Does tertiarisation lead to secular stagnation? A Kaldorian-Baumolian analysis across eight developed economies.

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Abstract. This study examines the impact of tertiarisation on labour productivity growth in eight developed economies from a Kaldorian-Baumolian perspective, going back to the late 1970s. Given that the literature has normally applied the shift-share analysis to estimate the impact of structural change, we develop a novel decomposition formula that corrects the main flaws of the conventional shift-share analysis and satisfactorily integrates both Kaldorian and Baumolian assumptions. Firstly, our decomposition does not assume that returns to scale are homogeneous across industries, but it rather incorporates the Verdoorn coefficients that we previously estimate using system GMM. This leads us to identify an additional effect of structural change that depends on the reallocation of labour that takes place across industries with heterogeneous Verdoorn coefficients. Secondly, our formula also includes the asymptotic Baumolian effects into a framework that considers productivity growth as endogenously determined by demand. This allows us to assess not only the average impact of structural change over a period, but also whether tertiarisation leads to a gradual decrease in the productivity growth rate. Our results show that only three countries (the USA, the UK and the Netherlands) exhibit, on average, a negative impact of structural change. To a large extent, this negative impact is linked to a reallocation of labour towards industries with low returns to scale. However, the cumulative changes that take place in terms of the nominal value added and employment shares lead to a gradual decrease in the contribution of structural change in seven of the eight economies. We also find that these Baumolian effects do not only increasingly slow down the actual productivity growth rate, but also the counterfactual productivity growth that could be achieved with a structural change that worked in favour of industries with high returns to scale.

JEL classification: E24, L60, L80, O47

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1. Introduction.

Since the contemporary formulation of Kaldor's (1966, 1968, 1975) Growth Laws and Baumol's (1967) model, these two theories have spurred a pessimistic view on the impact of tertiarisation on economic growth. Building on a sector-specific understanding of economic growth (Palma, 2005; Tregenna, 2009) based on the superior technological characteristics of the manufacturing sector, both theories emphasise that the expansion of the service sector at the expense of manufacturing slows down labour productivity. However, when it comes to substantiating the negative impact of the tertiarisation process, Kaldorian theory and Baumol's model do not underscore the same effects.

In Baumol's model, the gradual expansion of the service sector leads to an asymptotic result for aggregate labour productivity growth, which declines monotonically and approaches in the limit the productivity growth rate of the service sector. To achieve this asymptotic result, three conditions must be met. First, there must be a substantial productivity growth differential between the progressive sector of the economy (that is, the one whose productivity grows above the average of the economy) and the stagnant sector (that is, the one whose productivity grows below average). The model considers that the progressive sector exhibits significant productivity increases and resembles the manufacturing sector, while the stagnant sector has stagnant productivity and is more akin to the service sector. Second, the productivity gains of the progressive sector have to be passed on to consumers in lower relative prices, so that "[t]he growth of […] productivity in manufacturing becomes a sort of fund in which […] both manufacturing and the services share equally" (Baumol and Wolff, 1984). Therefore, "by means of declining relative prices, […] the productivity growth in manufacturing rapidly dissipates into the consumers' rent instead of raising the nominal value added earned by the industry" (Pender and Streicher, 2018). Third, despite this increase in their unit cost and relative price, services must present "persistent demand" (Raa and Schettkat, 2001), which means that their real output grows at about the same pace as that of manufacturing. As a consequence of the joint fulfillment of these three conditions, the service sector gradually increases its share in nominal value added and employment and aggregate labour productivity growth is increasingly determined by the productivity growth rate of the service sector. Therefore, according to Baumol's model, the tertiarisation process leads to the gradual slowdown of aggregate labour productivity growth, which asymptotically tends to mirror productivity growth in the service sector. This negative impact is known in the literature as 'Baumol's growth disease' (BGD) (Nordhaus, 2008).

Unlike Baumol's model, Kaldorian theory does not stress the asymptotic result, but the negative impact that takes place every period in which the shift to services is accompanied by a relative setback of industries with increasing returns to scale. Hence, to substantiate this Kaldorian effect, there must exist increasing returns to scale in certain industries of the economy. According to Kaldor's Second Law or Verdoorn's (1949) Law, productivity growth in manufacturing depends positively on the rate of growth of its demand, that is, manufacturing exhibits increasing returns to scale. It is essentially a dynamic relation in which the growth of demand stimulates the incorporation of new technologies in investment goods (induced technological change) and leads to a learning by doing process (Kaldor, 1966, 1972; McCombie and Roberts, 2007; McCombie and Spreafico, 2016). Since manufacturing shows increasing returns while the other sectors of the economy exhibit constant (or even decreasing) returns to scale, an insufficient expansion of demand in manufacturing that gives rise to its relative decline in employment limits the productivity gains that could be generated due to the existence of increasing returns in this sector and, as a consequence, constrains aggregate labour productivity growth. This is precisely the effect that is underscored in Kaldor's Third Law, which is the law that tackles in specific the impact of structural change in the Kaldorian framework. According to Kaldor's Third Law, aggregate labour productivity growth depends positively on the growth of manufacturing demand and negatively on the growth of employment outside of the manufacturing sector.

However, the dichotomy between services and manufacturing on which both Baumol's model and Kaldorian theory are based has been questioned in the empirical literature. On the one hand, certain market services exhibit productivity gains comparable to those of the manufacturing sector (Baumol *et al*., 1985; Duarte and Restuccia, 2017; Duernecker *et al.*, 2017; IMF, 2018; Inklaar and Timmer, 2014; Jorgenson and Timmer, 2011; Maroto-Sánchez and Cuadrado-Roura, 2009), so that the impact of 'Baumol's growth disease' will depend on which services are the ones that account for the expansion of the service sector. On the other hand, both industries within the manufacturing sector and industries within the service sector show substantial heterogeneity in their returns to scale. Although the Kaldorian literature has traditionally estimated Verdoorn's Law for the manufacturing sector as a whole, confirming the existence of increasing returns to scale (Angeriz *et al*., 2008, 2009; Kaldor, 1966; McCombie, 1982; McCombie and Rider, 1983, 1984; Millemaci and Ofria, 2014), it has recently conducted estimations for the service sector and different disaggregations of both sectors. Even though the evidence is still limited, some studies point to the existence of increasing returns to scale for different service industries in developing economies (Di Meglio *et al*., 2018; Pieper, 2003), as well as for the aggregate service sector in both developed and developing economies (Basu and Foley, 2013; Crespi and Pianta, 2008; Di Meglio *et al.*, 2018; Felipe *et al*., 2009; León-Ledesma, 2000; Pieper, 2003). Within the manufacturing sector, in the countries with the highest level of development, returns to scale appear to be higher in high and medium-high technological industries (Magacho and McCombie, 2018; Romero and McCombie, 2016) and in capital goods producing industries (Magacho and McCombie, 2017, 2018). In light of this heterogeneity in the returns to scale at the industry level, the Kaldorian impact of the tertiarisation process will only be negative if the industries whose employment share shrinks exhibit higher returns to scale than those of the rest of the economy.

Although both Baumol's model and Kaldorian theory provide relevant partial views of the impact of the tertiarisation process, it is more appealing to combine both frameworks to obtain a more complete picture of this impact. In order to incorporate in a single Kaldorian-Baumolian framework the effect emphasised by Kaldorian theory and the one indentified in Baumol's model, it is necessary to consider, on the one hand, that productivity growth at the industry level is endogenous and depends on the expansion of demand and, on the other hand, that the cumulative change in nominal value added shares may affect aggregate productivity growth. When combining these two frameworks, other effects stemming from the tertiarisation process arise[1]. To the extent

[1] Our Kaldorian-Baumolian framework is closely related to the theoretical model developed by Storm (2017) for the US economy. Storm stresses that the tertiarisation process slows down US productivity by putting a limit on the extent of the market of industries with increasing returns to scale. This insufficient demand would gradually lead to the expansion of stagnant industries in terms of employment and nominal value added and, eventually, to the asymptotic Baumolian result. However, given that it does not consider the effects that arise from the combination of both frameworks, Storm's model neglects how the cumulative structural change might gradually

that industries with higher returns to scale gradually loses weight in terms of nominal value added shares, this cumulative change will silently undermine the aggregate productivity gains that could be achieved with a structural change that worked more in favour of industries with higher returns to scale. If this structural change that worked more in favour of industries with higher returns to scale actually took place, the aggregate productivity gains would be eroded by a cumulative change in terms of the nominal value added shares that would worsen 'Baumol's growth disease'. As a result, these aggregate productivity gains would asymptotically approach the productivity gains that industries with lower returns to scale would exhibit under this structural change that worked more in favour of industries with higher returns to scale. Under these circumstances, the tertiarisation process would lead to the gradual slowdown of the counterfactual productivity growth rate that could be achieved with a structural change that worked more in favour of industries with higher returns to scale, which asymptotically would tend to be equal to the productivity growth of stagnant industries plus the productivity gains exhibited by industries with lower returns to scale.

Our paper aims to estimate the impact of the tertiarisation process on labour productivity growth in eight developed economies in the period 1978-2007, following a Kaldorian-Baumolian framework. To the best of our knowledge, this is the first empirical study that evaluates the impact of structural change from a Kaldorian-Baumolian perspective. To achieve this goal, we will use what is arguably the most widely used method in both the Baumolian and the Kaldorian literature to assess the impact of structural change on labour productivity growth: the shift-share analysis. This method breaks down aggregate labour productivity growth into industry contributions characterised by two terms or effects: the within effect, which measures the contribution to aggregate labour productivity growth due to factors other than compositional change, and the structural change effect, which quantifies the impact of structural change on aggregate labour productivity growth. Even though this method has been widely applied to estimate the impact of structural change from a Kaldorian perspective (Deleidi *et al.*, 2018; Di Meglio *et al*., 2018; Felipe *et al*., 2009; Magacho, 2017; Naastepad and Kleinknecht, 2004; Roncolato and Kucera, 2014; Storm, 2017), given that it assumes that productivity growth at the industry level is exogenous, it corresponds to the Baumolian framework rather than to the Kaldorian one. While there have been a few attempts to integrate Kaldorian effects into the shift-share analysis (McCombie, 1980, 1991; Timmer and Szirmai, 2000), the subsequent literature has not taken these contributions into account.

The main contribution of our study consists in modifying the shift-share analysis in order to satisfactorily integrate both Kaldorian and Baumolian effects to better estimate the impact of structural change. Firstly, by considering that productivity growth is endogenous and that there are heterogeneous Verdoorn coefficients across industries, we incorporate the effect underscored by Kaldorian theory. In this sense, our analysis also overcomes the usual limitations that econometric studies on the impact of structural change (Dasgupta and Singh, 2005, 2006; Dasgupta e*t al*., 2019; Dutt and Lee, 1993; Maroto-Sánchez and Cuadrado-Roura, 2009; Peneder, 2003) exhibit, in which structural change and those variables that affect productivity growth (e.g. demand expansion) are taken as independent from each other. To the extent that this Kaldorian impact depends on the existence of heterogeneous returns to scale, our shift-share analysis requires the previous econometric estimation of Verdoorn's Law for the different industries of the

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undermine the productivity gains that could be achieved with a structural change that worked more in favour of industries with higher returns to scale.

economy. Secondly, consistent with the Baumolian framework, our analysis also includes the impact that arises from the cumulative changes that take place in terms of the nominal value added and employment shares. Thirdly, by combining the two frameworks, we identify in our shift-share analysis a new Kaldorian-Baumolian effect that allows us to estimate how the cumulative change in nominal value added shares impacts the productivity gains that could be achieved with a structural change that worked more in favour of industries with higher returns to scale. Our results stress the necessity for merging the two frameworks, since the individual estimation of Kaldor's Third Law or the Baumolian impact of structural change would substantially overestimate (underestimate) the positive (negative) impact of the tertiarisation process in several economies.

The modification that we have introduced in the shift-share analysis allows us to answer three research questions. First, it allows us to assess whether the tertiarisation process has had a negative impact on productivity growth on average for the whole period. This is the question that is usually answered in the shift-share analysis literature, although, as we have said, only Baumolian effects are normally considered in this literature[2]. Second, by incorporating the Baumolian effect, it allows us to analyse whether the contribution of structural change has followed a declining trend, leading to a progressive fall in the productivity growth rate that brings the economy closer to the Baumolian asymptotic result. This aspect has been addressed in the literature that examines the asymptotic evolution of 'Baumol's growth disease' (Duernecker *et al*., 2017; Hartwig, 2011; Nishi, 2018; Nordhaus, 2008; Oh and Kim, 2015). Third, to the extent that the Baumolian framework is combined with the Kaldorian framework, it allows us to study whether the cumulative change in nominal value added shares has been gradually slowing down the counterfactual productivity growth rate that could be achieved with a structural change that worked more in favour of industries with higher returns to scale and whether it has gradually undermined the productivity gains that could be achieved under that counterfactual scenario. To the best of our knowledge, this third question has not been addressed in the empirical literature to date. In order to investigate this aspect, we will assume that the different economies exhibit the U.S. Golden Age structural change. As we shall see, the U.S. Golden Age structural change turned out to work more in favour of industries that, according to our results, show increasing returns to scale than the actual structural change exhibited by any of the eight economies in 1978-2007.

Lastly, our work also makes a valuable contribution to the literature on Verdoorn's Law. As we estimate Verdoorn's Law at the industry level, our research contributes to the still scarce literature that estimates returns to scale for manufacturing sector (Magacho and McCombie, 2017, 2018; Romero and McCombie, 2016) or service sector (Di Meglio *et al*., 2018; Pieper, 2003) disaggregations. Our results also confirm that there is substantial heterogeneity in returns to scale within both manufacturing and service industries. While trade, transport, communication and finance exhibit increasing returns to scale that are comparable in magnitude to those of high and medium-high tech manufacturing, non-market services, personal services, real estate, business services and low and medium-low tech manufacturing show constant returns to scale.

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[2] Despite previous attempts (McCombie, 1980, 1991; Timmer and Szirmai, 2000), our study is the first to include the Kaldorian effect in a shift-share analysis that is applied to the economy as a whole and for which returns to scale are previously estimated econometrically for the different industries of the economy. Contrary to these previous attempts, we also satisfactorily integrate Baumolian effects into our shift-share analysis.

2. A modified shift-share analysis for a Kaldorian-Baumolian framework.

2.1. Decomposing the actual aggregate labour productivity growth.

In a chained Törnqvist index framework, aggregate labour productivity growth in real terms in period t can be approximated as follows:

$$\Delta \ln(LP_t) = \sum w_{it-1} \Delta\, ln(LP_{it}) + \sum (w_{it-1} - h_{it-1}) \Delta\, ln(H_{it})$$

where $\Delta \ln(LP)$ stands for the aggregate labour productivity growth based on logarithmic growth rates, , $\Delta\, ln(LP_i)$ is the labour productivity growth of industry i based on logarithmic growth rates, $\Delta\, ln(H_i)$ is the employment (hours worked) growth of industry i based on logarithmic growth rates, w_i is the nominal value added share of industry i, h_i is the employment share of industry i in hours worked and the subscripts t and $t-1$ stand for the time period.

Aggregate labour productivity growth is broken down into industry contributions characterised by two terms or effects. The first term on the right side is known in the literature as the within effect and measures the contribution to aggregate labour productivity growth due to factors other than compositional change. The second term corresponds to the Denison (1962) effect and estimates the impact that arises from a reallocation of labour that takes place between industries with heterogeneous nominal productivity levels. The Denison effect is positive (negative) if employment reallocates towards industries with above (below)-average nominal productivity levels. Consequently, the only structural change effect taken into account in this decomposition is the Denison effect. To the extent that this formula does not identify the effects that arise from the reallocation of labour between industries with heterogeneous returns to scale and from the cumulative changes in terms of the nominal value added and employment shares, these effects are implicitly considered into the within effect. It is therefore necessary to introduce different modifications in this formula in order to satisfactorily estimate the different effects stemming from structural change in a Kaldorian-Baumolian framework.

This decomposition assumes that productivity growth at the industry level is not affected by the reallocation of labour that takes place in each period t. This means that every industry of the economy exhibits constant returns to scale, so that the reallocation of labour across these industries do not yield any productivity gain or loss at both the industry and the aggregate level. However, when industries show heterogeneous returns to scale, the reallocation of labour affects the productivity growth of the industries that do not exhibit constant returns to scale, generating productivity gains or losses at the aggregate level. If industries with above (below)-average returns to scale gain weight in terms of employment, aggregate productivity growth will be boosted (undermined) by this reallocation of labour across industries with heterogenous returns to scale. In order to incorporate this effect in the formula, we introduce the following modification in the decomposition:

$$\Delta \ln(LP_t) = \sum w_{it-1} \Delta\, ln(LP_{it}) - \sum w_{it-1} \left(\Delta\, ln(H_{it}) - \Delta\, ln(H_t)\right) \left(\frac{\beta_i}{1-\beta_i}\right) + \sum w_{it-1} \left(\Delta\, ln(H_{it}) - \Delta\, ln(H_t)\right) \left(\frac{\beta_i}{1-\beta_i}\right) + \sum (w_{it-1} - h_{it-1}) \Delta\, ln(H_{it})$$

where $\Delta\, ln(H)$ is the aggregate employment (hours worked) growth based on logarithmic growth rates and β_i is the Verdoorn coefficient for industry i.

The modification that we have introduced in the formula consists on the incorporation of an element that detracts from the within effect and is added to the Denison effect in the structural change term. The total structural change effect is now composed by the Denison effect and this new effect. This effect is defined as the summation of the product of the relative employment growth of industry i and the quotient $\left(\frac{\beta_i}{1-\beta_i}\right)$, which collects the productivity gains or losses exhibited by industry i due to this relative employment growth under the existence of non-constant returns to scale, weighted by the nominal value added share of industry i in period $t-1$. Given that Kaldor's Third Law emphasises the impact of the reallocation of labour that takes place across industries with heterogeneous returns to scale, we refer to this new term as the Kaldor effect.

Despite having introduced an additional effect of structural change, the decomposition formula continues to present strong limitations to account for the impact of structural change in a Kaldorian-Baumolian framework. To the extent that the weight that condition the within effect of industry i is defined by the nominal value added share of industry i in period $t-1$, the within effect is affected by the cumulative change that has taken place in terms of the nominal value added shares since the base period. In order to make sure that the within effect is not affected by this cumulative structural change, we develop the decomposition formula as follows:

$$\Delta \ln(LP_t) = \sum w_{it-1}\Delta\, ln(LP_{it}) - \sum w_{it-1}\,(\Delta\, ln(H_{it}) - \Delta\, ln(H_t))\,(\frac{\beta_i}{1-\beta_i}) +$$
$$\sum w_{it-1}\,(\Delta\, ln(H_{it}) - \Delta\, ln(H_t))\,\left(\frac{\beta_i}{1-\beta_i}\right) + \sum(w_{it-1} - h_{it-1})\Delta\, ln(H_{it}) =$$

$$\sum w_{it-1}(\Delta\, ln(LP_{it}) - (\Delta\, ln(H_{it}) - \Delta\, ln(H_t))\,(\frac{\beta_i}{1-\beta_i})) +$$
$$\sum w_{it-1}\,(\Delta\, ln(H_{it}) - \Delta\, ln(H_t))\,\left(\frac{\beta_i}{1-\beta_i}\right) + \sum(w_{it-1} - h_{it-1})\Delta\, ln(H_{it}) =$$

$$\sum(w_{i0} + (w_{it-1} - w_{i0}))(\Delta\, ln(LP_{it}) - (\Delta\, ln(H_{it}) - \Delta\, ln(H_t))\,(\frac{\beta_i}{1-\beta_i})) +$$
$$\sum w_{it-1}\,(\Delta\, ln(H_{it}) - \Delta\, ln(H_t))\,\left(\frac{\beta_i}{1-\beta_i}\right) + \sum(w_{it-1} - h_{it-1})\Delta\, ln(H_{it}) =$$

$$\sum w_{i0}(\Delta\, ln(LP_{it}) - (\Delta\, ln(H_{it}) - \Delta\, ln(H_t))\,(\frac{\beta_i}{1-\beta_i})) +$$

$$\sum(w_{it-1} - w_{i0})(\Delta\, ln(LP_{it}) - (\Delta\, ln(H_{it}) - \Delta\, ln(H_t))\,(\frac{\beta_i}{1-\beta_i})) +$$
$$\sum w_{it-1}\,(\Delta\, ln(H_{it}) - \Delta\, ln(H_t))\,\left(\frac{\beta_i}{1-\beta_i}\right) + \sum(w_{it-1} - h_{it-1})\Delta\, ln(H_{it}) =$$

$$\sum w_{i0}(\Delta\, ln(LP_{it}) - (\Delta\, ln(H_{it}) - \Delta\, ln(H_t))\,(\frac{\beta_i}{1-\beta_i})) +$$

$$\sum(w_{it-1} - w_{i0})\Delta\, ln(LP_{it}) - \sum(w_{it-1} - w_{i0})\,(\Delta\, ln(H_{it}) - \Delta\, ln(H_t))\,(\frac{\beta_i}{1-\beta_i}) +$$
$$\sum w_{it-1}\,(\Delta\, ln(H_{it}) - \Delta\, ln(H_t))\,\left(\frac{\beta_i}{1-\beta_i}\right) + \sum(w_{it-1} - h_{it-1})\Delta\, ln(H_{it}) =$$

$$\sum w_{i0}(\Delta\, ln(LP_{it}) - (\Delta\, ln(H_{it}) - \Delta\, ln(H_t))\,(\frac{\beta_i}{1-\beta_i})) +$$

$$\sum(w_{it-1} - w_{i0})\Delta\, ln(LP_{it}) + \sum w_{i0}\,(\Delta\, ln(H_{it}) - \Delta\, ln(H_t))\,(\frac{\beta_i}{1-\beta_i}) +$$

$\sum(w_{it-1} - h_{it-1})\Delta\, ln(H_{it})$

where the subscript 0 refers to the base period.

Consequently, in a Kaldorian-Baumolian framework, which takes into account both the impact of structural change that arises from the reallocation of labour across industries with heterogeneous returns to scale and the one that arises from the cumulative change in terms of the nominal value added shares, aggregate labour productivity growth can be broken down into the following effects:

$$\Delta \ln(LP_t) = \sum c_{it}^{W} + \sum c_{it}^{SCH}$$

$$\sum c_{it}^{W} = \sum w_{i0}(\Delta\, ln(LP_{it}) - (\Delta\, ln(H_{it}) - \Delta\, ln(H_t))\,(\tfrac{\beta_i}{1-\beta_i}))$$

$$\sum c_{it}^{SCH} = \sum c_{it}^{BGD} + \sum c_{it}^{RSE} + \sum c_{it}^{DE}$$

$$\sum c_{it}^{BGD} = \sum(w_{it-1} - w_{i0})\Delta\, ln(LP_{it})$$

$$\sum c_{it}^{RSE} = \sum w_{i0}\,(\Delta\, ln(H_{it}) - \Delta\, ln(H_t))\,(\tfrac{\beta_i}{1-\beta_i}) = \sum c_{it}^{KE} - \sum c_{it}^{KBE}$$

$$\sum c_{it}^{DE} = \sum(w_{it-1} - h_{it-1})\Delta\, ln(H_{it})$$

$$\sum c_{it}^{KE} = \sum w_{it-1}\,(\Delta\, ln(H_{it}) - \Delta\, ln(H_t))\,\left(\tfrac{\beta_i}{1-\beta_i}\right)$$

$$\sum c_{it}^{KBE} = \sum(w_{it-1} - w_{i0})\,(\Delta\, ln(H_{it}) - \Delta\, ln(H_t))\,(\tfrac{\beta_i}{1-\beta_i})$$

where $\sum c_{it}^{W}$ is the within effect, $\sum c_{it}^{SCH}$ is the structural change effect, $\sum c_{it}^{BGD}$ stands for the 'Baumol's growth disease' effect, $\sum c_{it}^{RSE}$ is the returns to scale effect, $\sum c_{it}^{DE}$ is the Denison effect, $\sum c_{it}^{KE}$ refers to the Kaldor effect and $\sum c_{it}^{KBE}$ is the Kaldor-Baumol effect.

Consistent with Baumol's model, the 'Baumol's growth disease' effect measures the impact that arises from the cumulative change in terms of the nominal value added shares that has taken place since the base period. This effect is positive (negative) if progressive industries have gained (lost) weight in total nominal value added with respect to the base period.

The returns to scale effect estimates the impact that stems from the reallocation of labour that takes place across industries with heterogeneous returns to scale. This effect is positive (negative) if labour reallocates towards industries with above (below)-average returns to scale.

The returns to scale effect is equal to the Kaldor effect minus the Kaldor-Baumol effect. The difference between the returns to scale effect and the Kaldor effect lies in the nominal value added shares that are used as weights for the industry contributions. While in the returns to scale effect we take the shares from the base period, in the Kaldor effect the shares are updated in every period. As a result, the Kaldor effect is affected by the cumulative change that takes place in terms of the nominal value added shares since the base period. Since the returns to scale effect does not depend on this cumulative change, it is the Kaldor-Baumol effect the one that captures how this cumulative change boosts or undermines the Kaldor effect beyond the magnitude of the returns to scale effect, leading to its divergence. If industries with above-average returns to scale lose (gain) weight in terms of employment (i.e. if there is both a negative (positive) returns to scale effect and a negative (positive) Kaldor effect), the Kaldor-Baumol effect will be positive if industries with productivity losses (gains) higher than the economy average as a result of the reallocation of labour across industries with heterogeneous returns to scale reduce (increase) their share in total nominal value added with respect to the base period and will be negative otherwise. As the Kaldor-Baumol effect detracts from the Kaldor effect in the formula, a positive Kaldor-Baumol effect will decrease the negative magnitude (boost the positive magnitude) of the Kaldor effect.

In the development of our decomposition formula we have stressed that the within effect cannot be affected by the cumulative change in terms of the nominal value added shares. By introducing some modifications, the structural change effect went from being composed of the sum of the Kaldor effect and the Denison effect to being equal to the sum of the 'Baumol's growth disease' effect, the returns to scale effect and the Denison effect. Since Kaldor's Third Law does not take into account the cumulative impact of structural change, this law can be estimated by summing the Kaldor effect and the Denison effect. However, if we do not rule out *a priori* the relevance of the cumulative impact of structural change, our formula shows that both the 'Baumol's growth disease' effect and the impact of the Kaldor-Baumol effect on the Kaldor effect must also be taken into account.

If every industry were to exhibit constant returns to scale, the elements of the decomposition formula that depend on returns to scale would vanish (the returns to scale effect, the Kaldor effect, the Kaldor-Baumol effect and the element of the within effect that depends on returns to scale would disappear) and our decomposition would be identical to that of Nordhaus (2001, 2002). By considering productivity growth at the industry level as exogenous and incorporating the 'Baumol's growth disease' effect and the Denison effect, this formula would estimate the impact of structural change according to the Baumolian framework.

Our formula is also related to the previous attempts made by Timmer and Szirmai (2000) and McCombie (1980, 1991) to introduce the role of returns to scale in the shift-share analysis. Nevertheless, our decomposition formula solves some of the important shortcomings that characterised those previous attempts. First, to the extent that they assume that relative prices are constant, the decompositions of Timmer and Szirmai and McCombie are not valid for a framework in which real output is deflated with a chained index. Second, although both Timmer and Szirmai and McCombie identify a Kaldorian effect that arises from a reallocation that takes place across industries with heterogenous returns to scale, none of these decompositions satisfactorily identify the cumulative impact of structural change and, therefore, they do not adequately integrate Baumolian and Kaldorian effects. Third, since the only Kaldorian effect identified by Timmer and Szirmai depends on the reallocation of real output that takes place across industries with heterogeneous returns to scale, the effects that make up the total impact of structural change do not depend on a consistent definition of structural change (it is considered that structural change may consist on the reallocation of both labour or nominal value added and real value added).

2.2. Decomposing aggregate labour productivity growth on a counterfactual structural change scenario.

Besides modifying the shift-share analysis to decompose the actual aggregate labour productivity growth according to a Kaldorian-Baumolian framework, we are also interested in developing a formula that allows us to analyse whether the cumulative change in the nominal value added shares has been gradually slowing down the productivity growth that could be achieved with a structural change that worked more in favour of industries with higher returns to scale.

As we have seen, aggregate labour productivity growth in period t can be expressed as follows:

$$\Delta \ln(LP_t) = \sum w_{it-1}(\Delta\, ln(LP_{it}) - (\Delta\, ln(H_{it}) - \Delta\, ln(H_t))\, (\frac{\beta_i}{1-\beta_i})) + \sum w_{it-1}\, (\Delta\, ln(H_{it}) - \Delta\, ln(H_t))\, \left(\frac{\beta_i}{1-\beta_i}\right) + \sum(w_{it-1} - h_{it-1})\Delta\, ln(H_{it})$$

If, instead of the observed structural change, the economy were to undergo a counterfactual structural change in period t, then aggregate labour productivity growth could be written as follows:

$$\Delta \ln(LP_t)_{CF} = \sum w_{it-1}(\Delta\, ln(LP_{it}) - (\Delta\, ln(H_{it}) - \Delta\, ln(H_t))\, (\frac{\beta_i}{1-\beta_i})) + \sum w_{it-1}\, (\Delta\, ln\left(H_{CF\,it}\right) - \Delta\, ln\left(H_{CF\,t}\right))\, \left(\frac{\beta_i}{1-\beta_i}\right) + \sum(w_{it-1} - h_{it-1})\Delta\, ln\left(H_{CF\,it}\right)$$

where the subscript CF refers to the counterfactual value of the variable.

The first term on the right side of the formula reflects the productivity growth that would be achieved in period t if there was not any reallocation of labour across industries in that period. In the formula we assume that this growth would be precisely the same as the one that stems from the decomposition of the actual aggregate labour productivity growth, i.e. the element $\sum w_{it-1}\Delta\, ln(LP_{it})$ modified by the Kaldor effect. Since at this stage we assume that there is not any reallocation of labour across industries in period t and we do not take into account the cumulative change in the nominal value added shares, the total impact of structural change would be 0 and aggregate labour productivity growth would be equal to the within effect as defined when nominal value added shares in period $t-1$ were used as weights for industry contributions in the within term. The second term on the right side would correspond to the impact of the counterfactual reallocation of labour across industries with heterogeneous returns to scale. As nominal value added shares in period $t-1$ are taken as weights for this second term, this effect would be the counterfactual Kaldor effect. Finally, the third term would capture the impact that arises from the counterfactual reallocation of labour across industries with heterogeneous nominal productivity levels, that is, the counterfactual Denison effect.

Again, both the within effect and the counterfactual Kaldor effect are affected by the cumulative change that has taken place in terms of the nominal value added shares since the base period. To correct this flaw, we develop the formula as follows:

$$\Delta \ln(LP_t)_{CF} = \sum w_{it-1}(\Delta\, ln(LP_{it}) - (\Delta\, ln(H_{it}) - \Delta\, ln(H_t))\, (\frac{\beta_i}{1-\beta_i})) + \sum w_{it-1}\, (\Delta\, ln\left(H_{CF\,it}\right) - \Delta\, ln\left(H_{CF\,t}\right))\, \left(\frac{\beta_i}{1-\beta_i}\right) + \sum(w_{it-1} - h_{it-1})\Delta\, ln\left(H_{CF\,it}\right) =$$

$$\sum(w_{i0} + (w_{it-1} - w_{i0}))(\Delta\, ln(LP_{it}) - (\Delta\, ln(H_{it}) - \Delta\, ln(H_t))\, (\frac{\beta_i}{1-\beta_i})) +$$

$$\sum(w_{i0} + (w_{it-1} - w_{i0}))\, (\Delta\, ln\left(H_{CF\,it}\right) - \Delta\, ln\left(H_{CF\,t}\right))\, \left(\frac{\beta_i}{1-\beta_i}\right) +$$

$$\sum(w_{it-1} - h_{it-1})\Delta\, ln\big(H_{CF\,it}\big) =$$

$$\sum w_{i0}(\Delta\, ln(LP_{it}) - (\Delta\, ln(H_{it}) - \Delta\, ln(H_t))\, (\tfrac{\beta_i}{1-\beta_i})) +$$

$$\sum(w_{it-1} - w_{i0})(\Delta\, ln(LP_{it}) - (\Delta\, ln(H_{it}) - \Delta\, ln(H_t))\, (\tfrac{\beta_i}{1-\beta_i})) +$$

$$\sum w_{i0}(\Delta\, ln\big(H_{CF\,it}\big) - \Delta\, ln\big(H_{CF\,t}\big))\, \left(\frac{\beta_i}{1-\beta_i}\right) +$$

$$\sum(w_{it-1} - w_{i0})(\Delta\, ln\big(H_{CF\,it}\big) - \Delta\, ln\big(H_{CF\,t}\big))\, \left(\frac{\beta_i}{1-\beta_i}\right) +$$

$$\sum(w_{it-1} - h_{it-1})\Delta\, ln\big(H_{CF\,it}\big) =$$

$$\sum w_{i0}(\Delta\, ln(LP_{it}) - (\Delta\, ln(H_{it}) - \Delta\, ln(H_t))\, (\tfrac{\beta_i}{1-\beta_i})) +$$

$$\sum(w_{it-1} - w_{i0})\Delta\, ln(LP_{it}) +$$

$$\sum(w_{it-1} - w_{i0})((\Delta\, ln\big(H_{CF\,it}\big) - \Delta\, ln\big(H_{CF\,t}\big))\, \left(\frac{\beta_i}{1-\beta_i}\right) - (\Delta\, ln(H_{it}) - \Delta\, ln(H_t))\, (\tfrac{\beta_i}{1-\beta_i})) +$$

$$\sum w_{i0}(\Delta\, ln\big(H_{CF\,it}\big) - \Delta\, ln\big(H_{CF\,t}\big))\, \left(\frac{\beta_i}{1-\beta_i}\right) +$$

$$\sum(w_{it-1} - h_{it-1})\Delta\, ln\big(H_{CF\,it}\big)$$

Consequently, aggregate labour productivity growth on a counterfactual structural change scenario can be broken down into the following effects:

$$\Delta\ln(LP_t)_{CF} = \sum c_{it}^{W} + \sum c_{it}^{SCH_{CF}}$$

$$\sum c_{it}^{W} = \sum w_{i0}(\Delta\, ln(LP_{it}) - (\Delta\, ln(H_{it}) - \Delta\, ln(H_t))\, (\tfrac{\beta_i}{1-\beta_i}))$$

$$\sum c_{it}^{SCH_{CF}} = \sum c_{it}^{BGD} + \sum c_{it}^{KBGD} + \sum c_{it}^{RSE_{CF}} + \sum c_{it}^{DE_{CF}}$$

$$\sum c_{it}^{BGD} = \sum(w_{it-1} - w_{i0})\Delta\, ln(LP_{it})$$

$$\sum c_{it}^{KBGD} = \sum(w_{it-1} - w_{i0})((\Delta\, ln\big(H_{CF\,it}\big) - \Delta\, ln\big(H_{CF\,t}\big))\, \left(\frac{\beta_i}{1-\beta_i}\right) -$$
$$(\Delta\, ln(H_{it}) - \Delta\, ln(H_t))\, (\tfrac{\beta_i}{1-\beta_i})) =$$

$$\sum(w_{it-1} - w_{i0})(\Delta\, ln\big(H_{CF\,it}\big) - \Delta\, ln\big(H_{CF\,t}\big))\, \left(\frac{\beta_i}{1-\beta_i}\right) - \sum c_{it}^{KBE}$$

$$\sum c_{it}^{RSE_{CF}} = \sum w_{i0}(\Delta\, ln\big(H_{CF\,it}\big) - \Delta\, ln\big(H_{CF\,t}\big))\, \left(\frac{\beta_i}{1-\beta_i}\right)$$

$$\sum c_{it}^{DE_{CF}} = \sum(w_{it-1} - h_{it-1})\Delta\, ln\big(H_{CF\,it}\big)$$

$$\sum c_{it}^{BGD_{CF}} = \sum c_{it}^{BGD} + \sum c_{it}^{KBGD} =$$

$$\sum(w_{it-1} - w_{i0})(\Delta\, ln(LP_{it}) + (\Delta\, ln\big(H_{CF\,it}\big) - \Delta\, ln\big(H_{CF\,t}\big))\, \left(\frac{\beta_i}{1-\beta_i}\right) -$$
$$(\Delta\, ln(H_{it}) - \Delta\, ln(H_t))\, (\tfrac{\beta_i}{1-\beta_i}))$$

where $\sum c_{it}^{KBGD}$ is the 'Kaldor-Baumol's growth disease' effect.

In this formula the within effect is the same as the one that we define in the decomposition of the actual aggregate labour productivity growth. It is the structural change effect the one that is modified in the counterfactual scenario. Both the counterfactual returns to scale effect and the counterfactual Denison effect are defined similarly to how they were defined for the actual aggregate labour productivity growth, although, instead of depending on the observed structural change, they depend on the counterfactual structural change.

In this decomposition a new effect that did not exist for the actual productivity growth arises: 'Kaldor-Baumol's growth disease'. This effect receives a similar interpretation to that of the Kaldor-Baumol effect. In fact, as it can be seen, the Kaldor-Baumol effect is part of the 'Kaldor-Baumol's growth disease' effect. To the extent that the element $\sum(\Delta\, ln(H_{CF_{it}}) - \Delta\, ln(H_{CF_t}))\left(\frac{\beta_i}{1-\beta_i}\right) - (\Delta\, ln(H_{it}) - \Delta\, ln(H_t))\,(\frac{\beta_i}{1-\beta_i})$ measures the productivity gains or losses resulting from the counterfactual reallocation of labour across industries with heterogeneous returns to scale with respect to the observed reallocation of labour, 'Kaldor-Baumol's growth disease' will be positive if, in the event of having a counterfactual structural change that works more (less) in favour of industries with higher returns to scale than the observed one, industries that exhibit above-average productivity gains (losses) with respect to the observed structural change gain (lose) weight in total nominal value added with respect to the base period and will be negative otherwise. If we add these productivity gains or losses that stem from the counterfactual structural change $((\Delta\, ln(H_{CF_{it}}) - \Delta\, ln(H_{CF_t}))\left(\frac{\beta_i}{1-\beta_i}\right) - (\Delta\, ln(H_{it}) - \Delta\, ln(H_t))\,(\frac{\beta_i}{1-\beta_i}))$ to the actual productivity growth $(\Delta\, ln(LP_{it}))$, we obtain the productivity growth for each industry i on the counterfactual structural change scenario. That is why the expression $\sum(w_{it-1} - w_{i0})(\Delta\, ln(LP_{it}) + (\Delta\, ln(H_{CF_{it}}) - \Delta\, ln(H_{CF_t}))\left(\frac{\beta_i}{1-\beta_i}\right) - (\Delta\, ln(H_{it}) - \Delta\, ln(H_t))\,(\frac{\beta_i}{1-\beta_i}))$, which is equal to the sum of the actual 'Baumol's growth disease' and 'Kaldor-Baumol's growth disease', is the 'Baumol's growth disease' that the economy would experience on this counterfactual scenario.

Unlike the Kaldor-Baumol effect on the decomposition of the actual aggregate labour productivity growth, 'Kaldor-Baumol's growth disease' does have a direct impact on the counterfactual aggregate labour productivity growth. In the decomposition of the actual productivity growth, we saw how the Kaldor-Baumol effect did only imply a trade-off with the Kaldor effect, given that the returns to scale effect was independent from the cumulative change in the nominal value added shares. Nevertheless, this did not mean that the identification of the Kaldor-Baumol effect was irrelevant, since it was necessary to illustrate how the Kaldor effect fails to capture the impact that stems from the structural change that takes place across industries with heterogeneous returns to scale. Furthermore, our decomposition of the productivity growth on a counterfactual structural change scenario gives us another strong argument for not ruling out *a priori* the relevance of the Kaldor-Baumol effect. To the extent that the Kaldor-Baumol effect is part of 'Kaldor-Baumol's growth disease', its evolution affects the productivity growth that could be achieved with a counterfactual structural change.

In short, although the impact of the observed structural change is channelled through 'Baumol's growth disease', the returns to scale effect and the Denison effect, the cumulative change in the nominal value added shares that takes place across industries with heterogeneous returns to scale that also experience a reallocation of labour silently gives rise to the Kaldor-Baumol effect. This effect will emerge and directly impact aggregate productivity growth through 'Kaldor-Baumol's growth disease' when a counterfactual structural change takes place.

If the counterfactual structural change works more (less) in favour of industries with higher returns to scale than the observed structural change, it would imply a bonus (burden) for productivity growth. This bonus (burden) can be estimated as the difference between the counterfactual productivity growth and the actual productivity growth. It is easy to show that this bonus (burden) is equal to the following expression:

Bonus (burden) = $\sum c_{it}^{RSE_{CF}}$ - $\sum c_{it}^{RSE}$ + $\sum c_{it}^{KBGD}$ + $\sum c_{it}^{DE_{CF}}$ - $\sum c_{it}^{DE}$

The bonus (burden) equals the sum of the bonus (burden) that is linked to the returns to scale effect, the bonus (burden) linked to the Denison effect and 'Kaldor-Baumol's growth disease'.

2.3. Asymptotic effects.

Beyond using our decomposition to estimate the average impact of the observed structural change over a period, we are also interested in analysing whether the cumulative structural change leads to a gradual slow down of the total contributions of the observed structural change and the counterfactual structural change. This would imply that the productivity growth that could be achieved with either the observed structural change or the counterfactual structural change decreases over time. In order to shed light on this question, we will make use of the method proposed by Nordhaus (2008) (also used in Duernecker *et al.*, 2017, Hartwig, 2011 and Nishi, 2018). For each of the effects that are able to evolve asymptotically and that condition the impact of structural change, we use the corresponding expression in our decomposition formulas, with the exception that, instead of using annual data, we use the average data for the whole period for all variables except for the shares in the nominal product and employment, which we update year by year. By eliminating the volatility of all the other variables, the results capture whether there has been a gradual change in the nominal value added or employment shares that has led to a decreasing contribution over time of the corresponding effect.

Consequently, the formulas that we will use to estimate the asymptotic effects of structural change and the asymptotic productivity growth are the following:

$$\sum c_{it}^{SCH_{ASYMP}} = \sum c_{it}^{BGD_{ASYMP}} + \sum c_{it}^{RSE} + \sum c_{it}^{DE_{ASYMP}}$$

$$\sum c_{it}^{BGD_{ASYMP}} = \sum (w_{it-1} - w_{i0}) \overline{\Delta\, ln(LP_{it})}$$

$$\sum c_{it}^{DE_{ASYMP}} = \sum (w_{it-1} - h_{it-1}) \overline{\Delta\, ln(H_{it})}$$

$$\Delta \ln(LP_t)_{ASYMP} = \sum c_{it}^{W} + \sum c_{it}^{SCH_{ASYMP}}$$

$$\sum c_{it}^{SCH_{CF_{ASYMP}}} = \sum c_{it}^{BGD_{ASYMP}} + \sum c_{it}^{KBGD_{ASYMP}} + \sum c_{it}^{RSE_{CF}} + \sum c_{it}^{DE_{CF_{ASYMP}}}$$

$$\sum c_{it}^{KBGD_{ASYMP}} = \sum (w_{it-1} - w_{i0})\left(\left(\overline{\Delta\, ln(H_{CF_{it}})} - \overline{\Delta\, ln(H_{CF_t})}\right)\left(\frac{\beta_i}{1-\beta_i}\right) - \left(\overline{\Delta\, ln(H_{it})} - \overline{\Delta\, ln(H_t)}\right)\left(\frac{\beta_i}{1-\beta_i}\right)\right)$$

$$\sum c_{it}^{DE_{CF_{ASYMP}}} = \sum (w_{it-1} - h_{it-1}) \overline{\Delta\, ln(H_{CF_{it}})}$$

$$\sum c_{it}^{BGD_{CF_{ASYMP}}} = \sum c_{it}^{BGD_{ASYMP}} + \sum c_{it}^{KBGD_{ASYMP}}$$

$\Delta \ln(LP_t)_{CF_{ASYMP}} = \sum c_{it}^{W} + \sum c_{it}^{SCH_{CF_{ASYMP}}}$

where the subscript $ASYMP$ refers to the asymptotic value of the variable and the symbol $\bar{}$ stands for the average value of the variable over the whole period.

The asymptotic impact of the observed structural change is determined by the asymptotic impacts of 'Baumol's growth disease' and the Denison effect. On the one hand, 'Baumol's growth disease' will have an increasingly negative impact if stagnant industries gradually gain weight in terms of nominal value added. On the other hand, the Denison effect will evolve asymptotically if the Baumolian assumption that establishes that the productivity growth differential of progressive industries fully dissipates into the consumers' rent is not met. If progressive industries do not fully share their productivity gains with stagnant industries, progressive industries will experience a cumulative change in terms of nominal value added that is more favourable than the one they experience in terms of employment. This will gradually increase the nominal productivity level of progressive industries with respect to stagnant industries, giving rise to the asymptotic evolution of the Denison effect.

The asymptotic impact of the counterfactual structural change is determined by the asymptotic evolution of the counterfactual 'Baumol's growth disease' and the counterfactual Denison effect. Likewise, the asymptotic impact of the counterfactual 'Baumol's growth disease' is determined by the asymptotic evolution of the 'Baumol's growth disease' that stems from the observed structural change and 'Kaldor-Baumol's growth disease'. 'Kaldor-Baumol's growth disease' will have an increasingly negative impact if nominal value added gradually reallocates towards industries that exhibit above-average productivity gains on the counterfactual structural change scenario with respect to the observed structural change. Similarly to the asymptotic evolution of the Denison effect, the counterfactual Denison effect will evolve asymptotically if the productivity growth differential of progressive industries on the counterfactual structural change scenario is not completely passed on to consumers.

Lastly, we can also analyse the asymptotic evolution of the bonus for productivity growth arising from the counterfactual structural change with respect to the observed structural change:

$\text{Bonus}_{\text{ASYMP}} = \sum c_{it}^{RSE_{CF}} - \sum c_{it}^{RSE} + \sum c_{it}^{KBGD_{ASYMP}} + \sum c_{it}^{DE_{CF_{ASYMP}}} - \sum c_{it}^{DE_{ASYMP}}$

The asymptotic evolution of the bonus depends on the asymptotic evolution of 'Kaldor-Baumol's growth disease' and the difference between the asymptotic impacts of the counterfactual Denison effect and the actual Denison effect. Consequently, for the bonus to decrease over time, it is necessary either that the industries that exhibit above-average productivity gains lose weight in terms of nominal value added or that the asymptotic evolution of the counterfactual Denison effect is less favourable than that of the Denison effect.

3. Results.

3.1. The average impact of the observed structural change.

Table 1 shows the aggregate results of the decomposition of the actual labour productivity growth on average over the period 1978-2007 according to three different perspectives: the Kaldorian-Baumolian framework, Kaldor's Third Law and the

Baumolian framework. The total impact of structural change (and, therefore, the within effect) that stems from the Kaldorian-Baumolian framework differs significantly in several economies from the corresponding estimates of Kaldor's Third Law and the Baumolian framework. On the one hand, Kaldor's Third Law overestimates (underestimates) the positive (negative) impact of structural change with respect to the Kaldorian-Baumolian framework by at least 0.3 percentage points in the United Kingdom, Spain, Italy and Austria. Given the irrelevance of the Kaldor-Baumol effect, this divergence is explained by the negative impact of 'Baumol's growth disease' on these economies (Table 2). On the other hand, the Baumolian framework underestimates the negative impact of structural change with respect to the Kaldorian-Baumolian framework by at least 0.3 percentage points in the United States and the United Kingdom. In these two economies, the reallocation of labour towards industries with constant returns to scale has led to a strongly negative returns to scale effect (Table 2), which underpins the difference between the results according to the Kaldorian-Baumolian framework and those of the Baumolian framework.

Focusing on the results for the Kaldorian-Baumolian framework, we can see that the tertiarisation process has only had a significant negative impact on productivity growth in the US, the UK and the Netherlands. Looking at the different effects within the total structural change term (Table 2), we find that the returns to scale effect is the one that yields the most negative contribution to productivity growth in these three economies. Within the returns to scale effect, it is the Kaldor effect the one that mainly explains its negative magnitude. However, in comparative terms, these three economies do no only exhibit a negative impact of structural change due to the strong negative contribution of the returns to scale effect, but also because, unlike the other countries, their Denison effect reinforces (or at least does not ease) the negative contribution of 'Baumol's growth disease'. In contrast, in the remaining five economies structural change exerts a limited impact (positive in Spain, Italy, Finland and Denmark and negative in Austria) because an extremely moderate returns to scale effect is combined with a positive Denison effect that compensates the negative magnitude of 'Baumol's growth disease'.

[Insert Table 1 here]
[Insert Table 2 here]

3.2. The asymptotic impact of the observed structural change.

As we have seen, the asymptotic impact of the observed structural change depends on the combined asymptotic evolution of 'Baumol's growth disease' and the Denison effect.

Regarding the asymptotic impact of the former effect (Figure 1), five of the eight economies exhibit a clear negative trend in the evolution of their BGD. Italy, Spain, the UK, the US and Austria have seen how stagnant industries have been gaining weight in terms of nominal value added. After thirty years of this cumulative structural change, BGD has led to a slow down in the productivity growth rate in these five economies that varies from -0.3 percentage points in the US or Austria to -0.8 points in Italy. On the contrary, in the other three economies, either there is no significant trend in the evolution of BGD (this is the case of Finland and the Netherlands), or there is a reallocation of nominal value added towards progressive industries (Denmark).

As we explained in the methodological section, the asymptotic evolution of the Denison effect depends on the divergence between the cumulative change in terms of employment and in terms of nominal value added. Since in most of the economies the productivity growth differential of progressive industries does not fully dissipate into the consumers' rent, progressive industries lose more weight in terms of employment than they do in terms of nominal value added. As a result, this process leads to the gradual increase of the nominal productivity level of progressive industries with respect to stagnant industries, giving rise to the asymptotic evolution of the Denison effect in most of these economies (Figure 2).

The only two countries that do not show a substantial decline in the Denison effect over the period are the US and the UK. For the US economy, it is the low degree of divergence between the cumulative change in terms of employment and in terms of nominal value added what explains the limited decrease in the contribution of the Denison effect. On the contrary, in the UK, the upward trend followed by the Denison effect is linked to the fact that progressive industries lose more weight in terms of nominal value added than in terms of employment, which happens when the fall in the relative price of progressive industries exceeds in absolute value the magnitude of their productivity growth differential.

Regarding the remaining economies, the Denison effect follows a declining trend in Italy, Austria, Finland, the Netherlands and Denmark. If we compare the results of the end-year of the period with those of the beginning-year, the decrease in the contribution of the Denison effect has slowed down the productivity growth rate in -0.3 percentage points in Austria, Finland, the Netherlands and Denmark and -0.5 points in Italy. Even though the Spanish economy exhibits an overall decline between 1978 and 2007 that is similar to that in Italy, this decline does not occur gradually. After an initial abrupt fall, the contribution of the Denison effect remains stable in Spain.

This decline (which is gradual in the case of Italy, Austria, Finland, the Netherlands and Denmark and abrupt for Spain) undermines the positive contribution that the Denison effect made in the first year in these economies. The magnitude of this positive contribution was mainly linked to the initial share of agriculture in employment, given the large negative differential in terms of nominal productivity levels that this industry exhibits when it concentrates more employment.

As a result of the asymptotic trends followed by BGD and the Denison effect, there is a gradual decrease in the total contribution of structural change in all these economies, with the only exception of Denmark (Figure 3). In Denmark, the gradual decline in the Denison effect is not strong enough to offset the impact of the expansion of progressive industries in total nominal value added. In the remaining seven economies, the asymptotic fall in the productivity growth rate stemming from the observed structural change varies from -0.4 points in the US, the Netherlands or Finland to -1.3 points in Italy. As we have showed, in the US and the UK the asymptotic decline is linked to 'Baumol's growth disease' and not to the Denison effect. In Spain, Italy and Austria both 'Baumol's growth disease' and the Denison effect contribute to the asymptotic decline. Lastly, in the Netherlands and Finland it is only the Denison effect what accounts for the asymptotic decline.

[Insert Figure 1 here]
[Insert Figure 2 here]
[Insert Figure 3 here]

3.3. The asymptotic growth of aggregate labour productivity on a counterfactual structural change scenario that worked in favour of industries with increasing returns to scale.

In the beginning-year of the period, for which there cannot be any asymptotic impact, this counterfactual structural change that worked in favour of industries with increasing returns to scale would boost productivity growth with respect to the observed structural change in all these economies (Figure 4). However, this bonus would only be higher than 0.3 percentage points in four countries. The economies that would achieve a substantial bonus are those in which, either the negative returns to scale effect would allow the economy to generate significant aggregate productivity gains through this counterfactual reallocation of labour (this is the case of the US, the UK and the Netherlands), or this counterfactual structural change would imply a reallocation of labour that worked more in favour of industries with higher nominal productivity levels than the observed one (this is the case of Austria).

Therefore, for the beginning-year, the asymptotic growth of productivity on this counterfactual structural change scenario is higher than the asymptotic growth that would be achieved with the observed structural change (although this difference is only significant in four economies). We are now interested in analysing whether the cumulative changes in the nominal value added and employment shares, besides having led to the gradual slowdown of the productivity growth rate in seven of the eight economies, have also increasingly undermined both the counterfactual productivity growth rate and the productivity bonus that could be achieved on this counterfactual structural change scenario.

As Figure 5 shows, the cumulative changes in the employment and nominal value added shares have led to a gradual decline in the contribution of the counterfactual structural change in six of the eight economies. The only economies that manage to keep a fairly stable contribution of the counterfactual structural change are Denmark and the Netherlands. In the remaining economies, the asymptotic decline varies from -0.3 points in the US to -1.2 points in Spain or Italy.

In order to shed some light on the asymptotic impact of the counterfactual structural change, it is necessary to analyse the asymptotic evolution of the effects that determine that impact.

Regarding ‘Kaldor-Baumol’s growth disease’ (Figure 6), none of the eight economies have suffered a substantial impact. The economy that exhibits the greatest negative contribution is the United Kingdom, but it barely exceeds -0.2 percentage points. This irrelevance of ‘Kaldor-Baumol’s growth disease’ is due to the fact that the industries that would show above-average productivity gains on this counterfactual scenario have not significantly lost weight in terms of nominal value added. As a result of the non-significant ‘Kaldor-Baumol’s growth disease’, the asymptotic impact of the counterfactual ‘Baumol’s growth disease’ is mainly determined by the asymptotic impact of the ‘Baumol’s growth disease’ that stems from the observed structural change (Figure 1).

The asymptotic counterfactual structural change effect also depends on the asymptotic evolution of the counterfactual Denison effect. As Figure 7 depicts, the counterfactual Denison effect behaves very similarly to the Denison effect that stems from the observed structural change in seven of the eight economies (Figure 2). On the one hand, the US and the UK do not suffer a significant fall in the contribution of the Denison effect and the counterfactual Denison effect. On the other hand, Spain, Italy, Denmark, Finland and Austria show a substantial decline in the contribution of both effects. Contrary to these economies, in the Netherlands these two effects do not behave similarly, since the counterfactual Denison effect does not exhibit the downward trend followed by the Denison effect.

As we have already seen, these asymptotic results lead to the gradual decline in the contribution of the counterfactual structural change in six of the eight economies. Regarding the two economies that escape this asymptotic decline, in Denmark the gradual fall in the contribution of the counterfactual Denison effect does not manage to offset the positive impact of the cumulative expansion of progressive industries in total nominal value added, while in the Netherlands none of the asymptotic effects follows a declining trend. As for the remaining countries, in the US and the UK the asymptotic fall in the contribution of the counterfactual structural change is linked to 'Baumol's growth disease'. In Spain, Italy and Austria both the BGD and the counterfactual Denison effect contribute to the asymptotic decline. Lastly, in Finland it is the counterfactual Denison effect what explains the asymptotic decline.

Given the asymptotic irrelevance of 'Kaldor-Baumol's growth disease' and the similarity between the evolution of the Denison effect and the counterfactual Denison effect, the asymptotic impact of the counterfactual structural change follows a comparable trend to that of the asymptotic impact of the observed structural change. This implies that the bonus for productivity growth that could be achieved under the counterfactual structural change scenario has remained fairly stable over time (Figure 8).

Although, as we have seen, the cumulative changes in the employment and nominal value added shares have led in most of the economies to a gradual decline of both the productivity growth rate on the observed structural change scenario and the counterfactual productivity growth rate, in the end-year productivity could still grow at around 2% in six of the eight economies if a structural change that worked in favour of industries with increasing returns to scale were to take place (Table 3). On the contrary, if the observed structural change were to take place, productivity would grow at that pace in only four of the eight economies. The US and the Netherlands, adversely affected by their large bonus linked the counterfactual structural change, would exhibit a mediocre productivity growth rate under the observed structural change (their within effect would be undermined by a remarkably negative asymptotic impact). The four economies that would achieve a robust productivity growth with both the observed structural change and the counterfactual one would be the UK, Finland, Denmark and Austria. Even though they would be adversely affected by their large bonus linked to the counterfactual structural change as the US and the Netherlands are, the UK and Austria would be able to exhibit a strong productivity growth on the observed structural change scenario due to their within contribution and, in the case of Austria, to the somewhat more limited asymptotic impact of the observed structural change with respect to the US and the Netherlands. In the case of Finland, the asymptotic impact of the observed structural change barely undermines its strong within effect. Regarding Denmark, despite its moderate within contribution, the positive asymptotic impact of structural change allows the economy to boost productivity growth at around 2% even on the observed structural change scenario. Lastly, in the remaining two economies (Spain and Italy), structural change exacerbates the weakness of the within effect. The impact of structural change in these two economies diverges from the one that has taken place in the two economies (Denmark and the Netherlands) that exhibit a within effect more akin to that of Spain and Italy. In contrast to Denmark, in Spain and Italy the asymptotic impact does not boost the weak within contribution, but rather undermines it. Likewise, the counterfactual structural change would not foster productivity growth substantially, since, contrary to what happens in the Netherlands, the productivity bonus has a small magnitude. Although Spain and Italy show an asymptotic impact of the observed structural change that is akin to that of other economies, the fact that it is almost entirely based on a strongly negative 'Baumol's growth disease' explains why, on the counterfactual scenario, the impact of structural change is also substantially negative.

[Insert Figure 4 here]
[Insert Figure 5 here]
[Insert Figure 6 here]
[Insert Figure 7 here]
[Insert Figure 8 here]
[Insert Table 3 here]

4. Concluding remarks.

This study has addressed the impact of the tertiarisation process on labour productivity growth in eight developed economies in the period 1978-2007, following a Kaldorian-Baumolian perspective. To that end, we have modified the shift-share analysis in order to satisfactorily integrate both Kaldorian and Baumolian effects to better estimate the impact of structural change. First, our shift-share analysis includes the effect emphasised by Kaldorian theory by considering that productivity growth is endogenous and that there are heterogeneous Verdoorn coefficients across industries. In this sense, our analysis also overcomes the usual limitations that econometric studies on the impact of structural change exhibit, in which structural change and those variables that affect productivity growth (e.g. demand expansion) are taken as independent from each other. Second, consistent with the Baumolian framework, our analysis also includes the impact that arises from the cumulative changes that take place in terms of the nominal value added and employment shares. Third, by combining the two frameworks, we identify in our shift-share analysis a new Kaldorian-Baumolian effect that allows us to estimate how the cumulative change in nominal value added shares impacts the productivity gains that could be achieved with a structural change that worked more in favour of industries with higher returns to scale. Our results stress the necessity for merging the two frameworks, since the individual estimation of Kaldor's Third Law or the Baumolian impact of structural change would substantially overestimate (underestimate) the positive (negative) impact of the tertiarisation process in several economies.

The modification that we have introduced in the shift-share analysis has allowed us to study three research questions. First, it has allowed us to assess whether the tertiarisation process has had a negative impact on productivity growth on average for the whole period. Second, by incorporating the Baumolian effect, it has allowed us to analyse whether the contribution of structural change has followed a declining trend, leading to a progressive fall in the productivity growth rate that brings the economy closer to the Baumolian asymptotic result. Third, to the extent that the Baumolian framework is combined with the Kaldorian framework, it has allowed us to study whether the cumulative change in nominal value added shares has been gradually slowing down the counterfactual productivity growth rate that could be achieved with a structural change that worked more in favour of industries with higher returns to scale and whether it has gradually undermined the productivity gains that could be achieved under that counterfactual scenario.

As our results show, the average impact of structural change has only been substantially negative in three economies (the US, the UK and the Netherlands). In comparative terms, these three economies do no only exhibit a negative impact of structural change due to the reallocation of labour towards industries with constant returns to scale, but also because, unlike the other countries, their Denison effect reinforces (or at least does not ease) the negative contribution of 'Baumol's growth disease'. Although the average impact of structural change has only been negative in three economies, the cumulative changes that take place in terms of the nominal value added and employment shares lead to a gradual decrease in the contribution of structural change in seven of the eight economies. Consequently, these cumulative changes has led to a gradual fall in the productivity growth rate that brings the economy closer to the Baumolian asymptotic result. Lastly, in six of the eight economies, these cumulative changes has also increasingly undermined the counterfactual productivity growth rate that could be achieved with a structural change that worked more in favour of industries with increasing returns to scale. However, given the asymptotic irrelevance of 'Kaldor-Baumol's growth disease', the bonus for productivity growth that could be achieved under the counterfactual structural change scenario has remained fairly stable over time.

Even though the cumulative changes in the employment and nominal value added shares have led in most of the economies to a gradual decline of both the productivity growth rate on the observed structural change scenario and the counterfactual productivity growth rate, in the end-year productivity could still grow at around 2% in six of the eight economies if a structural change that worked in favour of industries with increasing returns to scale were to take place and in four of the eight economies if the observed structural change were to take place. Therefore, the widespread mediocre performance of aggregate labour productivity after 2007 was not unexpected, according to our results, for the US, the Netherlands, Spain or Italy. In order to exhibit fast productivity growth, these four economies would have needed to boost their within effect to offset the negative asymptotic impact of the observed structural change[3] or, in the case of the US and the Netherlands, to experience a structural change that worked in favour of industries with increasing returns to scale. On the contrary, in the other four economies, the poor productivity performance after 2007 implies a substantial slowdown with respect to the end-year asymptotic productivity growth. This slowdown has been likely caused by a strong decrease in the within contribution with respect to the period 1978-2007.

Considering the virtues that our shift-share analysis exhibits compared to other shift-share decompositions or even to the econometric studies in which structural change and those variables that affect productivity growth are taken as independent from each other, it would be interesting to apply our method to estimate the impact of structural change that stems from processes of industrialisation or premature deindustrialisation and to assess the role of structural change in explaining the different rates of productivity growth observed across developing countries (Di Meglio *et al.*, 2018; Felipe *et al*., 2019; McMillan and Rodrik, 2011; McMillan e*t al*., 2014; Rodrik, 2016; Roncolato and Kucera, 2014).

However, despite its virtues, our method also presents some limitations. Since it is a decomposition technique, and although it incorporates the impact of structural change that arises from the reallocation of labour across industries with heterogeneous returns to scale, it neglects the causal relationships that define a growth process with structural change and cumulative causation. In this sense, it would be necessary to formulate a

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[3] If the within effect rises due to the increase in the Verdoorn coefficient of stagnant/low returns industries, this would ease the asymptotic impact of the observed structural change by improving the returns to scale effect and 'Baumol's growth disease'.

model in which structural change is endogenised, incorporating the different factors that explain for each industry or sector, on the one hand, its demand growth differential, and, on the other hand, its productivity growth differential (Araujo, 2013). Given that the Kaldorian literature has barely delved into the factors that determine the interrelationship between structural change and economic growth (Romero, 2016), we intend to address these issues in a future investigation.

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Tables and figures.

Table 1. Shift-share analysis of the actual labour productivity growth (1978-2007). Aggregate effects according to different frameworks.

		Kaldorian-Baumolian Framework		Kaldor's Third Law		Baumolian Framework	
	Total Contribution	Within	Structural Change	Within	Structural Change	Within	Structural Change
USA	1.4	2.0	-0.5	1.8	-0.3	1.7	-0.3
UK	2.1	2.9	-0.8	2.5	-0.4	2.6	-0.4
Spain	1.6	1.4	0.2	1.1	0.5	1.3	0.3
Italy	1.4	1.3	0.1	0.9	0.5	1.2	0.2
Netherlands	1.5	1.7	-0.3	1.6	-0.2	1.6	-0.1
Finland	2.7	2.7	0.1	2.5	0.2	2.7	0.1
Denmark	1.5	1.5	0.0	1.4	0.1	1.4	0.1
Austria	2.0	2.2	-0.1	1.9	0.1	2.2	-0.1

*The Kaldorian-Baumolian framework considers the following effects within the total structural change effect: the returns to scale effect, ‘Baumol’s growth disease’ and the Denison effect. Kaldor’s Third Law only takes into account the Kaldor effect and the Denison effect, ignoring ‘Baumol’s growth disease’ and the Kaldor-Baumol effect. Lastly, the Baumolian framework only considers ‘Baumol’s growth disease’ and the Denison effect, neglecting the returns to scale effect.

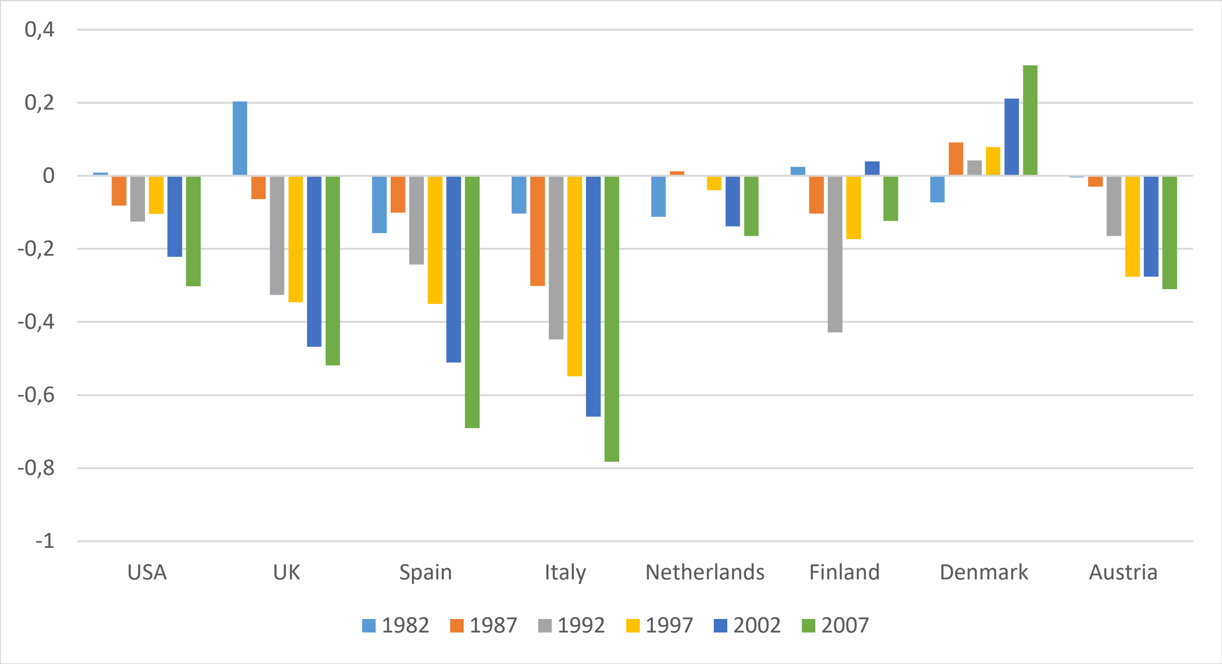
Source: own elaboration based on EU KLEMS.

Table 2. Decomposition of the structural change effect in a Kaldorian-Baumolian framework (1978-2007).

	Returns to Scale Effect	Kaldor Effect	Kaldor-Baumol Effect	Baumol's Growth Disease	Denison Effect
USA	-0.3	-0.2	0.1	-0.2	-0.1
UK	-0.4	-0.2	0.1	-0.3	-0.2
Spain	-0.1	0.0	0.0	-0.2	0.5
Italy	-0.1	0.0	0.0	-0.3	0.5
Netherlands	-0.2	-0.1	0.0	-0.1	0.0
Finland	0.0	0.0	0.0	-0.1	0.2
Denmark	-0.1	-0.1	0.0	0.0	0.2
Austria	0.0	0.0	0.0	-0.3	0.1

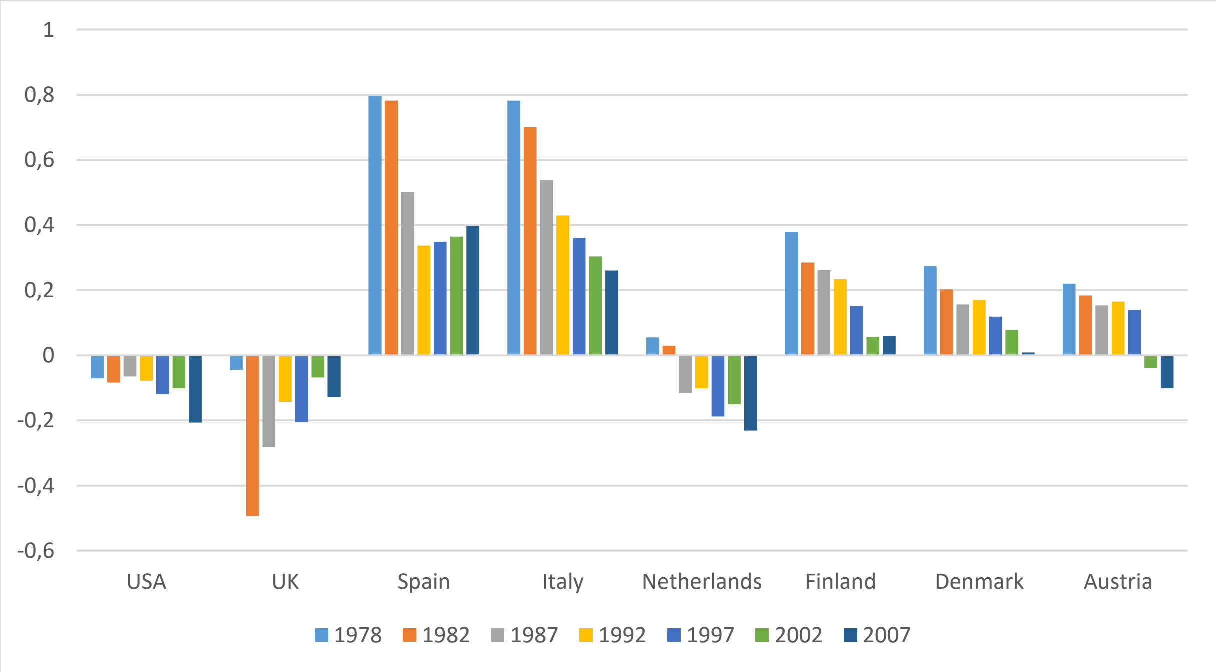
Source: own elaboration based on EU KLEMS.

Figure 1. Asymptotic impact of BGD in percentage points (selected years).



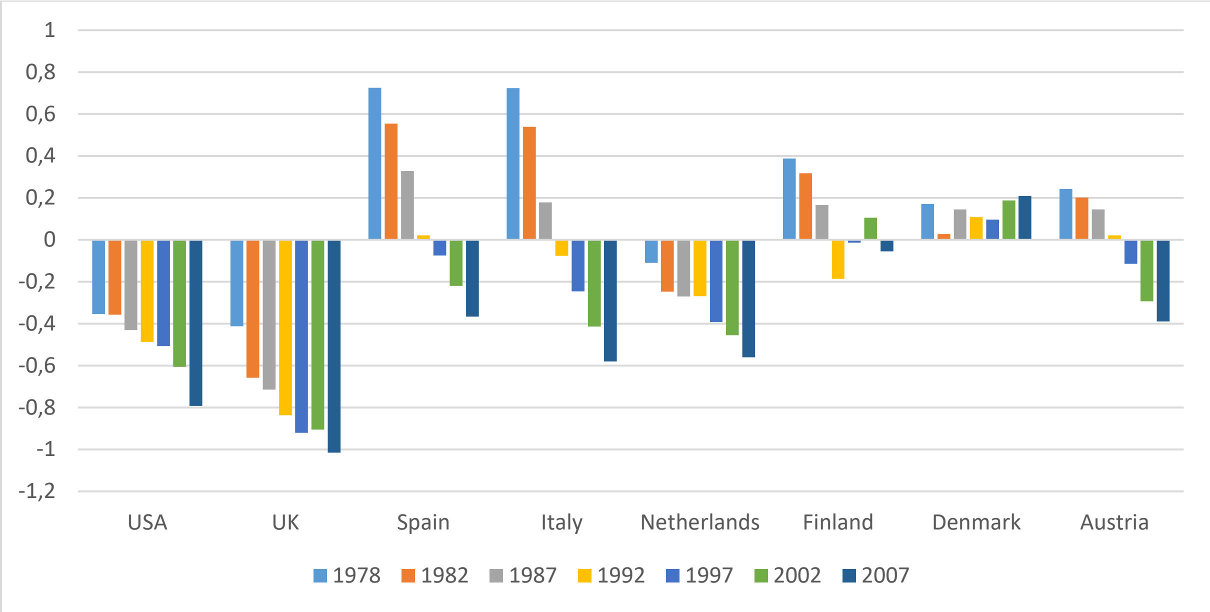
Source: own elaboration based on EU KLEMS.

Figure 2. Asymptotic impact of the Denison effect in percentage points (selected years).



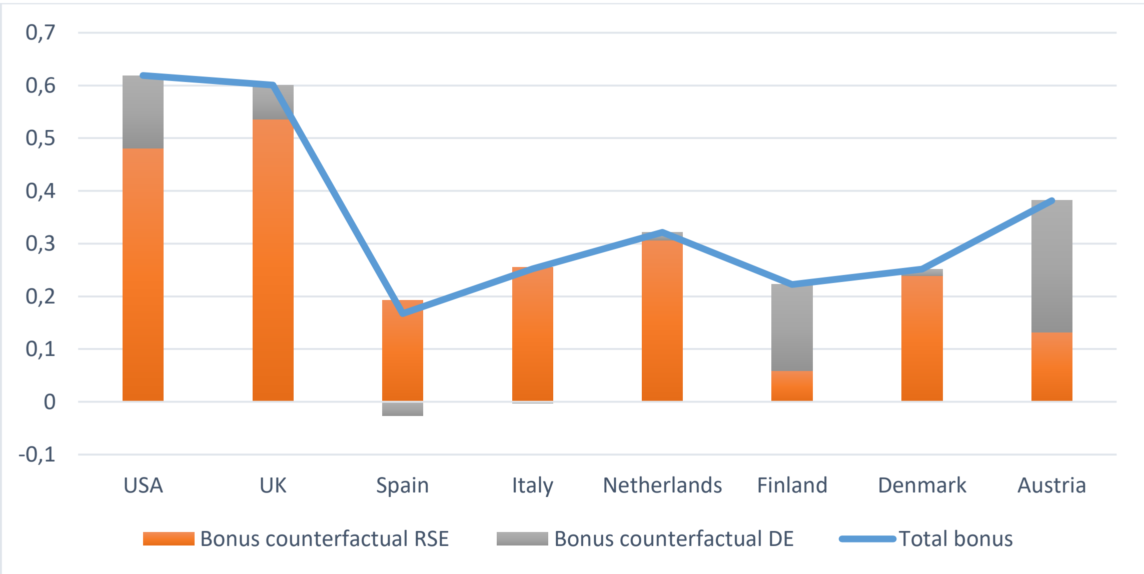
Source: own elaboration based on EU KLEMS.

Figure 3. Asymptotic impact of the observed structural change in percentage points (selected years).



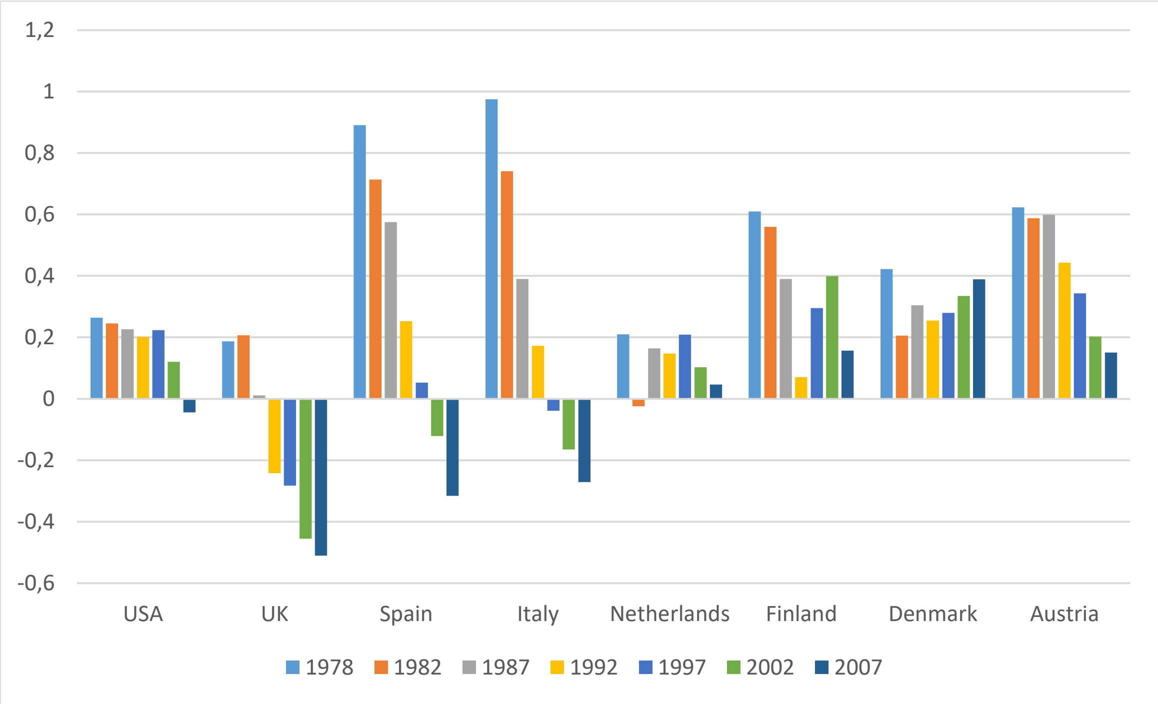
Source: own elaboration based on EU KLEMS.

Figure 4. Decomposition of the bonus for productivity growth on the counterfactual structural change scenario with respect to the observed structural change for the beginning-year (1978, in percentage points).



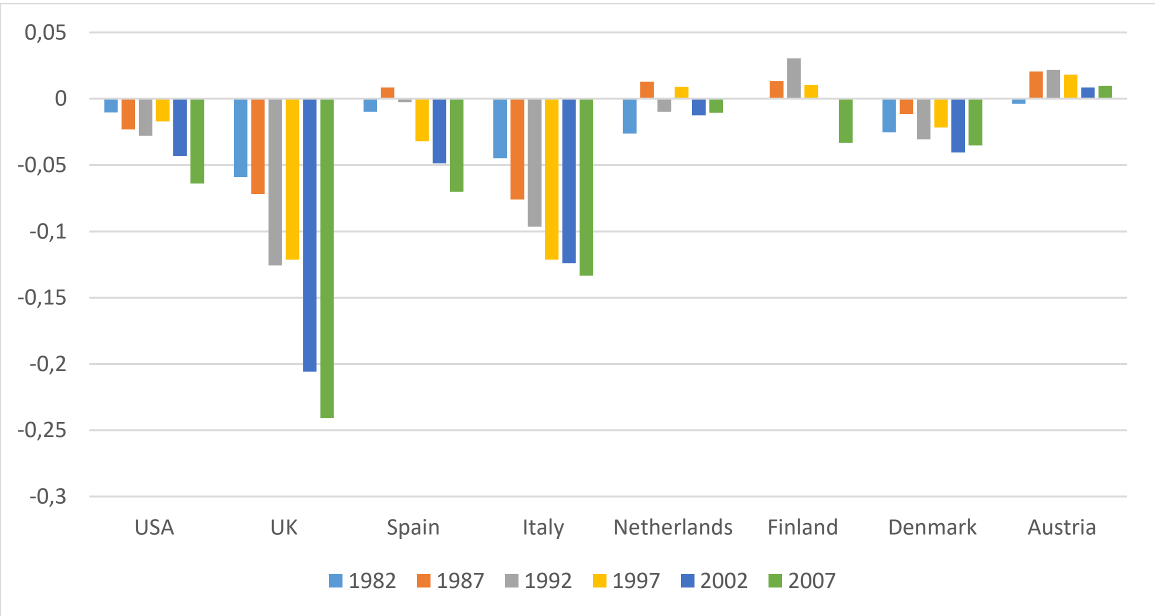
Source: own elaboration based on EU KLEMS and WORLD KLEMS.

Figure 5. Asymptotic impact of the counterfactual structural change in percentage points (selected years).



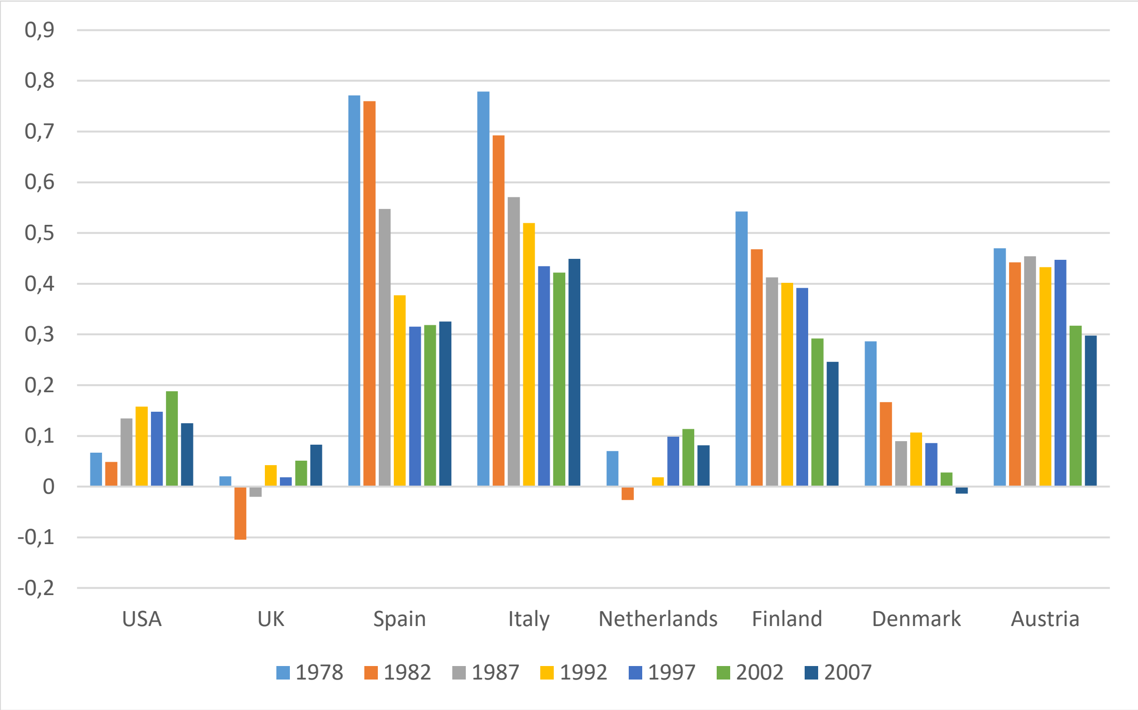
Source: own elaboration based on EU KLEMS and WORLD KLEMS.

Figure 6. Asymptotic impact of ‘Kaldor-Baumol’s growth disease’ in percentage points (selected years).



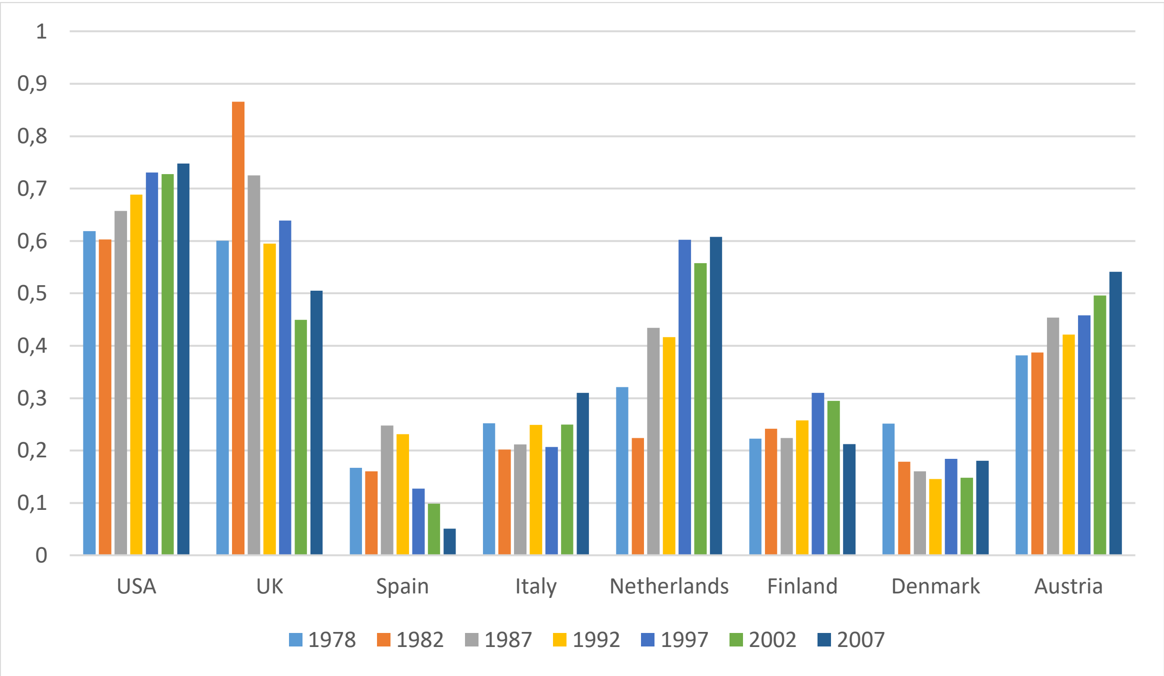
Source: own elaboration based on EU KLEMS and WORLD KLEMS.

Figure 7. Asymptotic impact of the counterfactual Denison effect in percentage points (selected years).



Source: own elaboration based on EU KLEMS and WORLD KLEMS.

Figure 8. Asymptotic evolution of the bonus for productivity growth on the counterfactual structural change scenario with respect to the observed structural change for selected years (in percentage points).



Source: own elaboration based on EU KLEMS and WORLD KLEMS.

Table 3. Decomposition of the asymptotic growth of aggregate labour productivity on the observed structural change and the counterfactual structural change scenarios for the end-year (2007, in percentage points).

	USA	UK	Spain	Italy	Netherlands	Finland	Denmark	Austria
$\Delta\ln(LP)_{CF_{ASYMP}}$	1.9	2.4	1.1	1.0	1.8	2.8	1.8	2.3
Within effect	2.0	2.9	1.4	1.3	1.7	2.7	1.5	2.2
Asymptotic structural change effect	0.0	-0.5	-0.3	-0.3	0.0	0.2	0.4	0.2
RSE_{CF}	0.2	0.2	0.1	0.2	0.1	0.1	0.1	0.2
Asymptotic BGD	-0.3	-0.5	-0.7	-0.8	-0.2	-0.1	0.3	-0.3
Asymptotic KBGD	-0.1	-0.2	-0.1	-0.1	0.0	0.0	0.0	0.0
Asymptotic DE_{CF}	0.1	0.1	0.3	0.4	0.1	0.2	0.0	0.3
$\Delta\ln(LP)_{ASYMP}$	1.2	1.9	1.0	0.7	1.2	2.6	1.7	1.8
Within effect	2.0	2.9	1.4	1.3	1.7	2.7	1.5	2.2
Asymptotic structural change effect	-0.8	-1.0	-0.4	-0.6	-0.6	-0.1	0.2	-0.4
RSE	-0.3	-0.4	-0.1	-0.1	-0.2	0.0	-0.1	0.0
Asymptotic BGD	-0.3	-0.5	-0.7	-0.8	-0.2	-0.1	0.3	-0.3
Asymptotic DE	-0.2	-0.1	0.4	0.3	-0.2	0.1	0.0	-0.1

Source: own elaboration based on EU KLEMS and WORLD KLEMS.