total output at constant prices combined with the share of manufacturing sector in total employment are the most common indicators. If the employment share of manufacturing is falling along with a falling share of manufacturing output at constant prices, it is a definite signal for a falling importance of the manufacturing sector in the economy because both, real output and employment shares, are falling. If the share of real output is constant/rising and the share of employment is falling, it cannot be conclusively said that de-industrialization is taking place because as discussed above such a scenario is more of an indicator of rising productivity in the manufacturing sector. However, if the share of real output is falling and the share of employment is constant/rising, it's a case of falling productivity and hence ineffective production.

Since the purpose of this paper is to study the patterns of structural change in industry across developing countries, we propose to examine the patterns of all three variables (nominal output, real output, employment) across income levels. A sustained decline in the values of these is termed as deindustrialization according to that variable. For the final interpretation, we aggregate the analysis over all the three trends.

Needless to say, merely looking at the absolute values of the above-mentioned variables would not serve the purpose because a rise in the absolute value of output produced by the manufacturing sector may, for example, result from a rise in the overall level of output in the economy and no rise in the share of manufacturing sector i.e. just the whole economic pie growing with the sectoral shares remaining unchanged. Therefore, we look at these variables as % shares in the total. Similarly, after conclusively determining cases of de-industrialization, further qualitative analysis of the process may incorporate many other factors like investment rates, openness of the economy, growth rates and so on. We attempt a preliminary analysis into the probable factors of the observed patterns in the last section.

Premature Deindustrialization

Premature de-industrialization is defined as "de-industrialisation that begins at a lower level of GDP per capita and/or at a lower level of manufacturing as a share of total employment and GDP, than is typically the case internationally" (Tregenna 2014). This has important consequences for the growth and development processes of countries. Successful structural transformation is very important for growth. This has been borne out from the experience of many countries, both winners (countries that have managed to propel themselves onto a high-growth path on the back of a strong manufacturing sector) and losers (countries that have lost out on the race towards higher growth because of failure to successfully 'industrialize'). Rodrik (2013) describes structural transformation, "the birth and expansion of new industries and the transfer of labor from traditional or lower-productivity activities to modern ones" as one of the two key dynamics for growth. He explains "With the exception of natural-resource bonanzas, extraordinarily high growth rates are almost always the result of rapid

structural transformation, industrialization in particular". Manufacturing is considered as a very important sector for the growth dynamics of the economy and rightly so. Rodrik (2015) describes formal manufacturing as "the most dynamic sector", contributing to employment, output and trade. Rodrik (2011) demonstrates that "unlike economies as a whole, manufacturing industries exhibit unconditional convergence in labour productivity." Moreover, the development of an efficient and dynamic services sector depends on the type of manufacturing structure in the economy (Gueirieri & Meliciani 2005). Some studies have also linked under-development of the manufacturing sector to the 'middle income trap' (Kersch 2018). Haraguchi (2011) in his empirical analysis demonstrates that "the most difficult part of industrialization may be to trigger it" and sustaining manufacturing performance at the "end of upper middle-income stage", thus adding weight to the middle-income trap theory. Thus, a well-developed industrial sector is a growth-propeller and under-development of the same makes it difficult for economies to achieve prosperous economic growth. When economies deindustrialize prematurely, they are usually characterized by "aggregate productivity stagnation, insufficient job generation, creation of low-quality jobs, increasing under and informal employment". The services sector, in such economies, has "not had enough time to mature" and not yet ready to "become a fundamental labour absorber and complement manufacturing sector as an engine of growth" (Cruz 2014).

However, when we define premature deindustrialization in this manner, i.e. in terms of "… lower level of GDP per capita and/or at a lower level of manufacturing as a share of total employment and GDP, than is typically the case internationally", we are ignoring the fact that the conditions for industrialization have changed substantially over the decades and the challenges to successful industrialization faced by economies today are very different from the challenges faced by the advanced nations when they began their process of industrialization. *"The challenge of industrialization in the twenty-first century differs in several ways from the experiences of developed countries when they initially industrialized in the nineteenth century, as well as developing countries that rapidly industrialized in the twentieth century."*

In this context, we propose to look at the experience of developing countries as a group with the aim of investigating whether these countries are experiencing premature deindustrialization in the context of today's date and time.

In line with the definition of premature deindustrialization that we discussed in the first section, we investigate trends of manufacturing output (both nominal and real) and employment over the decades in a selected set of developing countries.

Data

We took the list of the group of developing countries from the World Development Indicators. From this list, we exclude countries which have a population less than 15 million as "the small groups involved may be enclaves that are integral parts of larger entities; and in such cases, their industrial structure may well display peculiarities that would not, and could not, be true of larger and more self-contained and independent countries," (Kuznets 1957).

The final list of countries that we have varies from year to year subject to data-availability.

Data on output (manufacturing, industry), per capita GDP (in constant $2015) and industry employment is from World Development Indicators (1980 onwards). Data on manufacturing employment is from International Labour Organization (1991 onwards).

Methodology

We use panel regression analysis on our dataset to estimate underlying trends of:

- Manufacturing output as a share of GDP in relation to real GDP per capita.
- Real manufacturing output as a share of real GDP in relation to real GDP per capita.
- Manufacturing employment as a share of total employment in relation to real GDP per capita.

Further, we investigate the performance of the industrial sector in a similar manner.

We also conduct a preliminary analysis into the probable factors behind the observed performance in the manufacturing sector.

Results:

I. Trends in manufacturing output as a share of GDP in relation to real GDP per capita.

We estimate the following regression equation:

$Mfgva_t = \alpha + \beta_1 lngdppc_{t-1} + \beta_2 lngdppc2_{t-1} + \beta_3 1990 + \beta_4 2000 + \beta_5 2010 + \beta_6 2018 + u_t$

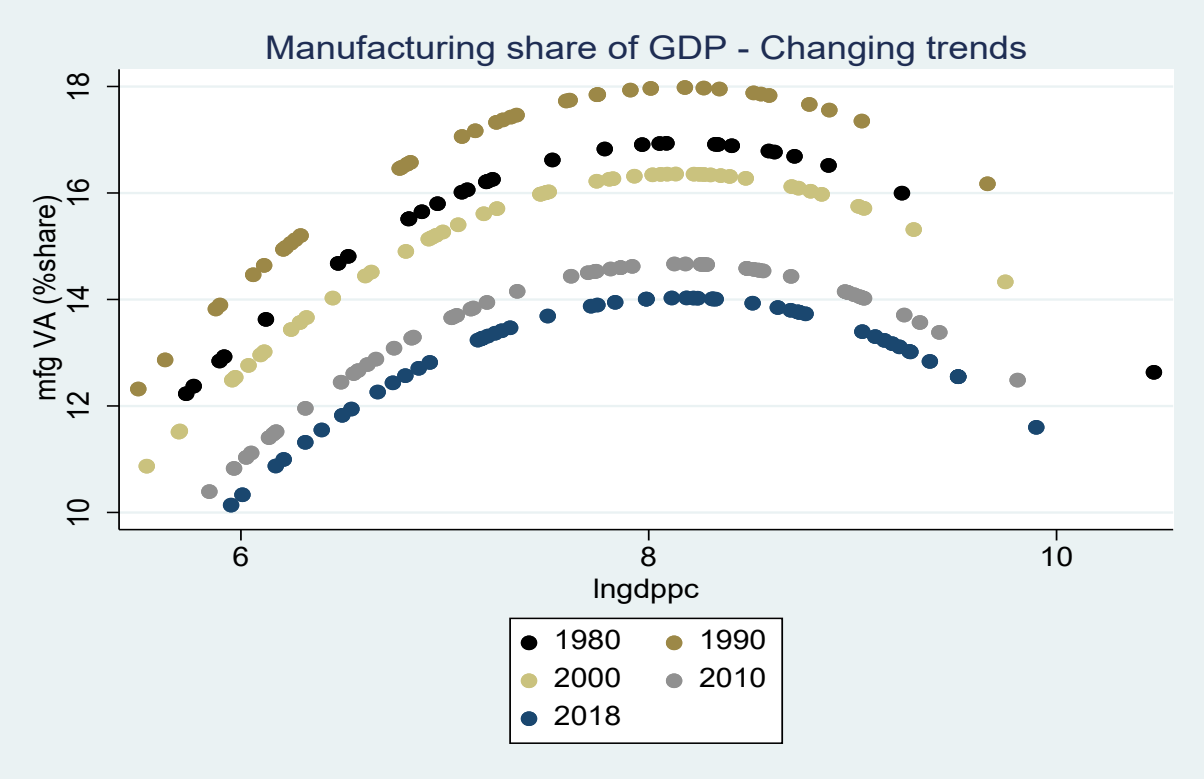
(Where, $Mfgva_t$ = share of Manufacturing Value Added in total GDP in period t, $lngdppc_{t-1}$ = log of per capita GDP in real terms in period (t-1), $lngdppc2_{t-1}$ = square of the log of per capita GDP in real terms in period (t-1), 1990 = period dummy corresponding to year 1990, 2000 = period dummy corresponding to year 2000, 2010 = period dummy corresponding to year 2010, 2018 = period dummy corresponding to year 2018, u_t = error term)

We are using per capita GDP level as a proxy for the level of economic development. We take the per capita GDP levels of period (t-1) and not period t in order to avoid the endogeneity issue. We include period dummies because we want to understand how this relationship is changing over-time. After conducting all the tests (LM test, Hausman test), it was found that the Random Effects model is best suited for our analysis.

The regression results are presented in following table.

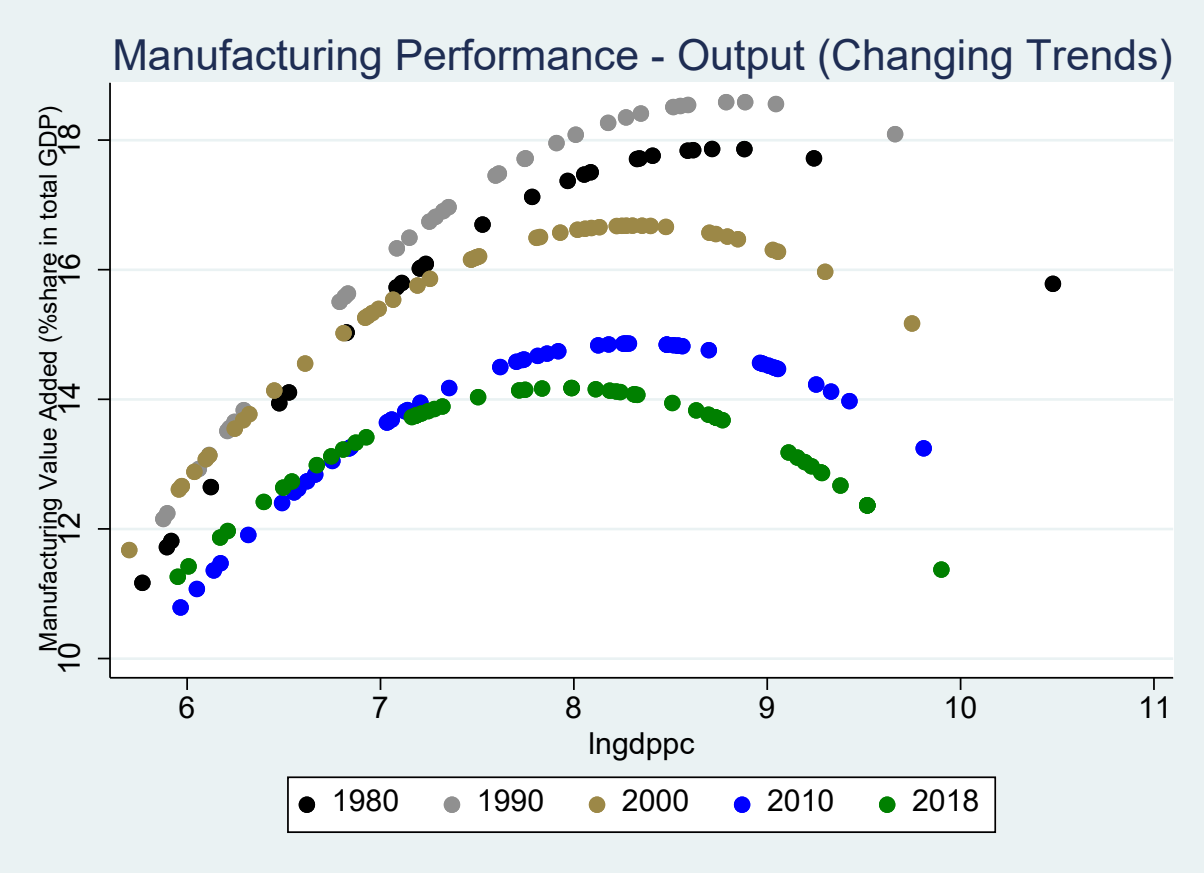
Variable	mfgva - nominal	mfgva - nominal	mfgva - real	mfgemp	mfgemp	indva	indemp	res
gdppc	13.05							
gdppc2	**-0.80**							
lngdppc		**12.89**	**2.69**	**27.93**	**8.98**	**20.39**	**10.06**	4.8
lngdppc2		**-0.73**	**-0.17**	**-1.58**	-0.43	**-1.07**	-0.47	-0.2
1990	1.04	0.10	-0.05					-2.1
2000	-0.58	4.80	-0.16	**-1.80**	4.58	5.17		2.5
2010	**-2.27**	2.86	**-1.37**	**-3.63**	**9.98**	0.19	7.84	3.4
2018	**-2.91**	6.69	**-1.66**	**-3.80**	**18.49**	**33.26**	**26.87**	**18.8**
Timefo.lngdppc								
1990		0.07	0.01					0.1
2000		-0.70	0.02		-0.81	-0.72		-0.6
2010		-0.69	**0.16**		**-1.64**	-0.35	-0.95	-0.4
2018		-1.24	**0.19**		**-2.67**	**-4.71**	**-3.24**	**-2.3**
cos	**-36.29**	**-38.79**	**-7.89**	**-106.12**	**-29.73**	**-61.29**	-31.35	-12.1

Note: The figures in bold denote significance at the 5% level.



In order to study how the relationship is changing over-time, we also add period-interaction dummies and get the following results.

Although the dummies and their interaction are not statistically significant, the coefficients add to the discussion



- Turning Points: income levels at which the share of manufacturing sector value added in total GDP starts experiencing a fall for each period.

Year	Turning Point (GDP per capita – constant $2015)
1980	6577
1990	6901
2000	4079
2010	4120
2018	2822

1. The manufacturing sector in the developing countries also follows the same pattern as observed in world-wide analysis (Rodrik 2015, Tregenna 2020) i.e. an inverted U-shaped curve depicting the standard relationship between the share of manufacturing in GDP and income levels. The shape indicates that with a rise in income level the share of manufacturing in a country's value-added increases up to a certain level where it reaches the maximum, after that it begins to fall with subsequent rise in income.

2. The curve is clearly shifting downward overtime, indicating that these developing countries are now reaching lower and lower levels of manufacturing share at each level of per capita income. This result is also in line with that observed in world-wide analysis.
3. Not only is the curve shifting downward overtime, the slope of the trend is changing substantially over the decades, indicating that these countries are now starting to deindustrialize at lower levels of per-capita income. These turning points are much lower than those observed in the advanced countries/world-wide analysis. (see.)

Conclusion: These developing countries are experiencing premature deindustrialization in terms of nominal manufacturing output.

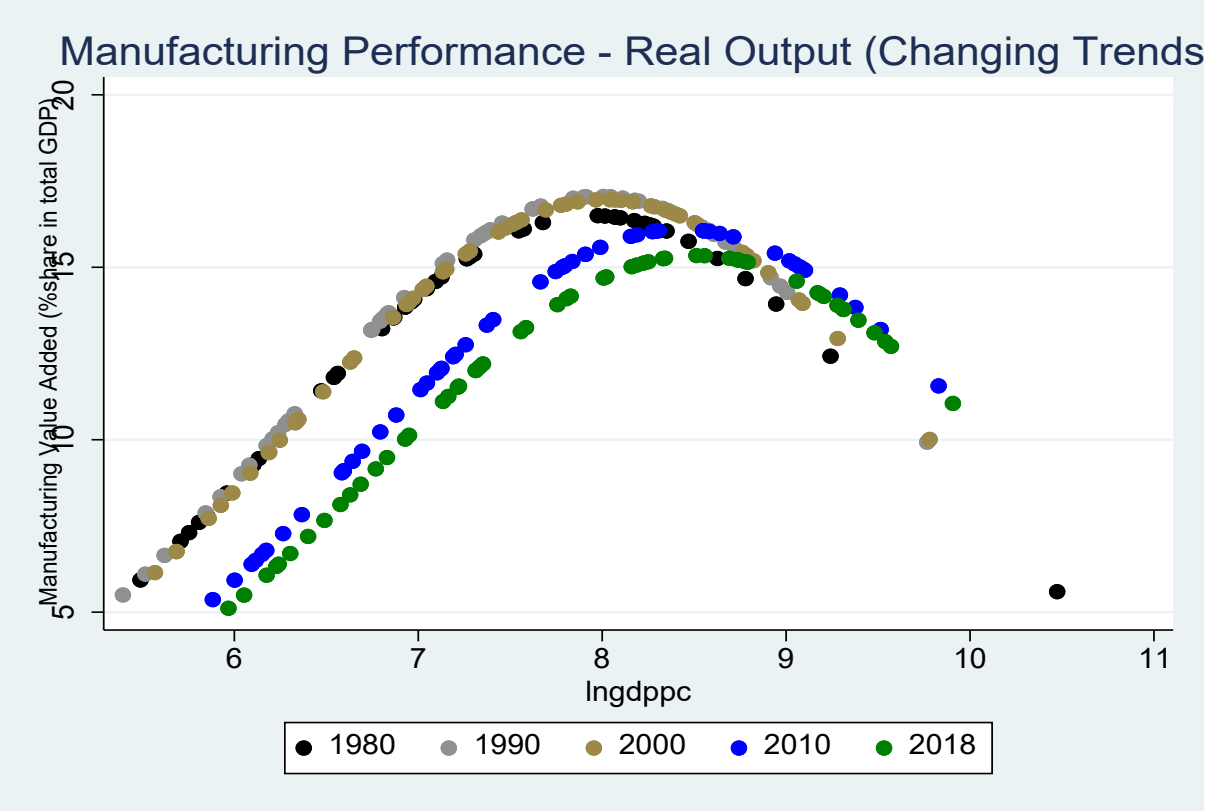
II. Manufacturing performance – Real Output

We estimate the following regression:

$mfgva_t = \alpha + \beta_1 lngdppc_{t-1} + \beta_2 lngdppc2_{t-1} + \beta_3 1990 + \beta_4 2000 + \beta_5 2010 + \beta_6 2018 + \beta_7 1990.\ lngdppc_{t-1} + \beta_8 2000.\ lngdppc_{t-1} + \beta_9 2010.\ lngdppc_{t-1} + \beta_{10} 2018.\ lngdppc_{t-1} + u_t$

(Where, $mfgva_t$ = share of Manufacturing Value Added (in constant terms) in total GDP (in constant terms) in period t, $lngdppc_{t-1}$ = log of per capita GDP in real terms in period (t-1), $lngdppc2_{t-1}$ = square of the log of per capita GDP in real terms in period (t-1), 1990 = period dummy corresponding to year 1990, 2000 = period dummy corresponding to year 2000, 2010 = period dummy corresponding to year 2010, 2018 = period dummy corresponding to year 2018, u_t = error term.)

After conducting all diagnostic tests (LM test, Hausman test), it was found that the Fixed Effects model is best suited for this analysis.



Turning points - income levels at which the share of manufacturing sector in total employment starts experiencing a fall for each period.

Year	GDP per capita (constant $2015)
1980	2827
1990	2921
2000	3029
2010	4585
2018	4991

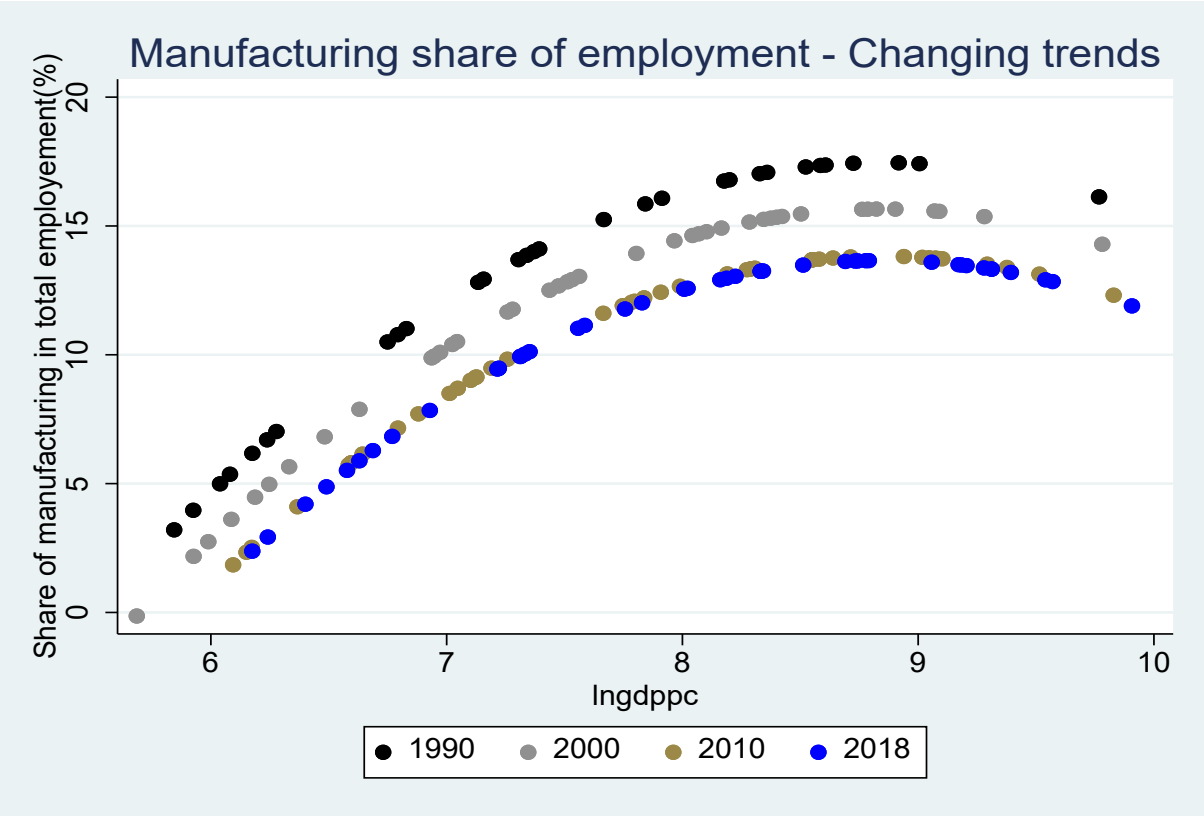
1. The above graph demonstrates that these trend lines are also showing Inverted-U pattern and are clearly shifting down overtime.
2. Unlike nominal output share, the curves are not shifting towards the right i.e., the turning points are now at higher levels of real per capita GDP. Thus, in a weak sense, it can be said that deindustrialization in terms of real output is starker than that in terms of nominal output.
3. Also, the downward shift of the trend line is not very apparent for the countries on the higher end of the income spectrum. So, we cannot conclusively say that these countries are experiencing premature deindustrialization in terms of real manufacturing output.

III. Trends in manufacturing employment as a share of total employment in relation to real GDP per capita.

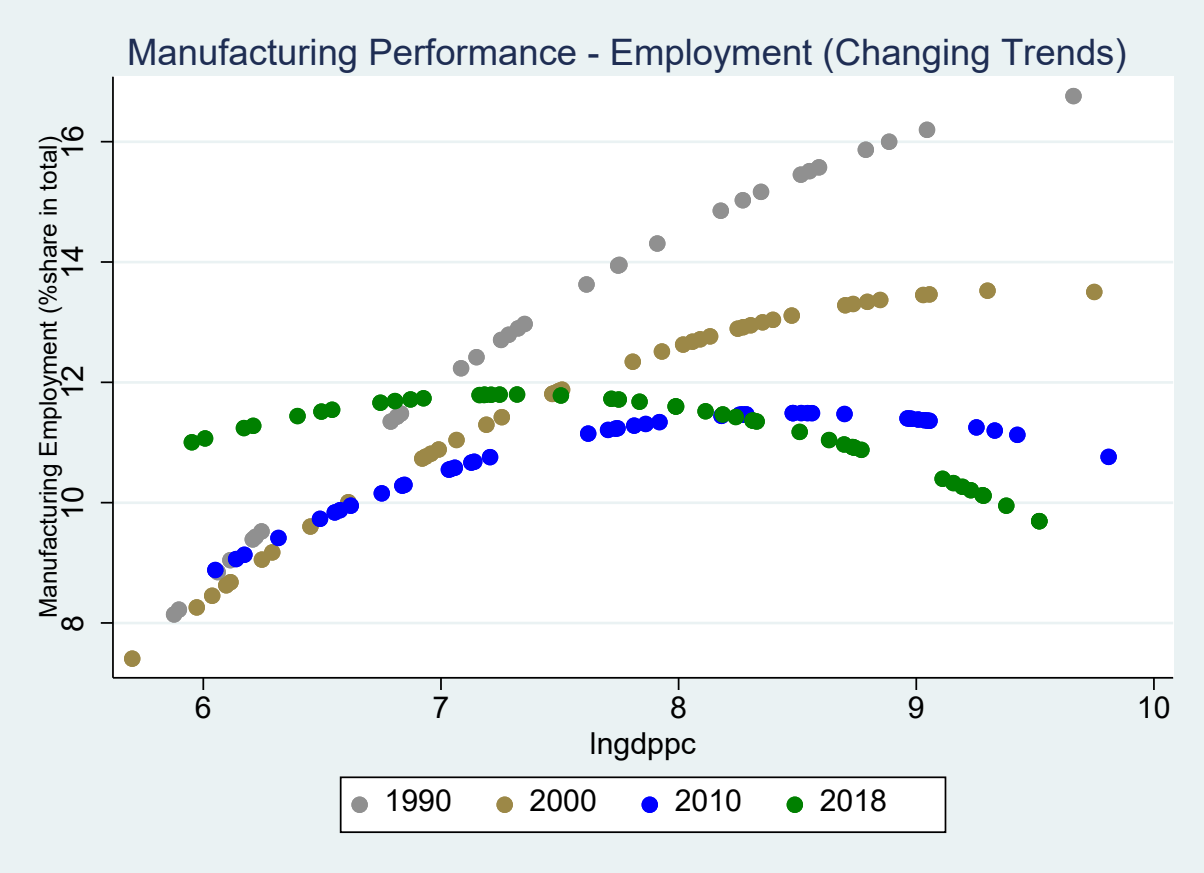
We estimate the following regression equation:

$mfgemp_t = \alpha + \beta_1 lngdppc_t + \beta_2 lngdppc2_t + \beta_3 2000 + \beta_4 2010 + \beta_5 2018 + u_t$

(Where, $mfgemp_t$ = share of manufacturing employment in total employment in period t , $lngdppc_t$ = log of per capita GDP in real terms in period t, $lngdppc2_t$ = square of log of per capita GDP in real terms in period t, 2000 = Dummy for year 2000, 2010 = Dummy for year 2010, 2018 = Dummy for year 2018, u_t = error term)



Again, we want to look at the total change in the trends, we also include dummy interaction terms in our regression.



- Turning points - income levels at which the share of manufacturing sector in total employment starts experiencing a fall for each period.

Year	Turning Point (GDP per capita – constant$ 2015)
1990	33122
2000	12965
2010	4962
2018	1493

The above graph demonstrates that these trend lines are also showing Inverted-U pattern and are curves are moving downward overtime and Slope is changing quite substantially over the decades

From the above analysis, we can conclude that the developing countries are experiencing premature deindustrialization in terms of manufacturing employment and turning points for manufacturing employment are (i) much lower and (ii) declined more than the turning points for manufacturing output and (iii) employment deindustrialization is starker than output deindustrialization.

Manufacturing performance – overall analysis

The following observations have been made:

1. The developing countries under observation are experiencing premature deindustrialization in terms of nominal output and employment.

2. The trends for premature deindustrialization in terms real manufacturing output are not as clear, especially for the higher income countries among the set of developing countries.

When we think about de-industrialization as a falling share of manufacturing output in total GDP at current prices, it doesn't necessarily signify a falling importance of the manufacturing sector because a falling share at current prices may also result from a proportional fall in the price index of manufacturing goods as compared to the general price level. One reason why this may happen is because of rising productivity and hence cost-effectiveness.

- When we look at the share of manufacturing output at constant prices, we are doing away with the price effect and hence are looking at what is happening in real terms. This may be one of the potential definers of de-industrialization.
- When we look at the share of manufacturing employment in total employment, it may reflect one of the following – either a falling share of manufacturing employment resulting from a shrinkage in manufacturing activity or a falling share of manufacturing employment resulting from a rise in labor productivity which effectively means that the same/higher output is being produced with lower labor.

This points towards the role of manufacturing productivity growth.

Manufacturing sector has a tendency for the fastest growth in productivity as compared to the agriculture and service sectors (Rodrik 2011). This implies: 1. a fall in the relative price of manufactured goods and 2. a fall in employment share of the manufacturing sector (assuming a low elasticity of substitution between final goods).

Therefore, we have evidence of premature deindustrialization (as we have defined it for the context of this paper) for developing countries as a group with two important highlights

I. Deindustrialization in terms of nominal output and employment is much starker than that in terms of real output.

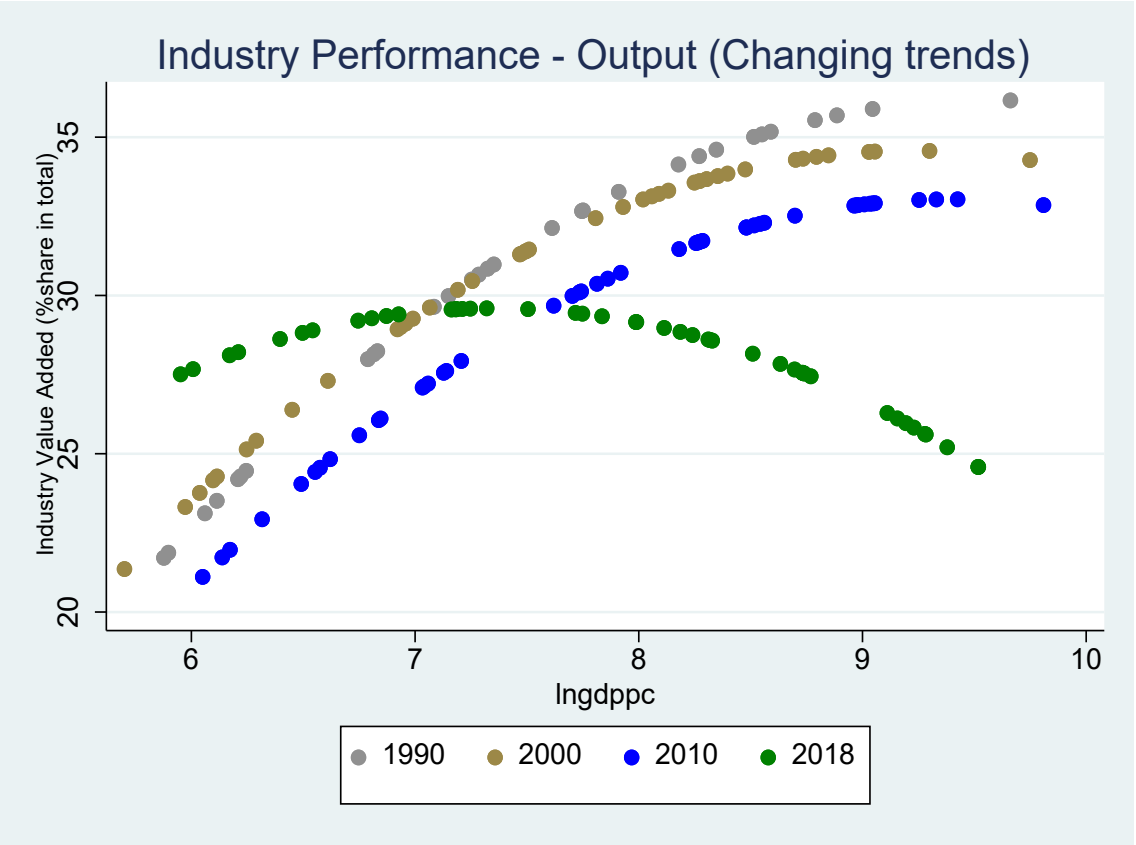
II. Although the developing countries as a group are deindustrializing in terms of real output (our main indictor), the evidence is not conclusive for the higher income developing countries.

IV. Trends in performance- total industry output

We estimate the following regression equation:

$indva_t = \alpha + \beta_1 lngdppc_{t-1} + \beta_2 lngdppc2_{t-1} + \beta_3 2000 + \beta_4 2010 + \beta_5 2018 + \beta_6 2000.\ lngdppc_{t-1} + \beta_7 2010.\ lngdppc_{t-1} + \beta_8 2018.\ lngdppc_{t-1} + u_t$

(Where, $indva_t$ = share of Industry Value Added in total GDP in period t, $lngdppc_{t-1}$ = log of per capita GDP in real terms in period (t-1), $lngdppc2_{t-1}$ = square of the log of per capita GDP in real terms in period (t-1), 2000 = period dummy corresponding to year 2000, 2010 = period dummy corresponding to year 2010, 2018 = period dummy corresponding to year 2018, u_t = error term)

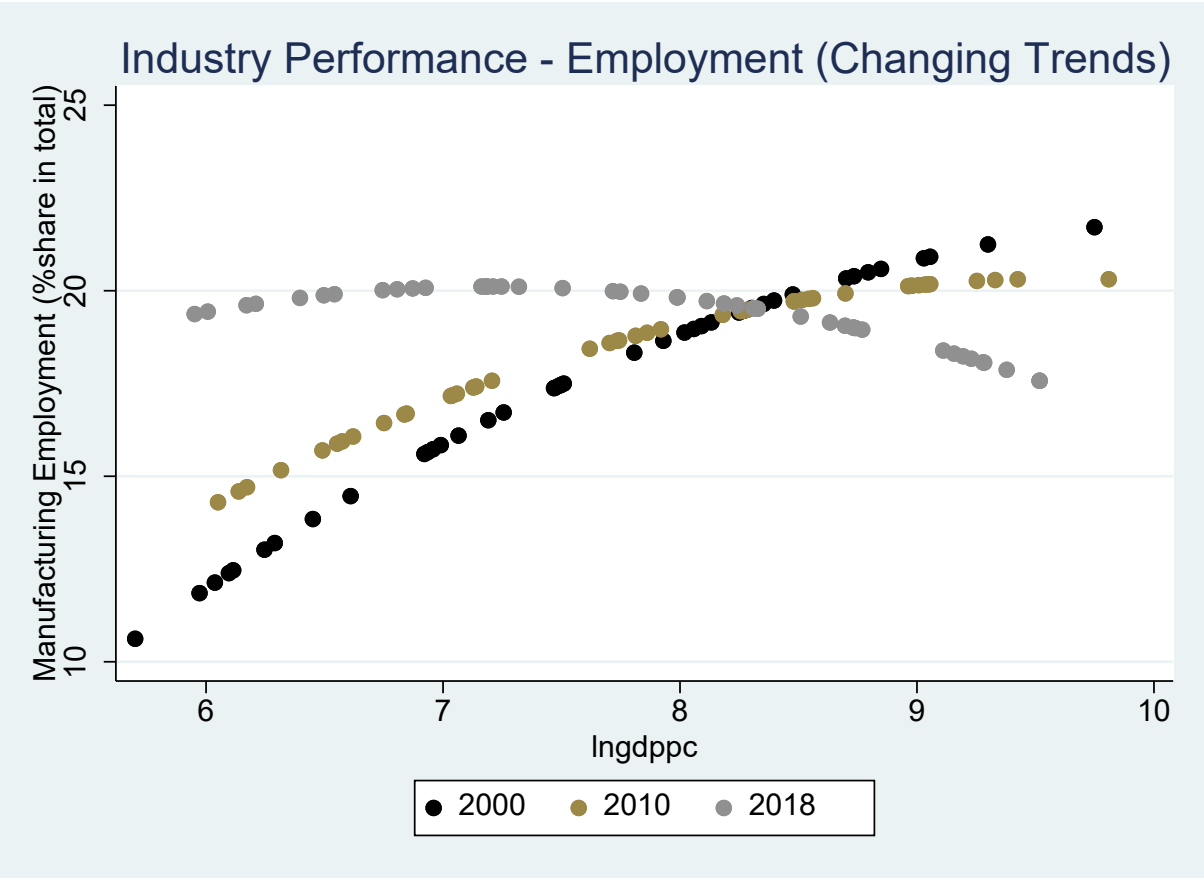


V. Trends in performance- total industry employment

We estimate the following regression equation:

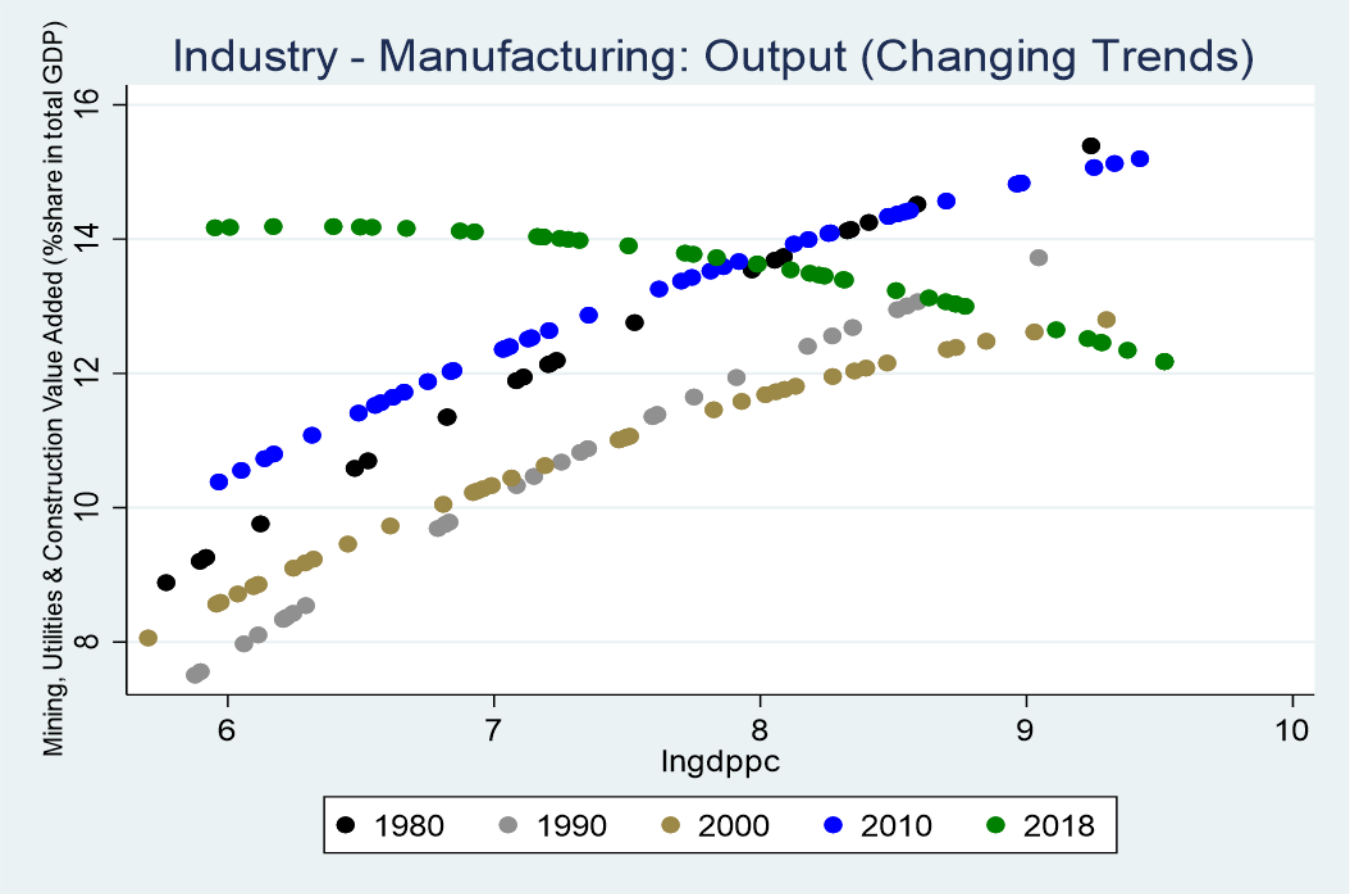
$indemp_t = \alpha + \beta_1 lngdppc_t + \beta_2 lngdppc2_t + \beta_3 2010 + \beta_4 2018 + \beta_5 2010.\ lngdppc_t + \beta_6 2018.lngdppc_t + u_t$

(Where, $indemp_t$ = share of industry employment in total employment in period t, $lngdppc_t$ = log of per capita GDP in real terms in period t, $lngdppc2_t$ = square of log of per capita GDP in real terms in period t, 2010 = Dummy for year 2010, 2018 = Dummy for year 2018, u_t = error term)



Share of manufacturing in total employment is clearly falling over the years. But the fall of the share of industry in total employment is not as stark. Is it the case then that the (Industry – Manufacturing) sector i.e. Mining, Utilities and Construction is growing? If this is found to be the case, then it would explain this employment puzzle since these sectors are inherently employment intensive.

We run a simple regression in order to understand the trends of this sub-sector.



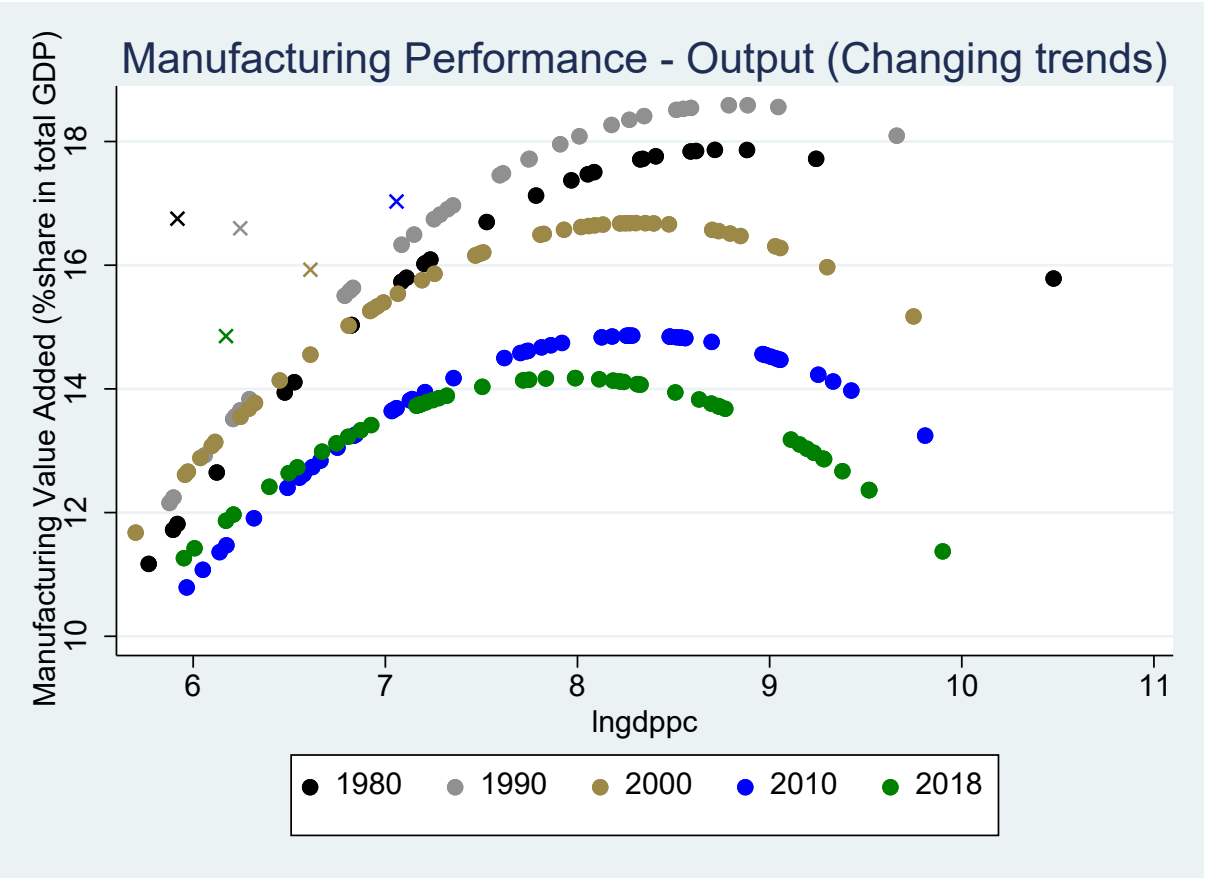
Although the coefficients of the estimated regression are not statistically significant, the results preliminarily point out to a growing mining, utilities and construction sector within an overall scenario of premature deindustrialization, esp. in manufacturing.

Within this sub-sector, mining and utilities typically constitute for % . The major chunk in accounted for by the construction sector.

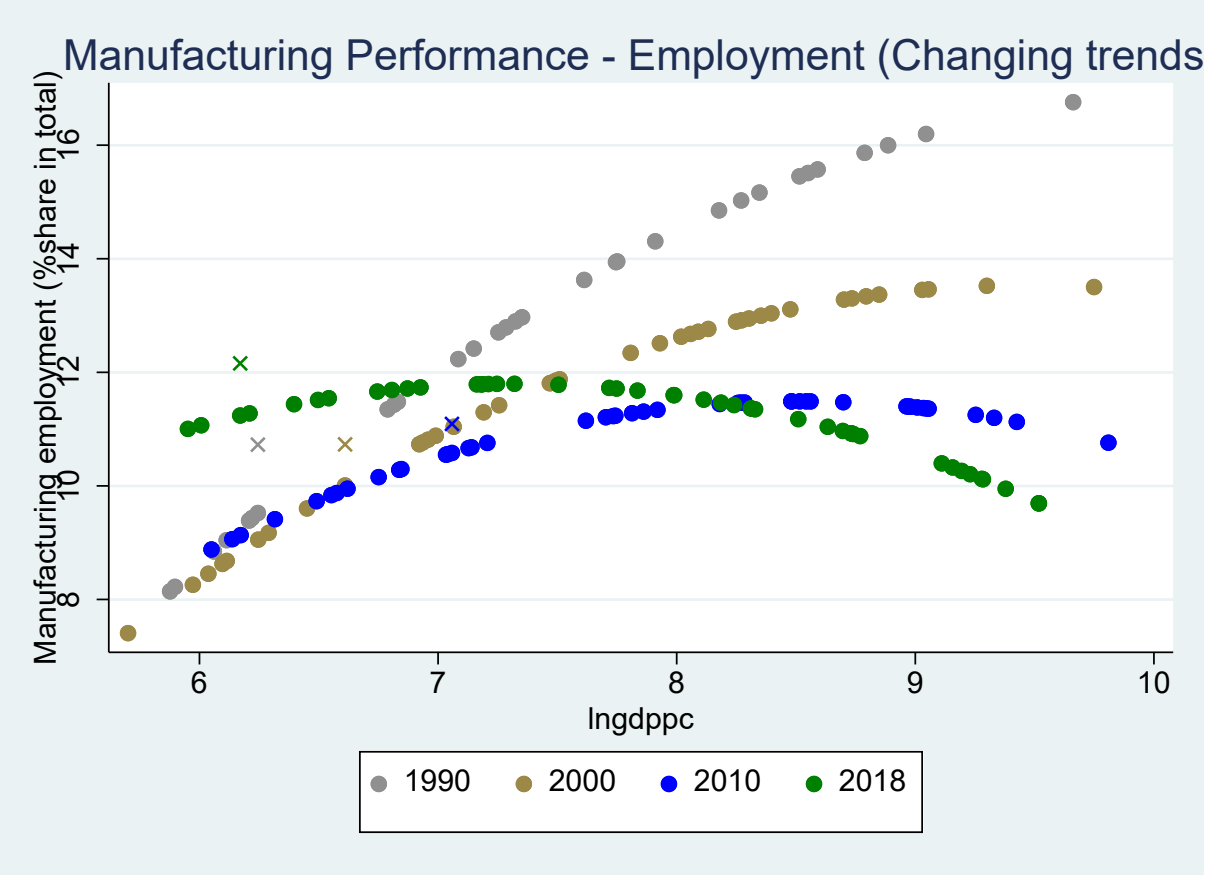
This has some important implications:

1. The discussion around premature deindustrialization has been associated with premature transition to the service sector. While this is true, all of the fall in manufacturing output and employment has not gone into the service sector. Rather, some of it has spilled over to the construction sector.
2. This has direct implications about the structural transformation path that these developing countries are following in general. This points towards the thwarted structural transformation that many developing countries including India are experiencing.
3. This is again linked to the failure of these countries to industrialise fully because the labour and capital released from agriculture then finds its way into these residual sectors.

VI. India's relative position



- For all time periods, the actual observed values for India lie above the trend line - indicating better manufacturing performance(relative to income level) as compared to the generalised trend over the developing countries' group.
- This is contrast to the relatively worse performance that we see India in when comparing it to all countries of the world. (Generally, India would lie to the south-west of the trend line) – see,
- Thus, when compared to its similar cohort of countries, the performance of India has been relatively better.



- Here again, the actual observed points for India lie to the west (above) of the trend line for each period under observation.
- This indicates better levels of manufacturing employment share at given levels of per capita income than that observed in the general trend.
- However when compared to the previous graph, we can say that relative performance on the output front is better than on the employment front in a comparative sense. This gives cues to the 'jobless growth' that India is said to have experienced.

VII. Probable factors

To understand the factors behind the observed performance of the manufacturing sector in the developing countries, we regress the equation:

$lnmfgva_t = \alpha + \beta_1 lngdppc_t + \beta_2 lngdppc2_t + \beta_5 lntrade_t + \beta_4 lngfcf_t + \beta_6 lnprody_t + u_t$

(where, lnnfgva = log of share of manufacturing VA in total GDP, lngdppc = log of GDP per capita (in constant terms), lngdppc2 = square of log of GDP per capita (in constant terms), lntrade = log of (total exports + total imports) as a share of GDP, lngfcf = log of gross fixed capital formation as a share of GDP, lnprody = Value added per worker in the industry sector)

Note: oil and gas resource-rich nations have been excluded for this analysis.

VARIABLES	POOLED OLS	RANDOM EFFECTS	FIXED EFFECTS
lngdppc	0.846105*	0.846105*	0.662141
	(0.398906)	(0.3989066)	(0.4151296)
Lngdppc2	-.053738*	0.0537384*	-0.043156
	(0.255369)	(0.0829735)	(0.0265267)
lngfcf	0.994379	0.0994379	0.0293639
	(0.089735)	(0.0724554)	(0.0859914)
lntrade	-0.16046*	-0.160469*	-0.19652*
	(0.0724554)	(0.0125832)	(0.0812219)
lnprody	-0.021672	-0.021672	-0.019283
	(0.0125832)	(0.0125832)	(0.0126383)
constant	-0.317616	-0.317616	0.814544
	(1.495277)	(1.495277)	(1.561753)

	lmfgva	lngdppc	lngdppc2	lngdpgr	lntrade	lngfcf
lmfgva (L1)	0.9261739**	0.0216243	0.2642818	0.0604152**	-0.0073897	-0.0113542
lngdppc (L1)	-0.0334356	0.7668612**	-1.791026	-0.2531433	-0.4935877**	-0.2140883
lngdppc2 (L1)	0.0027453	-0.0039447	0.918104**	0.00972	-.0393237**	0.0215747
lngdgr (L1)	-0.085692	-0.5590452**	-5.738424**	-0.6768781**	-0.8945656**	-0.3320672
lntrade (L1)	-0.0586443	0.0286619	0.1932445	0.0596419	0.8936062**	0.1411415**
lngfcf (L1)	0.0351149	0.0091163	0.1766548	0.0544214	0.0856191**	0.8125042**

The results from the Vector Auto-Regression and analysis and Granger causality analysis point towards the importance of the trade-openness factor and the investment factor. There is also evidence for the

growth-engine hypothesis for the manufacturing sector. Further analysis would be required to conclusively determine the probable causes.

VIII. Conclusion

This paper has tried to analyse the industrial sector in developing countries as a group. We start with understanding the concept of premature deindustrialization and then develop on it in order to understand what the underlying trends in this set of countries as distinguished from a general analysis of all countries of the world. In this regard, it needs to be noted that any of the trends observed do not point out to the structural transformation path/deindustrialisation of any single country. Instead, the study is an attempt to broadly understand what is happening to the developing countries as a group.

The results we observed were as follows:

1. These countries are clearly experiencing premature deindustrialization in the manufacturing sector in terms of nominal output. This experience is starker than that observed in worldwide analysis in terms of both the shift if the trends and the changing turning points.
2. The experience of premature deindustrialization in the manufacturing sector on the employment front is also analogous.
3. In terms of real output, the deindustrialization in the manufacturing sector is not as stark and cannot be conclusively determined for the higher income countries among the developing countries.
4. In terms of industry, premature deindustrialization is visible in the trends but it is not as stark pointing towards the balancing role played by the residual (industry – manufacturing) sector i.e. mining, utilities and construction.
5. The manufacturing sector is shrinking but the same is not true for the residual sector. This points towards the thwarted structural transformation undergoing in these countries.
6. India's manufacturing experience is relatively better on both the employment and output front compared to the cohort of developing countries. The relative margin by which the performance is better if greater for manufacturing output.
7. As far as the analysis of the probable factors is concerned, the analysis is preliminary and it points towards several important factors like trade openness, fixed investment, per capita incomes and the long run causality between these.