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Article

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The Interrelation between Manufacturing Productivity, Maximum Sectoral Employment and National Income Per Capita

By Rainer Przywara[*]

According to the three-sector hypothesis, the national share of employees in the industrial sector will be shrinking after having reached a specific peak level. In line with societal development over time, the tipping point at which deindustrialization starts should be related to a certain income per capita. Predictions from literature showed an inverted-U relationship of manufacturing employment (%) over income per capita (log) for mature countries. By regression analysis, a universal tipping point at which deindustrialization starts was calculated. In this study, this theory was tested on a sample of 12 mature (high income, tipping by 1980) and 25 emerging (upper-middle income, later tipping) countries. No single standard function for all national economies was found, but certain paths related to the general state of economic development of national economies. The tipping point is moving over time, driven by increasing sectoral productivity. Productivity rises result in a shift over time towards higher income (x-axis) and lower relative employment (y-axis). In accordance with existing theory, the country-specific maximum of relative employment in manufacturing is reached at a certain threshold productivity, which again corresponds to a specific national income per capita. As a stylized fact, two falling linear functions of maximum manufacturing employment (%) over GDP per capita (log) were identified for mature and emerging countries. Their divide follows the international division of labour between highly-productive technology owners (mature countries) and less productive sub-suppliers (emerging countries). In addition, the critical manufacturing productivity at which maximum manufacturing employment is reached was analysed as a function of time (tipping year). Corresponding to the findings on the tipping point, the critical manufacturing productivity is rising over time. Two markedly separated rising linear functions for mature and emerging countries were identified.

Keywords: *Structural Change, Economic Sectors, Sectoral Employment, Manufacturing, Productivity, Tipping Point, Economic Policies*

Introduction

The three-sector hypothesis predicts a standard pattern of different forms of societal development, each characterized by the leading macro-economic sector of the national economy. The agricultural society will be replaced by the industrial society which will then be followed by the service society. In this course, first agriculture, then industry will reach a peak level of relative employment over time. Since manufacturing is a very relevant industrial sector for assuring national welfare in terms of product supply and the trade balance, in most discussions on sectoral change it stands for industry as a whole.

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After reaching the tipping point of relative employment, the national share of employees in manufacturing will be shrinking. Often, this process is denominated as 'deindustrialization'. This is notwithstanding the fact that in the case of rising productivity, reduced employment does not necessarily go along with reduced output. In fact, the incidences of reduced output are rare; the UK has been the most prominent case over the last decade (Przywara 2016).

As a long-term trend, the income per capita of a socio-economically stable country will rise continuously on the basis of rising productivity. In line with this development, the tipping point of manufacturing employment will be related to income per capita. Rowthorn (1994) predicted an inverted-U relationship of manufacturing employment (%) over income per capita (log). By regression analysis, he calculated the tipping point at which deindustrialization starts.

In this paper, Rowthorn's theory was tested on a sample of 12 mature countries (maximum employment in manufacturing by 1980) and 25 emerging countries (countries before the tipping point by 1980).

Literature Review

This literature review consists of the following elements:

- introduction to the three-sector hypothesis of sectoral change of a national economy,
- explanation of the role of manufacturing within a national economy
- delineation of definitions of deindustrialization,
- description of the tipping point prediction of relative manufacturing employment over GDP per capita by Rowthorn (1994).

The results were taken as the starting point of the actual analysis, aiming at a comprehensive theory of sectoral change with specific regard to manufacturing employment and national wealth.

The Three-Sector Hypothesis

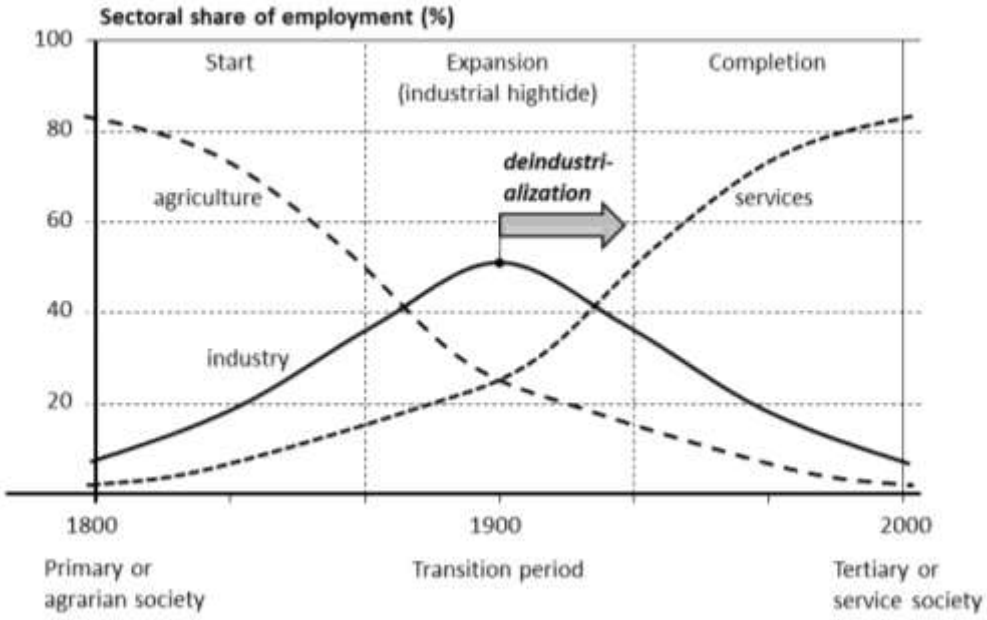
The three-sector hypothesis is a politico-economic theory describing and predicting sectoral structural change of a national economy (Klodt 2014c). On a low level of development, the primary sector (agriculture) dominates, later the secondary sector (industrial production) and, as the final achievement, the tertiary sector (services) (Klodt 2014b).

The three-sector theory was introduced by the British economists Fisher (1935) and Clark (1940) and taken further by the French economist Fourastié (1949). Clark (1940) was inspired by a remark of Petty (1690) published posthumously. Petty's idea of labour reallocation from agriculture to non-agricultural activities, the very ground for the three-sector hypothesis, is often referred to as *Petty's Law*, e.g. by Murata (2008). In Petty's own words, it reads:

"There is more to be gained by manufacture than by husbandry, and by merchandise than by manufacture" (cited after Hospers and Steenge 2002: 9).

After being translated into German in 1954, Fourastié's book was very influential in the German-speaking countries (Pohl 1970). Unlike his two immediate British predecessors, Fourastié did not only provide descriptions of the phenomena, but tried to identify the mechanisms behind them, namely technology and population growth (Hospers and Steenge 2002). On this basis, he predicted a transition of all then-developed societies to service societies by millennium. The phenomenon of a relative decline in industrial employment after reaching an all-time peak is considered as 'deindustrialization' (Klodt 2014b).

Figure 1. *Standard Pattern of Structural Change*



Source: Author's graph, after Henning (1995: 21), stylized scheme.

According to the three-sector hypothesis, the sectoral shift is mainly driven by two mechanisms:

1. Rising income elasticity of demand:
   On a low income level, the demand for goods is relatively inelastic and focused on the coverage of basic needs. With rising income, the elasticity of demand rises. Thus, industrial goods and – in the course of development – services become more and more favoured.
2. Different productivity growth rates per sector
   Technical progress leads to different patterns of growth per sector. In the secondary sector (capital-intensive production), the labour content is constantly reduced by innovations (automation), so a relative decline in sectoral employment results.
   Possibilities for productivity rises in the tertiary sector were considered as limited by the authors of the middle 20th century (Klodt 2014b).

The outlined pattern of structural change has been demonstrated in general by empirical studies (Pohl 1970). This notwithstanding, the presumption of a general backlog in productivity of the tertiary sector did not prove to be appropriate. It was based on the somewhat antiquated notion of services as typically being consumer-oriented. In recent decades, production- or enterprise-oriented services (e.g. financial or technical services) have played an important and still growing role. Modern information and communication technologies (ICT services) have contributed to increase the productivity of most other fields of goods and services (Klodt 2014a). Therefore, the dominant factor for the advancement of services can be seen in a shift of demand (Klodt 2014b).

The Role of Manufacturing

The classical three-sector hypothesis subsumes all industrial activities under the caption 'secondary sector'. According to the ISIC 4 classification, these are:

- mining and quarrying,
- manufacturing,
- electricity, gas, steam and air conditioning supply,
- water supply; sewerage, waste management and remediation activities,
- construction.

Since manufacturing assures the supply of goods and involves the majority of persons employed in the industrial sector, later analyses of sectoral change often focused on manufacturing. Moreover, the idea that "there is something special about manufacturing", as Kitson and Michie (2014: 322) put it, evolved. Among the authors that argued in that direction were Young (1928), Lewis (1954) and Kaldor (1966). Kaldor was of major influence not only in the scientific debate, but in real life as an advisor for the British Labour government since 1964 (Dasgupta and Singh 2006).

Kaldor derived his idea of the central role of manufacturing for the prosperity of an economy from diagnosed differences in central economic features of the economic sectors. He assumed an income elasticity of demand similar to that of services, but higher than that of agriculture (Dasgupta and Singh 2006). On the supply side, he estimated the productivity growth of manufacturing higher than that of both other sectors because of its exclusive potential to utilize economies of scale (Kitson and Michie 2014). From these basic assumptions, he derived generalizations known as 'Kaldor's laws'.

As Singh (1977) noted, the manufacturing sector is of crucial influence on the external balance of a country. He followed that idea three decades later when noticing that UK manufacturing accounted for less than 20% of the GDP, but still for 60% of its foreign trade (Dasgupta and Singh 2006). In line with this idea, in the course of its decline in manufacturing, from the early 1980s the UK for the first time since the industrial revolution had a negative balance on manufactures (Kitson and Michie 2014).

More recent discussions focussed on the idea that knowledge-intensive services could serve as a compensation for lacking manufacturing in a national economy. This argument is around the idea that the British Chancellor of the Exchequer, Nigel Lawson, delineated as follows (Lawson 1985: 554): "[T]here is no adamantine law that says we have to produce as much in the way of manufacturing as we consume. If it does turn out that we are more efficient in world terms at providing services than at producing goods, then our national interest lies in a surplus on services and a deficit on goods."

In a Kaldorian analysis, many services clearly depend on manufacturing, so Nigel Lawson's idea would not work out. But Kaldor's analysis, quite adequate at his day, referred to rather simple services (e.g. personal services and transportation). If high-technology services are concerned that have only recently been made available, knowledge-intensive business services (KIBS) like ICT services may well generate follow-up growth even in manufacturing (Dasgupta and Singh 2006).

The question remains whether services can fully replace the manufacturing sector. Kitson and Michie (2014) cast serious doubt on that assumption by highlighting the aforementioned trade deficit and regional imbalances resulting from a weak manufacturing sector in the UK. They blame ill-led capital flows, e.g. into a too big financial sector, for the distortions.

Definitions of Deindustrialization

In Kaldor's academic footsteps, Kollmeyer (2009) defined deindustrialization as a relative decline in manufacturing employment. He claimed this to be the single adequate definition of deindustrialization, but although Kollmeyer's definition is quite common in sociology and serves well to describe certain socio-economic phenomena, it can neither be considered as complete nor universally adequate:

- It does not comprise a time frame for structural change.
- It only refers to the role of manufacturing <u>within</u> a society. It is not well-suited for making international comparisons of the impact of the manufacturing sector.

For international comparisons of the economic impact, the absolute output and the productivity of a national economy are of crucial relevance. In this context, <u>absolute</u> employment figures are the reference parameter while <u>relative</u> employment is of minor interest.

Current definitions of deindustrialization of an economy are (Bryson and Taylor 2008, Lever 1991):

- long-term contraction of manufacturing (absolute contraction),
- a shift from manufacturing to services (relative contraction).

Both can be measured either in terms of employment or output. The resulting four indicators (Table 1) do not necessarily correlate. With rising productivity, the manufacturing output may increase at the same time as employment declines (def. 1a fulfilled, 1b not fulfilled). Moreover, in a growing economy, absolute growth can go along with a relative decline of the manufacturing sector (def. 1 not fulfilled, def. 2 fulfilled).

From this starting point, Przywara (2016) constituted rigid macro-economic definitions and utilized them in two complementary models of deindustrialization. These models were tested by macro-economic data for 12 mature and 25 emerging countries, covering the years 1973-2008 with successive 15 + 5 +15-year sub-periods. The novel scenario model of sectoral development, involving (human) labour content as a central indicator, was introduced by Przywara (2017).

Table 1. *Four Standard Indicators for Deindustrialization*

	(a) **Employment**	(b) **Output**
1. Absolute contraction of the manufacturing sector	(1a) Declining absolute value	(1b) Declining absolute value (CU at constant prices)
2. Relative contraction of the manufacturing sector	(2a) Declining sectoral share	(2b) Declining relative value (sectoral share)

Source: Author.

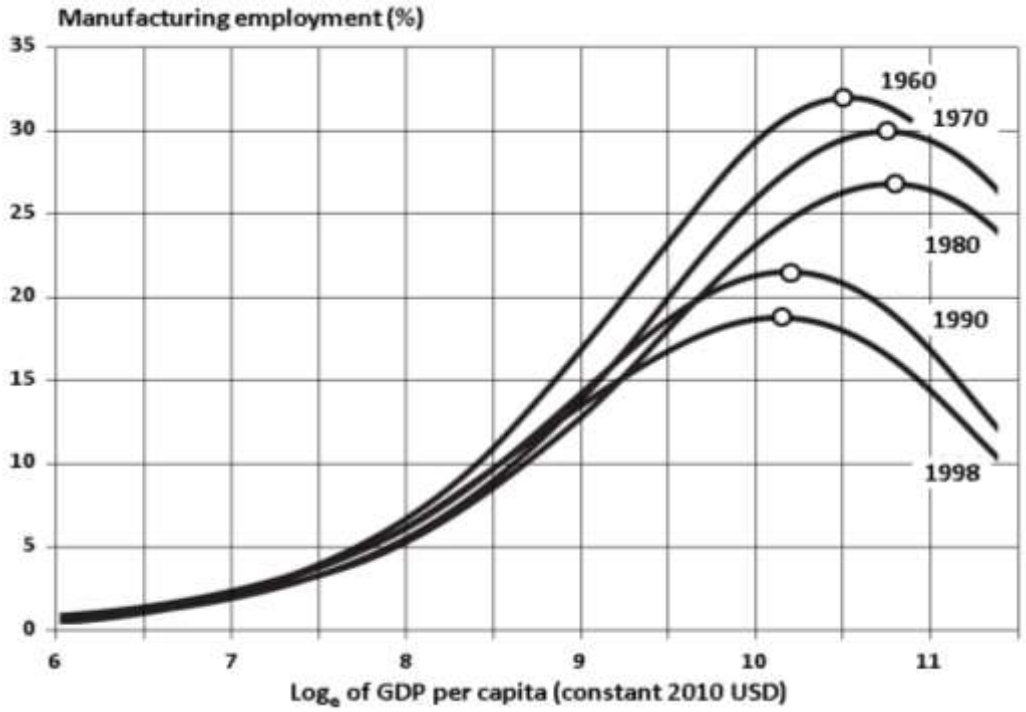
Prediction of the Tipping Point of Relative Manufacturing Employment

Rowthorn (1994) tried to predict the tipping point of relative manufacturing employment by relating it to the income level (GDP per capita) of a national economy. The underlying assumption of his theory is the continuously rising welfare of a country, driven by the manufacturing sector. In the course of a constant thrive for increased output, productivity is enhanced by automation. When at a certain point in time a specific critical productivity is reached, increases in output will not lead to hiring more employees but to invest in equipment. Thus, the tipping point of employment is reached. In line with societal and industrial development over time and rising productivity, the tipping point at which deindustrialization starts should be related to a certain income per capita.

Rowthorn (1994) predicted an inverted-U relationship between income per capita and the share of manufacturing employment. By regression analysis, he calculated the tipping point at which deindustrialization starts. He estimated tipping at around 12,000 USD (1990 prices), roughly equal to 18,000 USD (2010 prices), resulting in a log value of 9.8. Rowthorn's regression revealed a tipping point manufacturing employment rate of about 22%.

Palma (2005) tested Rowthorn's idea thoroughly and generally confirmed his hypothesis (Figure 2). Yet, Palma realized that things were not as simple as Rowthorn expected, since he found the tipping point to be moving over time. Palma found tipping points moving towards less manufacturing employment and GDP per capita.

Figure 2. *Palma's Findings for ME (%) vs. GDP per Capita (log)*



Source: Based on Palma (2005: 77), author's calculations.

A moving tipping point of the regressions had already been predicted by Rowthorn and Wells (1987). They attributed the decline to the rapid productivity growth in (at least some sectors of) manufacturing, brought about by the propagation of the new technological paradigm of microelectronics (Palma 2005). Because productivity catch-up is fastest in manufacturing, in developing countries deindustrialization would start at a lower level of income per capita than in the early industrialized countries (Rowthorn and Wells 1987). Still, the magnitude of the shift was surprising to Palma (Palma 2005).

Identified Gaps of Knowledge and Theory

Two main gaps of knowledge and theory were identified:

- The influence of productivity growth on the tipping point has been assumed by Rowthorn and Wells (1987) and diagnosed by Palmer (2005). Yet, a comprehensive understanding of the relation of manufacturing productivity, maximum sectoral employment and income per capita has not been achieved. Productivity was not included as a variable in the given research.
- In the existing investigations on the tipping point of manufacturing, national economies were considered as closed, thus following a similar development pattern with a country-specific time shift. Possible

interdependencies of countries and the role of firms in international value streams were not taken into account so far.

The research carried out aimed at closing these gaps.

Methodology

The analysis was carried out with regard to the long-term developments in mature and emerging states. All monetary values were transferred into 2010 US dollars on the basis of exchange rates as utilized by the World Bank (2014a) to assure international comparability over time. For the given purpose, it was found adequate to abstain from the use of purchasing power parities. Utilizing the plain exchange rate

- is the "simplest option" (Maddison 1995: 97),
- was found to be sufficing since this analysis is mainly on structural shifts within an economy,
- is the adequate method for following trade flows,
- does not lead to big errors because, in general, the parity has converged over time for the examined mature country group.

The timeframe for the underlying analysis (Przywara 2016) was the period from 1970 until 2010. This period exactly meets the frame set by a statistical database that resulted from an EU research project, the EU KLEMS database (Groningen Growth and Development Centre 2012). It aims at providing a statistical base for questions related to growth and productivity. Its accounts follow the ISIC 4 classification, with special attention to section C (manufacturing), equalling section D (ISIC 3) and section 3 (ISIC 2) of previous codes (European Commission 2014, United Nations 2002, United Nations 2008). Additional data on the developments before 1970 was gathered from national statistical bureaus and publications.

Data for emerging states was taken from World Bank (2014a) and ILO (2014) statistics. In a number of cases, incomplete data had to be replenished by inter- and extrapolation (for details see Przywara 2016).

Country Sample Selection and Data Processing

The underlying doctoral thesis (Przywara 2016) comprises economic analyses of 12 mature (high income) and 25 emerging countries. The grouping of countries was carried out in accordance with the World Bank classification (cf. Table 2), based on GNI comparisons. GNI is defined as "the sum of a country's gross domestic product (GDP) and net income (labour compensation and property income) from abroad" (World Bank 2011). For the major industrial countries, the GNI is only very slightly (<1%) above their GDP, so for practical reasons, the

more common GDP will be taken into consideration for grouping the countries according to national income per capita.

Table 2. *World Bank Classification of Countries*

Indicator Economy group	**GNI per capita**			
	minimum (USD)	maximum (USD)	$\log_e$ of minimum	$\log_e$ of maximum
Low income	0	1,005		6.91
Lower-middle income	1,006	3,975	6.91	8.29
Upper-middle income	3,976	12,275	8.29	9.42
High income	12,276		9.42	

Source: World Bank (2011), author's calculations. In constant 2010 USD.

The line between emerging and mature economies will be drawn along the line of high-income countries for two reasons:

- According to the World Bank, low-income and middle-income economies are sometimes referred to as developing countries, so this would exactly be the opposite of a mature country.
- It fits well with Rowthorn's and Palma's findings on the tipping point for deindustrialization of mature economies. These are always well above the high-income threshold (cf. Table 3).

A list of the examined mature countries is given in Table 3.

Table 3. *List of Analysed Mature Economies and Some Key Features (2010)*

Country	**Indicator Code**	**Population**	**Pop. density**	**GDP**	**GDP p/c**
		(million)	(# per km²)	(bn USD)	(k USD)
Austria*	***AUT***	8.4	101.8	377.7	45.0
Belgium*	***BEL***	10.9	360.6	471.1	43.2
Finland*	***FIN***	5.4	17.6	236.7	44.1
France*	***FRA***	65.0	118.7	2,565.0	39.4
Germany*	*DEU* ***(GER)***	81.8	234.6	3,304.4	40.4
Italy*	***ITA***	60.5	201.5	2,055.4	34.7
Japan	***JPN***	127.5	349.7	5,495.4	43.1
Netherlands*	***NLD***	16.6	492.6	777.2	46.8
Spain*	***ESP***	46.6	93.4	1,384.8	29.7
Sweden	***SWE***	9.4	22.9	462.9	49.4
UK	*GBR* ***(UK)***	62.7	259.4	2,285.5	36.6
USA	***USA***	309.3	33.8	14,958.3	48.4

Source: World Bank (2014a) data and codes (in brackets: codes utilized in this article), in constant 2010 USD. * Eurozone country

Industrialization and eventual deindustrialization in emerging economies is examined for a sample of countries from three regions, following the World Bank (2014b) grouping:

- Latin America,
- East Europe and Central Asia,
- East Asia.

A list of these countries is rendered by Table 4. By the end of the examined period, several countries have made a successful transition into the high-income group. Most clear examples are the Czech Republic, the Slovak Republic and especially (South) Korea.

Table 4. *Analysed Emerging Economies Including Key Features (2010 Data)*

Country	Indicator Code	Population	Population density	GDP	GDP per capita
		(million)	(per km²)	(bn USD)	(k USD)
Latin America					
Argentina	***ARG***	40.4	14.8	368.7	9.1
Brazil	***BRA***	195.0	23.1	2,143.0	11.0
Chile	***CHL***	12.5	23.1	217.6	12.7
Colombia	***COL***	46.4	41.9	287.0	6.2
Ecuador	***ECU***	15.0	60.4	67.5	4.5
Mexico	***MEX***	117.9	60.6	1,047.4	8.9
Venezuela	***VEN***	29.0	32.9	393.8	13.6
East Europe & Central Asia					
Bulgaria	***BUL***	7.4	68.1	47.7	6.5
Croatia	*HRV* ***(CRO)***	5.4	78.9	58.9	10.9
Czech Republic	***CZE***	10.5	135.6	198.5	18.9
Kazakhstan	***KAZ***	16.3	6.0	148.1	9.1
Poland	***POL***	38.2	125.5	469.7	12.3
Romania	***ROM***	20.2	88.0	164.8	8.1
Russia	***RUS***	142.4	8.7	1,524.9	10.7
Serbia	***SRB***	7.3	83.4	37.0	5.1
Slovak Republic	***SVK***	5.4	112.1	87.1	16.2
Turkey	***TUR***	72.1	93.7	731.1	10.1
Ukraine	***UKR***	45.9	79.2	136.4	3.0
East Asia					
China	***CHN***	1,337.7	143.4	5,930.5	4.4
India	***IND***	1,205.6	405.5	1,708.5	1.4
Indonesia	***IDN***	240.7	132.9	709.2	2.9
Korean Republic	***KOR***	49.4	508.9	1,014.9	20.5
Malaysia	***MYS***	28.3	86.1	247.5	8.8
Thailand	***THA***	66.4	130.0	318.9	4.8
Vietnam	***VNM***	86.9	280.4	115.9	1.3

Source: Based on World Bank (2014a) data and codes (in brackets: codes utilized in this article)

Results

This section contains three main elements:

- Detailed analysis of deindustrialization of the group of 12 mature countries
- Per region analysis of the industrial development of 25 emerging states
- Combination of the key findings for both groups.

Findings for Mature Countries

Rowthorn's (2014) theory on the course of economic maturing processes was tested for all economies of the sample. The share of employment in manufacturing was calculated as a variable depending on GDP per capita ($\log_e$ of constant 2010 USD).

The expectation was that mature economies in the period 1970-2010 would be able to constantly increase their income per capita. Over time, they should move from the left to the right side of the graph. Concerning the share of manufacturing, they will show one of the following types of behaviour:

- Very rich and mature countries, first of all the USA, should have already passed the tipping point predicted by Rowthorn. Thus, a constant decline of the share of manufacturing employment should result over time and increasing income per capita.
- Some of the fairly rich countries may not have reached their tipping point by 1970. For the first years, there is a parallel increase of manufacturing employment and GDP.

If the maximum employment point occurs at a GDP per capita of around 18.000 USD (2010 prices), as Rowthorn calculated, or at even higher values, as Palma (2005) determined, this is clearly above the entrance criterion for a high-income economy.

Courses of Deindustrialization

Key indicators for deindustrialization are summarized in Table 5. Given the GDP per capita for 1970, only Sweden, the USA and the Netherlands were clearly above the tipping point predicted by Rowthorn (1994), while in all other cases, both kinds of behaviour could have been possible. Spain was just short over the edge of being a high-income country, with a level of maturity clearly below that of all other economies of the sample

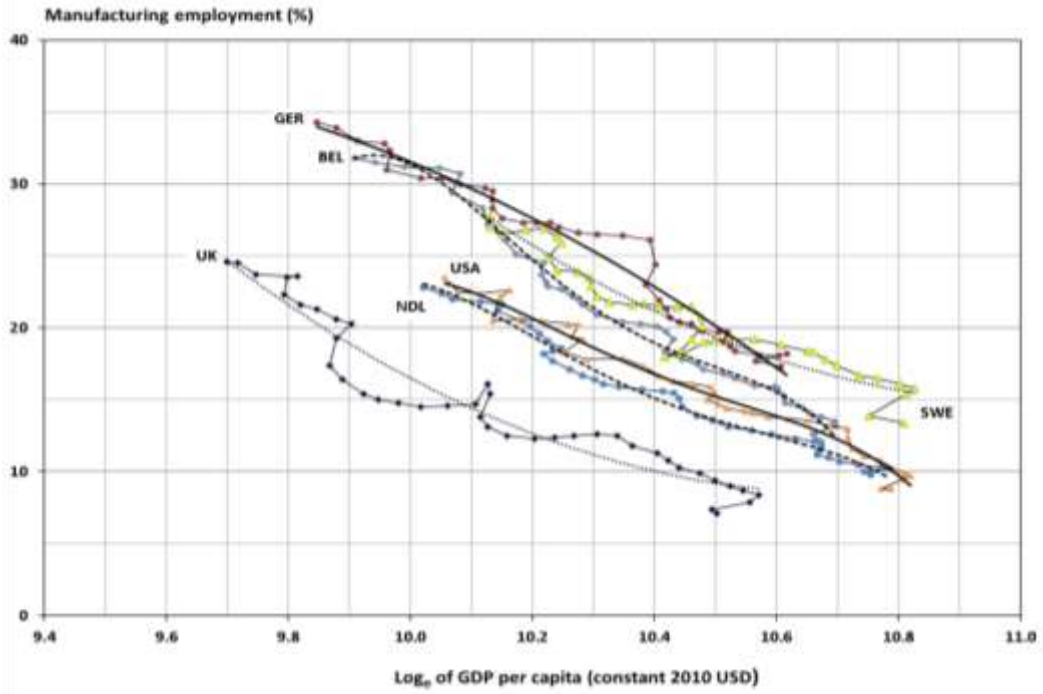
1970 to 2010 plots for manufacturing employment over GPD per capita (log) are given in Figure 3 (countries with a constant decrease in manufacturing employment, i.e. tipping before 1970) and Figure 4 (countries with a tipping point). Countries showing similar behaviour (constant decrease versus tipping point) were each grouped in one graph.

Table 5. *Key Data for Mature Countries*

	Country	**AUT**	**BEL**	**FIN**	**FRA**	**ESP**	**GER**	**ITA**	**JPN**	**NED**	**SWE**	**UK**	**USA**
Manufacturing employment (%)	1970	25.1	31.8	24.6	23.6	21.4	34.3	26.8	25.5	22.8	27.8	24.6	23.5
	2010	14.6	12.3	15.4	10.9	20.8	17.3	18.2	15.7	9.8	13.4	7.1	8.8
	CAGR	-1.41	-2.42	-1.10	-2.02	-1.67	-1.66	-0.98	-1.20	-2.14	-1.57	-3.06	-2.36
GDP per capita (k USD)	1970	18.8	20.1	18.0	20.1	13.3	18.9	22.9	17.9	22.5	25.1	16.3	23.3
	2010	45.0	43.2	44.1	39.4	29.7	40.4	34.0	43.1	46.8	49.4	36.4	48.4
	CAGR	2.19	1.87	2.33	1.64	2.03	1.90	1.82	2.07	1.93	1.80	2.13	1.86
	Tipping year	**1972**	**1970**	**1974**	**1974**	**1977**	**1967**	**1980**	**1973**	**1961**	**1965**	**1966**	**1953**
Manufacturing	employment (%)	25.6	31.8	25.2	24.2	22.6	37.9	28.2	25.8	26.3	31.9	28.3	32.1
	productivity (USD/h)	24,1	23,2	23,6	26,8	31,8	20,4	33,5	23,9	18,1	19,4	15,3	16,4
GDP	per capita (k USD)	20.8	20.1	21.5	23.8	15.7	14.5	23.6	21.2	15.0	21.4	14.9	16.2
	$\log_e$	9.94	9.91	9.98	10.08	9.66	9.56	10.04	9.96	9.61	9.97	9.61	9.69

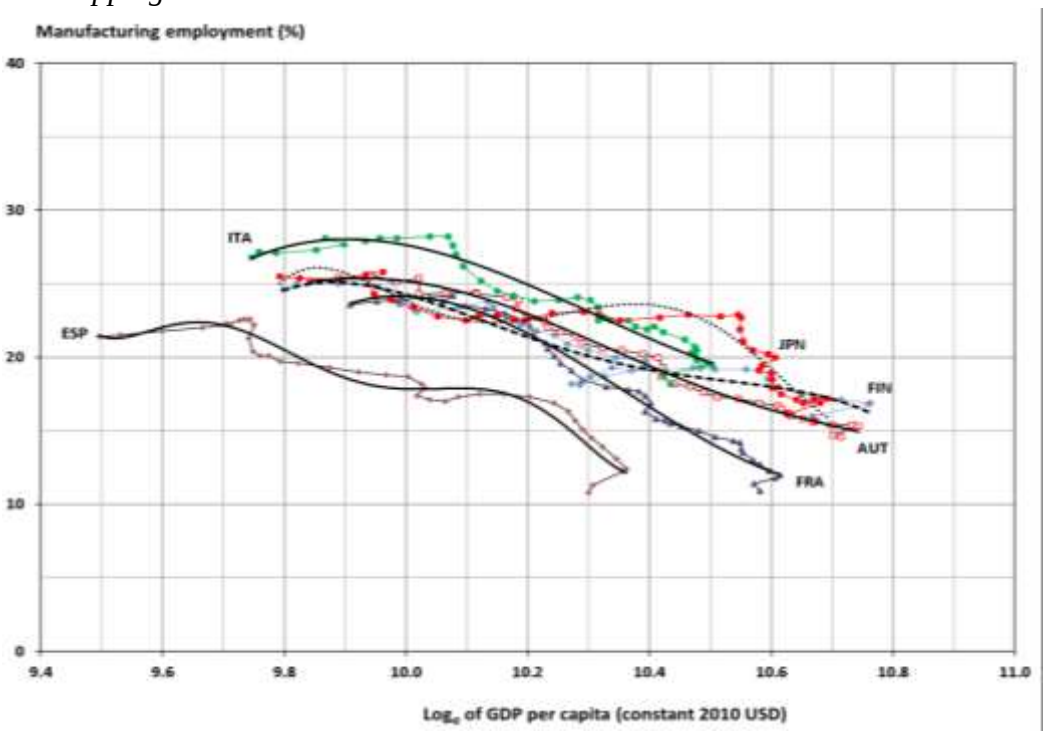
Sources: World Bank (2014a), Bach & Riefers (1970), Statistika Centralbyran (1970), Federal Reserve Bank of St. Louis (2018), author's calculations. In constant 2010 USD.

Figure 3. *Manufacturing Employment (%) vs. GDP p/c (log_e); Mature States Beyond Tipping*



Sources: Author's calculations, based on Groningen Growth and Development Centre (2012) and World Bank (2014a) data. Data for 1970-2010, polynomial trends

Figure 4. *Manufacturing Employment (%) vs. GDP p/c (log_e); Mature States with Tipping Points*



Sources: Author's calculations, based on Groningen Growth and Development Centre (2012) and World Bank (2014a) data. Data for 1970-2010, polynomial trends

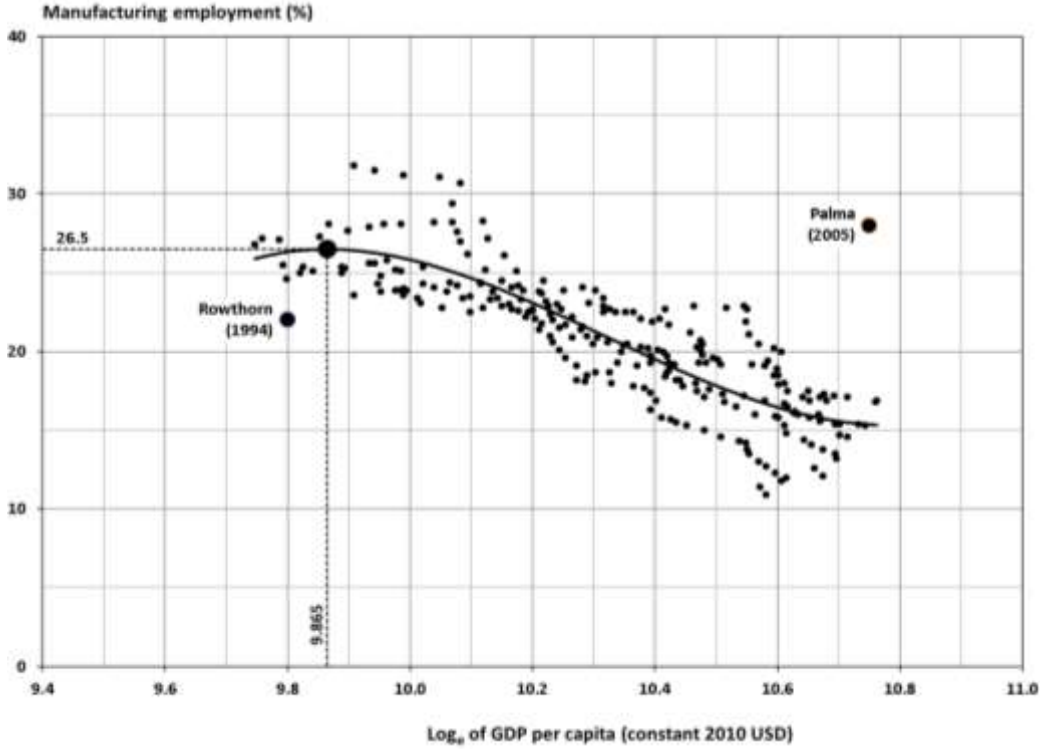
The left half of the expected inverted-U shape over time is not present by definition in the group of countries with a continuous decrease in manufacturing. This left half is almost invisible also for the tipping point group. In these cases, the 1970 values for manufacturing employment were already close to the maximum level reached a few years later. In the special case of Belgium, the tipping point was exactly reached in 1970.

Spain had reached a comparatively little level of maturity in 1970. Given Rowthorn's assumptions, Spain should have stayed on a growth path concerning manufacturing, but, as Figure 4 shows, it was not able to follow this path consequently. This might partially be attributed to national developments, but can also be attributed to more general observations which will be outlined in the following.

Tipping Points

The tipping points of mature economies from 1970 to 1980 are quite similar, concerning GDP per capita (cf. Table 5). By involving all alike mature countries with a tipping point, i.e. including Belgium but excluding Spain, a trend line for the structural shift of mature economies was derived as displayed in the following graph (Figure 5) from a polynomial regression analysis.

Figure 5. *Joint Regression Analysis of Tipping Mature Economies*



Sources: Author's calculations, based on Groningen Growth and Development Centre (2012) and World Bank (2014a) data for Austria, Belgium, Finland, France, Italy, Japan; Palma (2005). Regression: 3rd degree polynomial.

The average maximum manufacturing employment stood at 26.5 %, the GDP per capita around 21.7 k USD (log ≈ 9.9). This is somewhat higher than Rowthorn's (1994), but much lower than Palma's (2005) results for the 1970s.

The findings cast a certain doubt on some findings of Palma's (2005) analysis. In accordance with his interpretation, there is evidence that there is a shift over time towards lower tipping points in terms of manufacturing employment, but there is none towards a lower national income per capita.

Industrial development of 25 emerging states

Analogously to the analysis of mature countries, the interrelation of manufacturing employment and national wealth as income per capita was analysed. The plots for manufacturing employment over GDP per capita ($\log_e$) differ in the range of the GDP displayed, corresponding to national wealth. While for mature countries, a log range between 9.4 (~ 12.1 k USD) and 11.0 (~ 59.9 k USD) was adequate, meaning that all of the countries were permanently located in the World Bank high-income group, emerging countries were (and most of them still are) much poorer. The adequate range for Latin-American and East European countries was between 7.4 (~ 1.6 k USD) and 10.0 (~ 22.0 k USD) while some East Asian states required to extend the range to the left down to 5.4 (~ 0.3 k USD), meaning that people lived on less than one USD per day at average.

Respective graphs are given by Figures 6-8, describing the course of development of manufacturing employment over national income per capita. These are mostly related to growing national income per capita, rendering the following graph shapes:

- Inverted U-shape: industrialization and subsequent deindustrialization
- U-shape: (mild) deindustrialization and subsequent recovery
- →: constant share of manufacturing employment, rising productivity

There are some forms related to stagnation or (temporal) loss of national income per capita:

- C-shape: reverse deindustrialization (income losses), turning into subsequent deindustrialization with income recovery). Note: The C-shape cycle ends when the initial income per capita (in constant prices) is reached again.
- Inverted C-shape: continuous deindustrialization, starting with gains in income per capita, then waning, finally turning into income losses.

In the following, the regional results are summarized briefly per region.

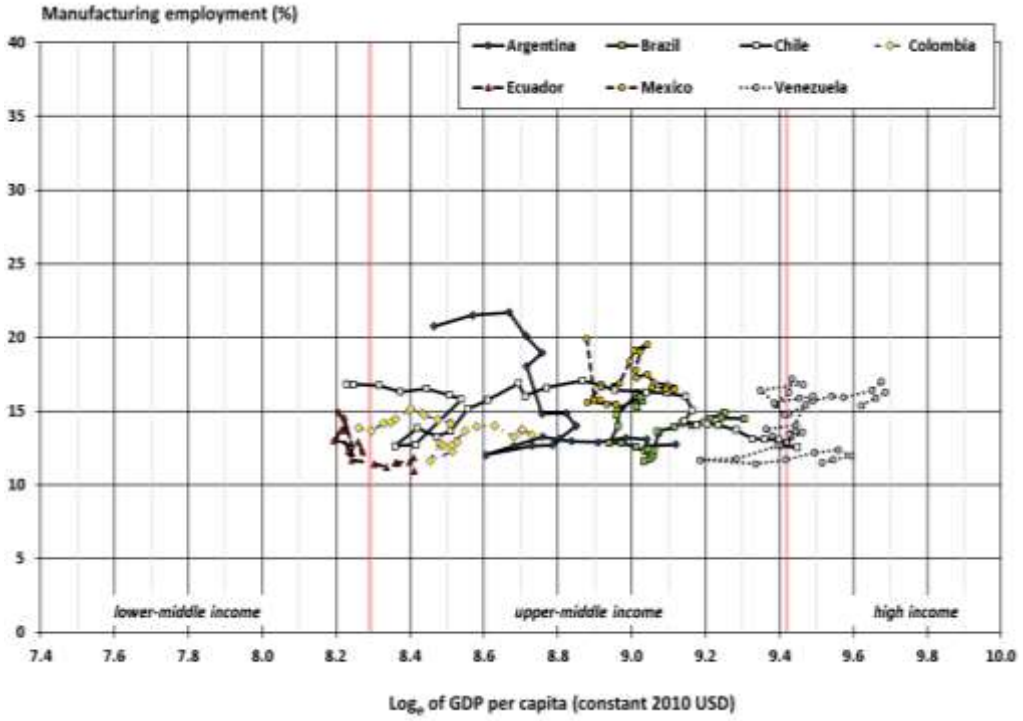
Latin America

The results for Latin America are shown in Figure 6. At first glance, no clear tendency and also no reverse U-shape curves including tipping points expected by

the classical economists can be traced. In all states, the share of manufacturing employment was most of the time in a very small range between 10 % and 20 % of total employment. In 2010, the investigated economies only had a tiny bandwidth from 11.5 % (Venezuela) to 16.5 % (Mexico) of manufacturing employment.

The values for Latin America are divided into two major phases. In the first phase until around the year 2000, negative deindustrialization (i.e. including welfare losses) prevailed. More recently, there has been industrial development (inverted U-shape, →) or at least on going recovery (C-shape).

Figure 6. *ME (%) vs. GDP p/c (log), Latin America*



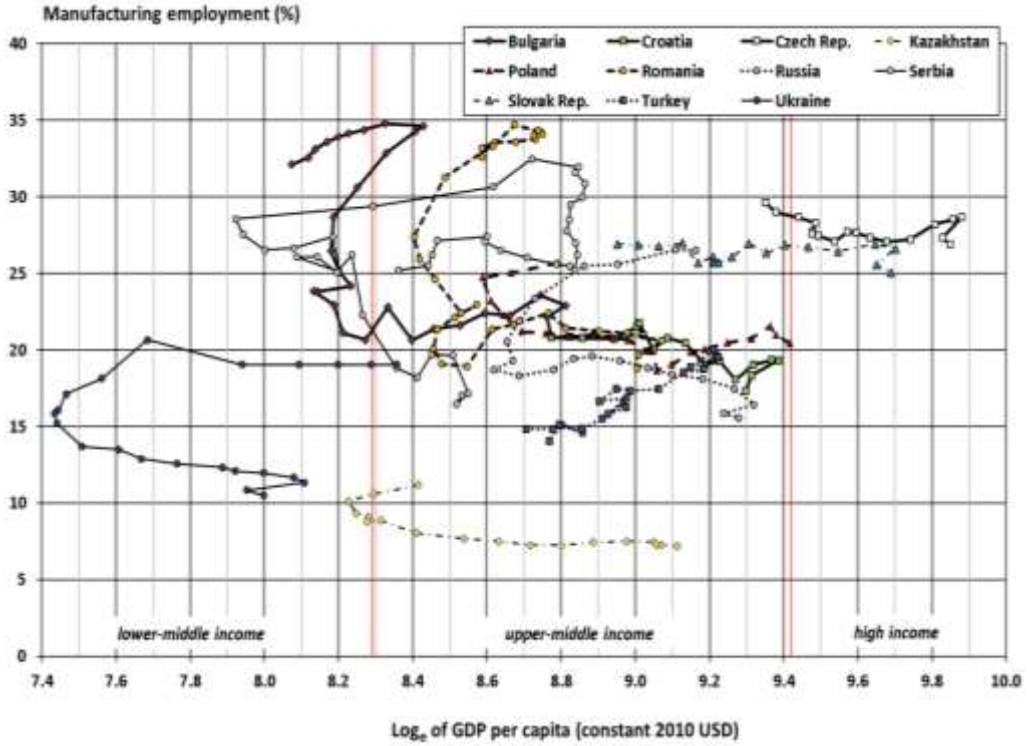
Sources: Author's graph, ILO (2014) and World Bank (2014a) data until 2010, starting in 1975 (CHL, VEN), 1985 (BRA), 1990-2010 (ARG, COL, ECU, MEX)

East Europe and Central Asia

The results for East Europe and Central Asia are shown in Figure 7. Compared to the Latin-American results, the bandwidth is much larger, also concerning the shapes of the curves. C-shape curves are not rare. No classical inverted U-shape curves can be traced, only some left or right 'legs' of the U letter. Turkey, the only former non-communist country, is an exception within the investigated group, pursuing a constant industrial development (inverted U-shape).

The investigated former communist states all went through a crisis (C-shape) but have all managed to recover and keep the remains of their industrial base constant (→), apart from Serbia with its fast-eroding manufacturing base and the Ukraine somewhat lagging behind (both still C-shape).

Figure 7. *ME (%) vs. GDP p/c (log), East Europe and Central Asia*



Sources: Author's graph, ILO (2014) and World Bank (2014a) data until 2008; starting in 1970 (SRB); 1980 (BUL, ROM); 1989 (POL, UKR, TUR), 1990 (RUS), 1991 (CRO), 1993 (CZE, KAZ, SVK)

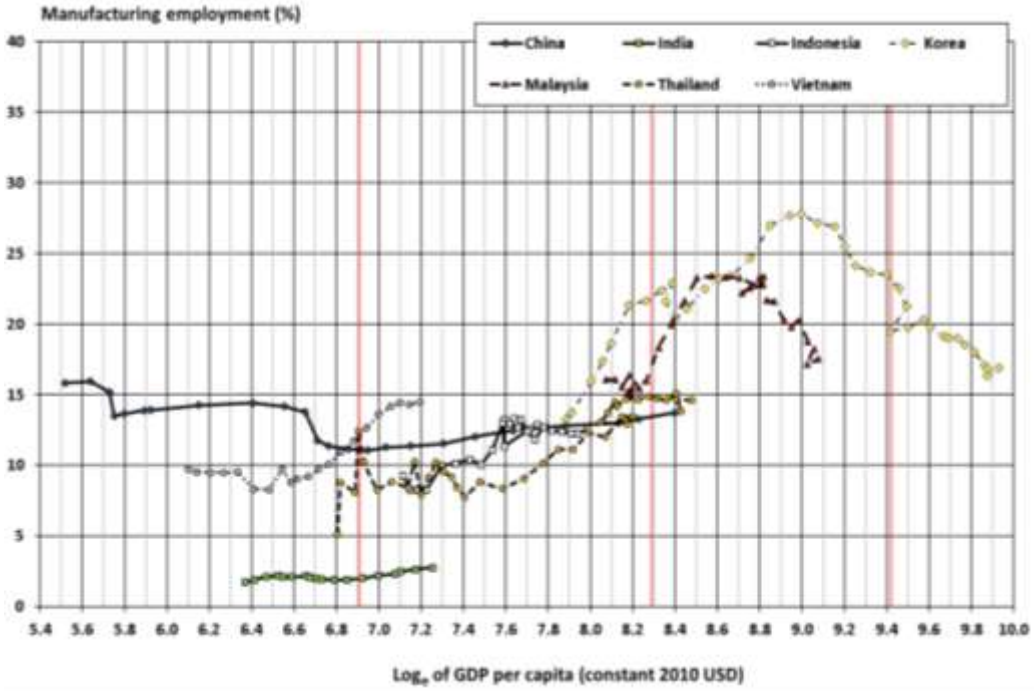
Although being much less productive than Western states, very highly industrialized states in East Europe reached peaks in manufacturing employment shortly before or in 1990, as the examples of Bulgaria, Romania and Serbia (Ex-Yugoslavian federal state) illustrate.

East Asia

The results for East Asia are shown in Figure 8. In all of these states apart from China (→), industrial development follows, at least partly, the course predicted by 20th century economists (inverted U). In the cases of South Korea and Malaysia, even almost classical inverted U-shape curves can be seen.

By this form of catch-up modernization, East Asia made significant economic progress. China has become the 'workshop of the world' without altering the size of its workforce in manufacturing, but on the basis of its giant population and immense progress in productivity.

Figure 8. *ME (%) vs. GDP p/c (log), East Asia*



Sources: Author's graph, ILO (2014) and World Bank (2014a) data until 2010, starting in 1970 (KOR), 1971 (THA), 1980 (MYS), 1985 (IDN), 1987, (CHI), 1990 (VNM), 1993 (IND, w/o informal economy).

Key Findings for Emerging Countries

The interpretations of the detected phenomena are compiled in Table 6. Eight states have reached their maximum level of manufacturing employment over the investigated period.

Table 6. *Industrial Development Processes in Emerging Countries*

Country	Start	Income group		Curve shape			Tipping point		
	Year	Start	2010	Prev. phases	Tran-sition	Most actual phase	Year	Manuf. empl. (%)	GDP p/c (kUSD)
Latin America									
Argentina	1990	UMI	UMI	inv. C	2002	→			
Brazil	1985	UMI	UMI	C	1999	inv. U	n/a		
Chile	1975	LMI	HI	inv. C	1983	inv. U	1992	17.1	7.1
Colombia	1985	UMI	UMI	n/a	n/a	→			
Ecuador	1990	LMI	UMI	↓	2003	→			
Mexico	1990	UMI	UMI	U	2000	C	2000	19.5	8.5
Venezuela	1975	HI	HI	n/a	n/a	C			
East Europe & Central Asia									
Bulgaria	1980	LMI	UMI	inv. U C	1989 2002	→	1987	34.8	4.1
Croatia	1991	UMI	UMI	n/a	n/a	→			
Czech Rep.	1993	UMI	HI	n/a	n/a	→			
Kazakhstan	1993	UMI	UMI	C	2000	→			
Poland	1990	UMI	HI	C	2000	→			
Romania	1980	UMI	UMI	inv. U C	1986 2004	→	1989	34.7	5.9
Russia	1990	UMI	UMI	C	2006	→			
Serbia	1970	UMI	UMI	inv. U	1987	C	1990	32.5	6.1
Slovak Rep.	1993	UMI	HI	n/a	n/a	→			
Turkey	1990	UMI	UMI	n/a	n/a	inv. U	2008	20.0	10.0
Ukraine	1993	UMI	LMI	n/a	n/a	C			
East Asia									
China	1987	LI	UMI	n/a	n/a	→			
India	1993	LI	LMI	n/a	n/a	inv. U	n/a		
Indonesia	1985	LMI	LMI	n/a	n/a	inv. U	n/a		
Korean Rep.	1970	UMI	HI	n/a	n/a	inv. U	1989	27.8	8.1
Malaysia	1980	LMI	UMI	n/a	n/a	inv. U	1997	23.4	6.8
Thailand	1971	LI	UMI	n/a	n/a	inv. U			
Vietnam	1990	LI	LMI	n/a	n/a	inv. U			

Sources: Author's analysis, based on ILO (2014) and World Bank (2014a) data. In constant 2010 USD. Groups: LI = low income; LMI = lower-middle income; HMI = upper-middle income; HI = high income

Combination of the Key Findings for Mature and Emerging States

Deindustrialization in terms of reductions in relative manufacturing employment was found in all mature countries, but also in certain emerging countries. According to literature (Rowthorn 1994, Palma 2005), the tipping point of manufacturing employment, i.e. the all-time high, is reached at a certain level of national wealth which was supposed to be falling over the years. In fact, the identified relations are somewhat different to these predictions from literature, as will be explicated in the following.

Comprehensive Evaluation of the Tipping of Mature and Emerging States

In Figure 9, the identified tipping points of all investigated mature and emerging economies are summarized in one graph.

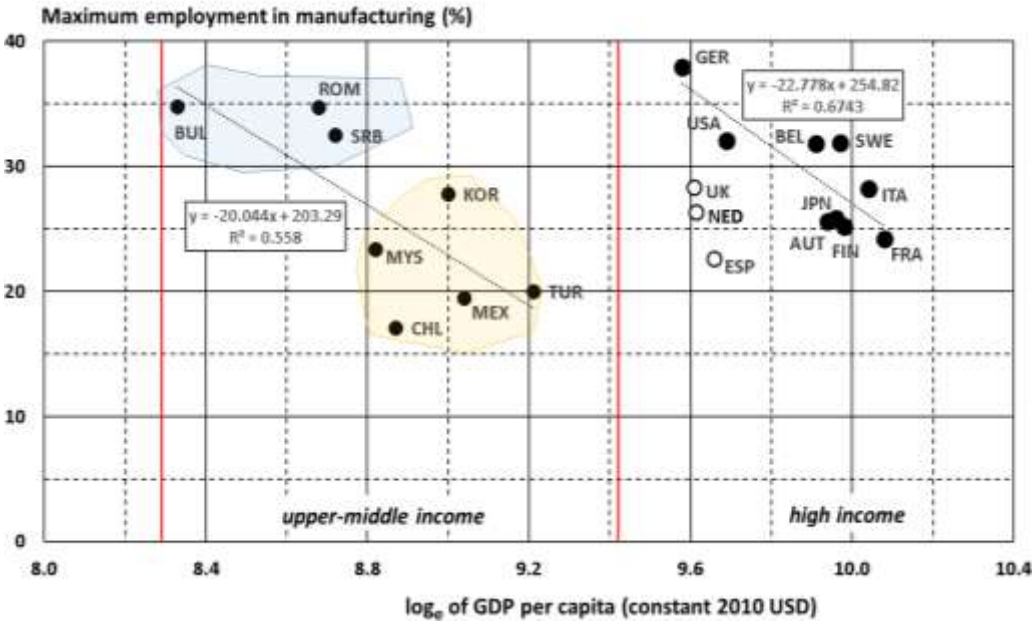
Mature Countries

Austria, Japan, France, Finland, Spain and Italy tipped in 1972-80 at around 25% manufacturing employment. Spain was remarkably poorer than the others and was thus considered as an outlier in the calculation of the trend.

Early industrializers like the USA, Germany, Sweden and Belgium tipped at more than 30% of manufacturing employment.

The manufacturing industry of the Netherlands and the UK also tipped early but never blossomed to the extent that could be expected from the trendline. Thus, both points were qualified as outliers.

Figure 9. *Tipping Points of Mature and Emerging Countries*



Source: Author's graph, based on ILO (2014) and World Bank (2014a) data, linear trends. Two groups are identified:

Emerging Countries

The former socialist countries Bulgaria, Serbia and Romania tipped in the late 1980s at about 35% manufacturing employment.

The catch-up modernizers Korea, Chile, Malaysia, Mexico and Turkey tipped in the last two decades under investigation at around 20%.

Both sub-groups are characterized by far less national wealth than the mature states. When united in one group, there is a trend line approximately parallel to the one of mature states.

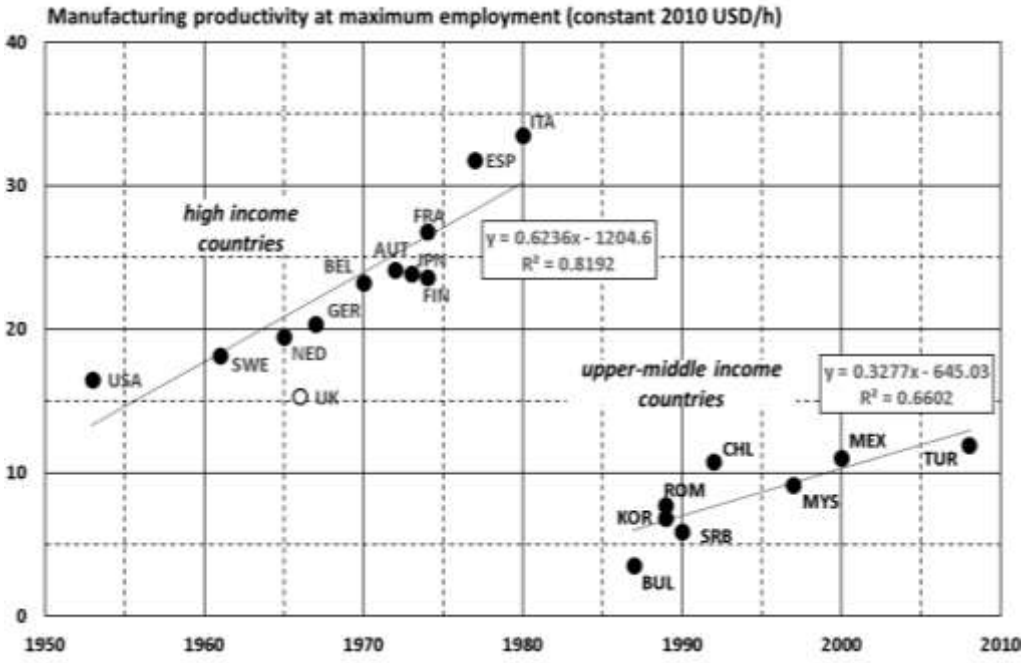
Key Findings

Two almost parallel falling linear functions of maximum manufacturing employment (%) over GDP per capita (log) were identified for mature and emerging countries. In both cases, the tipping point moves over time from high to low manufacturing employment and from low to high income. The functions are clearly separated; hence the income differences between both identified groups are large.

Analysis of the Threshold Productivity for Tipping

Since manufacturing productivity is a key driver of national wealth and structural change (see above), the manufacturing productivity reached at the tipping points of manufacturing employment was analysed. This critical productivity of manufacturing is displayed in Figure 10 over time.

Figure 10. *Manufacturing Productivity over Time, Mature and Emerging Countries*



Source: Author's graph, based on ILO (2014) and World Bank (2014a) data, linear trends.

The productivity related to tipping is a rising linear function, but (again) a different one for the high-income group and the upper-middle income group. Notably, the latter function unites the former socialist and the emerging countries. Generally, the results are – given the very high R^2 values – very convincing. The UK performed much below the trend line level of productivity and is thus seen as an outlier.

Discussion

After World War II, national economies were rather confined entities with export rates lower than before World War I. The USA was by far the most powerful and wealthy economy. Over the years, the frame conditions for business changed. By the GATT/WTO rounds and voluntary cooperation like the European Union, markets became more permeable and interconnected (Meier and Roehr 2004). The new market conditions helped to raise the welfare of high-income countries to about the American level (Vernon 1979).

With the fall of the iron curtain and the opening of the East around 1990, these developments have been taken further. In the globalized economy, most markets are open and connected and more and more less-developed countries have become economically involved, taking part in the international division of labour (Abele et al. 2006). This has been driven by multi-national companies (MNCs) whose economic rationale is not the benefit of any national economy, but their own (transnational) well-being, i.e. profit. The economic power of the strongest MNCs is in the order of magnitude of national states, and so is their aspired political influence.

The mature countries tipped before the era of globalization, when internationalisation was mainly pursued on the basis of exports and largely independent production in foreign countries built up by MNCs. Division of labour along the value chain was rare.

Due to limited cross-border competition, national economies could develop independently and with more differences than in the globalized era. Under these conditions, the welfare state could blossom in many developed countries. In such a comparably little-connected environment, there was like a standard course of industrial development, but also room for national peculiarities. Due to mainly national competition, the sectoral productivity increased continuously. At a certain productivity level, further transfer of workforce into the manufacturing sector was inhibited. The sectoral output fulfilled the actual demand, so further productivity rises would rather diminish the workforce than grow the market size and in this course require more workforce. The tipping point is reached.

Since technical development becomes at least partly transferred across national borders, the tipping point of national economies is moving over time, productivity rises result in a shift over time towards higher income (x-axis) and lower relative employment (y-axis).

The outliers of the standard function of mature economies for relative manufacturing employment over GDP per capita (log) can be explained as follows:

- Netherlands
  The Netherlands were a case of sectoral crowding out. Investment went into the natural resource sector rather than in manufacturing after the detection of the Groningen gas field (Backhouse, 2002).

- United Kingdom
  The productivity development of the UK was the elimination of competition by creating national trusts ('champions') in post-war UK (Bailey et al. 2008).
- Spain
  Spain's economic development was very unsteady due to disruptive political changes, namely those from Franco's dictatorship to democracy and abrupt changes between socialists and conservative governments and policies. Moreover, a bubble economy funnelled by Spain's over-large construction sector (Bielsa and Duarte 2011). Spain remained the poorest country of the sample. Its national economy also suffered from high unemployment rates.

Only from the 1980s, global production networks and cross-functional cooperation evolved, driven by improved frame conditions such as reduced hindrances for trade and foreign direct investment (FDI), improved information and communication technology (ICT) and constantly falling transport costs per unit. Companies now split their value chains globally, with vendor and supplier networks controlled by worldwide supply chain management (Abele et al. 2006).

Industrial late movers cannot use the full potential that the industrial pioneers could realize in terms of employment and income. This has two main reasons:

- Technical progress
  Permanent process innovation constantly raises manufacturing productivity, leading to less employment needed for the same output. Thus, it is likely that national levels of manufacturing employment share will decrease over time.
- Increased competition
  Market pressure from globalization limits possible earnings of manufacturers.

The latter observance is in line with the product cycle hypothesis (Vernon 1979) which shows that mature production is shifted to low-cost locations over time. These countries will achieve less earnings from manufacturing than the pioneering group, even more so when multi-national firms utilize international competition to put growing pressure on their producers. In the investigated period, Western multi-national companies were able to develop and maintain a sector-specific advantage. More simple steps of the production of investment and complex consumer goods were gradually transferred to low-cost countries which also took over the production of mass commodities.

It might be concluded that in a globalized economy, manufacturing becomes increasingly unattractive for countries – but 'beggars can't be choosers'.

For emerging countries, the productivity within reach is controlled by the external and internal demand of their goods. External demand for manufacturing goods of emerging countries is related to the willingness to pay and the bargaining power of their buyers in mature countries. Since in most cases, the offer of

emerging countries does not involve cutting-edge but catch-up technology (East Asia) and middle positions in international supply chains (East Europe), their selling proposition is not unique and the achievable prices are rather low. As a consequence, so is the productivity and so is the national income per capita which again determines the domestic demand. Since from both buyers, external and internal, the willingness and ability to pay is low in tendency, so is the productivity that can be reached. As a consequence, lower-income countries tend to tip at lower productivity levels.

By the outlined mechanisms, a two-tier system of the maximum extension of manufacturing employment in relation to productivity has evolved. The different functions of both tipping clusters can be explained by the different level of technology produced in these groups. While the Western producers are original equipment manufacturers and technology owners, thus being able to have a high share of high-technology products in their portfolio and especially their part of international value chains, catch-up modernizers often act as sub-contractors and are not able to develop their own products. The created value is limited by the inherent technological prowess. The macro-economic two-tier system has its origin and equivalent in the micro-economic value chains where the firms of the catch-up modernization countries are mostly placed in the lower deck.

This finding is very different from the predictions of the structuralists and their successors who described a united system, a standard path of industrialization and deindustrialization.

For the late modernizers, it is hard to catch up as long as strong and well-established economies will defend their economic advance. The role of Mexico in comparison to the USA is a fine example to illustrate that process. Mexico could not change its role as a sub-supplier in international value chains and accordingly also stagnated in terms of national wealth. On the other hand, there are chances on the basis of close cooperation and open markets, as the largely improved living conditions in several East European countries illustrate.

The underlying analysis (Przywara 2016) has shown that catch-up modernization can be well supported by state dirigisme, as the very different examples of post-war France and lately China illustrate. To achieve technological leadership requires innovation capacities that are only released by independent thinking. This means that the state in some form has to give way to entrepreneurial spirit and activity.

Most impressive results were achieved by Korea which has fully caught up on the basis of consequent technological development, bringing its leading firms into the position of technological leadership. Korea has shown that it is possible to overcome the distance on the basis of the acquisition of technological know-how (ship-building, cars, consumer electronics, and computers).

While the findings for mature and developing countries and their two-tier system are considered as sound and well-based, it has to be underlined that each country follows its own unique path set by its geography and its societal and economic pre-requisites and finally carved by its political system and actors. Social unrest and class segregation hampers economic development as well as well-meant protection of dying industries to avoid social hardships, as especially a

number of examples of Latin American countries have shown (see addendum below).

Summary and Outlook

Industrialization and subsequent deindustrialization in terms of a decline of the share of workers in manufacturing are natural consequences of the technical development towards automation and innovation. The course of deindustrialization is country-specific and is influenced by the respective country's position in the international division of labour.

Rowthorn (1994) predicted an inverted-U relationship of the share of manufacturing employment over income per capita (log) and calculated the tipping point at which deindustrialization starts. In this study, Rowthorn's theory was tested on a sample of 12 mature and 25 emerging countries.

Two approximately parallel falling linear functions for relative manufacturing employment over GDP per capita (log) for mature and emerging states were identified. There is a large welfare gap between both groups. It results from the international division of labour, i.e. mature country OEMs with technological ownership and innovative high-price products vs. sub-suppliers and well-known low-cost products of emerging states.

Manufacturing productivity was identified as the key driver and indicator for success of the manufacturing sector. In accordance with Rowthorn's theory, it was found that the country-specific maximum in relative employment in manufacturing is reached at a certain threshold productivity. Corresponding to the findings on peak manufacturing employment of income per capita, there are two rising linear functions of critical manufacturing productivity over time related to mature and emerging economies, respectively.

The novel theory is ready to be tested in subsequent analyses of the structural change of emerging states.

Addendum: Hints for successful Industrial Policies

By a detailed investigation of structural shifts (Przywara 2016), it became clear that economic success can be assured by different economic means, i.e. an emphasis on different industrial or service sectors, in the course of international division of labour.

Manufacturing, especially high-technology manufacturing, is one of the options to achieve economic success that several states pursued. In the investigated globalized period (1993-2008), Austria and Germany, Finland and Sweden were the most successful of these states.

Focusing on manufacturing requires a sound and specific know-how base which can be considered as a core competency. Furthermore, a continuous ambition to innovate products and processes is necessary to assure state-of-the-art products and a high productivity. Especially in the globalized economy of recent

decades, characterized by merciless competition through open-market policies and neo-liberal politics, long-known economic success stories in manufacturing like those of Spain, Italy, France and Japan became jeopardized and their habitual policies scrutinized. Their strongly state-led policies sufficed for developing a strong manufacturing sector after World War II and being successful through the 1970s and 1980s, but in the globalized era, these policies were apparently more and more insufficient for sectoral and overall economic success.

Productivity was identified as the key driver and indicator of success in the manufacturing sector. Industrial policies need to aim at high productivity since competition today is on a global platform. Countries not being able to keep up with the speed are running the risk of trade losses and in that turn economic shortfalls. Under these circumstances, short-term 'social' policies, i.e. those of retaining jobs instead of raising productivity, have little chances to lead to satisfactory results in the mid or long term as a number of examples from Latin America, but also Spain and France prove.

On the other hand, oversteered neo-liberal policies can lead to very critical economic situations, especially if applied dogmatically at the wrong time and the wrong place, as the example of Finland around 1990 showed impressively. Such policies do not fit well with high-tech manufacturing which depends on institutions for training and education to be ready to create the incremental innovations that assure market success. If the delicate interplay of institutions that have evolved over a long time is interrupted by harsh interventions, the comparative institutional advantage of an economy will suffer. The case of Finland is exemplary for this.

While in Western economies, a constant increase in productivity over time was the normal case, four nations stepped out of line and stagnated:

- Spain, Italy (from around 1995)
- France (from around 2000)
- Japan (from around 2005)

In terms of productivity, the UK was lagging far behind in 1973. On the basis of merciless industrial policies, only the fittest manufacturing firms survived, so the productivity rose fast, but very high numbers of jobs became cut. The face of the British society changed by far most radically, even in relation to many former Eastern Bloc states.

The main lesson to be learned for achieving a solid macro-economy is that it is composed of many healthy and ambitious micro-economic units. This means two things:

- Private micro-economic units will not be able to organize adequate institutions to assure their human resources and an efficient state administration. From high market pressure and limited resources for the individual firm, market failure will result, i.e. the privatization of public goods will not work. Examples are the education sector and also basic research which need to be organized on a broad basis which individual

firms will not provide. To put it more poignantly: Neo-liberalism will dig its own grave if taken too far.

- On the other hand, as the results of socialism, but also western dirigisme show, governments and their administrations are poor entrepreneurs. They are lacking creativity and drive to be innovative, so in a globalized economy, there is hardly a possibility for state-owned conglomerates to succeed in the top tier of global manufacturing.

While the latter is without any doubt correct for mature economies, see the failed attempt to grow 'national champions' in the UK, it has to be noted that catch-up industrialization can be and has been successfully organized by or with strong support of government in many states like France, Japan, Korea and recently in China. By state support, their infant industries could be taken over the first steps to marketability of their products.

But when reaching a certain stage of maturity, simply copying available know-how does not lead to further progress. Thus, especially late-moving states have to learn that old apodictic certainty has to be given up at a certain point if progress shall not come to a halt at that stage of development.

Industrial policies and forms of deindustrialization in emerging countries showed a very heterogeneous picture. Initially, a regional structure of analysis was pursued. Although the industrial development of nations within regions was by no means homogeneous, regional clusters of deindustrialization patterns were detected.

- In East Asia, industry was built up, so the economic development was largely related to the success of the industry. Restless catch-up modernization helped to increase the national wealth of all states. Industrialization in any investigated respect (workforce, total working time, output) was the normal case.
  China managed to raise its productivity by outstanding growth rates, so it could increase its industrial output without raising its number of people employed in the manufacturing sector.
  High GDP p/c rises were the predominant scenario in East Asia.
- The manufacturing sector in Latin America was found to be largely stagnating. Most Latin-American countries limited their deindustrialization in terms of employment by very low productivity rises or even losses. Very little increases of the average wealth per capita were the logical consequence of such efforts.
  Argentina and Chile pursued a different agenda. Their comparatively tough industrial policies assured high productivity rises and improvements in the national income per capita, but also boosted the volatility of the change process.
  In Venezuela, with its abundance of oil, crowding out by its primary product sector prevented the manufacturing industry from growing. Yet, since this assured that only productive investments were made, the remaining manufacturing industry was relatively efficient.

- In East Europe's EU member states, there was some very limited relative shrinking of employment in the manufacturing industry, but at rising output.
  Like in East Asia, high GDP p/c rises were the predominant scenario. They were mostly achieved by becoming part of international value chains of MNCs, so the national economies turned into dependent market economies (DMEs).
- The CIS and EU aspirants group shows a mixed picture. Most countries were tough modernizers which were pushing their productivity while accepting grave signs of deindustrialization. They were able to boost their national income on primary products (Russia, Kazakhstan) or services (Croatia).
  The Ukraine could not keep pace with these countries. It arrived quite miserably and with an eroded industrial base.

As in all mature states, also in almost all emerging states a shift out of agriculture (with the exception of Ecuador) and into services, especially knowledge-intensive business services (with the exception of Venezuela), was observed.

Abundance in natural resources helped a number of states (Kazakhstan, Russia, Venezuela) to increase their national income but hampered their manufacturing sector because of detouring necessary investments ('Dutch disease').

Bringing know-how into an emerging country is a delicate task for the government since it requires to cooperate with MNCs. In return, they will urge for political influence. In the case of East European dependent market economies, this influence has been taken very far, but it helped to raise the living standard rapidly. The feeling of a lack of control together with mental over-burdening by the very rapid change has contributed to the recently growing success of nationalist parties, e.g. in Hungary and Poland.

State-permeated market economies (SMEs) like China are powerful enough to stay in control even of large MNCs, so they allow them to invest but at the same time try to get into possession of their technology, i.e. intellectual property, be it legally or illegally.

Leaving familiar paths is not an easy task. It is even harder to work against the deeply internalized collective memory that is subsumed under the concept of national culture. Policies need to consider the inherent values and the long-term impact of cultural coinage. National culture is of major influence on the success of the national manufacturing sector. According to the underlying study (Przywara, 2016), countries with a lower power distance, indicating less hierarchical thinking and management, were better able to increase their manufacturing productivity, i.e. the most important indicator for sectoral ambition and predicator for economic success.

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