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# DEINDUSTRIALIZATION IN DEVELOPED COUNTRIES AMID ACCELERATED GLOBALIZATION: PATTERNS, INFLUENCERS AND POLICY INSIGHTS

DEPARTMENT OF POLICY, RESEARCH AND STATISTICS

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# Deindustrialization in developed countries amid accelerated globalization: Patterns, influencers and policy insights

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## Abstract

This paper examines the changing dynamics of deindustrialization in developed countries amid the acceleration of globalization in the early 1990s. For this purpose, we investigate the patterns and factors that influence employment growth in manufacturing industries by employing data at the 2-digit ISIC level of 12 developed economies over the period 1970-2015. To gain comparative insights and a deeper understanding of the results of this analysis, we also conduct similar investigations for market services industries and subsamples of manufacturing industries classified by the status of the country's trade balance and by the industry's level of technology. The study produces a range of new findings. First, deindustrialization trends display a structural break from the pre-1990 to the post-1990 period, with industries with higher levels of employment being more affected. This effect is particularly pronounced for high-tech industries. Second, restructuring efforts aimed at moving labour from lower- to higher-productivity sectors in the post-1990 period appear significant, especially for low-tech industries. Third, countries with a large population and a deficit-prone trade balance display greater manufacturing employment shrinkage in the post-1990 era. This finding lends support to the conjecture that trade tensions between the U.S. and China will intensify, and that trade wars will likely be unavoidable to address this tension.

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**Keywords**: *deindustrialization; globalization; structural change; productivity.*
**JEL codes**: F60, O40, O57

## 1. Introduction

Deindustrialization and globalization are among the most important policy issues policymakers are currently facing. This is true not only for industrialized countries but also for emerging economies. While globalization has made the world economy more productive and vibrant, with more robust growth arising from the multilateral trade of goods and services, it has resulted in growing tensions among some countries due to the problem of fairness in the distribution of gains and heterogeneity in trade practices. For industrialized economies, the decline in manufacturing employment, especially in unskilled labour-intensive industries, has been pronounced, which has resulted in considerable socioeconomic and political effects.[1]

This paper explores how increasing global integration has been associated with the dynamics of structural change within the manufacturing and services sectors in advanced economies. The insights from this study are important for policy debates and formulation for several reasons. First, despite substantial gains generated by global integration, fast-paced labour market disruptions have posed a challenge for both the government and labour force in many advanced economies. With manufacturing jobs rapidly diminishing over the last few decades and an increasing degree of job polarization in high-income economies (Keller and Utar, 2016), resistance to globalization has recently become stronger in many developed countries (Fischer and Egger, 2019). Second, insights into the timing and effect of accelerated globalization on deindustrialization at the sector level may introduce new challenges and pathways of economic transformation. Understanding the extent to which deindustrialization patterns have evolved and changed over time is relevant not only for the most advanced economies, but also for developing economies, which will very likely face similar challenges in the foreseeable future.

This study conducts a cross-country empirical investigation of 12 developed economies over the period 1970-2015, for which industry data at the ISIC two-digit level are available. These 12 countries include all G7 economies (Canada, France, Germany, Italy, Japan, the United Kingdom and the United States) and five other industrialized nations: Austria, Denmark, Finland, the Netherlands and Spain.

The findings from this paper suggest that deindustrialization trends in the 12 countries under investigation experienced significant structural changes in the early 1990s, coinciding with the acceleration of globalization trends. At the same time, there is a significant positive link between manufacturing productivity and accelerated restructuring in the post-1990 period, whereas similar

[1] See, among others, Bluestone and Harrison (1982), Ross and Trachte (1992), Sachs et al. (1994), Wood (1995a, b), Saeger (1997), Kucera and Milberg (2003) and Autor et al. (2013, 2017)

patterns have not been observed for the market services sector. Furthermore, we find that countries featuring a large population, deficit-prone trade balance and high employment concentration in some manufacturing industries suffered most from the adverse effect of accelerated globalization.

The remainder of this paper is structured as follows. Section 2 develops the hypothesis that the acceleration of globalization has a strong link with the pace of deindustrialization in advanced economies. Section 3 details our empirical study, and Section 4 presents the results. Section 5 concludes.

## 2. The link between global integration and deindustrialization

### 2.1 The mechanics and consequences of globalization: insights from previous studies

In an attempt to explain the rapid pace of deindustrialization, previous studies have identified three primary drivers. The first factor is imbalanced productivity growth across industries in a manufacturing-led economy.[2] The rationale behind this approach is that the most productive manufacturing industries are those that produce more output with less labour. This, in turn, implies a declining employment share in the most dynamic industries. Recently, Bernard, Smeets, and Warzynski (2017) adds a new valuable insight about the strategic transition of manufacturing firms to services through their analysis of the transformation Denmark's manufacturing sector. This insight suggests a positive aspect of deindustrialization.

The second factor are changes in an economy's demand structure, whereby consumer preferences for services become higher than preferences for manufactured goods as a country becomes wealthier. The reasoning behind this argument follows the notion underlying Engel's law, which states that the fraction a household spends on food decreases as the household's income rises. This concept was adapted to the case of manufacturing by Clark (1957) to illustrate the shift in production priority from agriculture to manufacturing in a country's predevelopment phase and, within manufacturing, from food to more technology-intensive products, such as electrical goods and motor vehicles, at later stages of development (UNIDO, 2018). The notion of a change in the demand structure away from manufacturing and towards services once an economy reaches the post-industrial stage has also been put forward by Bell (1976) and complemented by Kongsamut et al. (2001), who discuss models that combine balanced growth with labour reallocation dynamics. Even though it is true that the share of income spent on manufacturing goods decreases

[2] This view has been expressed in a wide range of empirical as well as theoretical enquiries; see, among others, Clark (1957), Baumol et al. (1985, 1989), Ramaswamy and Rowthorn (1997), Ramaswamy and Rowthorn (1998) or Rowthorn and Coutts (2004, 2013).

as income levels rise, it has often been argued that it is not so much the change or saturation in demand but rather the significant drop in the relative prices of manufacturing goods that is responsible for this trend. This is attributable to the fact that manufacturing typically offers greater potential for productivity growth than other sectors (UNIDO, 2018). In other words, it is the inexpensiveness of manufactured goods in recent times that has led to the relative decline in proportional household spending on manufactured goods (Rowthorn and Coutts, 2013), although individuals are consuming manufactured goods, such as clothes and IT devices, at unprecedented rates.

Together, these two factors can be considered internal 'natural market forces' associated with the development of domestic labour and goods markets as economies grow richer. According to this view, the contraction in the share of manufacturing employment in the economy caused by these 'internal' factors and their interaction is largely a domestic concern.[3]

The third factor that causes deindustrialization is associated with the effect of North-South trade links, a major force underlying globalization trends. The rapid growth of North-South trade has been fuelled by the joint effect of two forces. First, multinationals in advanced economies have had to undertake major restructuring to remain competitive[4], as their labour cost disadvantage has become a major concern (Wood, 1995a; Alderson, 1997, 1999). Second, developing countries can reap enormous benefits from attracting investments from multinationals to develop domestic production capacity and acquire technology and management know-how.

However, there is less consensus among scholars about the magnitude of the impact of North-South trade on deindustrialization. On the one hand, Krugman and Lawrence (1993), Ramaswamy and Rowthorn (1997, 1998), and Rowthorn and Coutts (2004) argue that its effect is minor. Furthermore, several studies point to non-trade-related factors as causes of deindustrialization.[5]

[3] Another factor often cited in the literature is the outsourcing of activities previously performed in-house to specialized service providers such as call centres, caterers, transportation providers, etc. This reclassification is not to be mistaken for an actual contraction in manufacturing but is rather the consequence of the current accounting system.

[4] The effect of international trade on firm restructuring has, for example, been theoretically demonstrated by Melitz (2003) or Disney et al. (2003), who study UK manufacturing from 1980 to 1992, and find that external restructuring, much of which comes from multinationals closing poorly performing plants and opening new, high-performing ones, plays a major role in driving labour productivity and TFP growth.

[5] For example, McKinnon (2013) demonstrates that saving deficiency, especially chronic fiscal deficits, was a factor in the deindustrialization of the USA.

On the other hand, Bluestone and Harrison (1982), Ross and Trachte (1992), Sachs et al. (1994), Wood (1995a, b), Saeger (1997), Kucera and Milberg (2003) and Autor et al. (2013, 2017), among others, emphasize the substantial impact North-South trade has had on the decline in manufacturing employment, especially in unskilled labour-intensive industries. These studies also point out the significant socioeconomic and political implications of these developments.

The above discussion reveals that deindustrialization is an indicator with a mixed valence. On the one hand, it may represent a healthy transformation of a country's economic structure towards higher value-added activities to adapt to a changing global landscape. On the other hand, it could be a sign of deterioration in national competitiveness and may potentially carry high social costs.[6] Thus, globalization presents advanced economies with both threats and opportunities that require careful policy analysis and appropriate policy interventions.[7] As emphasized by Rowthorn and Coutts (2004, 2013) as well as Haraguchi (2015) and Haraguchi et al. (2017), manufacturing still matters, even for the most advanced economies, and its development should be diligently monitored to forestall undesirable but avoidable outcomes that might reach beyond the manufacturing sector.

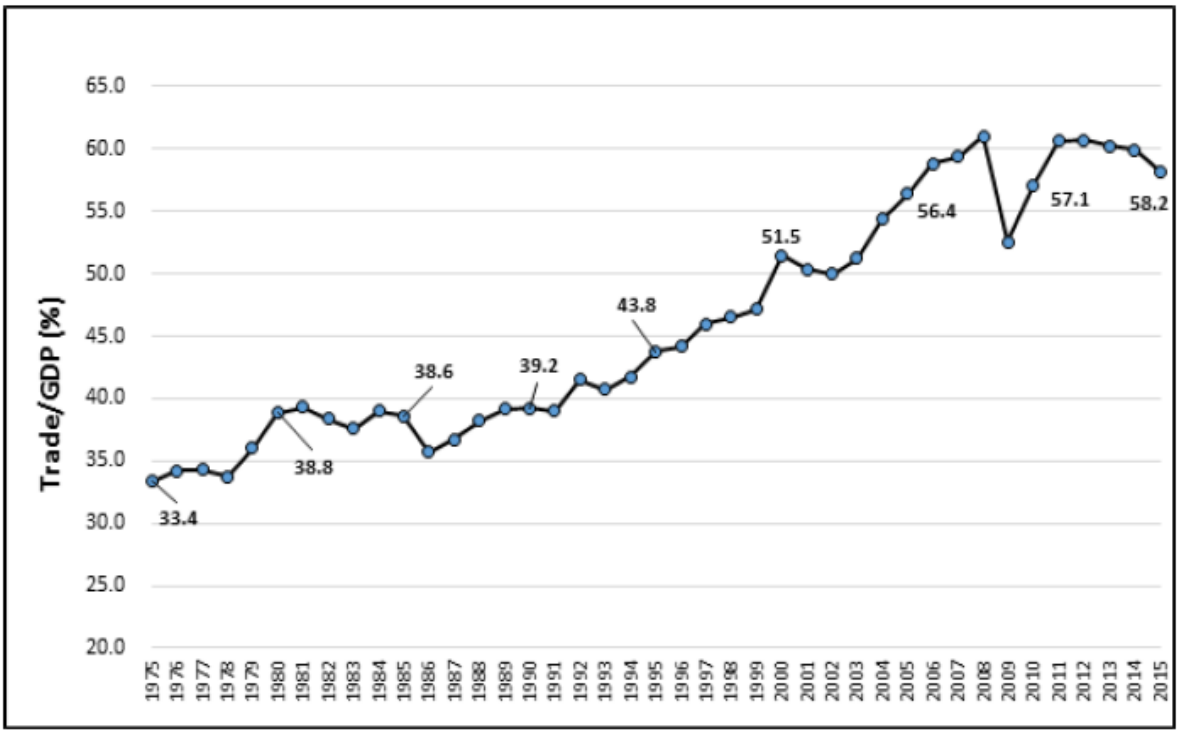
## 2.2 Accelerated global integration: salient facts

The 1990s witnessed unprecedented advancements in global economic integration. Indeed, although global integration, captured by the world trade-to-GDP ratio, has exhibited a clear upward trend over the past four decades, the ratio surged by 12.3 percentage points during the 10-year period from 1990-2000, namely from 39.2 per cent to 51.5 per cent, while this change had only been 0.4 percentage points over the previous decade (Figure 1, Panel A). At the same time, worldwide FDI inflows to developing countries experienced a notable surge in the 1990s, and have remained at a substantially higher level since then (Figure 1, Panel B). Furthermore, the foundation of globalization has also been significantly strengthened since the 1990s with an accelerated increase in the number of regional trade agreements (RTAs), which indicates the increasing attractiveness of trade integration as an effective way of promoting economic development (Figure 1, Panel C).

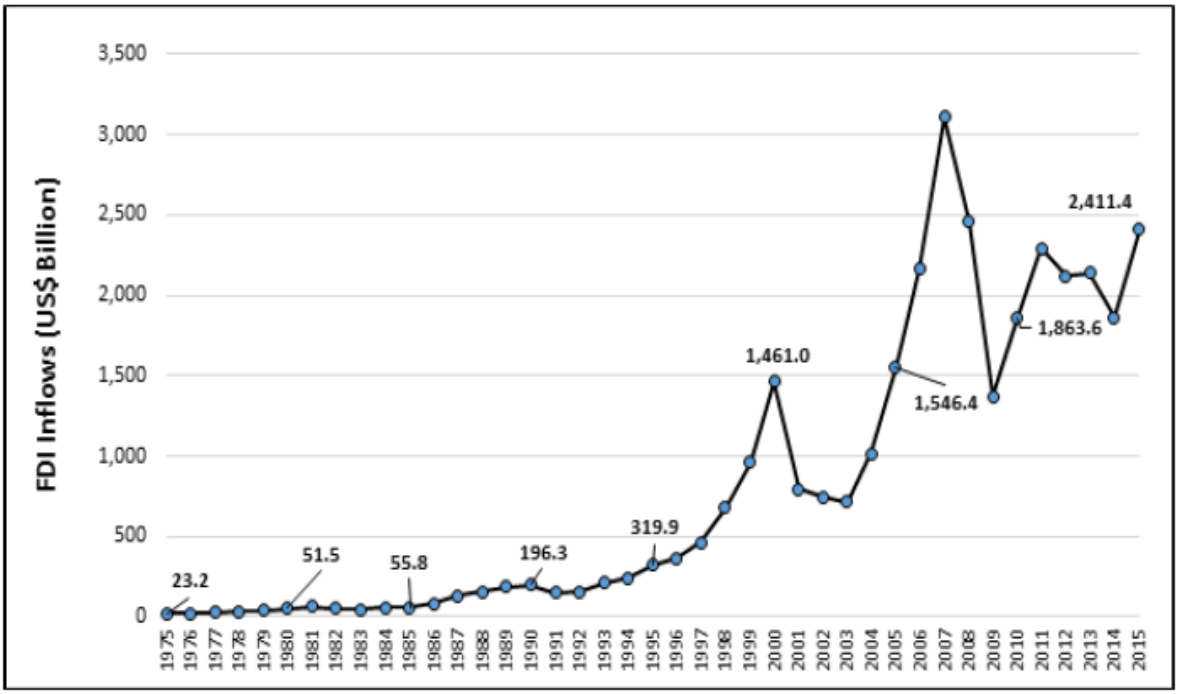
[6] Tregenna (2014) provides a conceptual framework to determine whether a deindustrialization process is desirable.
[7] Jorgenson and Timmer (2011) show that an in-depth analysis of structural change at the sector level is needed to better understand the process of economic growth and structural change of a national economy.

**Figure 1: Surging trends in globalization**

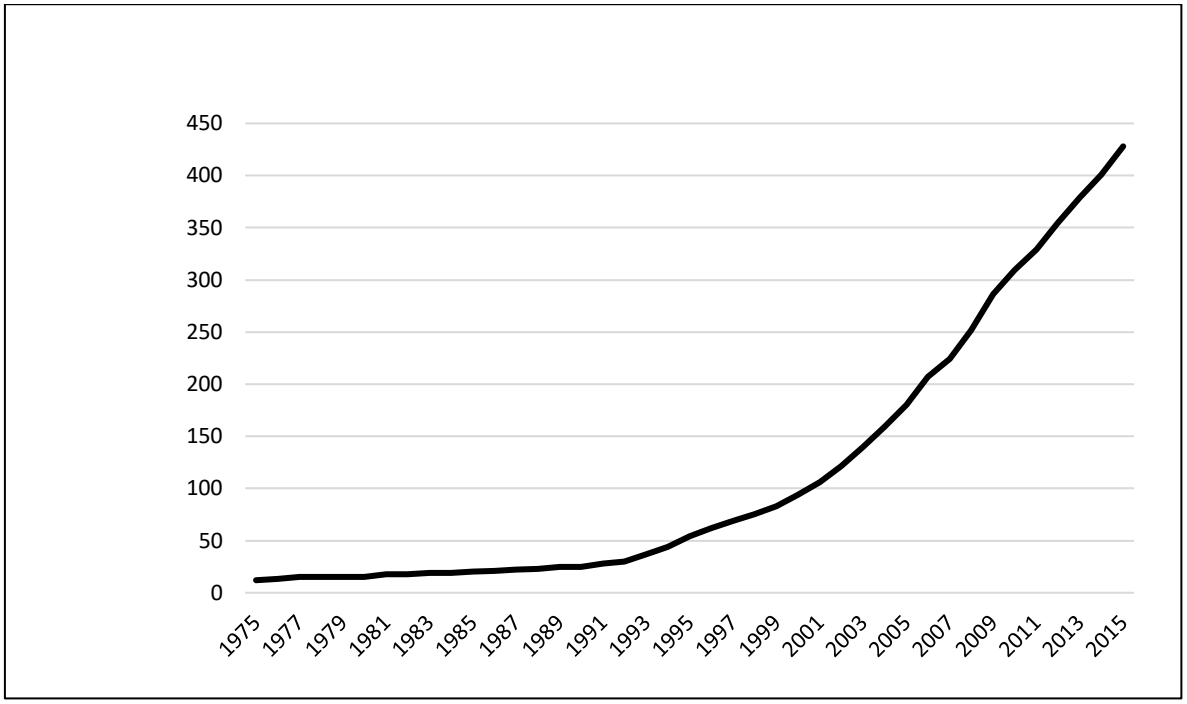
**Panel A: The world trade-to-GDP ratio, 1975-2015**




**Panel B: World foreign direct investment (FDI), 1975-2015**



**Panel C: The cumulative number of RTAs worldwide, 1975-2015**



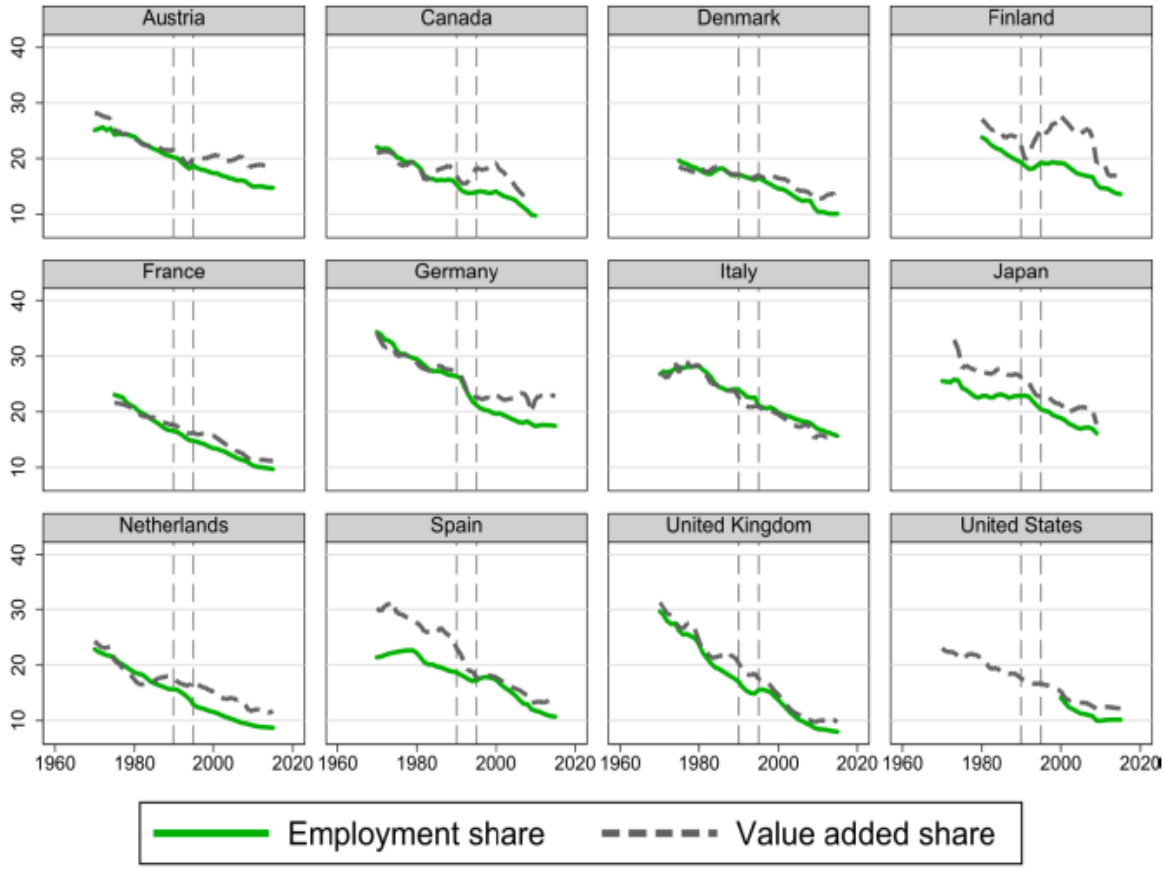

*Sources*: Data from the WDI (2018) and WTO (2018).

Rapid global integration can be attributed to three key factors. First, the end of the Cold War with the collapse of the Soviet Union resulted in the de facto elimination of ideological walls and fostered international collaboration. Second, accelerated economic reforms have taken place in developing countries, including the two giant economies of China and India, whose success has been largely driven by the adoption of a market economy, the implementation of the opening-up policy, and integration into the world economy. Third, the rapid progress and penetration of information and communication technology (ICT) across nations has substantially facilitated cross-border trade and investment and improved their efficiency.

## 2.3 Varying patterns of deindustrialization in advanced economies

Deindustrialization in developed economies has been a notable trend since the second half of the last century. Bluestone and Harrison (1982) describe the steady fall in the share of manufacturing employment in the total economy as the central phenomenon behind the systematic disinvestment in a country's manufacturing industries. Furthermore, Brady and Denniston (2006) and Tregenna (2009), among others, point out that deindustrialization in industrialized economies is associated with the contraction of the manufacturing sector's share not only of employment, but also of value added in the economy. Figure 2 illustrates the manufacturing employment and value-added shares in the 12 investigated economies over 1970-2015.

**Figure 2: Manufacturing employment and value-added shares, 1975-2015**




*Note*: The years 1990 and 1995 are identified by dashed vertical lines.
*Source*: Authors' calculations based on KLEMS data; see Appendix 1 for details.

Three observations stand out in Figure 2. First, with the exception of Italy, the share of value added was generally higher than that of employment, which means that the labour productivity of manufacturing workers was, on average, higher than the level in the overall economy. Second, the patterns of deindustrialization appear to have undergone a significant change from the early 1990s, as the gap between the employment and value-added shares noticeably widened or narrowed in most countries. Specifically, this gap improved for Austria, Canada, Denmark, Finland, France, Germany, the Netherlands and the U.S., which means that labour productivity grew faster in the manufacturing sector than in the overall economy. At the same time, this gap worsened for Japan, Italy and Spain, which means that the manufacturing sector in these countries underperformed relative to the overall economy in the post-1990 period. Third, among the 12 countries, Germany stands out as the leading performer on two measures: a sustained high share of manufacturing employment and value-added in the economy, and the widening of the gap between value-added and employment shares since the early 1990s. This tends to suggest that the

country's efforts at restructuring the manufacturing sector were more successful than those of the other economies examined.

## 2.4 Link between accelerated globalization and deindustrialization trends

This subsection presents descriptive evidence that highlights the link between accelerated globalization since the early 1990s and deindustrialization trends. This evidence is drawn from three salient observations: (i) the rapid expansion of imports from China since 1990; (ii) the abrupt fall in the U.S. price index for unskilled labour-intensive products proxied by garments and footwear since the early 1990s; and (iii) the acceleration of manufacturing employment contraction between the two 20-year periods: 1970-1990 and 1990-2010.

a) *Rapid expansion of imports from China since 1990*

The facts presented in Subsection 2.2 show that international trade since 1990 has accelerated with a more rapid pace than GDP growth. In this new global dynamics, the North-South trade flows, in which China emerges as a rapidly expanding partner, play a major role, especially as a source of merchandise imports. In fact, as shown in Table 1, for all the 12 economies investigated, the share of Chinese goods as a source of their merchandise imports expanded considerably from 1990 to 2015. This increase is particularly high for Japan (21.2 percentage points), the U.S. (19.0 percentage points) and Canada (11.5 percentage points ). By contrast, the share of imports from high-income countries shrank substantially over the same period, especially for the U.S. (-18.6 percentage points).

**Table 1: Share of imports from high-income countries and from China in total imports by country: 1985, 1990, 2015**

***(The countries are in decreasing order by their change in import share from China over 1998-2015)***

*Units: % for share in total and % points for period change*

| Economy | Imports from high-income countries | | | | | Imports from China | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Share in total | | | Period change | | Share in total | | | Period change | |
| | 1985 | 1990 | 2015 | 1985-1990 | 1990-2015 | 1985 | 1990 | 2015 | 1985-1990 | 1990-2015 |
| | (1) | (2) | (3) | (2)-(1) | (3)-(2) | (4) | (5) | (6) | (5)-(4) | (6)-(5) |
| Japan | 61.2 | 61.9 | 48.6 | 0.6 | -13.3 | 6.0 | 5.5 | 26.7 | -0.5 | 21.2 |
| U.S. | 72.5 | 67.1 | 48.5 | -5.4 | -18.6 | 1.3 | 3.3 | 22.3 | 2.1 | 19.0 |
| Canada | 92.2 | 90.7 | 74.0 | -1.5 | -16.7 | 0.4 | 1.1 | 12.6 | 0.7 | 11.5 |
| UK | 86.1 | 88.2 | 77.0 | 2.1 | -11.2 | 0.4 | 0.5 | 10.5 | 0.1 | 10.0 |
| Netherlands | 83.5 | 87.0 | 73.8 | 3.5 | -13.2 | 0.3 | 0.6 | 9.2 | 0.3 | 8.6 |
| France | 77.6 | 84.0 | 75.3 | 6.4 | -8.7 | 0.5 | 1.0 | 9.4 | 0.5 | 8.4 |
| Spain | 62.2 | 79.3 | 67.3 | 17.2 | -12.0 | 0.5 | 0.9 | 8.8 | 0.4 | 7.9 |
| Germany | … | 78.2* | 74.2 | … | -4.0 | … | 2.6* | 10.2 | … | 7.7 |
| Finland | 90.5 | 90.1 | 73.5 | -0.4 | -16.6 | 0.4 | 0.8 | 7.6 | 0.5 | 6.8 |
| Italy | 75.0 | 80.3 | 68.4 | 5.3 | -11.9 | 0.8 | 1.1 | 7.8 | 0.3 | 6.7 |
| Denmark | 91.4 | 90.9 | 83.7 | -0.5 | -7.2 | 0.7 | 1.1 | 7.6 | 0.4 | 6.5 |
| Austria | 89.3 | 89.0 | 83.8 | -0.4 | -5.2 | 0.3 | 0.8 | 6.2 | 0.5 | 5.5 |

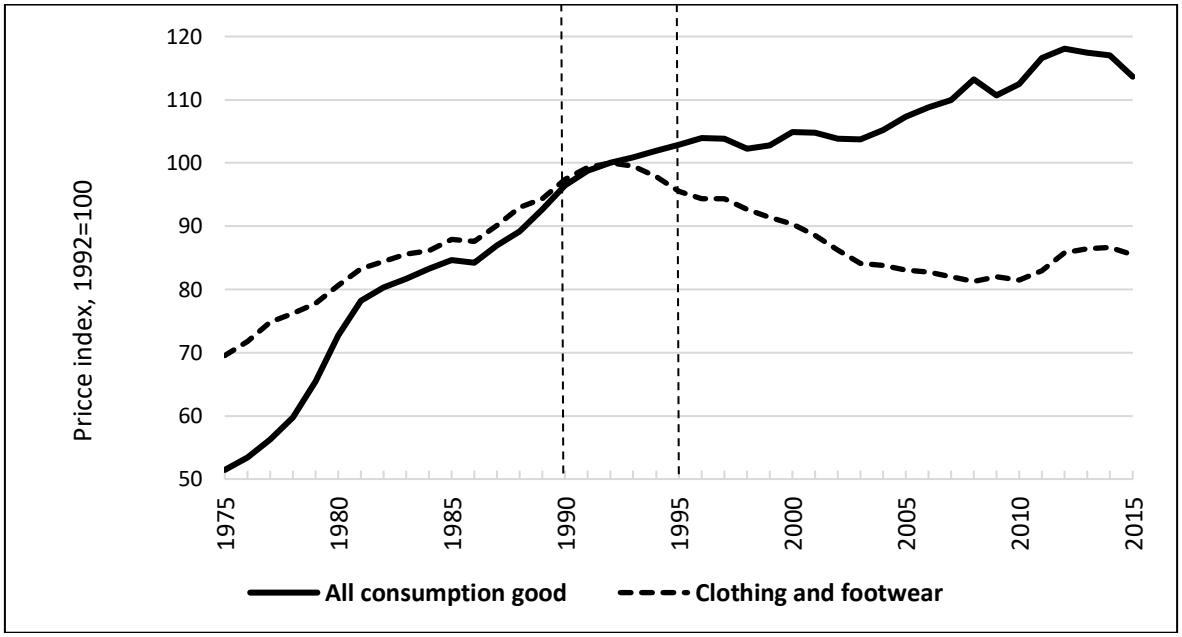
*Source:* Authors' calculations based on UNCOMTRADE.
*Note:* *For Germany, data for 1990 is not available; data for 1995 is used instead.

*b) Divergence of the price index of labour-intensive goods from the overall price trend in the early 1990s*

One immediate impact of the acceleration of North-South trade links on typical advanced economies is the rapid growth in imports of cheaper labour-intensive products from developing countries. This impact entails a fall in the price of goods produced by domestic unskilled, labour-intensive industries. As a result, these industries become less profitable than skill-intensive industries, and their contraction occurs at a higher rate than in the pre-1990 period. To provide evidence of this trend, we use U.S. data to examine the price index for clothing and footwear, which is a proxy for unskilled, labour-intensive products, and the index for aggregate consumption goods.

As Figure 3 shows, the period 1990-1995 witnessed an abrupt divergence between the price index for clothing and footwear and the index for aggregate consumption goods. More specifically, in the pre-1990 period, the price index for clothing and footwear increased along with that for aggregate consumption goods, albeit at a lower rate. In the post-1990 era, however, the price index for clothing and footwear showed a sharp declining trend. This observation supports the existence of the Stolper-Samuelson mechanism, which implies a strong negative effect of trade on unskilled, labour-intensive industries and became more pronounced since the early 1990s.[8]

**Figure 3: Price index trends: clothing and footwear vs. all consumer goods**




*Note*: Price index of personal consumption expenditure for clothes in the US. The years 1990 and 1995 are identified by dashed vertical lines.
*Source*: Authors' calculations based on BEA (2018) data.

[8] Similar tendencies were observed not only for industrialized economies but also for medium-income countries such as Argentina, Brazil and Mexico (Cruz, 2015). See UNIDO (2018) for a related discussion on the declining trend of the price of manufactured goods relative to prices in the overall economy.

*c) Accelerated pace of deindustrialization in the post-1990 period*

As North-South trade induces the contraction of labour-intensive industries in advanced economies, the affected workers might move to new jobs, including emerging high-skilled jobs associated with new technologies (Bessen, 2017). The number of new manufacturing jobs, however, is far below that of manufacturing jobs lost. This implies that we should see an accelerated contraction in manufacturing employment between the two 20-year periods: 1970-1990 (pre-1990) and 1990-2010 (post-1990). The data reported in Table 1 support this projection. In fact, ten out of the 12 economies examined experienced a higher rate of contraction in manufacturing employment in the post-1990 period. The accelerated contraction ((B)-(A)) was most pronounced for Japan (-2.6 percentage points), the U.S. (-2.0 percentage points), Denmark (-1.9 percentage points), Italy (-1.4 percentage points) and Canada (-1.3 percentage points). For the two countries that did not witness an accelerated contraction, the deceleration in employment contraction between the two periods was low, namely 0.1 percentage points for Finland and 0.2 percentage points for the Netherlands (Table 2). It should be noted that these results not only demonstrate that although the acceleration of deindustrialization in the post-1990 period is pervasive and substantial, its degree of severity varies by country, which suggests that policy responses can play a significant role in smoothing it out.

**Table 2: Manufacturing employment growth: post-1990 vs. pre-1990 period**

| | Mean employment growth | | | Change |
|---|---|---|---|---|
| | | (A) | (B) | (B)-(A) |
| | 1970-2010 | 1970-1990 | 1990-2010 | |
| ***Manufacturing industries*** | | | | |
| Austria | -1.20 | -0.80 | -1.60 | -0.80 |
| Canada | -0.30 | 0.30 | -1.00 | -1.30 |
| Denmark | -1.90 | -0.80 | -2.70 | -1.90 |
| Finland | -1.80 | -1.80 | -1.70 | 0.10 |
| France | -2.30 | -2.00 | -2.50 | -0.50 |
| Germany | -2.30 | -1.90 | -2.70 | -0.80 |
| Italy | -0.60 | 0.10 | -1.30 | -1.40 |
| Japan | -1.50 | -0.20 | -2.80 | -2.60 |
| Netherlands | -1.70 | -1.80 | -1.60 | 0.20 |
| Spain | -0.50 | -0.30 | -0.70 | -0.40 |
| United Kingdom | -2.70 | -1.90 | -3.50 | -1.60 |
| United States | -1.40 | -0.20 | -2.20 | -2.00 |

*Source*: Authors' calculations based on KLEMS data; see Appendix 1 for more information.

## 3. Empirical investigation

### 3.1 Econometric model

*The baseline model*

To examine the factors that predict employment growth at the industry level, we use the following dynamic model:[9]

$$dlnH_{i,c,t} = \beta_0 + \beta_1 dlnH_{i,c,t-1} + \beta_2 lnH_{i,c,t-1} + \beta_3 RLP_{i,c,t-1} + \beta_4 dlnLP_{i,c,t-1} + \boldsymbol{X}_{c,t-1}\theta + \mu_{ic} + \tau_t + \varepsilon_{i,c,t} \quad (1)$$

where $dlnH_{i,c,t}$ denotes employment growth in industry $i$ of country $c$ in year $t$; the right hand-side variables and parameters are described below.

The right hand-side variables (for a given country) are:

- $dlnH_{i,c,t-1}$, the first lag of the dependent variable, is included to capture the effect of unobserved factors underlying the persistent pattern of the dependent variable.
- $lnH_{i,c,t-1}$, the industry's initial level of employment, captures the influence of the industry's employment size on its growth.
- $Hshare_{i,c,t-1}$, the share of industry $i$ in its sector's total employment (manufacturing or market services), captures the concentration degree of the sector's employment in industry $i$.
- $RLP_{i,c,t-1}$is the industry's labour productivity relative to its sector.[10] A positive coefficient on this variable implies a healthy pattern of structural change: employment is expanding in an industry with higher relative labour productivity. In other words, labour is reallocated to a higher productivity activity.
- $dlnLP_{i,c,t-1}$ is the industry's labour productivity growth in the previous period; its coefficient assesses whether productivity performance is a significant predictor of employment growth.

[9] This approach is widely used in growth literature. For example, see Hall and Jones (1999) and Acemoglu et al. (2007, 2008) as well as Eicher and Schreiber (2010).

[10] Relative labour productivity is calculated as $RLP_{i,c,t} = LP_{i,c,t}/LP_{S,c,t}$, where $LP_{i,c,t}$ and $LP_{S,c,t}$are the average labour productivity of industry $i$ and sector $S$ of country $c$. Note that sector $S$ can be manufacturing or market services in our different empirical examinations.

Vector $\boldsymbol{X}_{c,t-1}$ is the set of variables controlling for the characteristics of country $c$ at the beginning of the year, which include the following:

- $unemp_{c,t-1}$ is the unemployment rate. High unemployment is expected to slow down the pace of deindustrialization; hence, its coefficient is expected to take a positive sign.
- $lnpop_{c,t-1}$ is the log of population size; this factor may be a negative influencer of manufacturing employment growth because it makes market services industries more attractive for labour reallocation.
- $FC$ is a time dummy for the recent global financial crisis period, which is equal to 1 for 2007 and 2008, and 0 otherwise.

Parameters:

- $\mu_{ic}$ represents the effects of industry-specific characteristics in a given country.
- $\tau_t$ captures time fixed effects.
- $\varepsilon_{i,c,t}$ is the random error term.

*Accounting for the structural break*

To gain insights into the factors influencing employment growth at industry level, taking into account the apparent structural break in patterns in the post-1990 period, we extend the model specification in Eq (1) as follows:

$$dlnH_{i,c,t} = \beta_0 + \beta_1 dlnH_{i,c,t-1} + \beta_2 lnH_{i,c,t-1} + \beta_3 RLP_{i,c,t-1} + \beta_4 dlnLP_{i,c,t-1} + \boldsymbol{X}_{c,t-1}\theta + \left(\gamma_0 + \beta_1 dlnH_{i,c,t-1} + \gamma_2 lnH_{i,c,t-1} + \gamma_3 RLP_{i,c,t-1} + \gamma_4 dlnLP_{i,c,t-1} + \boldsymbol{X}_{c,t-1}\Gamma\right) \times post90 + \mu_{ic} + \tau_t + \varepsilon_{i,c,t} \quad (2)$$

where the dummy *post*90 is equal to 1 for the years after 1990, and 0 otherwise. This dummy variable separates the data set into two periods: the pre-1990 period (*post*90 = 0) and the post-1990 period *(post90 = 1*). Consequently, the coefficients of the interaction terms $\gamma$ and $\Gamma$ capture the acceleration effects of the explanatory variables described above in the post-1990 period.[11]

[11] Note that the variable *post*90 is dropped if time fixed effects $\tau_t$ are included in Equation 2.

## 3.2 Data

The main dataset for our analysis is compiled from the EU KLEMS (2018) and the WORLD KLEMS (2018) *Growth and Productivity Accounts* databases. The 12 countries are selected based on the availability of data at the 2-digit ISIC industry level for the period 1970-2015. The main variables of interest are the growth rate of '*Total hours worked by persons engaged'* and '*Gross value added per hour worked (volume indices, 2010 = 100)',* which we use to construct related key variables, including labour productivity and employment shares. Appendix 1 provides details about the dataset.

## 3.3 Estimation methods

Endogeneity, especially the omitted variable bias (OVB), is the major problem estimation methods must address if they are to produce consistent results. To lessen the OVB problem, including fixed effects is a natural way to control for the effects of unobserved variables that are potentially correlated with the explanatory variables (Hsiao, 2013). However, controlling for fixed effects is not sufficient to eliminate endogeneity concerns (Roodman, 2009b). One widely used approach[12] to overcoming this problem is the generalized method of moments (GMM), proposed by Holtz-Eakin, Newey and Rosen (1988), and developed further by Arellano and Bond (1991), Arellano and Bover (1995) and Blundell and Bond (1998).

As pointed out by Arellano and Bover (1995), Blundell and Bond (1998), and Bond, Hoeffer, and Temple (2001), in comparison to other estimation techniques, GMM estimators possess several strengths. First, they are designed to analyse large N and small T panel data, in which the correlation between the lagged dependent variables and the error term may be significant. Second, GMM estimators consider the presence of country fixed effects. Third, they address the heteroscedasticity and serial correlation potentially faced by the error term. Finally, they allow some regressors to be endogenous, using their own lags as "internal" instruments.

When applying the GMM procedure, one can choose between two estimators: i) first-differenced GMM (DGMM), and ii) system GMM (SGMM). The DGMM estimator, developed by Holtz-Eakin et al. (1988) and Arellano and Bond (1991), uses first-differences to remove entity fixed effects and instruments of these first-differences with the earlier values of explanatory variables. The SGMM estimator, proposed by Arellano and Bover (1995) and Blundell and Bond (1998),

[12] Note that this approach has been widely used by previous studies. For example, see Caselli, Esquivel and Lefort (1996), Benhabib and Spiegel (1997, 2000), Easterly, Loayza and Montiel (1997), Forbes (2000), Beck, Levine and Loayza (2000), Levine, Loayza, and Beck (2000), Forbes (2000), Acemoglu, Johnson, Robinson, and Yared (2008), Giuliano and Ruiz-Arranz (2009), and Eicher and Schreiber (2010).

augments the DGMM to obtain a system of two equations: one in differences and one in levels. In the levels equation, the variables are instrumented with the lagged values of their own first differences. As demonstrated by Soto (2009), the SGMM estimator is superior to other estimators, including the DGMM estimator, because of its lower bias and higher efficiency. Furthermore, the SGMM works better than the DGMM when the number of entities (such as countries) is small and the dependent variable is closer to a random walk (Blundell and Bond, 1998). More specifically, Bond, Hoeffer and Temple (2001) demonstrate that SGMM is better suited for empirical growth studies than DGMM. For these results, we choose the SGMM estimator for the GMM estimations. For a GMM estimation to yield consistent estimates, it has to pass two tests. The Arellano-Bond (AB) AR(2) test addresses the null hypothesis of the non-existence of second-order autocorrelation in the residuals, while the Hansen test is concerned with the validity of instruments as a group. Estimates from a GMM estimation are only valid if these two tests reject their null hypotheses.

## 4. Estimation results

This section conducts regression analyses using the models specified in Eq (1) and Eq (2) to gain insights into the factors influencing employment growth at industry level. The regressions employ two main estimation methods, namely fixed effect (FE) and system GMM (SGMM). Although estimates from FE regressions substantially reduce the bias caused by omitted variables, they are not sufficient to eliminate the endogeneity problem. Therefore, the estimates from FE regressions should be interpreted as predictors, while those from SGMM regressions can be considered to be drivers. We loosely refer to these estimates as influencers.

### 4.1. Main findings

The estimation results for the full sample of countries and all industries are reported in Table 3. While our main focus is on the manufacturing sector, we also run parallel regressions for market services industries to gain comparative insights. Columns (1)-(4) of Table 3 represent manufacturing industries, and columns (5)-(8) market services industries.[13]

To save space, the table only reports estimation results from the fixed effect (FE) and system GMM (SGMM) estimators. Note that the p-values from the AB AR(2) test and the Hansen test of over-identifying restrictions reported at the bottom of each table confirm the validity of the SGMM estimations.

[13] Market services industries are all 2-digit level services industries excluding ISIC (Rev. 3) = O ("Public administration and defense; compulsory social security"). See details in Appendix 2.

Because the SGMM estimations address concerns over the problem of endogeneity, their results are considered more reliable than the FE estimations. Hence, we rely on the SGMM estimates reported in columns (4) and (8) from the complete specification to make concluding assessments. Table 3 reveals eight findings on the factors influencing employment growth in manufacturing industries. Note that observations for market services sectors are provided to allow for comparative insights.

***Finding #1: The pattern of deindustrialization is broad-based and persistent.***

The coefficient on lagged employment growth, $dlnH_{t-1}$, is positive and significant at the 1 per cent level in all regressions for the manufacturing sector (columns (1)-(4)), with its estimated magnitude ranging between 0.22-0.24. Furthermore, the coefficient on the interaction term, $post90*dlnH_{t-1}$, is positive in regressions (3) and (4), although it is not statistically significant. Note that employment contraction is a common trend in manufacturing industries; this finding indicates that the contraction pattern of manufacturing industries is robust and persistent. In other words, the pattern of deindustrialization is broad-based and persistent in both the pre- and post-1990 periods.

The results for the market services sector also show persistence in their pattern. Again, the coefficient on $dlnH_{t-1}$ is positive and significant at the 1 per cent level in all regressions (5)-(8), with its magnitude in the range of 0.24-0.37. At the same time, however, the coefficient on the interaction term, $post90*dlnH_{t-1}$, is negative in regressions (7) and (8), although it is not statistically significant. Since employment expansion is the prevailing trend in the market services sector, this finding suggests that the expansion mode of market services industries is persistent in both the pre- and post-1990 periods.

***Finding #2: Industries with a larger employment size or a larger share in their sector's employment are more affected, particularly in the post-1990 period.***

The coefficient on $lnH_{t-1}$ is negative in all regressions for the manufacturing sector (columns (1)-(4)) and significant in all but regression (4). At the same time, the coefficient on the interaction term, $post90*lnH_{t-1}$, in regression (4) is negative and significant at the 1 per cent level. This finding shows that at the industry level, employment size has a negative effect on employment growth in the manufacturing sector, and this negative link is particularly strong in the post-1990 period. In turn, the market services sector exhibits slightly different patterns. While the coefficient on $lnH_{t-1}$ is also negative and significant at the 1 per cent level, the coefficient on the interaction term, $post90*lnH_{t-1}$, is positive and significant at the 5 per cent level in regression (8). These observations suggest that while employment size has a negative effect on employment growth in market services industries, this negative link declines in the post-1990 period.

In comparison to the effect of employment size, that of employment share in the sector is even more robust for manufacturing industries. In fact, the coefficient on $Hshare_{t-1}$ and that on the interaction term, $post90*Hshare_{t-1}$, in regression (4) are both negative and significant at the 5 per cent level. This finding implies that industries with a larger employment share in the manufacturing sector are more affected by the deindustrialization trend, and this effect is more pronounced in the post-1990 period. In comparison, the results from regression (8) for market services industries show that the coefficients of $Hshare_{t-1}$ and its interaction term, $post90*Hshare_{t-1}$, are both negative but not statistically significant. This is, the negative link between the employment share and employment growth observed for market services industries may exist, but its effect is not statistically significant.

***Finding #3: Employment growth favours industries with higher relative labour productivity, particularly in the post-1990 period.***

The coefficient on relative labour productivity, $RLP_{t-1}$, is positive and significant at the 5 per cent level in all regressions (1)-(4). Furthermore, the coefficient on its interaction term, $post90*RLP_{t-1}$, is positive and significant at the 10 per cent level in regressions (3) and (4). These observations suggest that manufacturing industries with higher relative labour productivity have a notable advantage in sustaining employment growth, and this advantage is stronger in the post-1990 period. By contrast, the results from regressions (5)-(8) for the market services sector show that the coefficient on $RLP_{t-1}$ is negative and significant at the 1 per cent level, while the coefficient on its interaction term, $post90*RLP_{t-1}$, is negative but non-significant in regression (4). These observations imply that employment tends to expand faster in market services industries with lower labour productivity, and this effect may be more pronounced in the post-1990 period, although it is not statistically significant.

***Finding #4: Lagged productivity growth in manufacturing shows some effects on employment growth.***

The coefficient of lagged productivity growth, $dlnLP_{t-1}$, is not significant in the regressions for manufacturing industries, with the exception of regression (3).

Note that regression (3) is based on the complete specification, which controls for industry fixed characteristics and takes into account the effect of the post-1990 break. Therefore, although regression (3) does not effectively eliminate the potential problem of endogeneity, its results provide meaningful association links of the regressors with the dependent variable, which can be interpreted as the strength of predictive power.[14] From regression (3), the coefficient on $dlnLP_{t-1}$

[14] Levine and Zervos (1993: 426) argue that these partial correlations are very helpful in suggesting potential links between policy and the outcome of interest.

is positive and significant at the 5 per cent level, while the coefficient on its interaction term, *post90* dlnLP$_{t-1}$*, is negative and significant at the 10 per cent level. These results suggest that for manufacturing industries in the pre-1990 period, productivity growth in the previous year is a positive predictor of employment growth in the following year, but this link weakens in the post-1990 period.

The coefficient on *dlnLP$_{t-1}$* is positive and significant for the services sector regressions in columns (5)-(8). At the same time, the coefficient on the interaction term *post90*dlnLP$_{t-1}$* is also positive but not statistically significant. These results suggest that productivity growth for the market services industries in the previous year is a significant driver of employment expansion in the following year, and this effect is somewhat more pronounced, although not statistically significant, in the post-1990 period.

***Finding #5: The pattern of industry-level employment growth displays a significant structural change from the pre- to the post-1990 period.***

We conduct a Chow test of structural stability between the pre- and post-1990 periods by running F-tests of joint significance for the dummy *post90* and its interaction terms in regressions (3) and (4). The results from these tests are robustly significant at the 1 per cent level, which means that employment growth in manufacturing industries displays a notable structural break at the start of the post-1990 period. It is interesting to observe a similar structural break for market services industries. That is, the acceleration of globalization in the early 1990s caused structural change in the pattern of industry-level employment growth not only in manufacturing industries, but also in market services industries.

***Finding #6: The unemployment rate is a positive predictor of manufacturing employment growth, with this link largely determined by the growth patterns in the post-1990 period.***

The coefficient on *unemp$_{t-1}$* is positive and significant in all the baseline regressions for the manufacturing sector (columns (1) and (2)). However, in regressions (3) and (4), this coefficient is positive but not significant, while the coefficient on its interaction term, *post90*unemp$_{t-1}$*, is positive and significant at the 1 per cent level. This result suggests that the unemployment rate in the previous year has a positive effect on manufacturing employment growth the following year, but this effect is only statistically significant in the post-1990 period. A possible explanation is that a higher unemployment rate increases the supply of lower wage labour, which therefore has a positive effect on manufacturing employment.

By contrast, the patterns observed for market service industries differ. The coefficient on $unemp_{t-1}$ is negative in all regressions (5)-(8), although they are not statistically significant. At the same time, the coefficient on the interaction term $post90^* unemp_{t-1}$ is positive but also not statistically significant. That is, the lagged unemployment rate has a non-significant effect on employment growth in market services industries.

***Finding #7: Population size is a significant negative predictor of manufacturing employment growth.***

The coefficient of lagged population size, $lnpop_{t-1}$, is negative in all regressions (1)-(4) and significant at the 5 per cent level in regression (4). This evidence indicates a significant negative effect of increases in population size on employment growth in manufacturing industries. Furthermore, the coefficient on the interaction term $post90^*lnpop_{t-1}$ is negative in regressions (3) and (4), but statistically significant only at the 10 per cent level in regression (3). This finding suggests that the predictive power of population size is more pronounced in the post-1990 period.

By contrast, the coefficient for lagged population size is positive and robustly significant in regressions (5)-(8) for market services industries. At the same time, however, the coefficient on the interaction term $post90^*lnpop_{t-1}$ is negative and statistically significant in regressions (7) and (8). This implies that population size is a significant stimulator of employment growth in market services industries, but this effect declines considerably in the post-1990 period.

***Finding #8: The 2007-2008 financial crisis had a larger negative effect on employment growth in manufacturing than in services industries.***

The coefficient identifying the financial crisis (dummy *FC)* is negative and robustly significant in all regressions for the manufacturing and market services industries. The magnitude of this coefficient, however, is notably larger for the manufacturing sector than for the services sector. That is, controlling for other factors, we find that while the financial crisis of 2007-2008 had a significant negative effect on employment growth in both the manufacturing and market services sectors, the effect was more pronounced for manufacturing.

**Table 3: Industry-level employment growth: manufacturing vs. market services**

| Variable | Manufacturing sector | | | | Market services sector | | | |
|---|---|---|---|---|---|---|---|---|
| | (1) FE | (2) SGMM | (3) FE | (4) SGMM | (5) FE | (6) SGMM | (7) FE | (8) SGMM |
| $dlnH_{t-1}$ | 0.237*** | 0.240*** | 0.232*** | 0.223*** | 0.243*** | 0.341*** | 0.305*** | 0.374*** |
| | (0.040) | (0.030) | (0.051) | (0.049) | (0.053) | (0.060) | (0.064) | (0.060) |
| $lnH_{t-1}$ | -3.186*** | -2.332** | -2.770*** | -0.643 | -5.188*** | -5.636*** | -5.215*** | -5.952*** |
| | (0.520) | (0.957) | (0.475) | (1.124) | (0.770) | (1.013) | (0.767) | (1.099) |
| $Hshare_{t-1}$ | 0.072 | 0.060 | -0.108 | -0.255** | -0.004 | -0.019 | 0.016 | -0.036 |
| | (0.090) | (0.076) | (0.152) | (0.112) | (0.027) | (0.028) | (0.045) | (0.046) |
| $RLP_{t-1}$ | 0.006** | 0.006*** | 0.005** | 0.004** | -0.016*** | -0.021*** | -0.016*** | -0.026*** |
| | (0.002) | (0.002) | (0.002) | (0.002) | (0.003) | (0.005) | (0.003) | (0.005) |
| $dlnLP_{t-1}$ | 0.014 | -0.004 | 0.039** | 0.010 | 0.086** | 0.122* | 0.080** | 0.086* |
| | (0.010) | (0.009) | (0.017) | (0.018) | (0.028) | (0.068) | (0.030) | (0.047) |
| $uemp_{t-1}$ | 0.173* | 0.249*** | 0.081 | 0.078 | 0.000 | -0.042 | -0.021 | -0.075 |
| | (0.083) | (0.048) | (0.092) | (0.060) | (0.021) | (0.030) | (0.048) | (0.062) |
| $lnpop_{t-1}$ | -4.364 | -4.978 | -7.423 | -13.942** | 7.860** | 10.460*** | 11.569*** | 20.315*** |
| | (3.577) | (3.560) | (4.330) | (5.735) | (3.414) | (3.571) | (2.370) | (5.605) |
| *FC* | -1.655** | -1.532*** | -2.215*** | -2.255*** | -1.233*** | -1.136*** | -1.456*** | -1.484*** |
| | (0.587) | (0.268) | (0.565) | (0.252) | (0.311) | (0.163) | (0.288) | (0.184) |
| *post90* | | | 8.700** | 11.303* | | | 5.488 | 9.579 |
| | | | (3.202) | (6.429) | | | (5.247) | (7.340) |
| $post90 \times dlnH_{t-1}$ | | | 0.008 | 0.027 | | | -0.097 | -0.103 |
| | | | (0.057) | (0.054) | | | (0.060) | (0.079) |
| $post90 \times lnH_{t-1}$ | | | -0.174 | -0.364*** | | | 0.121 | 0.308** |
| | | | (0.098) | (0.135) | | | (0.085) | (0.140) |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| ***post90 x Hshare$_{t-1}$*** | | | -0.152 | -0.261** | | | -0.001 | -0.005 |
| | | | (0.086) | (0.116) | | | (0.034) | (0.050) |
| ***post90 x RLP$_{t-1}$*** | | | 0.010* | 0.006* | | | 0.006** | -0.002 |
| | | | (0.005) | (0.003) | | | (0.002) | (0.004) |
| ***post90 x dlnLP$_{t-1}$*** | | | -0.036* | -0.017 | | | 0.012 | 0.072 |
| | | | (0.017) | (0.016) | | | (0.030) | (0.099) |
| ***post90 x uemp$_{t-1}$*** | | | 0.201*** | 0.347*** | | | 0.010 | 0.016 |
| | | | (0.035) | (0.068) | | | (0.037) | (0.062) |
| ***post90 x lnpop$_{t-1}$*** | | | -0.452* | -0.413 | | | -0.482** | -0.811*** |
| | | | (0.216) | (0.333) | | | (0.203) | (0.303) |
| ***N*** | **4,948** | **4,948** | **4,948** | **4,948** | **5,903** | **5,903** | **5,903** | **5,903** |
| **adj. $R_2$** | **0.104** | | **0.128** | | **0.103** | | **0.113** | |
| ***p-value of hypothesis tests*** | | | | | | | | |
| AB-test AR(2) | | 0.769 | | 0.592 | | 0.574 | | 00826 |
| Hansen test | | 0.268 | | 0.147 | | 0.687 | | 0.392 |
| F-test of joint significance of post90 and interaction terms | | | 0.000 | 0.000 | | | 0.000 | 0.000 |

*Notes:* Robust standard errors in parentheses. Significance level: * p < 0.10, ** p < 0.05, *** p < 0.01.

***Further insights: trade surplus-prone vs. trade deficit-prone countries***

This subsection adds further insights into the main findings presented in Subsection 4.1 by examining whether the status of a country's trade balance affects the behaviour of the factors influencing employment growth in manufacturing industries. For this purpose, we divide the sample of 12 countries into two subsamples: trade surplus-prone countries, which include five states (Austria, Denmark, Germany, Japan and the Netherlands), and trade deficit-prone countries, comprising seven states (Canada, Finland, France, the United Kingdom, the United States, Italy and Spain).

The estimation results of this exercise are reported in Table 4, where columns (1)-(4) and columns (5)-(8) represent the trade surplus-prone and the trade deficit-prone subsamples, respectively. Table 4 highlights the following notable insights4.

With regard to Finding #1 on the persistence of employment growth patterns, the results from both subsamples are consistent. The magnitude of this persistence (captured by the coefficient of $dlnH_{t-1}$) is much greater, however, for trade deficit-prone countries (0.310 in regression (4)) than for trade surplus-prone countries (0.136 in regression (8)). That is, the accelerated deindustrialization trend is more pronounced in trade-deficit countries than in trade-surplus countries.

As regards Findings #2 and #3 on the negative effects of employment size and share of employment growth, the two subsamples' results are consistent. These effects are, however, more severe for trade deficit-prone countries in the post-1990 period. In fact, the coefficients on the interaction terms $post90 \times lnH_{t-1}$ and $post90*Hshare_{t-1}$ are generally more significant and larger in magnitude for trade deficit-prone economies.

Pertaining to Finding #4, which asserts that manufacturing industries with higher relative productivity are more favourable for employment growth, especially in the post-1990 period, the results of the two subsamples differ notably in the degree of support. While evidence for this support is solid for the trade surplus-prone countries, it is weak for the trade deficit-prone subsample. In fact, for trade surplus-prone economies, the coefficient of $RLP_{t-1}$ is positive in all regressions and statistically significant in regressions (5) and (6), while the coefficient of the interaction term $post90*RLP_{t-1}$ is positive and robustly significant at the 1 per cent level in regressions (7) and (8). By contrast, the coefficients on these variables for trade deficit-prone economies are all insignificant and even display a negative sign in some regressions.

As regards Finding #4 (some effect of lagged productivity growth on employment growth), the results of the two subsamples provide weak support. This is understandable because the evidence for Finding #5 is not robust.

As to Finding #5 structural break in the post-1990 period), Finding #6 (positive effects of unemployment), Finding #7 (negative effect of population size), and Finding #8 (negative effect of the 2007-2008 financial crisis), the results of both subsamples are consistent. There are some significant differences between the results of the two groups. In particular, the effects of unemployment (Finding #6) and population (Finding #7) are more pronounced for trade deficit-prone countries in the pos-1990 period than for trade surplus-prone ones. Next, the effect of the global financial crisis (Finding #8) is more pronounced for trade surplus-prone economies than for trade deficit-prone ones. In fact, the coefficient on *FC* for the two groups are -2.423 and -1.960 as shown in regressions (4) and (8), respectively.

**Table 4: Employment growth in manufacturing industries: "Trade surplus-prone" vs. "Trade deficit-prone" countries**

| | Trade deficit-prone subsample | | | | Trade surplus-prone subsample | | | |
|---|---|---|---|---|---|---|---|---|
| **Variable** | **FE (1)** | **SGMM (2)** | **FE (3)** | **SGMM (4)** | **FE (5)** | **SGMM (6)** | **FE (7)** | **SGMM (8)** |
| $dlnH_{t-1}$ | 0.300*** | 0.320*** | 0.297*** | 0.310*** | 0.153** | 0.172*** | 0.127 | 0.136** |
| | (0.033) | (0.040) | (0.041) | (0.053) | (0.047) | (0.049) | (0.076) | (0.053) |
| $lnH_{t-1}$ | -3.947*** | -3.925** | -3.353*** | -1.284 | -2.123* | -1.969 | -2.024* | -1.762 |
| | (0.357) | (1.977) | (0.416) | (0.983) | (0.967) | (1.420) | (0.847) | (1.349) |
| $Hshare_{t-1}$ | 0.165* | 0.199* | -0.029 | -0.155* | -0.283** | -0.443*** | -0.423 | -0.444** |
| | (0.084) | (0.119) | (0.111) | (0.088) | (0.076) | (0.109) | (0.408) | (0.204) |
| $RLP_{t-1}$ | 0.001 | -0.001 | 0.003 | -0.000 | 0.008* | 0.009*** | 0.003 | 0.004 |
| | (0.003) | (0.005) | (0.002) | (0.003) | (0.003) | (0.003) | (0.005) | (0.003) |
| $dlnLP_{t-1}$ | 0.067* | 0.100** | 0.066 | 0.088*** | -0.001 | -0.008 | 0.022 | 0.011 |
| | (0.032) | (0.043) | (0.040) | (0.027) | (0.005) | (0.005) | (0.013) | (0.014) |
| $unemp_{t-1}$ | 0.167 | 0.180*** | 0.050 | 0.048 | 0.170 | 0.239** | 0.139 | 0.157 |
| | (0.093) | (0.054) | (0.061) | (0.060) | (0.153) | (0.096) | (0.370) | (0.148) |
| $lnpop_{t-1}$ | -0.795 | 1.250 | -7.824** | -7.123 | -21.998* | -34.178*** | -9.787 | -15.109 |
| | (2.523) | (4.821) | (3.134) | (4.453) | (9.686) | (8.548) | (19.188) | (9.291) |
| $FC$ | -1.513* | -1.351*** | -1.940** | -1.960*** | -1.861 | -1.877*** | -2.400** | -2.423*** |
| | (0.743) | (0.375) | (0.606) | (0.311) | (0.924) | (0.362) | (0.755) | (0.335) |
| $post90$ | | | 4.574 | 15.523** | | | 3.781 | -0.208 |
| | | | (4.264) | (6.500) | | | (6.723) | (5.239) |
| $post90 \times dlnH_{t-1}$ | | | 0.001 | 0.009 | | | 0.024 | 0.035 |
| | | | (0.027) | (0.066) | | | (0.114) | (0.070) |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| ***post90 x lnH$_{t-1}$*** | | | -0.301*** | -0.177 | | | 0.041 | 0.124 |
| | | | (0.070) | (0.115) | | | (0.361) | (0.204) |
| ***post90 x Hshare$_{t-1}$*** | | | -0.167* | -0.216** | | | -0.038 | -0.116 |
| | | | (0.077) | (0.108) | | | (0.569) | (0.245) |
| ***post90 x RLP$_{t-1}$*** | | | 0.004 | 0.003 | | | 0.016*** | 0.015*** |
| | | | (0.006) | (0.004) | | | (0.002) | (0.005) |
| ***post90 x dlnLP$_{t-1}$*** | | | -0.009 | 0.007 | | | -0.030 | -0.023 |
| | | | (0.031) | (0.059) | | | (0.014) | (0.015) |
| ***post90 x unemp$_{t-1}$*** | | | 0.263** | 0.299*** | | | 0.102 | 0.100 |
| | | | (0.078) | (0.065) | | | (0.329) | (0.143) |
| ***post90 x lnpop$_{t-1}$*** | | | -0.112 | -0.815* | | | -0.466 | -0.183 |
| | | | (0.207) | (0.421) | | | (0.883) | (0.436) |
| ***N*** | **2815** | **2815** | **2815** | **2815** | **2133** | **2133** | **2133** | **2133** |
| **adj. $R^2$** | **0.155** | | **0.173** | | **0.059** | | **0.093** | |
| ***p-value of hypothesis tests*** | | | | | | | | |
| AB-test AR(2) | | 0.601 | | 0.441 | | 0.721 | | 0.939 |
| Hansen test | | 0.781 | | 0.246 | | 0.172 | | 0.134 |
| F-test of joint significance: *post90* and interaction terms | | | 0.000 | 0.000 | | | 0.962 | 0.000 |

*Notes*: Robust standard errors in parentheses. Significance level: * p < 0.10, ** p < 0.05, *** p < 0.01.

### *4.2 Further insights: low-tech vs. high-tech industries*

This subsection explores further insights to enrich the main findings presented in Subsection 4.1 by examining whether these findings differ between groups of industries classified by technology level. For this purpose, we focus our examination on low-tech and high-tech industries, using the classification adopted by the OECD (2003) as elaborated in Appendix 3.

The estimation results are reported in Table 5, where columns (1)-(4) represent the low-tech subsample and columns (5)-(8) represent the high-tech subsample. The following insights are drawn from Table 5.

Regarding Finding #1 on the persistent pattern of industry-level employment growth, the results of both the low-tech and high-tech groups robustly support it. However, the degree of persistence captured by the magnitude of the coefficient on $dlnH_{t-1}$, is notably larger for the low-tech group (0.372 in regression (4)) than for its high-tech counterpart (0.289 in regression (8)). This means that the persistence of deindustrialization is more severe in low-tech than in high-tech industries.

The results for low-tech and high-tech countries differ in their degree of support for Finding #2 (negative effect of employment size) and Finding #3 (negative effect of employment share). While the results for high-tech industries provide stronger evidence for Finding #2, the results for low-tech industries are more robust in supporting Finding #3. In fact, the coefficients on $lnH_{t-1}$ and $Post1990*lnH_{t-1}$ are both negative and significant at the 5 per cent level for the high-tech subsample (regression (8)); while the coefficients on $Hshare_{t-1}$ and $Post1990*Hshare_{t-1}$ are both negative and statistically significant for the low-tech subsample (regression (4)). This result tends to suggest two important trends: first, high-tech industries that are labour intensive are more inclined to move their activity overseas, with this pattern being more pronounced in the post-1990 period. Second, low-tech industries with a higher degree of employment concentration are subject to a stronger downsizing effort, with this trend becoming stronger in the post-1990 period.

With regard to Finding #4 (advantage of industries with higher relative labour productivity in employment growth), the results for low-tech industries are more robustly supportive. In fact, the coefficient on $RLP_{t-1}$, is positive in all regressions for the low-tech industries subsample and significant in regression (2), while the coefficient on its interaction term, $post90*RLP_{t-1}$, is positive and robustly significant at the 1 per cent level in regressions (3) and (4). These results suggest that structural change that shifts labour towards higher-productivity industries is stronger in low-tech industries, with this pattern being more pronounced in the post-1990 period. On the other hand, the coefficients on $RLP_{t-1}$ and $post90*RLP_{t-1}$ are all positive but not statistically insignificant for high-tech industries.

Concerning Finding #4 (some effect of lagged productivity growth on employment growth), the results of the low-tech subsample provide significant evidence. However, the results of the two subsamples are consistent but not solid. This is understandable because the evidence for Finding #5 is not robust.

As for Finding #5 (the structural break in the post-1990 period), Finding #6 (positive effects of unemployment), Finding #7 (negative effect of population size), and Finding #8 (negative effect of the 2007-2008 financial crisis), the results of both subsamples are consistent. There are, however, some significant differences in magnitude of these effects on the two subsamples. In particular, the coefficients of $unemp_{t-1}$ and $lnpop_{t-1}$ in regressions (1) and (2), respectively, are greater in magnitude than those in regressions (5) and (6), which means that the positive effect of unemployment and the negative effect of population size are stronger for low-tech industries than for high-tech ones. Furthermore, the coefficient of *FC* is larger in magnitude for high-tech industries than for low-tech ones in every corresponding regression, which means that the 2007-2008 financial crisis had a greater adverse effect on high-tech industries than on low-tech ones.

**Table 5: Employment growth: low-technology vs. high-tech industries**

| Explanatory Variable | Low-tech industries | | | | High-tech industries | | | |
|---|---|---|---|---|---|---|---|---|
| | FE (1) | SGMM (2) | FE (3) | SGMM (4) | FE (5) | SGMM (6) | FE (7) | SGMM (8) |
| $dlnH_{t-1}$ | 0.363*** | 0.391*** | 0.306** | 0.372*** | 0.278*** | 0.310*** | 0.259*** | 0.289*** |
| | (0.037) | (0.054) | (0.100) | (0.087) | (0.050) | (0.052) | (0.060) | (0.052) |
| $lnH_{t-1}$ | -0.834 | 0.025 | -0.848* | 0.780 | -5.222*** | -6.466** | -4.579*** | -4.051** |
| | (0.542) | (0.691) | (0.440) | (0.759) | (1.270) | (3.070) | (1.350) | (1.602) |
| $Hshare_{t-1}$ | -0.007 | -0.048 | -0.138 | -0.209* | 0.190 | 0.233 | -0.044 | -0.211 |
| | (0.077) | (0.085) | (0.147) | (0.120) | (0.145) | (0.237) | (0.211) | (0.158) |
| $RLP_{t-1}$ | 0.022 | 0.031** | 0.004 | 0.010 | 0.013 | 0.008 | 0.009 | 0.009 |
| | (0.014) | (0.016) | (0.012) | (0.014) | (0.009) | (0.023) | (0.008) | (0.011) |
| $dlnLP_{t-1}$ | 0.090*** | 0.101*** | 0.064 | 0.089* | 0.078*** | 0.129*** | 0.045 | 0.072 |
| | (0.024) | (0.033) | (0.050) | (0.052) | (0.016) | (0.034) | (0.041) | (0.045) |
| $unemp_{t-1}$ | 0.240*** | 0.279*** | 0.184** | 0.234*** | 0.169 | 0.196** | 0.059 | 0.013 |
| | (0.064) | (0.066) | (0.081) | (0.064) | (0.095) | (0.081) | (0.096) | (0.076) |
| $lnpop_{t-1}$ | -8.894** | -9.164** | -11.463** | -14.409** | -1.468 | 0.329 | -6.055 | -11.442* |
| | (3.224) | (4.147) | (4.816) | (5.916) | (5.923) | (11.793) | (7.354) | (6.537) |
| *FC* | -0.648 | -0.514 | -1.399*** | -1.453*** | -1.532** | -1.359*** | -2.096*** | -2.056*** |
| | (0.494) | (0.441) | (0.405) | (0.360) | (0.655) | (0.394) | (0.598) | (0.347) |
| *post90* | | | 5.853 | 9.707** | | | 12.986*** | 16.729** |
| | | | (3.796) | (4.892) | | | (3.673) | (6.834) |
| $post90 \times dlnH_{t-1}$ | | | 0.064 | -0.004 | | | 0.015 | 0.020 |
| | | | (0.110) | (0.094) | | | (0.061) | (0.060) |
| | | | | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| ***post90 x lnH$_{t-1}$*** | | | -0.129 | -0.097 | | | -0.221 | -0.384** |
| | | | (0.146) | (0.147) | | | (0.130) | (0.168) |
| ***post90 x Hshare$_{t-1}$*** | | | -0.182* | -0.295*** | | | -0.082 | -0.077 |
| | | | (0.084) | (0.109) | | | (0.109) | (0.129) |
| ***post90 x RLP$_{t-1}$*** | | | 0.047*** | 0.063*** | | | 0.016 | 0.014 |
| | | | (0.011) | (0.015) | | | (0.012) | (0.013) |
| ***post90 x dlnLP$_{t-1}$*** | | | 0.024 | -0.014 | | | 0.035 | 0.053 |
| | | | (0.051) | (0.057) | | | (0.047) | (0.050) |
| ***post90 x unemp$_{t-1}$*** | | | 0.148*** | 0.150** | | | 0.218*** | 0.339*** |
| | | | (0.027) | (0.062) | | | (0.040) | (0.084) |
| ***post90 x lnpop$_{t-1}$*** | | | -0.457* | -0.660** | | | -0.784** | -0.968** |
| | | | (0.223) | (0.280) | | | (0.279) | (0.379) |
| ***N*** | **1350** | **1350** | **1350** | **1350** | **2250** | **2250** | **2250** | **2250** |
| **adj. $R_2$** | **0.199** | | **0.233** | | **0.142** | | **0.164** | |
| ***p-value of hypothesis tests*** | | | | | | | | |
| AB-test AR(2) | | 0.202 | | 0.106 | | 0.294 | | 0.356 |
| Hansen test | | 0.219 | | 0.251 | | 0.294 | | 0.252 |
| F-test of joint significance: *post90* and interaction terms | | | 0.000 | 0.000 | | | 0.000 | 0.000 |

*Notes*: Robust standard errors in parentheses. Significance level: * p < 0.10, ** p < 0.05, *** p < 0.01.

## 5. Summary and conclusion

The main focus of this paper is to gain a comprehensive and in-depth understanding of the dynamics of deindustrialization in developed countries, taking into account the acceleration of globalization since the early 1990s. We examine these dynamics with a comprehensive data set of 12 advanced countries, including the G7 economies plus five additional European nations. Combining thorough examinations of descriptive statistics with rigorous econometric investigations, we uncover eight key findings on the main factors that influence employment growth in manufacturing industries. We also conduct similar investigations for market services industries and subsamples classified by either the status of the country's trade balance or the level of technology of manufacturing industries. Table 6 summarizes the eight key findings and the additional insights gained from the investigations of the subsamples classified by the country's trade balance status and technology level of industries.

Our study sheds light on a number of issues underlying the dynamics of deindustrialization in advanced countries. Among them, the following are the most salient. First, deindustrialization trends in developed countries display a notable structural break in early 1990, coinciding with the surge of North-South trade in this period. Second, deindustrialization is persistent across countries, but this persistence is greater in trade deficit-prone countries than in trade surplus-prone countries. Third, high-tech industries with a larger employment size tend to pursue more aggressive in downsizing, especially in the post-1990 period. This finding sheds light on the reallocation of labour-intensive activities to developing countries by multinationals in high-tech industries, such as electronics and computers. Fourth, the shift of labour towards higher-productivity industries is significant, with a pronounced effect in the post-1990 period, and these findings are more solid for low-tech industries than for high-tech ones. Finally, countries characterized by a large population, a deficit-prone trade balance, and less diversified manufacturing industries tend to suffer more from accelerated globalization.

The findings of this study also point towards several important policy issues. First, despite the numerous advantages of global integration, certain adverse effects on labour markets in developed economies, especially in manufacturing industries, cannot be overlooked and require policymakers to respond effectively and with strategic insight. Second, as some countries appear to gain more than others from accelerated globalization, trade tensions between some countries will unavoidably emerge and intensify. In other words, our findings lend support to the prediction that the adverse effect of trade will be elevated in the U.S., as the country's manufacturing employment has suffered more due to its severe trade deficits and large population size. Consequently, China—the U.S.'s major trade partner, which commands a large trade surplus with

the U.S.—would be a natural recipient of such criticism while geopolitical aspects may further intensify tensions between both countries. Finally, insights into the timing and effect of accelerated globalization on the dynamics of structural change at the industry level can help policymakers better understand what structural reforms are needed for their countries to succeed.

**Table 6: Summary of the main findings and additional insights**

| **All sample (Table 3, Column (1)-(4))** | **All manufacturing industries (Table 4)** | | **All 12 countries (Table 5)** | |
|---|---|---|---|---|
| | **Trade deficit-prone countries** | **Trade surplus-prone countries** | **Low-tech industries** | **High-tech industries** |
| ***Finding #1: The pattern of deindustrialization is broad-based and persistent.*** | Consistent; persistence is more severe | Consistent; persistence is less severe | Consistent; persistence is stronger | Consistent; persistence is weaker |
| ***Finding #2: Industries with a larger employment size or a larger share in their sector's employment are more affected, particularly in the post-1990 period.*** | Consistent; more severe and more pronounced in the post-1990 period | Consistent; less severe and not pronounced in the post-1990 period | Consistent; less significant on employment size; more significant on employment share | Consistent; more significant on employment size; less significant on employment share |
| ***Finding #3: Employment growth favours industries with higher relative labour productivity, particularly in the post-1990 period.*** | Weak evidence | Solid evidence | Consistent; more significant evidence for the post-1990 period | Consistent, with insignificant evidence |
| ***Finding #4: Lagged productivity growth in manufacturing shows some effects on employment growth.*** | Consistent in sign, but not statistically significant | Consistent in sign, but not statistically significant | Consistent, with significant evidence | Consistent, with insignificant evidence |
| ***Finding #5: The pattern of industry-level employment growth displays a significant structural change from the pre- to the post-1990 period.*** | Consistent | Consistent | Consistent | Consistent |

| | | | | |
|---|---|---|---|---|
| ***Finding #6: The unemployment rate is a positive predictor of manufacturing employment growth, with this link largely determined by the growth patterns in the post-1990 period.*** | Consistent, more pronounced in the post-1990 period | Consistent | Consistent, more solid | Consistent |
| ***Finding #7: Population size is a significant negative predictor of manufacturing employment growth.*** | Consistent, more pronounced in the post-1990 period | Consistent | Consistent, more solid | Consistent |
| ***Finding #8: The 2007-2008 financial crisis had a larger negative effect on employment growth in manufacturing than in the services industries.*** | Consistent, less severe | Consistent, more severe | Consistent | Consistent, more solid |

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## Appendix 1: Data

The main data source for this paper derives from EU KLEMS (2018), the main variables of interest being the growth rate of '*Total hours worked by persons engaged*' as well as '*Gross value added per hour worked (volume indices, 2010 = 100)'*, which we use to construct the variables of interest for our empirical model. The following extensions to the 2018 instalment of the EU KLEMS (2018) data have been made:

- For the case of Japan, we resort to the 2012 EU KLEMS release of the data, which we rebase accordingly.

- For the U.S., data on *RLP* and *dlnLP* are obtained by combining data from the March 2013 and 2017 releases of EU KLEMS (2018).

- Data for Canada are obtained from WORLD KLEMS (2018). Due to conflicting ISIC revision classification schemes, we reclassify the Canadian data to ISIC Revision 4.

## Appendix 2: Classification of services industries

***Market service industries***

| | | |
|---|---|---|
| 45 | (50) | Wholesale and retail trade and repair of motor vehicles and motorcycles |
| 46 | (51) | Wholesale trade, except of motor vehicles and motorcycles |
| 47 | (52) | Retail trade, except of motor vehicles and motorcycles |
| 49-52 | (60t63) | Transport and storage |
| 53+61 | (64) | Postal and courier activities, telecommunications |
| I | (H) | Accommodation and food market service activities |
| 58-63* M-N | (71t74) | Publishing, audio-visual and broadcasting activities, IT and other information market services. Professional, scientific, technical, administrative and support market service activities |
| K | (J) | Financial and insurance activities |
| L | (70) | Real estate activities |
| P | (M) | Education |
| Q | (N) | Health and social work |
| R+S | (O) | Arts, entertainment and recreation; other market service activities. Other market service activities |
| T | (P) | Activities of households as employers; goods- and market services-production activities of households for own use |

***Non-market service industries***

| | | |
|---|---|---|
| O | (L) | Public administration and defence; compulsory social security |

## Appendix 3: Classification of manufacturing industries by technology level

| ISIC Code | | Description | Remark |
|---|---|---|---|
| Rev. 4 | (Rev. 3) | | |
| ***Manufacturing industries*** | | | |
| 10-12 | (15t16) | Food products, beverages and tobacco | Low-tech |
| 13-15 | (17t19) | Textiles, wearing apparel, leather and related products | Low-tech |
| 16-18 | (20+21t22) | Wood and paper products; | Low-tech |
| 19 | (23) | Coke and refined petroleum products | Medium-tech |
| 20-21 | (24) | Chemicals and chemical products | High-tech |
| 22-23 | (25+26) | Rubber and plastic products, and other non-metallic mineral products | Medium-tech |
| 24-25 | (27t28) | Basic metals and fabricated metal products, except machinery and equipment | Medium-tech |
| 26-27 | (30t33) | Electrical and optical equipment | High-tech |
| 28 | (29) | Machinery and equipment n.e.c. | High-tech |
| 29-30 | (34t35) | Transport equipment | High-tech |
| 31-33 | (36t37) | Other manufacturing; repair and installation of machinery and equipment | High-tech |

*Note*: * Partly contained in ISIC Rev.3 industry 22.
*Source*: Industry re-classification based on authors' elaboration following EU KLEMS (2018) aggregation and UNSD (2000)

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