TEXTO PARA DISCUSSÃO

ISSN 0103-9466

469

Beyond inverted-U curve: deindustrialisation and industry's contribution to development in high and middle-income countries

Antonio Carlos Diegues
Flávio Vinícius Ferreira

Agosto 2024

UNICAMP
IE instituto de economia

Beyond inverted-U curve: deindustrialisation and industry's contribution to development in high and middle-income countries

Antonio Carlos Diegues [1]
Flávio Vinícius Ferreira [2]

Abstract

Since the seminal contributions of Hamilton (1791) and List (1841), economic development has been understood as a process of accumulation and subsequent investment associated with technological progress and structural transformation towards higher productivity activities in manufacturing. In context, this paper aims to measure and analyze the industry's contributions to development in high-income (HICs) and middle-income countries (MICs) from 2000 to 2019. Its main purpose is to re-evaluate the inverted U-shaped curve analysis estimated in Rowthorn's seminal works (Rowthorn, 1995; Rowthorn; Ramaswamy, 1999; Rowthorn; Ramaswamy, 1997). The innovative contribution of this paper is to verify the validity of this relationship to MIC and HIC by looking not at the share of industry in GDP, but at the contribution of manufacturing to development – measured by structural decomposition of productivity. In sum, our main contributions show: (i) that there is heterogeneity in the behavior of this curve according to the technological intensities of the sectors, (ii) that this pattern of sectoral heterogeneity is different between HIC and MIC, and that (iii) despite the work of Rowthorn (1994) and Palma (2005) showing a stylized relationship in the form of an inverted U curve when analyzing the share of industry in GDP and the level of per capita income, this relationship does not hold either at the aggregate level or at any kind of sectoral disaggregation when analyzing the capacity of industry to contribute to development – either in HICs and MICs, measured by its ability to increase the productivity of the economy.

Keywords: Industry and Development; Structural change: Deindustrialisation; High-income countries; Middle-income countries.

Resumo

Além da curva de U invertido: desindustrialização e a contribuição da indústria ao desenvolvimento nos países de alta e média renda

A compreensão do desenvolvimento como um processo de acumulação e subsequente investimento associado ao progresso tecnológico e à transformação estrutural para atividades de maior produtividade tem atribuído, histórica e teoricamente, um papel central ao setor manufatureiro na literatura econômica, pelo menos desde as contribuições seminais de Hamilton (1791) e List (1841). Neste contexto, este artigo tem como objetivo medir e analisar a contribuição da indústria para o desenvolvimento dos países de alta renda (PAR) e dos países de renda média (PRM) entre 2000 e 2019. O seu principal objetivo é reavaliar a análise da curva em U invertido estimada nos trabalhos seminais de Rowthorn (Rowthorn, 1995; Rowthorn; Ramaswamy, 1999; Rowthorn; Ramaswamy, 1997). A contribuição inovadora do presente artigo consiste em verificar a validade desta relação para os PAR e para os PRM, analisando não a participação da indústria no PIB, mas a contribuição da indústria de transformação para o desenvolvimento – medida pela decomposição estrutural da produtividade. Em resumo, os resultados mostram que o crescimento médio da produtividade nos PRM foi mais de 3,4 vezes maior do que nos PAR. Além disso, esse crescimento foi distribuído de forma bastante homogênea entre os vários

(1) Professor, Deputy Coordinator for the undergraduate program, Institute of Economics, University of Campinas (Unicamp), Brazil. E-mail: diegues@unicamp.br. ORCID: https://orcid.org/0000-0002-4124-666X.

(2) Institute of Economics, University of Campinas (Unicamp), Brazil. ORCID: https://orcid.org/0009-0008-8122-1978.

componentes da decomposição estrutural. Assim, pode-se observar que, para os PRMs, os componentes intra-setoriais, de mudança estrutural estática e de mudança estrutural dinâmica tiveram um desempenho muito semelhante durante o período. Além disso, nesses países, uma grande parte do crescimento da produtividade é explicada pela sofisticação de setores e atividades que não estão necessariamente na fronteira tecnológica internacional, inclusive em países em *catching-up* como a China. Ao contrário, entre os PAR, há uma concentração muito alta de crescimento da produtividade em setores de alta tecnologia. Assim, apesar dos movimentos de desindustrialização nas últimas décadas, conforme sugerido por Andreoni e Tregenna (2019) e Andreoni e Chang (2017), os setores de alta tecnologia ainda são os principais vetores da contribuição industrial para o desenvolvimento nesses países.

Palavras-chave: Indústria e desenvolvimento; Mudança estrutural: Desindustrialização; Países de alta renda; Países de renda média.
JEL: L16, O14, O47.

1. Introduction

The understanding of development as a process involving accumulation and the subsequent investment associated with technological progress and structural transformation towards activities with higher productivity has historically and theoretically assigned a central role to the manufacturing sector in the economic literature (Mcmillan; Rodrik, 2011). This fact stems from the perception, which dates back to, at least, the seminal contributions of Hamilton (1791) and List (1841) that indicated the existence of a mutual determination between industrialization and development. Since investments are important instruments for incorporating technical progress into productive activities, structural transformation is intrinsically related to the increase of Schumpterian efficiency by fostering creative destruction (Dosi; Orsenigo, 1988; Schumpeter, 1934).

Based on the classical interpretations of economists of development since the mid-twentieth century, this mutual determination led to a generalized understanding that the industrial sector presents some characteristics that would reserve to it a central role in determining long-term nations' development (Rosenstein-Rodan, 1943; Hirschmann, 1958; Furtado, 1961; Gerschenkron, 1962).

In general, these interpretations define economic development as a process of structural transformation, essentially characterized by the sophistication of the productive structure. Thus, they suggest that the three main ways in which industry contributes to development are: (i) the ability to promote productivity growth among different sectors, (ii) the creation of jobs with higher wages than the average of the economy, and (iii) the productive and technological sophistication of national exports.

Subsequently, synthesized in what is conventionally called Kaldor's laws (Kaldor, 1966; 1967; Thirlwall, 1979), such characteristics would result from the greater added value and greater productivity present in industrial activities, from their high capacity to enable positive returns of scale and to transmit gains from technical progress towards other economic sectors and, finally, from its ability to alleviate external restrictions on development given the greater income elasticity of demand for its products when compared to non-manufactured products.

According to this background, this paper aims to measure and analyze the contributions of high-income countries (HIC) and middle-income countries (MIC) manufacturing structures to development. To this end, the article will focus on analyzing one of the three aforementioned dimensions of industry's contribution to development: its ability to foster productivity growth in the economy through structural transformation towards more technologically complex activities. Empirically, the article will analyze the structural decomposition of productivity between 2000 and 2019. The choice to analyze only one of the three dimensions is due to the inherent limitations of an academic article (in terms of scope and size).

The object of analysis will be the sectoral dimension of the respective national industries, based on their aggregation according to technological intensity, as suggested by works with high impacts in international literature, such as OECD (1987) and Andreoni and Tregenna (2019).

When analyzing the recent international literature on industry and development, there is a concentration of works on the deindustrialization debate. Among the different dimensions of this literature, it is worth highlighting the debates on the causes of deindustrialization (Tregenna, 2009; Andreoni; Tregenna, 2018; Andreoni; Chang, 2019; Chang; Andreoni, 2021; Dosi; Riccio; Virgillito, 2021), its definitions (Tregenna, 2016; Rodrik, 2016; 2017; Özçelik; Özmen, 2023) and the relationship between deindustrialization and the level of per capita income (Castillo; Martins, 2016; Felipe; Mehta; Rhee. 2018; Vu et al., 2021).

In this context, the gap identified in the international literature on the subject is as follows*: although it extensively analyzes the definitions and causes of deindustrialization as well as changes in the international organization of industry, the literature still lacks empirical efforts to measure how these phenomena affect the contribution of industry to economic development*. In other words, although the literature identifies patterns that relate the behavior of industrialization and deindustrialization movements to the per capita income levels of HICs and MICs, there is no similar effort to identify, analyze, and measure the relationship between transformations in the capacity of industry to contribute to development and the per capita income of countries. This capacity to contribute to long-term development would be the fundamental pillar that justifies the extensive literature on recent transformations in global industry, as well as the widespread revival of industrial policy. (Cherif; Hasanov, 2019; Aiginger; Rodrik, 2020; Chang; Andreoni, 2020; Mazzucato; Kattel; Ryan-Collins, 2020; Mazzucato; Rodrik, 2023).

Thus, the intended contribution of the paper will be based on the re-evaluation of the inverted U-shaped curve analysis estimated in Rowthorn's seminal works (Rowthorn, 1995; Rowthorn; Ramaswamy, 1997; Rowthorn; Ramaswamy, 1999), which relates the share of industry in GDP to the level of per capita income. According to this curve, initially, there is an increase in the industry's share of GDP as per capita income rises. After a certain point, this trend reverses.

The innovative contribution intended by this paper is to verify the validity of this relationship to MIC and HIC by looking not at the industry share of GDP, but at the manufacturing sector contribution to development measured by the structural decomposition of productivity. This contribution is going to be calculated using shift-share techniques (Haraguchi, 2015; Mcmillan; Rodik, 2011; OECD, 1987; Timmer; De Vries, 2009; De Vries; Timmer; De Vries, 2015).

In this sense, our understanding of one of the main factors of industry's contribution to development is to enable a structural transformation process where both dynamic and static intrasectoral and intersectoral components of the shift-share analysis are positive. In other words, it is expected that a virtuous development process is associated with the reconfiguration of the productive structure towards activities that increase productivity.

Based on the dialogue with Andreoni and Tregenna (2019) and Tregenna and Andreoni (2020), we intend to verify the hypothesis that there would not be an inverted U-shaped relationship between the level of per capita income and the contribution of industry to development, measured in this work by its ability to increase productivity. In other words, it would not be expected that as per capita income increases, the capacity of the manufacturing sector to continue contributing to the productivity growth of the economies of both HICs and MICs would decrease.

Thus, in addition to what Andreoni and Tregenna (2019) and Tregenna and Andreoni (2020) suggest, we would like to show: (i) that there is heterogeneity in the behavior of this curve according to the technological intensities of the sectors, (ii) that this pattern of sectoral heterogeneity is different between HIC and MIC, and that (iii) despite the work of Rowthorn (1994) and Palma (2005) showing a stylized relationship in the form of an inverted U curve when analyzing the share of industry in GDP and the level of per capita income, this relationship does not hold either at the national level or at the regional level, this relationship does not hold either at the aggregate level or at any kind of sectoral disaggregation when analyzing the capacity of industry to contribute to development, measured by its ability to increase the productivity of the economy.

To this end, this article is divided into three sections. Section 2 reviews the literature on the relationship between industry and development. Section 3 describes the methodology used in the article. Section 4 presents the results. This is followed by the concluding remarks.

2. Literature review: industry and development

Manufacturing has long been contemplated as the backbone of economic growth, with industrialization as a pivotal prerequisite for enabling structural changes compatible with higher complex stages of development. Such a central argument is synthesized in what are conventionally called Kaldor's laws (Kaldor, 1966; 1967), which are based on the higher value added and productivity of industrial activities, given their dynamically increasing returns to scale and the spillovers of technical progress to other sectors of the economy. Additionally, manufacturing goods present greater income elasticity of demand compared to non-manufactured goods, which contributes to alleviating external restrictions on a country's balance of payments (Thirlwall, 1979). This association, in turn, contributes to more robust catching-up pathways.

On the other hand, deindustrialization is an expected phenomenon that is detrimental to sustainable growth opportunities, as pointed out in Rowthorn's seminal works. (Rowthorn, 1995; Rowthorn; Ramaswamy, 1997; Rowthorn; Ramaswamy, 1999). From this standpoint, an inverted U-shaped curve of industrialization related to income is estimated, which measures the industry's share in total employment with respect to per capita income levels. Accordingly, as per capita income rises over time, there is a corresponding rise in industrial employment, coupled with a simultaneous decline in the share of agricultural employment. At a critical inflection point, estimated by Rowthorn (1994) at US$12,000, the share of industrial employment stabilizes and this trend reverses, marked by an upswing in employment and productivity in the service sector, indicating the onset of deindustrialization.

In developed economies, deindustrialisation begins at elevated levels of per capita income and is considered a "normal" phenomenon, since it is the result of a country's own industrial maturity.

Therefore, it refers to a decrease in the industry's share of the national GDP without undergoing a definitive decrease in value added (Palma, 2005). Conversely, as for developing economies, the decline of manufacturing in terms of employment and value added occurs before the formation of a diverse, highly productive and innovative industrial sector, i.e. at much premature lower levels of per capita income than in advanced economies (Tregenna, 2016). This in turn, perversely diminishes the industrial sector's capacity in fostering development (Tregenna; Andreoni, 2020).

From this perspective, the literature on deindustrialisation highlights its elevated degree of complexity. Studies based on empirical evidence expose that per-capita income levels at the turning point of the inverted-U curve are prone to be noticeably lower in developing countries as compared to the advanced ones. Palma (2008) reveals that a shift on the employment share of the inverted-U has prominently evolved over time, which exposes sustained levels of manufacturing decline at various levels of per capita income, irrespective of whether countries have reached the turning point or not. In this sense, between the 1980s and 1990s the turning point moved respectively from $21.000 to a little over $10.000, signaling that deindustrialisation primarily affected advanced countries in the 1980s and only posteriorly middle-income countries in the 1990s. Nonetheless, by the 2000s this reverse had become so pronounced that no country had surpassed the turning point.

Drawing on similar analysis, Rodrik (2016) observes that, across various indicators and for groups of forty-two countries, the turning point of the inverted-U curve has been steadily declining over the last few decades, especially among the premature deindustrialisers, at very insignificant income levels. In reference to late industrializers, Asian economies were the least affected by deindustrialisation, while Latin American countries were the most severely and negatively affected. In contrast, industrialized countries have lost significant shares of employment, mostly in low-skilled jobs, although they have managed to retain important shares of manufacturing output.

Felipe, Mehta and Rhee (2018) explore the key relationship between the inverted-U curve and manufacturing employment, through 1970-2010. It turns out that while output has little predictive power for a country's wealth prospects, such a crucial element lies in manufacturing employment. It is clear from the author's observations that there is a causal link between the share of industrial jobs and a country's development status, that is, whilst all sampled wealthy countries experienced an employment share of over 18% sometime since 1970, developing countries were unable to meet this employment level given the historical-structural characteristics of its late development process, that have severely impaired their industrialization prospects. Such dynamics are the fuel for premature deindustrialisation, which is increasingly set at lower levels of employment and output in the 2010s than in the past.

Alternatively, looking at possible premature deindustrializers, Özçelik and Özmen (2023) examine that the peak relationship between manufacturing value added and real per capita GDP has shifted downwards and towards the inverted-U origin. It is clear from their results that peak manufacturing value added and real GDP per capita are much higher in advanced economies, at 27% and US$9,015 respectively, while the same elements account for 19.3% and US$1,225 in developing and emerging economies, which reveals a striking premature diagnosis of deindustrialisation in the latter, despite East Asian countries.

In a different and innovative perspective, Tregenna and Andreoni (2020) highlight the heterogeneity of deindustrialisation experiences on the sub-sectoral level, with special emphasis on the identification of potential instances of premature deindustrialisation based on the inverted-U pattern. Their findings unveil alterations in the curve according to different levels of technology complexity of the products manufactured. In other words, they provide evidence that the higher the technological intensity of manufacturing, the less concave its pattern becomes, evolving into a monotonically increasing line, or even a convex curve, particularly evident in the most advanced high-tech sub-sectors.

In this context, Tregenna and Andreoni (2020) uncover that Asian economies, including South Korea, Thailand, and China, present a higher proportion of technologically intensive products in their GDP, contributing to their successful convergence. Conversely, numerous industrialized economies such as the UK, Spain and Canada, struggle to foster the manufacturing sector's contributions to economic growth. As for Latin America, the prevailing issue is the consolidation of premature deindustrialisation. Hence, Tregenna and Andreoni (2020) conclude that one can verify different curves according to technology intensity across sub-sectors, which implies heterogeneous patterns of both industrialization and deindustrialization that calls the literature to (re)analyze, in a more complex way, the traditional U curve hypothesis.

It is precisely in this context that our paper aims to contribute to the literature by analyzing the limits of industry's contribution to development inspired by adding an additional perspective to the U-curve background.

3. Methodology

In order to comprehend the limits of international industry's contribution to development, the methodological approach proposed by this study is based on the structural decomposition of productivity, through shift-share techniques, as in OECD (1987), Timmer and De Vries (2009), McMillan and Rodrik (2011), Haraguchi (2015) and specially De Vries, Timmer and De Vries (2015). For the purpose of this study, the overall decomposition of productivity analysis is based on data from the United Nations Industrial Development Organization (UNIDO) Industrial Statistics Database at the 2-digit level of ISIC (INDSTAT2), which provides disaggregated data on the manufacturing sector. This analysis is supplemented with GDP per capita (at Parity Power Purchase) in current US$, obtained from World Bank's DataBank.

As seen in Table 1, the sample comprises data from 40 economies, half from high-income countries (HIC) and half from middle-income countries (MIC). Among these, 15 economies are from Europe, 10 from Asia, 3 each from North America, Latin America, and Africa, and 1 from Oceania. The total industry sample represents 97% of world manufacturing value added in 2019, with 51.1% from HIC and 41.8% from MIC. In addition, the sample countries account for 98% of world manufacturing employment, with 21% contributed by HIC and 57% by MIC. On average, manufacturing value added represents 16.05% and 16.64% of HIC and MIC GDP, respectively. This provides a representative perspective of the international manufacturing industry.

Table 1
HIC and MIC sample, share in world manufacturing value added and employment, manufacturing value added as proportion of GDP (%), 2019

	Share in world manufacturing value added (%)	**Share in world manufacturing employment (%)**	**Manufacturing value added as proportion of GDP (%)**
High Income Countries			
Australia	0,60%	0,84%	5,60%
Austria	0,60%	1,11%	17,50%
Belgium	0,60%	0,91%	12,30%
Canada	1,60%	0,84%	9,70%
Czechia	0,40%	1,63%	25,30%
Denmark	0,40%	0,81%	14,20%
France	2,30%	0,89%	10,40%
Germany	6,00%	1,19%	20,40%
Italy	2,30%	1,13%	14,90%
Japan	7,70%	1,06%	20,90%
Netherlands	0,70%	0,71%	11,10%
Poland	0,80%	1,41%	17%
Republic of Korea	3,90%	1,08%	26,40%
Singapore	0,60%	0,65%	19,20%
Spain	1,10%	0,90%	11%
Sweden	0,50%	0,81%	13,10%
Switzerland	1,00%	0,89%	19,20%
Taiwan	1,50%	1,57%	31,90%
United Kingdom	1,90%	0,79%	9,10%
United States of America	20,80%	0,86%	11,70%
Total – HIC	**55%**	**21%**	
Middle Income Countries			
Brazil	1,79%	3,21%	10,30%
China	28,01%	34,76%	27,90%
Colombia	0,24%	0,33%	11,80%
Egypt	0,34%	0,91%	15,30%
India	1,64%	7,4%	14,50%
Indonesia	1,89%	2,9%	20,30%
Iran	0,44%	0,83%	13,90%
Malaysia	0,62%	1,04%	22,20%
Mexico	1,35%	2,02%	17,10%
Morocco	0,13%	0,39%	15%
Oman	0,13%	0,04%	9,50%
Pakistan	0,27%	1,16%	12,10%
Peru	0,24%	0,34%	12,80%
Philippines	0,22%	0,64%	19,40%
Romania	0,19%	0,54%	19%
Russia	1,78%	3,15%	13,20%
South Africa	0,34%	0,54%	12,20%
Thailand	0,74%	1,89%	25,80%
Türkiye	0,70%	1,76%	16,30%
Viet Nam	0,71%	3,51%	24,20%
Total – MIC	**42%**	**67%**	
Total	**97%**	**97%**	

Source: Authors, based on World Bank – DataBank and Unido – SDG 9 Monitoring.

Therefore, the value-added dataset was calculated in local currencies and posteriorly deflated through World Bank's Consumer's Price Index for each country, with 2019 as the base year. Productivity was calculated using local currencies in order to eliminate the effects of exchange rate variations on the results.

In line with Tregenna and Andreoni (2020) manufacturing is disaggregated into 23 sub-sectors, at the 2-digit level of ISIC Rev. 3 and grouped by the technological intensity as proposed by Galindo-Rueda and Verger (2016) and Unido (2010), as Table 2.

Table 2
Sub-sectoral technological classification

Low-tech	Medium-tech	High-tech
Food and beverages (15) and Tobacco products (16)	Coke, refined petroleum products, nuclear fuel (23)	Chemicals and chemical products (24)
Textiles (17)	Rubber and plastics products (25)	Machinery and equipment n.e.c. (29) and Office, accounting and computing machinery (30)
Wearing apparel, fur (18) and Leather, leather products and footwear (19)	Non-metallic mineral products (26)	Electrical machinery and apparatus (31) and Radio, television and communication equipment (32)
Wood products (excl. furniture) (20)	Basic metals (27)	Medical, precision and optical instruments (33)
Paper and paper products (21)	Fabricated metal products (28)	Motor vehicles, trailers, semitrailers (34) and Other transport equipment (35)
Paper and paper products (21)		
Furniture; manufacturing n.e.c. (36) and Recycling (37)		

Source: Tregenna and Andreoni (2020), according to Galindo-Rueda and Verger (2016) and Unido (2010).

Labor productivity was thus measured by the ratio between value-added and employed population in industrial sectors, while GDP at current PPP USD was measured by the average between 2000 to 2019.

3.1. Shift-share techniques

The shift-share method is a descriptive analytical tool that decomposes the variation of an aggregate into a structural component, thereby assessing shifts in the composition of the aggregate and shifts within the individual units that make up the aggregate. It is therefore closely related to variance analysis (Fagerberg, 2000).

The early applications of productivity's decomposition and its relationship between growth and structural change is derived from the seminal work of Fabricant (1942). The study allows for the comprehension of the effects of employment reallocation on productivity through two different components, revealing whether changes stem from sectoral productivity variation (intrasectoral, or within effect), from shifts in employment to sectors with differing productivity levels (intersectoral, or between effect), or even through fluctuations in aggregate productivity growth rates. In this respect, aggregate productivity growth rates within a sector are driven by capital accumulation or technological change, while across sectors it is primarily driven by the reallocation of workers to sectors with greater productivity differentials.

In this paper, similar to OECD (1987), Timmer and De Vries (2009), McMillan and Rodrik (2011) and Haraguchi (2015), we use a shift-share technique to analyze the decomposition of productivity variation in high- and middle-income countries. Specifically, by adopting the methodology of De Vries, Timmer and De Vries (2015), it is possible to capture the impact of sectoral productivity variation through different components: intrasectoral, intersectoral (static structural change), and dynamic structural change. Accordingly, in a virtuous process of structural change, all components are expected to be positive, i.e., associated with the reconfiguration of the productive structure towards activities that increase productivity.

Formally, the applied model is derived as follows:

T = Σ of all sectors i ;

S_i =participation of sector i in the total number of employed population;

L_i = employed population;

fy = final period;

by = initial period;

Q_i = value added;

LP = labor productivity.

t = time

First, the share of the respective industrial sector i in the total number of the employed population in manufacturing sectors is calculated:

$$\boldsymbol{S_i} = \frac{\boldsymbol{L_i}}{\boldsymbol{\Sigma\, L_i}} \tag{1}$$

Next, labor productivity is measured by the ratio between the value added of industrial transformation and the employed population:

$$\boldsymbol{LP_i} = \frac{\boldsymbol{Q_i}}{\boldsymbol{L_i}} \tag{2}$$

$$LP_T = \frac{Q_T}{L_T} = \frac{\sum_i Q_i}{\sum_i L_i} = \sum_i \left(\frac{Q_i}{L_i}\frac{L_i}{L}\right) = \sum_i LP_i S_i \tag{3}$$

Differentiating equation 1 in time (from t-k to t, where t>k), we obtain

$$LP_t - LP_{t-k} = \Delta LP_t = \sum_i LPP_{i,t} S_{i,t} - \sum_i LP_{i,t-k} S_{i,t-k} \tag{4}$$

The level of productivity for the years of analysis (2000 and 2019) is calculated taking into account the final and initial analysis periods.

As in De Vries, Timmer and De Vries (2015), productivity growth (4) was decomposed in 3 components, as follows:

$$\boldsymbol{\Delta(LP_T) = \frac{LP_{T,fy} - LP_{T,by}}{LP_{T,by}} = I + II + III} \quad (5)$$

Or, as in the growth-rate form, where:

$$\frac{\boldsymbol{\Sigma_{i=1}^{n} LP_{T,by}\left(S_{i,fy} - S_{i,by}\right)}}{\boldsymbol{LP_{T,by}}} \quad (6)$$

I

Equation (6) represents the first term by the right side of Equation (5), term I, and it accounts for the intersectoral, or static, component of the structural transformation. This component stands for the contribution to productivity growth from changes in the allocation of labor between the differing industrial segments. Therefore, it is assumed that in a virtuous development process, the relative share of employment shifts from low productivity sectors to those with above-average productivity rates, raising the overall labor productivity of the economy and making this component positive in the process (Mcmillan; Rodrik, 2011).

$$\frac{\boldsymbol{\Sigma_{i=1}^{n}\left(LP_{i,fy} - LP_{i,by}\right)\left(S_{i,fy} - S_{i,by}\right)}}{\boldsymbol{LP_{T,by}}} \quad (7)$$

II

Term II, is the dynamic component of structural transformation is represented by Equation (7). It essentially captures the interaction between the change in labor productivity and the change in the relative share of employment across all sectors of the economy. This component is basically the internal product of productivity levels at the end of the analysis period and represents the change in the share of employment across sectors. Thus, in a virtuous process of structural transformation, the relative share of employment is expected to be positively correlated with the reallocation of resources towards industries with rapid productivity growth.

$$\frac{\boldsymbol{\Sigma_{i=1}^{n}\left(LP_{i,fy} - LP_{i,by}\right) S_{i,by}}}{\boldsymbol{LP_{T,by}}} \quad (8)$$

III

As for Term III, represented by Equation (8), it stands for the intrasectoral component of the structural transformation and captures the productivity growth within the different industrial segments, mainly through improvements in innovation, scale, or other internal variables to each sector. Similarly, if the change in this component is positive, regardless of the sector's share of total employment in the economy, based on an analysis of the share of employment in each sector at the beginning of the analysis period, then the contribution of this component to structural change is also expected to be positive (Mcmillan; Rodrik, 2011).

4. Structural decomposition of productivity and the limits of industry's contribution to development: results

Comparing the aggregate results of the structural decomposition of productivity between MICs and HICs from 2000 to 2019, the first highlighting conclusion is the fact that the average growth in productivity among MICs was more than 3.4 times that observed among HICs – 108% versus 32%. Moreover, this growth was fairly evenly distributed among the different components of the structural decomposition (Table 3). Thus, it can be seen that for MICs, the intra-sector components, static structural change, and dynamic structural change, performed very similarly over the period.

It is also worth noting that, in accordance with the theoretical framework presented in Section 2, the sum of the structural change components was the main factor responsible for industrial productivity growth in the MICs (explaining 71% of productivity growth). This implies that, over the period, there was a reorientation of industrial employment towards activities with a higher level of productivity.

In terms of the sectoral dimension, while high-tech sectors have contributed most to this movement, the level of this contribution is only slightly higher than that of medium-tech sectors. In other words, in MICs, a very significant part of productivity growth is still explained by the productive sophistication of sectors and activities that are not necessarily at the international technological frontier. Even in countries with an accelerated catching-up process, such as China, low and medium technology sectors accounted for almost 60% of productivity growth. In India, they accounted for 45% and in Vietnam for 44%.

Table 3
Productivity shift-share structural decomposition – 2000 to 2019 – Middle Income Countries

Structural decomposition effects	**Tech intensity**			**Total**	**GDP PPP per-capita (2000 to 2019 mean) (USD)**
	High	**Low**	**Medium**		
Structural change (static component)	12,8%	7,9%	12,9%	33,6%	12.943
Intra sectoral component	13,9%	8,5%	13,9%	36,3%	
Structural change (dynamic component)	15,1%	8,3%	14,3%	37,8%	
Structural decomposition – Total	**41,9%**	**24,7%**	**41,1%**	**107,7%**	

Source: Authors, based on Unido – INDSTAT2, World Bank and IMF.

On the other hand, the HICs had a very high concentration of productivity growth in the high-tech sectors. These accounted for 65% of the total variation in productivity over the period. Moreover, in contrast to the MICs, virtually all productivity growth in the HICs (94%) is explained by the intra-sectoral component.

Thus, contrary to what might be suggested by interpretations of the possible beneficial effects of “natural” deindustrialization on HICs, movements of structural change (static and dynamic) with the redirection of industrial jobs towards sectors with a higher level of productivity are not significant at a level that could be one of the main sources of productivity growth in HICs. On the contrary, they account for only 6% of its growth (Table 4) (Rowthorn; Ramaswamy, 1999; Palma, 2005; Tregenna, 2009; Rodrik, 2016; Andreoni; Tregenna, 2019). This movement can be observed even in economies with a prominent position in the international market in technology-intensive segments, such as the US (where the combined contribution of static and dynamic structural change was 4.1%), the UK (4.9%) and Germany (5.8%).

Despite this deindustrialization movement in recent decades, hight-tech sectors are still the main drivers of industry’s contribution to development in HICs, as suggested by Andreoni and Gregory (2013), Andreoni and Tregenna (2019), and Andreoni and Chang (2017). As mentioned above, these sectors accounted for almost ¾ of the productivity growth in these countries between 2000 and 2019.

Table 4
Productivity shift-share structural decomposition – 2000 to 2019
High Income Countries

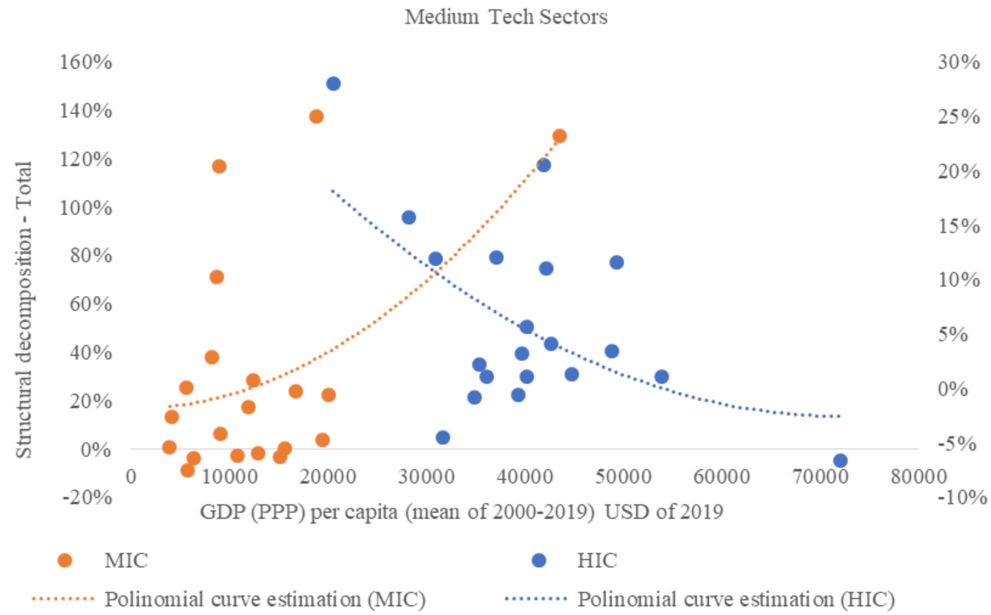
Structural decomposition effects	**Tech intensity**			**Total**	**GDP PPP per-capita (2000 to 2019 mean) (USD)**
	High	**Low**	**Medium**		
Structural change (static component)	3,7%	-3,6%	0,8%	1,2%	40.522
Intra sectoral component	15,4%	8,7%	5,1%	29,7%	
Structural change (dynamic component)	1,6%	-1,1%	0,2%	0,8%	
	20,7%	4,0%	6,1%	31,6%	
Structural decomposition – Total	**20,7%**	**4,0%**	**6,1%**	**31,6%**	

Source: Authors, based on Unido – INDSTAT2, World Bank and IMF.

Also, in line with Andreoni and Tregenna (2019), this study sought to analyze the structural decomposition of productivity according to the level of income per capita. This effort was carried out simultaneously based on the technological intensity of sectors and based on the structural decomposition components mentioned above (static, dynamic and intra-sector), as in OECD (1987), Timer and DeVries (2009), McMillan and Rodrik (2011), and Haraguchi, (2015).

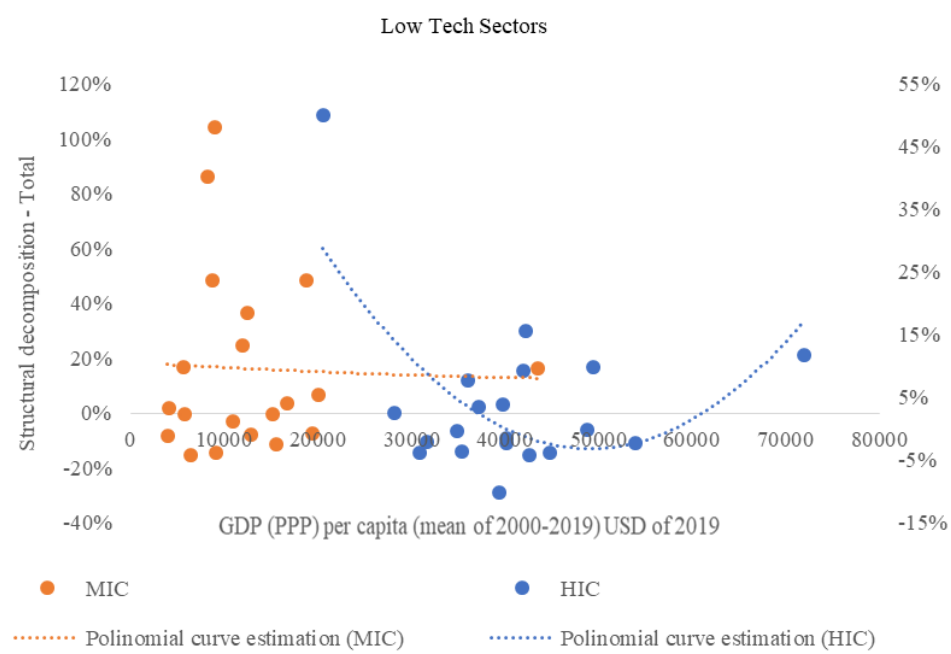
Concerning the sectoral analysis, in general, it is worth noting the distinction between behaviors according to country blocs (Figures 1, 2 and 3).

Figure 2
Productivity shift-share structural decomposition (sum of static, dynamic and intrasectoral components) and GDP (PPP) per capita – High (right axis) and Middle-income countries (left axis) – 2000 to 2019



Source: Authors, based on Indstat-Unido, World Bank and IMF.

Figure 3
Productivity shift-share structural decomposition (sum of static, dynamic and intrasectoral components) and GDP (PPP) per capita – High (right axis) and Middle-income countries (left axis) – 2000 to 2019



Source: Authors, based on Indstat-Unido, World Bank and IMF.

For high-tech sectors, the MICs show a positive exponential trend along most of the curve (Figure 1). In other words, the higher the income per capita, the higher the contribution of technology-intensive sectors to productivity growth.

It's worth noting that despite this trend, in four countries the contribution of these sectors was negative between 2000 and 2019 (of the four in question, three are Latin American – Brazil, Mexico, and Peru – and one is Asian – Pakistan). At the other extreme, of the five best-performing countries, four are Asian (China, Indonesia, Vietnam, and Oman) and one is European (Romania).

Among the HICs, on the other hand, there is a tendency towards a U-shaped curve, although the points are more dispersed than among the MICs. Even among the HICs, of the five best performing countries, three are Asian (Singapore, Taiwan and South Korea) and two are European (Czech Republic and Germany).

In the medium-tech sectors (Figure 2), there is the greatest discrepancy between the growth patterns of productivity and per capita income between MICs and HICs. For the former, there is a positive relationship between the two variables. For the HICs, the opposite movement is observed, with a decline in productivity growth in medium-tech sectors as per capita income rises.

An explanatory hypothesis for this different behavior could be that some of the medium-tech sectors (rubber and plastic products, basic metals, fabricated metal products and non-metallic mineral products) are those in which there has been an intense process of productive defragmentation, with deindustrialization in the HICs and a shift of activities to the MICs.

Finally, for the low-tech sectors (Figure 3), it is difficult to identify a well-behaved trend in the relationship between the variation in productivity and the level of income per capita. In general, in both MICs and HICs, these sectors are the ones with the highest number of cases of declining productivity.

Among the HICs, 11 of the 20 countries experienced a decline in productivity. The highlight was Poland, which grew by 50% over the period.

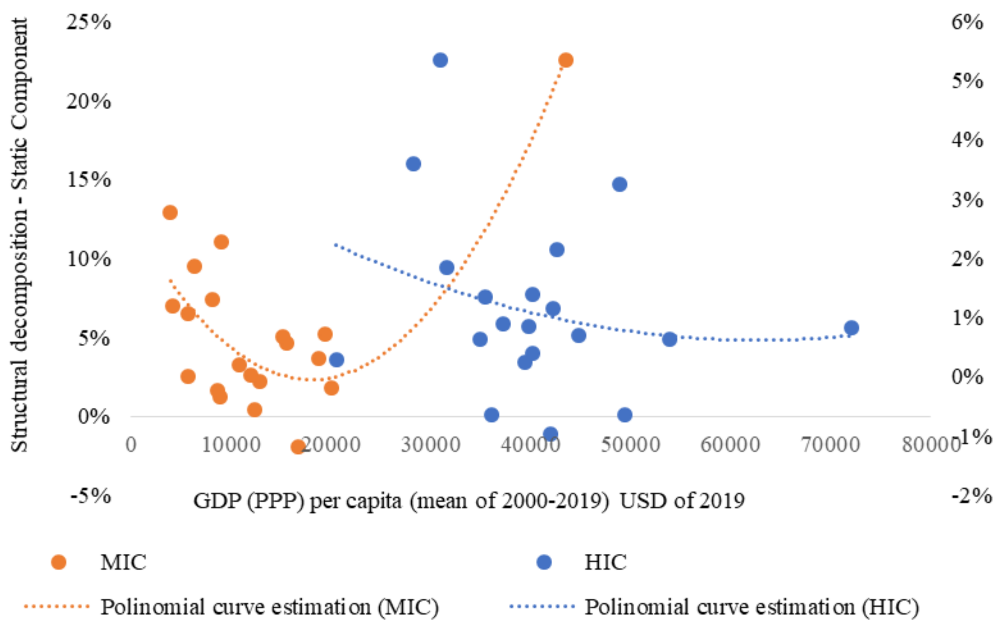
Additionally, in MICs, all Latin American countries experienced a decline in productivity (Brazil, Mexico, Colombia and Peru), while Asian countries showed the opposite trend. This may be due, on the one hand, to a process of premature deindustrialization in the Latin American countries (Palma, 2009; Andreoni; Tregenna, 2019; Diegues; Rossi, 2020; Morceiro, 2021) and, on the other hand, to a widespread process of productive sophistication – even in sectors of low technological intensity – and catch-up in the Asian countries belonging to the MICs.

Based on this evidence, it is suggested that these countries, despite transforming their productive structure towards more technologically complex activities and sectors, do not necessarily relegate the productive modernization of low-tech sectors to second place. When analyzing Chinese industrial policies, Diegues et al. (2023) argue that Chinese strategy results in the coexistence of characteristics of different stages of development at the same time inside its territory, which combines qualitatively distinct productive policies and institutions according to different regions of the country, sectors and technologies. In synthetic terms, the article brings evidence that, unlike the historical experiences of countries such as South Korea and Taiwan under the flying geese paradigm, the orientation of the Chinese economy toward an innovation-driven strategy does not necessarily eliminate the country's strength as the factory of the World including in low and medium-low tech sectors. According to the authors

> An illustration of this coexistence of a structure with a relevant share of low-tech, mid-high and high-tech industries simultaneously is the fact that an increase in Chinese market share in world exports in electronics, machinery and transport equipment does not occur in parallel to the reduction of market share in labor-intensive sectors (Diegues et al., 2023, p. 12).

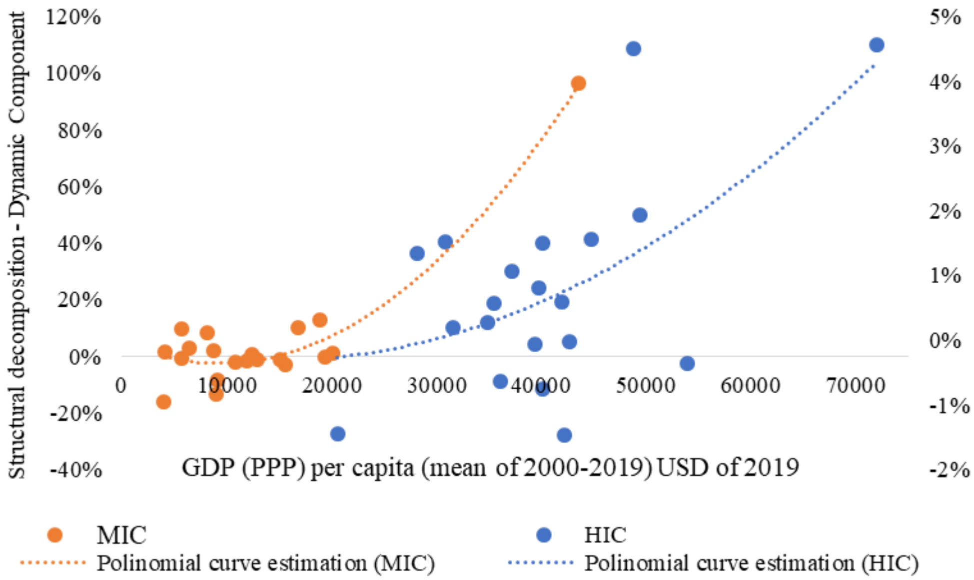
In addition to analyzing the structural decomposition of productivity by sectoral technological intensity, this article has also analyzed this movement based on the components of static structural change, dynamic structural change, the intra-sectoral component, and the relationship between these components and the level of per capita income in the countries (Figures 4, 5 and 6).

Figure 4
Productivity shift-share structural decomposition (static component) and GDP (PPP) per capita – High (right axis) and Middle-income countries (left axis) – 2000 to 2019 – Total Manufacturing



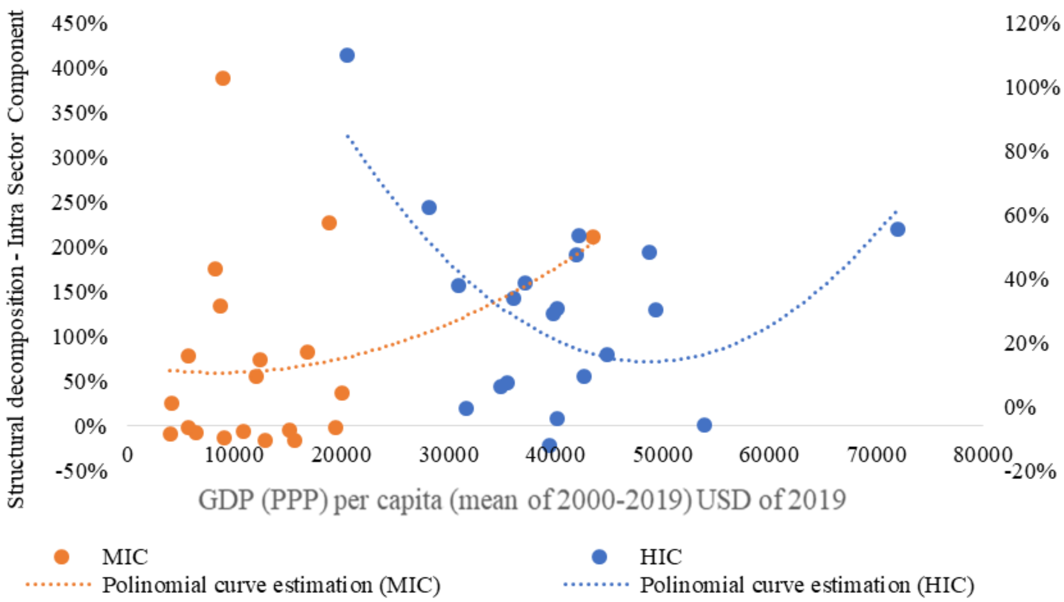
Source: Authors, based on Indstat-Unido, World Bank and IMF.

Figure 5
Productivity shift-share structural decomposition (dynamic component) and GDP (PPP) per capita – High (right axis) and Middle-income countries (left axis) – 2000 to 2019 – Total Manufacturing



Source: Authors, based on Indstat-Unido, World Bank and IMF.

Figure 6
Productivity shift-share structural decomposition (static component) and GDP (PPP) per capita – High (right axis) and Middle-income countries (left axis) – 2000 to 2019 – Total Manufacturing



Source: Authors, based on Indstat-Unido, World Bank and IMF.

For the static component of structural change (Figure 4), there is a kind of U-shaped curve for MICs. In other words, structural change makes a positive contribution to productivity growth in the early stages of development, and once per capita income reaches a certain level around USD 10,000, this contribution tends to decline.

As suggested by interpretations based on the middle-income trap (Andreoni; Tregenna, 2019; Lee, 2019), one explanation for this phenomenon may be that the continuity of structural transformation beyond a certain level of per capita income would require a broad set of industrial and innovation policies capable of building dynamic capabilities and fostering innovative learning. Given the difficulty of such a transition, the continuation of structural transformation beyond certain levels of per capita income would be a movement limited to a smaller number of countries, as Figure 5 suggests.

For the HICs, two results stand out: (i) the contribution of the structural change component to productivity growth is much lower than for the MICs, and (ii) there does not seem to be a clear relationship between the contribution of structural change to productivity growth and the level of income per capita.

However, when analyzing the dynamic component of structural change (Figure 5), a very similar pattern can be observed between MICs and HICs, namely that there is a clear relationship, albeit much stronger in MICs, between per capita income growth and productivity growth derived from dynamic structural change.

This means that, in line with Andreoni and Tregenna (2019), there is also a movement of workers in HICs towards activities with a higher productivity growth rate than the economy's average, even at high levels of per capita income. In other words, even the processes of deindustrialization that have plagued these economies in recent decades have not been able to disrupt this movement of industry's contribution to development.

In the MICs, on the other hand, it is clear that the growth in per capita income has gone hand in hand with the structural transformation of the economy towards more complex and technologically sophisticated industrial activities.

Finally, with regard to the intra-sectoral component of structural change (Figure 6), despite the very high levels among MICs, it is not possible to identify a clear trend between the level of per capita income and the variation in productivity.

For HICs, on the other hand, there is again a U-shaped curve in which the level of productivity growth declines until income per capita is close to USD 40,000 and then increases again. It is also worth noting that despite the U-shape of the curve, it is asymmetric. In other words, the level of productivity growth is higher in countries with lower per capita income (such as Poland and the Czech Republic, with growth of 110% and 62%, respectively).

5. Concluding remarks

The recent and intense revival of the debate on industrial policy has made a decisive contribution to the economic literature, including mainstream approaches, to regain the perception of the central role of industry for economic development. The construction of such a perception is the result of a series of factors that go back to the 2008 economic-financial crisis, the emergence of a new techno-productive paradigm based on the dual transition (digitalization / Industry 4.0 and decarbonization), the intensification of the technological war between China and the United States, and the need to increase the resilience of global value chains after systemic shocks such as that caused by the Covid-19 pandemic.

In this context, there are numerous and extensive industrial policies that attempt to address the challenges mentioned in the previous paragraph. One can highlight the Inflation Reduction Act and the Chips Act (which provide for investments of around US$800 billion and US$52 billion respectively) booth in the USA, the structuring of China's gigantic Industrial Guidance Funds (with estimated resources of around US$1. 5 trillion) to promote technologies defined as strategic on the basis 2016´s Innovation Driven Development Strategy, the European Green Deal Industrial Plan initiative, and the recently published Brazilian industrial policy – New Industry Brazil, with estimated resources of more than US$65 billion to be made available between 2023 and 2026.

According to Dipippo et al (2022), in 2019 – i.e. before the disruption of global value chains due to the COVID pandemic – industrial policy spending by China, the US, Japan, Germany and France accounted for US$389 billion. Of this, 64% is concentrated in China and 21.6% in the US. According to a working paper published by the IMF in 2024 (Evenett et al., 2024), more than 2,500 industrial policy measures were identified worldwide in 2023.

In general, the aim behind all these measures is to restore, directly or indirectly, the capacity of industry to contribute to economic development. This contribution, based on the interpretation of classical development authors, can be summarized in three dimensions: (i) the capacity to promote the growth of the economy's productivity, (ii) the creation of jobs with higher salaries than the economy's average, and (iii) the productive and technological sophistication of national exports.

It is precisely from this perspective that this paper sought to measure and analyze the contributions of the manufacturing structures of high-income countries (HICs) and middle-income countries (MICs) to development between 2000 and 2019. To this end, given the limitations of scope and space of an academic article, this effort focused on analyzing the capacity of industry to contribute to productivity growth in HICs and MICs.

Complementary to the works of Andreoni and Tregenna (2019) and Tregenna and Andreoni (2020), we sought to verify the existence of an inverted U-shaped relationship between the level of per capita income and the contribution of industry to development, measured in this work by its ability to increase productivity. In this way, we sought to add complementary elements to Rowthorn's seminal contributions (Rowthorn, 1995; Rowthorn; Ramaswamy, 1997; Rowthorn; Ramaswamy, 1999), which relate the share of industry in GDP to the level of per capita income.

In this context, we have analyzed the contribution of industry to development from two perspectives. The first is based on the sectoral decomposition of productivity growth according to technological intensity, based on the definition adopted in Andreoni and Tregenna (2019) and Tregenna and Andreoni (2020). The second is based on the analysis of the structural decomposition as in Timmer and DeVries (2009), McMillan and Rodrik (2011), Haraguchi (2015) and De Vries, Timmer and De Vries (2015).

In this effort we analyzed productivity growth according to changes in three components: static structural change, dynamic structural change, and intrasectoral.

The first conclusion is that in none of the several empirical exercises carried out in the article was it possible to observe an inverted U curve relating productivity growth to the level of per capita income, either among HICs or MICs. Similar to the conclusions presented in Andreoni and Tregenna (2019) and Tregenna and Andreoni (2020), there was heterogeneity in this relationship, both by sector and for manufacturing as a whole.

However, as the authors show, the two most recurrent pattern of the relationship were (i) a positive exponential and (ii) a curve similar to a traditional U-shaped one – albeit asymmetric at its extremes. In other words, in both cases, even among the HICs, it was not possible to say that the capacity of industry to contribute to productivity growth declines with high levels of per capita income. On the contrary, from a level of per capita income close to USD 45,000 (in PPP), there is a positive relationship between income growth and productivity growth. For MICs, this relationship is positive all along the curve.

In terms of sectoral breakdown, there is a discrepancy between the HIC and the MIC. The former shows that high-tech sectors account for 65% of the total variation in productivity over the period. In other words, despite the deindustrialization of the HICs in recent decades, the high-tech sectors are still the main drivers of the industrial contribution to development in the HICs, as suggested by Andreoni and Gregory (2013), Andreoni and Chang (2017) and Andreoni and Treggenna (2019). This movement is taking place with greater intensity in three Asian countries (Singapore, Taiwan, and South Korea) and two European countries (Czech Republic and Germany).

In MICs, high-tech sectors are also the main source of productivity growth, but the level of their contribution is only slightly higher than that of medium-tech sectors. In other words, these countries show a better distribution of productivity growth across sectors, with medium- and low-tech sectors accounting for 41.1% and 24.7% of total growth, respectively. Moreover, it can be concluded that the structural transformation of the MICs towards more technologically complex activities and sectors goes hand in hand with the modernization of low- and medium-tech sectors. However, it is worth noting that this movement is quite heterogeneous when comparing Asian and Latin American countries, especially in the high-tech sectors (where China, Indonesia, Vietnam and Oman stand out). Among the Latin American countries, the contribution of high-tech sectors to productivity growth was negative for Brazil, Mexico and Peru.

Finally, when analysing the breakdown of productivity according to the structural change (static and dynamic) and intra-sectoral components, the heterogeneities between HICs and MICs reappear.

For the MICs, in line with what the international literature would define as a virtuous trajectory of industry's contribution to development, it can be seen that the structural change components (static and dynamic) account for almost ¾ of their productivity growth between 2000 and 2019. In other words, in empirical terms, this movement has implied an increase in industry's contribution to development, as it is caused by the reorientation of industrial employment towards activities with a higher level – or higher growth rate – of productivity.

As for the HICs, there is a clear limit to the extent to which the process of structural change can contribute to productivity growth. Indeed, the sum of the static and dynamic components of structural change accounts for only 6% of productivity growth between 2000 and 2019. This finding, in turn, contradicts interpretations that relativize the impact of deindustrialization on HICs by suggesting that it is "natural" and the result of the reorientation of these economies towards activities and sectors with high technological intensity, which would sustain productivity growth in the long run. In other words, it was empirically shown that the reorientation of HICs towards sectors with higher productivity and/or growth rates than the national average has a low capacity to contribute to aggregate industrial productivity growth in these economies. This movement took place even in countries at the forefront of international technology, such as the USA, the UK and Germany, where the combined contribution of static and dynamic structural change was 4.1%, 4.9% and 5.8% respectively.

References

AIGINGER, K.; RODRIK, D. Rebirth of industrial policy and an agenda for the twenty-first century. *Journal of Industry, Competition and Trade*, v. 20, p. 189-207, 2020.

ANDREONI, A.; CHANG, H.-J. Bringing production and employment back into development: Alice Amsden's legacy for a new developmentalist agenda. *Cambridge Journal of Regions, Economy and Society*, v. 10, n. 1, p. 173-187, 2017.

ANDREONI, A.; GREGORY, M. Why and how does manufacturing still matter: old rationales, new realities. *Revue D'Économie Industrielle*, n. 144, p. 21-57, 2013.

ANDREONI, Antonio; TREGENNA, Fiona. *Stuck in the middle*: premature deindustrialisation and industrial policy. CCRED, 2018. (Working Paper, n. 11).

ANDREONI, A.; CHANG, H. The political economy of industrial policy: structural interdependencies, policy alignment and conflict management. *Structural Change and Economic Dynamics*, v. 48, p. 136-150, 2019.

ANDREONI, A.; TREGENNA, F. *Beyond the inverted U*: the changing nature and structural heterogeneity of premature de-industrialisation. In: INTERNATIONAL WORKSHOP: The future of industrial work: New pathways and policies of structural transformation. Vienna, 2019.

ANDREONI, A.; TREGENNA, F. Escaping the middle-income technology trap: a comparative analysis of industrial policies in China, Brazil and South Africa. *Structural Change and Economic Dynamics*, v. 54, p. 324-340, 2020.

CASTILLO, M.; MARTINS, A. *Premature deindustrialization in Latin America*. ECLAC, 2016. (Production Development Series, n. 205).

CHANG, H.; ANDREONI, A. Industrial policy in the 21st century. *Development and Change*, v. 51, n. 2, p. 324-351, 2020.

CHANG, H.; ANDREONI, A. Bringing production back into development: an introduction. *The European Journal of Development Research*, v. 33, p. 165-178, 2021.

CHERIF, R.; HASANOV, F. *The return of the policy that shall not be named*: principles of industrial policy. International Monetary Fund, 2019.

DE VRIES, Gaaitzen; TIMMER, Marcel; DE VRIES, Klaas. Structural transformation in Africa: static gains, dynamic losses. *The Journal of Development Studies*, v. 51, n. 6, p. 674-688, 2015.

DIEGUES, A. C.; PEREIRA, A. J.; HIRATUKA, C. *Chinese developmental state uniqueness*: an interpretation based on productive development policies and the dynamics of institutional change. Campinas: Unicamp. IE, maio 2023. (Texto para Discussão, n. 449).

DIEGUES, A. C.; ROSSI, C. G. Beyond deindustrialization: changes in the pattern of industry organization and accumulation in a scenario of the 'Brazilian Disease'. *Economia e Sociedade*, 29, p. 1-28, 2020.

DIPIPPO, G. et al. *Red ink*: estimating Chinese industrial policy spending in comparative perspective. Center for Strategic & International Studies – CSIS, May 2022.

DOSI, G.; RICCIO, F.; VIRGILLITO, M. E. Varieties of deindustrialization and patterns of diversification: why microchips are not potato chips. *Structural Change and Economic Dynamics*, v. 57, p. 182-202, 2021.

EVENETT, S. et al. *The return of industrial policy in data*. International Monetary Fund – IMF, Jan. 2024. (Working Paper, 2024).

FABRICANT, S. *Employment in manufacturing, 1899-1939*: an analysis of its relation to the volume of production. New York: National Bureau of Economic Research – NBER, 1942.

FAGERBERG, J. Technological progress, structural change and productivity growth: a comparative study. *Structural Change and Economic Dynamics*, Elsevier, v. 11, p. 393-411, 2000.

FELIPE, J.; MEHTA, A.; RHEE, C. Manufacturing matters… but it's the jobs that count. *Cambridge Journal of Economics*, v. 43, n. 1, p. 139-168, 2018.

FURTADO, C. *Development and underdevelopment*. California: University of California Press, 1964.

GALINDO-RUEDA, Fernando; VERGER, Fabien. *OECD taxonomy of economic activities based on R&D intensity*. 2016.

GERSCHENKRON, A. Economic backwardness in historical perspective. In: GERSCHENKRON, A. *Economic backwardness in historical perspective*. Cambridge MA: Harvard University Press, 1962.

HAMILTON, A. Report on manufactures (1791). *Reprinted in US Senate Documents*, v. 22, n. 172, 1913.

HARAGUCHI, N. Patterns of structural change and manufacturing development. In: ROUTLEDGE handbook of industry and development. Routledge, 2015. p. 38-64.

HIRSCHMAN, A. *The strategy of economic development*. New Haven: Yale University Press, 1958. v. 10.

KALDOR, N. *Causes of the slow rate of economic growth of the United Kingdom*. (No Title), 1966.

KALDOR, N. Problems of industrialization in underdeveloped countries. *Strategic Factors in Economic Development*, p. 53-72, 1967.

LEE, K. *The art of economic catch-up*: Barriers, detours and leapfrogging in innovation systems. Cambridge University Press, 2019.

LIST, F. National. *System of Political Economy*. 1841.

MAZZUCATO, M.; KATTEL, R.; RYAN-COLLINS, J. Challenge-driven innovation policy: towards a new policy toolkit. *Journal of Industry, Competition and Trade*, v. 20, p. 421-437, 2020.

MAZZUCATO, M.; RODRIK, D. *Industrial policy with conditionalities*: a taxonomy and sample cases. UCL Institute for Innovation and Public Purpose – IIPP, 2023. (Working Paper Series, v. 7).

MCMILLAN, M. S.; RODRIK, D. *Globalization, structural change and productivity growth*. NBER, 2011. (Working paper, n. 17143).

MORCEIRO, P. C. Methodological influence on Brazilian deindustrialization, *Brazilian Journal of Political Economy*, v. 41, n. 4, p. 700-722, 2021.

OECD, P. *Structural adjustment and economic performance*. 1987.

ÖZÇELIK, E.; ÖZMEN, E. Premature deindustrialisation: the international evidence. *Cambridge Journal of Economics*, p. 1-22, 2023.

PALMA, G. Four sources of de-industrialisation and a new concept of the Dutch Disease. *Beyond reforms: structural dynamics and macroeconomic vulnerability*, v. 3, n. 5, p. 71-116, 2005.

PALMA, J. G. *Deindustrialisation, premature deindustrialisation, and the Dutch disease*. In: BLUME, L. E.; DURLAUF, S. N. (Ed.). *The New Palgrave*: a dictionary of economics. 2nd ed. Palgrave Macmillan, 2008. p. 401-410.

PALMA, J. G. Flying-geese and waddling-ducks: the different capabilities of East Asia and Latin America to ‘demand-adapt’ and ‘supply-upgrade’their export productive capacity. *Industrial Policy in Developing Countries, OUP*, 2009.

RODRIK, D. Premature deindustrialization. *Journal of Economic Growth*, 21, p. 1-33, 2016.

RODRIK, D. Premature deindustrialisation in the developing world 1, 2. *Frontiers of Economics in China*, v. 12, n. 1, p. 1, 2017.

ROSENSTEIN-RODAN, P. N. Problems of industrialisation of Eastern and South-Eastern Europe. *The Economic Journal*, v. 53, n. 210-211, p. 202-211, 1943.

ROWTHORN, B. *Korea at the cross-roads*. ESRC Centre for Business Research, University of Cambridge, 1995.

ROWTHORN, R.; RAMASWAMY R. Growth, trade, and deindustrialization. *Imf Staff Papers*, v. 46, n. 1, p. 18-41, 1999.

ROWTHORN, R. E.; RAMASWAMY, R. *Deindustrialization*: causes and implications, 1997.

SCHUMPETER, J. *The theory of economic development*. Cambridge, MA: Harvard University Press, 1934.

THIRLWALL, A. P. The balance of payments constraint as an explanation of international growth rates. *Banca Nazionale del Lavoro Quarterly Review*, 1979.

TIMMER, M. P.; DE VRIES, G. J. Structural change and growth accelerations in Asia and Latin America: a new sectoral data set. *Cliometrica*, 3, p. 165-190, 2009.

TREGENNA, F. Characterising deindustrialisation: an analysis of changes in manufacturing employment and output internationally. *Cambridge Journal of Economics*, v. 33, n. 3, p. 433-466, 2009.

TREGENNA, F. Deindustrialization and premature deindustrialization. In: GHOSH, J.; KATTEL, R.; REINERT, E. (Org.). *Elgar handbook of alternative theories of economic development*, 2016.

TREGENNA, F.; ANDREONI, A. Deindustrialisation reconsidered: structural shifts and sectoral heterogeneity. UCL Institute for Innovation and Public Purpose – IIPP, 2020. (Working Paper Series).

UNIDO. *Industrial statistics*: guidelines and methodology. Vienna, Austria, 2010.

VU, K.; HARAGUCHI, N.; AMANN, J. Deindustrialization in developed countries amid accelerated globalization: patterns, influencers, and policy insights. *Structural Change and Economic Dynamics*, v. 59, p. 454-469, 2021.