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FULL ARTICLE

Beyond productivity slowdown: Quality, pricing and resource reallocation in regional competitiveness

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Abstract

Labour productivity change at constant prices is the mainstream indicator of regional competitiveness. However, it hides and overlooks some relevant sources of competitiveness that may partly explain the Solow paradox. First, it mixes productivity improvements from technological progress with those from relocating activities to more productive sectors. Second, it partially overlooks novelties and qualities embedded in new products and the effects of market power. This paper proposes a methodology to disentangle the different effects and to apply it to recent development of European regions. Results highlight the highly heterogeneous competitive strategies of regions, and the persistent discrepancy between Eastern and Western ones.

KEYWORDS

European regions, labour productivity growth, regional competitiveness

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1 | INTRODUCTION

More than thirty years ago, Robert Solow conceptualized for the first time what is known now as the "productivity paradox" (Solow, 1987). This idea refers to the puzzling evidence according to which labour productivity in the

United States slowed down from the 1970s on, in spite of the rapid technological change and widespread diffusion of information technology (IT). Some decades after, the paradox is still far from being resolved. Rather, the further progress of automation technologies and the outset of unprecedented possibilities of integration between artificial and human intelligence did not match a parallel increase in productivity (Brynjolfsson & McAfee, 2014).

While the debate on the paradox originated in the United States, it fully applies to the European Union (EU) where, in the last fifty years, productivity grew at an average rate even lower than the one of other advanced world economies. In EU15 countries, labour productivity growth declined from an average yearly rate of 2.4% over the period 1973–1995 to 1.5% between 1995 and 2006 (van Ark et al., 2008). More recently, after the generalized slowdown unleashed by the economic crisis, this decline continued, and labour productivity in EU15 countries grew at a modest 0.71% average yearly rate between 2013 and 2018. From a regional perspective the evidence is even more puzzling, with increasing disparities in regional labour productivity within the EU, broadened in the last two decades (Gómez-Tello et al., 2020).

The literature already suggested several explanations to this finding, pointing in general to the excessive expectations about the ICTs' impact on productivity, as a consequence of the concentration of the benefits of the new technologies in a relatively small fraction of the economy; the time-lag between the rise of a new technology and its widespread and effective implementation into production processes; and finally to measurement issues (Acemoglu et al., 2014; Brynjolfsson et al., 2017; Byrne et al., 2016; Cuadrado-Roura, 2020; Kim & McCann, 2020; Syverson, 2017).

The present paper enters this debate by reflecting on two aspects. The first relates to Aghion et al.'s (2019) theorem stating that the usual statistical treatment of productivity growth at constant prices overstates inflation and assigns a too limited increase in real output reached through product novelty and quality. The paper proposes to resort to a less "manipulated" indicator given by the value added at current prices, supplying information on relative price trends on different sectors, mirroring their capacity to sell at increasing prices: this pricing capacity residing in a faster product innovation, superior and increasing product quality or in other marketing and delivery capabilities in monopolistic-competitive markets. This reasoning was already suggested by some authors (Acemoglu et al., 2014; Denison, 1967).

The identification of such missing element in GDP is rather crucial at the regional level. When erroneously attributed to inflation, this element hides important market powers, spatially localized (e.g. in large metro-regions), provoking heavy inter-regional redistributive effects. In fact, the relevant advantage of some areas, selling goods and services at favourable terms-of-trade in inter-regional exchanges is not captured, generating a misperception about the relative growth trends and the degree of competitiveness of the single areas. Moreover, statistical offices, at least in the EU, do not compute specific regional price deflators and use national sectoral deflators, missing the effects of inter-regional differences in product innovation capabilities, product differentiation and market power. Third, a specific specialization in highly dynamic sectors, with price/quality increases and high Schumpeterian profits would be overlooked by productivity statistics, with a major effect at the regional level, given that regions are much more specialized than countries. Fourth, different regions sell at different prices similar goods due to the presence of specific location costs, namely, land and building rents. Rents represent both production costs and incomes, and, in particular regions like metropolitan ones, when they are passed on to prices, they generate an advantage that should be highlighted in inter-regional income distribution (Camagni, 2020).

For these reasons, the quality/monopolistic competitive effect on prices needs to be (partially) re-introduced in regional productivity growth analyses: the value added of this paper is to propose a measurement for this effect.

Moreover, the paper suggests that aggregate productivity gains associated to technological progress contain in reality a hidden element, namely inter-sectoral "reallocation of resources" following some suggestions already present in the prewar and afterwar studies on the "sources of economic growth" (Denison, 1962, 1967; Fabricant, 1942), transposed into a formalized shift-share model on productivity growth starting from 1980 (Camagni, 1980; Camagni & Cappellin, 1985; Ledebur & Moomaw, 1983). This same modelling idea was widely replicated thereafter, and is very popular nowadays (Bernard & Jones, 1996; Caselli & Tenreyro, 2006; Enflo & Rosés, 2015; McMillan & Rodrik, 2011; Paci & Pigliaru, 1998). The distinction between pure technological progress taking place inside industry and productivity increases through sectoral shifts towards higher value added sectors reveals two completely different competitive trajectories. This is even more true at the regional level, where such a hidden element registers a high heterogeneity: it can be in fact particularly high in less developed regions, since they generally go through a rapid structural change accompanying the early phases of industrialization, with massive reallocation from agriculture to manufacturing.

All the previous reflections are of paramount importance today, when we are confronted with the difficult predictions of the effects of the 4.0 technological revolution (Capello & Lenzi, 2021; Rullani & Rullani, 2018).

The paper proposes methodologies to disentangle the hidden element and to identify the overlooked one (Section 2), providing the appropriate statistical formula for their measurement (Section 3). In the case of the overlooked element (the pricing effect linked to quality and/or monopolistic power), the empirical approach is an original one. In the case of the hidden element (the reallocation effect), a well-known decomposition method is applied, and the novelty resides in its application not just to the traditional increase in real output *per capita*, but also to the proposed pricing effect (quality/monopoly effect) with the necessary adjustments in the formula. Then, the paper applies the methodologies to European regional data, so as to build an original taxonomy of regional development patterns through the different sources of regional competitiveness. Interesting results do emerge (Section 4).

2 | PRODUCTIVITY GROWTH ANALYSIS: BEYOND THE STATE OF THE ART

2.1 | The hidden element: the sectoral reallocation effect

Productivity growth has been the topic of an extensive literature.[1] Traditionally, productivity growth analysis aimed at measuring the increase of output produced by different geographical units (countries, regions, firms, etc.) separating the contribution of the growth of single production factors, alone and in conjunction with each other, from that of external factors, called "technological progress" (Solow, 1957).

The regional production function generally takes the form of a Cobb–Douglas:

$$Q_r = A_r {K_r}^{\alpha} {L_r}^{(1-\alpha)}, \tag{1}$$

where r stands for the region, Q is the total value added, K and L are respectively capital and labour, whose returns (output elasticities) are equal to α and (1-α) under the assumption of constant returns to scale. The term A represents technical progress, a multiplier showing the capability of the region of transforming inputs into output. Dividing the two members by L and taking the time derivative in log terms we get the growth rate of labour productivity:

$$ln\frac{Q_r}{L_r} = lnA_r + \alpha ln\left(\frac{K_r}{L_r}\right). \tag{2}$$

Technical progress (also called total factor productivity) was empirically proved to be by far the most important determinant of efficiency gains, particularly with respect to the increase in capital intensity of production processes (the second term of the right hand side).

In the last decades, since 1980–1990, the analysis of productivity growth at the country and regional level pointed to the paradoxical result that, in spite of unprecedented technological developments, productivity gains were relatively low. While we are still far from the full explanation of what has been labelled as the "productivity paradox" (Solow, 1987), previous studies summarized some of the elements that contributed to this unexpected empirical finding. These elements refer to the time-lag between the emergence of new technologies and their application into production processes (David, 1990), to the relatively narrow field of application of new technologies (Triplett, 1999), to the rather poor performance of ICT-using sectors in Europe compared with other advanced economies (Dahl et al., 2011; Van Ark et al., 2008), and to the limitations of national accounting statistics (Aghion et al., 2019; Moulton, 2000).

[1]For a comprehensive discussion on the topic see Del Gatto et al. (2011).

Without neglecting the importance of the abovementioned factors, this paper aims at presenting a new perspective on the issue of *regional labour productivity growth*, strictly related to its measurement: in particular, to the traditional measurement of increases in real output, namely the increase in value added at constant prices. As mentioned in the introductory section, the main idea in this work is that measures of labour productivity growth contain, on the one hand, hidden elements that have to be explicitly recognized, and, on the other, overlook other important sources of regional competitiveness.

The hidden element is the *reallocation effect*. Aggregate productivity growth (at constant prices), in fact, can increase even in the absence of any technological progress inside each single sector, when regions simply register a shift of employment from less to more productive sectors. The problem is witnessed by the fact that there is a difference between average productivity increases measured through *aggregate* data and the weighted productivity increases *by sectors* (Camagni, 1980):

$$\Delta Y = \frac{\Delta Q}{\Delta L} \neq \sum_{i=1}^{N} \frac{\Delta Q_i}{\Delta L_i} \theta_i = \sum_{i=1}^{N} \Delta y_i \theta_i, \tag{3}$$

where ΔY is the increase in aggregate regional labour productivity (at constant prices) and Δy_i the productivity increase of each sector *i*.

Given the fact that sectoral weights θ_i are defined by the *initial* sectoral structure of the economy, the last term—which is the most appropriate to interpret technical change *stricto* sensu, as it applies to single productions—does not consider the effect of shifts in the sectoral structure of the economy. A redistribution of employment in more or less advanced productive sectors has an effect on the regional aggregate productivity growth.[2,3]

The result reached by Solow (1957) using an aggregate production function included the strong reallocation effects from agriculture, typical of those years. This fact can partly explain his paradoxical results of a relevant productivity increase with respect to later analyses. In a subsequent work (Solow, 1987), he turned to sectoral analyses. In this case, sectoral reallocation is by definition excluded.

The effect of resource reallocation on labour productivity growth was already clearly stated and estimated at least since the works of Denison (1962, 1967): in his growth accounting exercise, he added *ad hoc* procedures to "squeeze down the residual" found by Solow (Nelson, 1981), isolating the effects of an "overallocation to agriculture and non-farm self-employment" (Denison, 1967, p. 332).

Subsequently, some pioneering studies proposed methods for the decomposition of labour productivity growth in a shift-share context, in order to set apart the role of its different sources/processes (Camagni, 1980; Camagni & Cappellin, 1985; Ledebur & Moomaw, 1983). The first two studies proposed a shift-share analysis with three effects: the usual differential, sectoral competitive effect (nowadays generally called "within-sector productivity growth"); a MIX effect, indicating a higher (lower) initial share of sectors with a relatively high (low) productivity growth (today called "static shift effect") and a reallocation effect showing an increasing share of high and increasing productivity sectors (today called "dynamic shift effect"). In the same years, Ledebur and Moomaw (1983) proposed a slightly more complex model with the same components, disentangling, inside the reallocation effect a high concentration from an increasing concentration of high-productivity industries capturing an increasing share of national employment.

In subsequent years, the method consolidated with minor adjustments (Caselli & Tenreyro, 2006; Enflo & Rosés, 2015; Paci & Pigliaru, 1998).[4] The most relevant adjustment refers to the use of absolute rates of change

[2]The difference is not the MIX effect of the Shift-Share analysis on productivity growth, which stems from the difference of sectoral structure in the *initial year* in the region with respect to the country or to another reference region. In fact, in shift-share analysis this MIX effect persists, together with the differential effect (sectoral growth with respect to the reference) and the reallocation effect. See Camagni & Cappellin, 1985, Appendix VI. p. 143; Caselli & Tenreyro, 2006, p. 492).

[3]One may question why, in the traditional shift-share analysis on GDP growth, the reallocation effect was not present. The answer is: because its effect merges with the growth of each sector (when weighted by GDP shares). In case of a shift-share analysis on productivity, the right weight is given by employment shares.

[4]One of the most common adjustments concerns the substitution of the initial sectoral employment shares with an average of shares along the time span (usually an average between the initial and the final year). We prefer to stick to the traditional way, in order to keep the full effect of resource shifts inside the reallocation effect.

instead of the relative ones with respect to the aggregate (the national, the EU, etc.), typical of the shift-share analysis (Bernard & Jones, 1996; McMillan & Rodrik, 2011; OECD, 2018). The three effects maintain their meaning: with-sectors, static shift and dynamic shift effects (OECD, 2018). This absolute growth form is the one utilized in the specification of the present paper (Section 3).

The reallocation phenomenon is likely to be more significant in developing and transition economies, for instance with massive reallocation from agriculture to manufacturing. Between 2000 and 2017, 8.9% of total employment in the Eastern countries that joined the EU since 2004 moved away from the agriculture towards more productive sectors.

The early empirical analysis for the European Commission already quoted (Camagni & Cappellin, 1985) found—for the countries in which a sufficient sectoral breakdown of productivity was available, namely Italy and France—that a reallocation effect from agriculture and commerce towards industry in the period 1970–1978 was strong in many "follower" and catching-up regions, often stronger that the "differential" or "competitive" effect in single sectors. A similar positive reallocation effect was present also, more rarely, in some advanced regions, particularly in Ile-de-France, moving in the direction of advanced industrial and service sectors.

Paci and Pigliaru (1998) showed how, between 1980 and 1990, workforce reallocation explained a large part of the convergence of the relatively less productive southern European regions towards the EU average. This effect seemed to slow down in the subsequent years, and Martino (2015) demonstrated that in the period from 1990 to 2007 the contribution of employment shifts to labour productivity growth in the EU was generally negative, with the exclusion of eastern transition regions. The weak effect of workforce sectoral change on labour productivity is consistent with the findings of Fotopoulos (2008) and Fiaschi and Lavezzi (2007), both focused on EU15 regions in the two decades after 1980. In the same vein, in their city-level analysis on UK, Martin et al. (2018) argued that the employment shifts from manufacturing to services had a negative effect on labour productivity.

2.2 | The overlooked pricing element: the quality/monopolistic competitive effect

Economic systems do not compete just on their technical efficiency in producing a given quantity of standardized output, but also on the quality of what they produce (Moulton, 2000; Van Biesebroeck, 2003). Not just product innovation, but also horizontal differentiation represents an important way to enhance regional competitiveness, generating a localized temporary monopoly power and allowing firms to increase the price of their output, also in those sectors typically characterized by low productivity growth (Libery & Kneafsey, 1998). Many studies, for instance, showed how, without any technological improvement, the agricultural sector was able in some regions to increase the price of the local products thanks to institutional innovation such as designations of origin and other strategies of product differentiation (Macedo et al., 2020).

Enhancing regional competitiveness through price discrimination and quality improvements becomes particularly important in a context characterized by an overwhelming development and implementation of 4.0 technologies, as:

- new technologies increase production flexibility, enabling companies to multiply product and variety at zero marginal costs (Brooke, 1991);
- automation in the context of the 4th industrial revolution, increasingly allows for the production of 'mass customized' products (Fogliatto et al., 2012); and
- the disproportionate increase of market size at zero marginal costs for the same service, through multiplication of virtual users leads to huge increases in labour productivity and consequently remunerations (Capello & Lenzi, 2021; Rullani & Rullani, 2018).

Value added at constant prices for constant quality products or for carefully monitored increases in quality reflects well the real expansion of volumes of these products on time. But when new products appear the usual statistical treatment overstates inflation and assigns a too limited increase in real output reached through product quality; this last point, according to Aghion et al. (2019), represents from one-quarter to one-third of total real productivity growth.

Such price increase can be the result of an increase in quality, or a monopolistic competitive behaviour or the synergies of the two: a monopolistic competitive behaviour can in fact stimulate quality increases, as well as a novelty in the product may lead to monopolistic competitive behaviours. Independently from which of the two causes prevails, the result is that growth is mis-measured. This is what we call a "quality/monopolistic competitive effect," which needs to be (partially) reintroduced in productivity growth analyses.

Our proposal concerning such measurement is the following. We consider the already analysed productivity increases at constant prices ΔY as encompassing normal, "business as usual" quality increases in existing products and add a second component, namely the sectoral differential increases in prices with respect to the national average inflation rate, to be intended as the expression of the "quality/monopolistic competitive effect" of new products, in line with Acemoglu et al. (2014).[5]

Isolating this component allows us to identify those regions that were able to sell their output at increasing prices thanks to a monopoly power created by novelty/quality/differentiation of products appreciated by the market. If regional sectoral deflators were available, there would be a more precise and direct way to measure the "quality/monopolistic competitive" effect. Unfortunately, this is not the case, since only national sectoral deflators are available, imposing their use at regional level through the regional sectoral specialization. The consequences of this is that we can only capture "quality/monopolistic competitive" effect through the presence of a favourable mix of sectors in regions and not through a specific sectoral regional price variation.[6]

Measured in this way, the "quality" effect may mirror other mechanisms leading to an increase in prices that have nothing to do with quality increases or monopoly power. In particular, it may capture increases in cost of inputs, that may characterize either general resources, largely used across sectors, like oil and natural resources, or specific intermediate inputs used only in specific economic activities. In the former case, the effect on the differential increases in prices across sectors is expected to be limited, as the shock in the market of input spreads to the whole economy. In the latter case, instead, the sectoral difference in intermediate cost increases would raise a concern in empirical analyses on specific products or well specified sectors. In our case, due to data limitations, the manufacturing sector is analysed at a rather aggregate level, and we do not register input–output exchange. Furthermore, our analysis shows that the sectors driving the regional quality /monopolistic competitive effect are mostly services, whose use of intermediate inputs is relatively small. However, as a robustness check for our assumptions explained so far, we analysed the trend in oil and gas process over the period of analysis: its negative trend guarantees that our "quality/monopolistic competitive price" index is not influenced by pervasive energy price increases (Appendix A, Table A1).

Moreover, a further source of relevant price changes may be a shock on the demand-side of the economy.[7] While we are not able to empirically separate these demand-side effects from the supply-side ones, we claim that the period under analysis is long enough to avoid the facts of demand volatility and to restore demand–supply equilibrium (in absence of major shocks like the ones determined by the recent pandemic or the war in Ukraine).[8]

For these reasons, we think that the difference between a sectoral price change and the national inflation rate is valuable enough to capture a pricing effect linked to quality increase or other forms of market power. The aggregate regional "quality/monopolistic competitive effect" emerges as the sum of the contributions of all sectors, weighted

[5]In their paper, Acemoglu et al. (2014) claim that "If IT-intensive industries have upgraded their quality relative to other industries and *this is not fully captured by the industry price deflators*, this mismeasurement could explain the decline in real shipments" (p. 397) (Italics added). The same authors add that, in case evidence suggests also a "decline in nominal shipments" the Solow's conclusion about a persistent slowdown would be confirmed.

[6]Given the unavailability of regional sectoral deflators, if in a region the sectoral mix were equal to the national one, then the aggregate regional Δy^* would be equal to 0.

[7]Studies exist that try to disentangle the different effects at plant level (Ehrl, 2013), not applicable at aggregate level.

[8]Several studies focused on the relationship between productivity, prices and output's quality (Feenstra & Romalis, 2014). The use of prices as a proxy of quality is especially troublesome at the firm-level, because of the potential endogeneity with productivity (see Ehrl, 2013, for a discussion on the topic). In order to unambiguously account for changes in output's quality, national statistical institutes rely more and more on analysis at the product-level, making use of scanner-data (Argente et al., 2020; Silver & Heravi, 2001). While these methods provide effective instruments for capturing variations of output's quality at a micro-level, our approach is aimed at measuring their aggregate effect at the regional level.

by their relative importance and stems from the difference in the sectoral mix in each region compared with the one of the country. The availability of regional-sector deflators would improve substantially this analysis. Nevertheless, it is a wellknown fact that the most relevant difference in performance of different regions (e.g., between a global city-region and a small-city region) resides in the sectoral mix (defined at sufficiently detailed level) due to selective attraction/development of more advanced activities (the ones that are likely to introduce innovation and quality in products) and "sorting processes" of best workers (Combes et al., 2008, 2012).

Given the high diversification of territorial structures, a regional analysis is able to reveal the importance of the pricing/quality mechanism as a major factor of income production, income distribution and income transfer across space, uncovering the limitations of analyses made on pure volumes or physical measures. Overlooking the role of price changes, unequal terms-of-trade among regions and market powers—which nowadays are solidly built on continuous innovation, high efficiency and no more on direct coercion or prince's decision—means neglecting the generation of huge real effects across territories, regions and countries (Camagni, 2020).

Once the "quality/monopolistic competitive effect" is measured at the sectoral level by price increases, we decompose it between a "pure quality/monopolistic competitive effect" and a "sectoral reallocation effect towards high quality/monopolistic competitive sectors," able to sell their output at increasing prices. This type of reallocation represents a highly selective strategy, which could be implemented by already developed regions whose marginal gains from purely technological advances are relatively limited.

3 | METHODOLOGY FOR DISENTANGLING THE SOURCES OF REGIONAL COMPETITIVENESS

According to the conceptual basis illustrated before, an appropriate indicator of overall regional productivity growth can be represented by the increase of labour productivity measured at *current* prices corrected for an average inflation rate (ΔY_{tot}). This indicator encompasses four distinct statistical effects, that refer to four sources of economic competitiveness and success. First of all, inside the aggregate productivity growth at constant prices (ΔY), it should highlight the usually hidden element represented by the *reallocation effect* towards more productive sectors, to keep separate from *technological progress stricto sensu* happening inside *sectors* (ΔY_s) (Camagni, 1980). Second, and specularly, it should provide an appropriate measure of product quality increases, distinguishing, as in the previous case, *the pricing effect of product quality stricto sensu* and a *dynamic reallocation process* towards high quality/monopolistic-competitive sectors, able to sell at increasing prices. Summarizing, we define:

$$\Delta Y_{tot} = \Delta Y_{cur} - d_{agg} = \Delta Y + \Delta Y^*, \tag{4}$$

where: ΔY_{tot} is the aggregate regional productivity growth at current prices (ΔY_{cur}), corrected for the average inflation rate (d_{agg}); ΔY is the aggregate regional productivity growth in real terms (volumes, at constant prices); ΔY^* is the aggregate regional growth of prices corrected for a national inflation, which represents the aggregate "quality/monopolistic-competitive effect."

The decomposition of the two aggregate productivity growth elements (volumes and prices) follows:

$$\Delta Y = \underbrace{\Delta Y_s}_{\substack{\textit{Technological}\\ \textit{progress stricto}\\ \textit{sensu, sectoral}}} + \underbrace{Reallocation}_{\substack{\textit{Sectoral reallocation}\\ \textit{towards more/less}\\ \textit{productive sectors}}} \tag{5}$$

$$\Delta Y^* = \underbrace{\Delta Y_s^*}_{\substack{\textit{Quality /} \\ \textit{monopolistic} \\ \textit{competitive effect''} \\ \textit{stricto sensu,} \\ \textit{sectoral}}} + \underbrace{Reallocation^*}_{\substack{\textit{Sectoral reallocation} \\ \textit{towards high quality/} \\ \textit{monopolistic} \\ \textit{competitive sectors}}} \tag{6}$$

where *s* denotes summation over all sectors.

In order to separate technological progress *stricto* sensu from sectoral reallocation, we apply the methodology proposed by McMillan and Rodrik (2011), where absolute regional growth substitutes for relative growth with respect to a benchmark, typical of the shift-share analysis. Overall, regional labour productivity growth (at constant prices) is decomposed as follows[9]:

$$\Delta Y = \underbrace{\sum_{i=1}^{N} \theta_{i,\,t0} \Delta y_i}_{\substack{\textit{Technological} \\ \textit{progress stricto} \\ \textit{sensu, sectoral}}} + \underbrace{\sum_{i=1}^{N} \Delta \theta_i y_{i,t1}}_{\substack{\textit{Sectoral reallocation} \\ \textit{towards more/less} \\ \textit{productive sectors}}} \tag{7}$$

Δy_i in Equation (7) and Δy_i^* in Equation (8) are respectively productivity growth and prices growth at the sectoral level.

The Δ operator denotes the percentage change in employment or productivity between t_0 and t_1. *Technological progress stricto sensu* is captured by the increase of labour productivity of all sectors (Δy_i) weighted by the regional sectoral share of employment at time t_0 ($\theta_{i,t0}$), implicitly imposing no sectoral reallocation in the period of analysis. *Sectoral reallocation towards more (or less) productive sectors* is, in its turn, measured by the shift of the sectoral share of employment ($\Delta\theta_i$) assigning to it the sectoral productivity at the end of the period ($y_{i,t1}$).[10]

The other major source of regional competitiveness concerns the output quality improvement. As said before, an approach based on value added at sector-specific constant prices partially overlooks quality measurement, especially for that part that belongs to the introduction of new products, for which statistical offices have little reference to previous virtual prices.[11]

The rationale (Section 2) is to consider the productivity increases at constant prices ΔY as encompassing normal, "business as usual" quality increases in existing products; to add sectoral increases in prices as a measure of the "quality/monopolistic competitive effect" *stricto sensu* embedded in new or strongly improved products; to remove from this pricing effect the average inflation rate, encompassing different pure monetary effects (cost inflation, demand inflation, quantitative easing monetary policies, exogenous shocks) with no logical link with quality improvement.

In empirical terms, we apply the difference between the sectoral deflator ($d_{i,t1}$) (indicating the sectoral price index numbers in the final year for sectors *i* with respect to the initial year at the national level) and the aggregate national deflator (d_{agg} for the same interval). The formula for the "quality/monopolistic competitive effect" for the generical sector *i* then reads as follows:

[9]This methodology was followed recently by OECD (2018), where the decomposition was in the three usual effects, namely "within-sectors productivity growth", "static shift effect" and "dynamic shift effect". Here the last two factors are combined in a single reallocation indicator, as "the sum of the two effects is often used as a measure of the overall resource allocation process in the economy" (OECD, 2018, p.28).

[10]We are aware that this analysis does not allow shedding light on the specific mechanisms through which productivity gains are achieved. In the literature focused on the firm-level, for instance, alternative decomposition allows for separating the role of incumbent and new-comers in increasing productivity within a certain sector (see for instance Haltiwanger et al., 2001). However, while these approaches make explicit these within-sector mechanisms, they do not allow for the measurement of the across-sector effects, which are fundamental for our analysis since they are the determinants of very different regional competitiveness patterns, as it will be explained with more details in section 4.

[11]When improved products are sold at higher prices, much of this difference due to improved quality is assigned to inflation by statistical offices, thus reducing 'real' development. Our method allows to counterbalance this inaccuracy. When a completely new product is offered, often at lower prices with respect to existing alternatives (negative inflation), statistical offices assign the same inflation rate of incumbent producers in the same sectors; in this case the underestimation of output growth is even higher (Aghion et al., 2019) but our method cannot make up for this.

$$\Delta y_i^* = \left(d_{i,t1/0} - d_{agg,t1/0}\right). \quad (8)$$

The difference between a sectoral price change and the national aggregate one is intended as the quality increase contribution of each sector (Δy_i^*) to aggregate "quality/monopolistic competitive effect" (ΔY_s^*) in productivity increase.

Empirically, this regional "quality / monopolistic competitive effect" is expected to register a significant regional variance. Urbanized regions, for example, are generally able to impose higher prices, since: (i) they supply higher functions; (ii) their sectoral mix favours sectors selling at higher and increasing prices with respect to rural or small city regions; and (iii) they register higher prices because they contain high urban rents, and not merely production costs.[12] Such an expectation is empirically proved with an analysis of variance (ANOVA) witnessing a higher quality/monopolistic competitive effect in urban (capital city) regions with respect to other regions, as reported in Appendix A, Table A2.

When applied in European countries, the "quality/monopolistic competitive effect" in terms of prices is found in almost all countries in tertiary sectors such as professional, technical and research activities, public administration and health, arts, entertainment and recreation, which are those in which, with a different methodology, Aghion et al. (2019) found "creative destruction," product innovation and the maximum "missing growth."

Specularly to the preceding case of technological progress, the weighted sum of the sectoral contributions with the shares in the initial year (ΔY_s^*) hides a second element inside the aggregate quality increase indicator (ΔY^*): a sectoral reallocation effect towards high quality/ monopolistic-competitive sectors in which quality/monopolistic competitive effects are higher. In order to separate the two effects, we applied a similar decomposition method as in Equation (7):

$$\Delta Y^* = \underbrace{\sum_{i=1}^{N} \theta_{i,t0} \Delta y_i^*}_{\substack{\text{Quality / monopolistic} \\ \text{competitive effect} \\ \text{stricto sensu, sectoral}}} + \underbrace{\sum_{i=1}^{N} \Delta\theta_i y_{i,t1}^*}_{\substack{\text{Reallocation towards} \\ \text{high quality/ monopolistic-competitive} \\ \text{sectors}}} \quad (9)$$

The first term of Equation (9) measures the *quality/monopolistic competitive effect stricto sensu*. It occurs when in the region one finds a combination of sectors (θ_i) able to sell at superior prices with respect to the national average (Δy_i^*). The second term is the *reallocation effect towards high quality/monopolistic competitive sectors*, measured by the shift of workforce ($\Delta\theta_i$) towards those sectors that increased more than the others the price of their output during the analysed period ($y_{i,t1}^*$).

For the second term, the reallocation one, we use here an expression that underlines the similarity with Equation (7). In fact, though, due to the nature of the deflator y_i^*—a sectoral price index number—the two terms Δy_i^* *and* $y_{i,t1}^*$ are equal, showing the increase in prices of sector *i* in the time interval (net of aggregate inflation). Accepting this equality and collecting the common factor one gets from Equations (9) and (8):

$$\Delta Y^* = \sum_{i=1}^{N} d_{i,t1} \left(\theta_{i,t0} + \Delta\theta_i\right) - d_{agg} = \sum_{i=1}^{N} d_{i,t1} . \theta_{i,t1} - d_{agg} \quad (10)$$

[12]Such effects would be more correctly measured if deflators were differentiated across sectors *and* regions. Unfortunately, statistical offices do not provide these regionalized data. Our methodology maintains, however, its logical and theoretical meaning: in fact, the indicator used represents a multiplication between a sectoral price index – national – and a regional sectoral share, something that makes the indicator at least partially region-specific. In addition, we would dear to claim that this regional/place-specificity of our indicator is likely to represent the widest share of the real pricing/quality effect: taking the example of internationalized consultancy services, the most important gains for large metro areas result from the huge share of these services with respect to smaller peripheral areas rather than in a difference of prices for the same quality of services (a mix effect rather than a differential effect, in the logic of a shift-share analysis).

a result which drives to two relevant conclusions: (i) as said before, ΔY^* is the aggregate regional growth of prices corrected for national inflation, and (ii) consequently, Equation (10) is in fact an identity (similarly to Equation (7), demonstrated by the entire quoted literature on the reallocation effect).[13] Such identity on the pricing effect was confirmed by the empirical results.

As in the case of productivity growth at constant prices, also in this case the hidden reallocation effect emerges comparing the results obtained working on aggregate figures with those achieved aggregating sectoral figures.

4 | A TAXONOMY OF REGIONAL COMPETITIVENESS PATTERNS

4.1 | Conceptual approach

Our interest in disentangling the different sources of labour productivity growth discussed in the previous section relies on the fact that each of these dimensions and their combinations theoretically depict different modes on which competitiveness relies.

Within an abstract/theoretical approach, at least five different modes of competitiveness can be highlighted, namely:

1. *technological progress stricto sensu*, visible at sectoral level, particularly thanks to the 4.0 technological revolution (Brynjolfsson & McAfee, 2014; Capello & Lenzi, 2021; Schwab, 2016), measured by the first term of Equation (7);
2. *reallocation towards higher-value added sectors* (Camagni & Cappellin, 1985; Esteban, 2000), measured by the second term of Equation (7);
3. *output quality stricto sensu/market power*, driven by the capability of increasing relative prices through either product quality or market power (Camagni, 2020; Saviotti & Pyka, 2013), measured with the first term of Equation (9). These two drivers are somehow similar but also different: quality leads to market power, but market power can exist without quality. Empirical analyses could help us disentangle the two effects;
4. *reallocation towards high quality/monopolistic competitive sectors*, measured by the second term of Equation (9); and
5. *price competitiveness*, where regional economies conquer new market share by decreasing the relative price of their output—in a sense, the opposite strategy with respect to the "output quality" one, measured by a negative value of the first term of Equation (9). This situation, in fact, signals regions selling at relatively decreasing, rather than increasing, prices, with the goal of enlarging market share. Product standardization and vertical differentiation are the two factors explaining this pattern (Fagerberg, 1988; McCann, 2020).

Each region could follow a composite strategy, combining two or more sources of competitive advantage in an integrated way; in all cases, there exists a dominant, statistically more significant source, which assigns the region to a specific pattern.

The implementation of the indicators previously mentioned for the European regions allows to empirically identify in a map where the different regional competitiveness strategies take place (with the caveat just mentioned). Before presenting the results, data applied for the analysis are presented in the next sub-section.

4.2 | The sources of regional competitiveness in EU regions: data

We created a database for 271 NUTS 2 regions from EU27 countries plus UK, with the exclusion of Ireland and Malta, for which data are missing. For each region, we collected information on both value added at current prices

[13]More details on this are provided in Appendix B.

TABLE 1 Number of regions included in each of the groups

	Reallocation towards more monopolistic-competitive sectors	
	Positive	**Negative**
Reallocation towards higher productivity sectors		
Positive	38 (13)	60 (22)
Negative	79 (8)	66 (14)

Note: Total number of regions by group, of which those in CEEC countries in parenthesis.

and employed persons in 11 sectors.[14] In order to disentangle the two sources of competitiveness associated to technological progress (Equation (3) we applied country- and sectoral-specific deflators provided by the EUKLEMS data repository (Stehrer et al., 2019). These deflators allow tracking over time the change in the price of output in the 11 sectors and for each of the 26 countries included in our analysis. The same source also provides the overall county-level deflator, used to calculate Δy^* in Equation (9).

Our analysis focuses on the period 2013–2017, and we chose 2013 as base year for the deflators. Years antecedent to 2013 were not considered since the economic crisis of 2007 significantly affected our variables of interest, namely, value added and occupation (Mazzola & Pizzuto, 2020). Since our goal consists in identifying regional competitiveness strategies, we aim at minimizing the potential influence of exogenous, macroeconomic factors. However, to verify that the results obtained are not influenced by the choice of the period, the indices of quality/monopolistic competitive effect and technological development have been calculated for the period 2008–2017. A strongly positive and significant correlation exists between the indicators calculated in the two different periods (p-value < 0.001), suggesting that the same results would have been achieved in a different period of time (more details are reported in Table C1, Appendix C).

4.3 | Regional competitiveness patterns in European regions

Regional competitiveness patterns have been detected by grouping regions with the following methodology.[15] European regions were first classified according to the simultaneous presence of positive and/or negative values of the two main sources of competitiveness, using the two indicators of overall technological progress and "quality/monopolistic competitive effect" (i.e., ΔY and ΔY^*). Through this first step, we were able to identify a first group of 28 regions characterized by a negative value in both indicators.

The remaining regions were split according to the two indicators of reallocation, respectively towards higher productivity sectors and towards higher price-increase sectors (mirroring higher quality and/or monopolistic competition). The choice of these two indicators is explained by the relatively small value taken by these two indicators, confining them in ne,gligible roles when analysed and interpreted jointly with the other indicators (i.e., technological progress *stricto sensu* and "quality/monopolistic competition" *stricto sensu*).

Table 1 reports the number of observations included in each of the possible four general groups. These four groups, jointly with the fifth one previously identified, are then compared in terms of productivity growth sources, in

[14]The sectors are (the letters indicated the NACE codes): Agriculture, forestry and fishing (A), B + D-E – Industry, except construction and manufacturing (B + D + E), Manufacturing (C), Construction (F), Wholesale and retail trade, transport, accommodation and food service activities (G-I), Information and communication (J), Financial and insurance activities (K), Real estate activities (L), Professional, scientific and technical activities; administrative and support service activities (M-N), Public administration, defence, education, human health and social work activities (O-Q), Arts, entertainment and recreation; other service activities; activities of household and extra-territorial organizations and bodies (R-U).

[15]A cluster analysis was first applied, but it did not provide any interesting results. The results of the cluster analysis were in fact substantially influenced by the technological progress *stricto* sensu indicator, which assumes much higher values compared to the other indicators, with the consequence that no statistically significant role was played by the other sources of competitiveness.

TABLE 2 Productivity growth indicators (2013-2017): mean values and their significance by group of regions

	Patterns of competitiveness					
Sources of competitiveness	**Technological progress *stricto sensu***	**Reallocation towards higher productivity sectors**	**Quality/ monopolistic competition *stricto sensu***	**Reallocation towards high quality/ monopolistic-competitive sectors**	**Price competitiveness**	**Average**
Technological progress effect	**4.089***	2.408	1.190*	3.996*	-2.200*	2.535
Sectoral reallocation to higher productivity sectors	-1.097*	**1.788***	1.691*	-1.520*	-.808	-.168
Quality/ monopolistic competitive effect *stricto sensu*	.205	.371	**.619***	.316	**-.704***	.258
Reallocation effect towards high quality/ monopolistic competitive sectors	-.095*	.187*	-.148*	**.163***	**-.033**	.015
Number of obs. (CEECs)	*66 (14)*	*38 (13)*	*60 (22)*	*79 (8)*	*28 (2)*	*271 (59)*
Share of regions belonging to the first quartile of the increasing price sector indicator	*18%*	*18%*	*37%*	*28%*	*0*	*100%*

Note: * = t-test significant at p < 0.01. In brackets = number of observations in New Member States. In bold the elements characterizing each of the regional competitiveness patterns. Data represent percentage change of the different indicators.

order to highlight the possible sources of regional competitiveness, and identify the prevailing competitiveness pattern.

Table 2 reports the results of this analysis. It shows the distribution of the four indicators capturing the different sources of competitiveness (i.e., the rows of the table) across the five groups of regions (i.e. the columns of the table) in terms of mean values and their statistical difference with respect to the whole regional sample, whose (*t*-test) significance is reported with an asterisk. The sources of regional competitiveness characterizing each pattern are highlighted in bold.

Starting from the left of Table 2, the first group is characterized by a pure effect of technological progress *stricto sensu*, independent from any kind of sectoral reallocation (indicated with a - in Table 2).

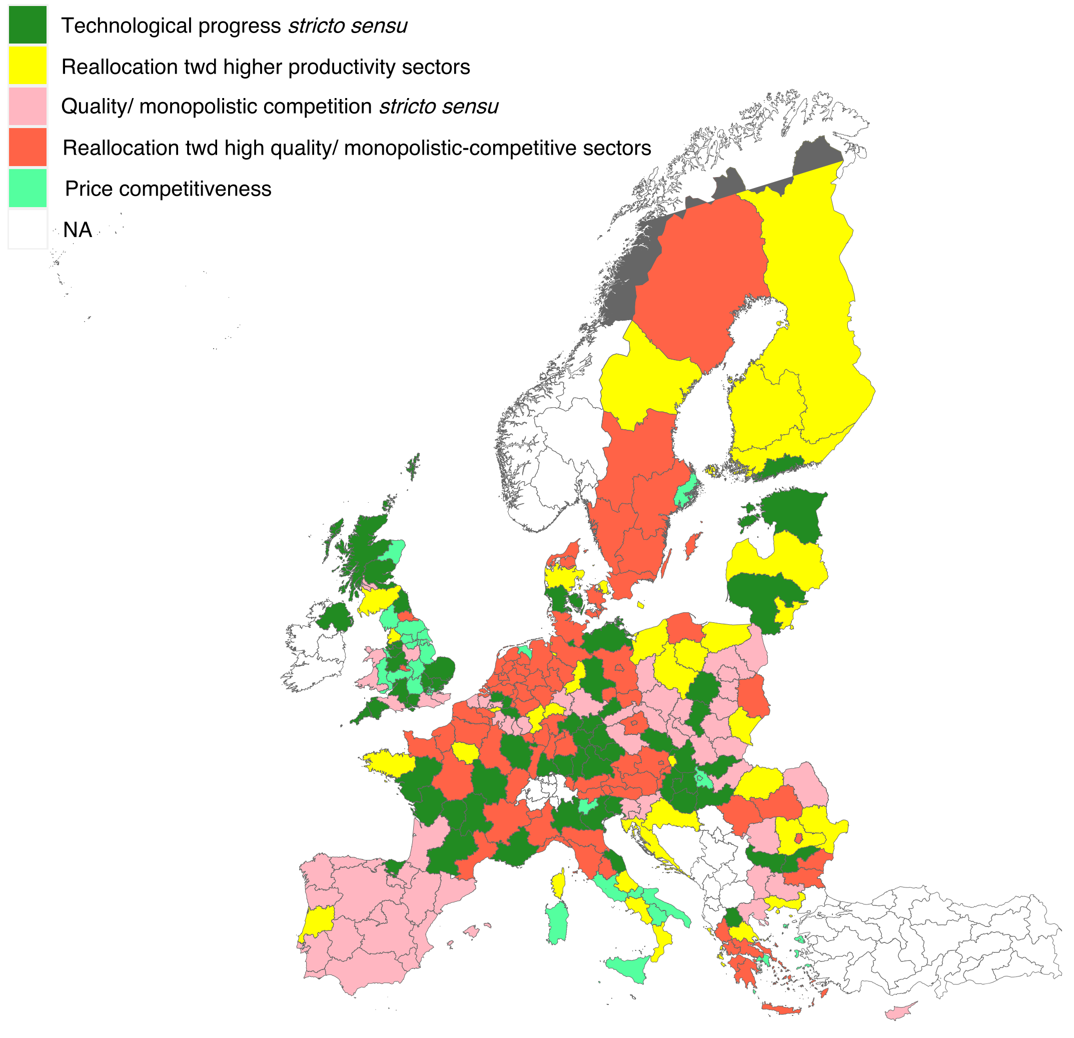

FIGURE 1 Regional competitiveness patterns (2013–2017).

The second group of regions (second column) is characterized by a significantly higher than average reallocation to higher value added sectors, accompanied by a positive, significant but weak pricing reallocation (+ in Table 2) and by a high, even if not significantly higher than average, technological progress. It is therefore assigned to the "reallocation towards higher productivity sectors" pattern.

The third group of regions (third column) is characterized by a positive reallocation towards higher productivity sectors and a negative reallocation towards high quality/ monopolistic competitive sectors, and is the only group with a highly significant and positive score in the quality/monopolistic competitive effect *stricto sensu*. Therefore, it was assigned to the "quality/monopolistic competition *stricto sensu*" pattern, in which the capability of selling at high prices was reached, thanks also to a decisive technological progress.[16]

[16]It is worth noting that, as it is defined, the Quality / monopolistic competition *stricto* sensu effect mediates sectors with positive and negative increases in prices with respect to the national average. In order to be sure that the quality is related to sectors with rising prices, we proceeded by extracting from the quality indicator an indicator equivalent to the weighted sum of only those regional sectors selling at increasing prices. Regions falling in the first quartile of the distribution were then inspected in terms of their presence across the five patterns (last raw of Table 2). Interestingly enough, results are confirmed. First of all, none of such regions fall in the "price competitiveness" pattern; more than two thirds of regions belong either to the "Quality/ monopolistic competition *stricto* sensu" pattern (37%) or to the "reallocation" of the second type ("towards high quality/ monopolistic-competitive sectors" pattern: 28%).

TABLE 3 Leading sectors of different competitiveness patterns by country

	Technological progress *stricto sensu*	Reallocation towards higher productivity sectors	Quality/ monopolistic competition *stricto sensu*	Reallocation towards high quality / monopolistic-competitive sectors	Price competitiveness
Western countries					
AT				Q-Q - Public admin.	
BE	C - Manufacturing	M-N - Professional & scientific activities	G-I - Wholesale and retail trade, transport	O-Q - Public admin.	
DE	C - Manufacturing	L - Real estate	G-I - Wholesale and retail trade, transport	O-Q - Public admin.	
DK	C - Manufacturing	M-N - Professional & scientific activities		K - Finance & insurance	
EL	L - Real estate	G-I - Wholesale and retail trade, transport	C - Manufacturing	G-I - Wholesale and retail trade, transport	L - Real estate
ES	G-I - Wholesale and retail trade, transport		K - Finance & insurance, construction		
FI	C - Manufacturing	L - Real estate			
FR	C - Manufacturing	M-N - Professional & scientific activities	L - Real estate	M-N - Professional & scientific activities	
IT	C - Manufacturing	G-I - Wholesale and retail trade, transport		G-I - Wholesale and retail trade, transport	B-D-E - Energy production sectors
LU			K - Finance & insurance		
NL				M-N - Professional & scientific activities	B-D-E - Energy production sectors
PT		G-I - Wholesale and retail trade, transport	K - Finance & insurance, construction		O-Q - Public admin.
SE	B-D-E - Energy production sectors			O-Q - Public admin.	K - Finance & insurance
UK	G-I - Wholesale and retail trade, transport	L - Real estate	L - Real estate	L - Real estate	M-N - Professional & scientific activities
CEEC countries					
BG	B-D-E - Energy production sectors		C - Manufacturing	C - Manufacturing	

TABLE 3 (Continued)

	Technological progress *stricto sensu*	Reallocation towards higher productivity sectors	Quality/ monopolistic competition *stricto sensu*	Reallocation towards high quality / monopolistic-competitive sectors	Price competitiveness
CY			G-I - Wholesale and retail trade, transport		
CZ	G-I - Wholesale and retail trade, transport		G-I - Wholesale and retail trade, transport	O-Q - Public admin.	
EE	B-D-E - Energy production sectors				
HR		L - Real estate	O-Q - Public admin.		
HU	C - Manufacturing		O-Q - Public admin.		J - Information & Communication
LT	L - Real estate	L - Real estate			
LV		J - Information & Communication			
PL	C - Manufacturing	G-I - Wholesale and retail trade, transport	G-I - Wholesale and retail trade, transport	G-I - Wholesale and retail trade, transport	
RO		G-I - Wholesale and retail trade, transport	O-Q - Public admin.	O-Q - Public admin.	
SI			O-Q - Public admin.		
SK	C - Manufacturing	L - Real estate	O-Q - Public admin.		

The fourth group presents a statistically significant reallocation effect of the second type (towards high quality/monopolistic competitive sectors: fourth column) and a negative reallocation towards high productivity sectors. It is also characterized by a high (and statistically significant) effect of technological progress.

The last column in Table 2 highlights a fifth group of regions characterized by "*price competitiveness*". Empirically, these regions are associated to the significantly lowest and negative value of quality/monopolistic competitive effect *stricto sensu*, which captures the regions that sell at decreasing prices. Due to the way in which the class was defined, as said before, this group presents a negative, statistically significant and much lower than average indicator of technological progress, an element that suggests the double nature of the critical condition of these regions: lack of technological progress and endowment with sectors with low market power.

Figure 1 shows the geographical distribution of the regional competitiveness patterns in the post-crisis period 2013–2017. In order to better interpret the results, the leading sectors of each pattern by country have been identified: this is done by looking, for each pattern, the sector that has the highest score in the productivity growth indicator characterizing the pattern.[17] The results of this elaboration are reported in Table 3.

Technological progress *stricto sensu* is the dominant competitiveness strategy. For a non-negligible number of regions (66), this is the main and only source of productivity gains. However, it also characterizes at least other two groups of regions ("quality/monopolistic competition *stricto sensu*" and "reallocation towards high quality/monopolistic competitive sectors"), emerging as a complementary aspect to other competitiveness sources. It turns out as the main source of competitiveness mainly in many German regions, in regions in Northern Italy, in some French regions like Provence-Alpes-Côte d'Azur and Midi-Pyrenées, in the Helsinki region, in Scotland, East Anglia and Northern Ireland (Figure 1), in all cases thanks to the manufacturing specialization (Table 3). Some regions in Hungary and Slovakia register technological progress, mainly as a result of their participation in the manufacturing global value chains, especially in the automotive sector (Table 3). The pattern is also driven by the energy production sector, both in Western and Central-Eastern countries, which probably reflects investments in green technologies (Table 3).

"Reallocation towards higher productivity sectors" is scattered around Europe, more pronounced in Central and Eastern countries (Figure 1). This part of Europe is still gaining from the very high increase in value added obtained by reallocating employment from agriculture towards other sectors. Our results show that regions in Eastern countries gain competitiveness by shifting their employment towards the wholesale, retail and transport sector, where many Western European foreign direct investments are present, together with the real estate sector (Croatia, see Table 3). This strategy prevails also in some regions located in Southern Italy, Greece and Portugal (Figure 1), mainly driven by the wholesale and retail, accommodation and transport sector (Table 3).

In this part of Europe this large sector probably reflects the high remunerations and profit margins generated by the touristic activities. Interestingly, in France, Denmark and Belgium this pattern is led by the sector of professional and scientific activities, while the ICT service sectors leads in Latvia (Table 3).

By looking at the "quality/monopolistic competition *stricto sensu*" effect, this pattern appears in both Western and Eastern countries. Some Polish and Romanian regions, Spain, some southern regions in the UK, Luxembourg, Portugal and a few German regions grow mostly through quality improvement strategies (Figure 1). The result finds a logic when one looks at the sectors determining it: in Western countries the result is driven by finance and insurance (Madrid and Catalonia in Spain, Luxembourg, Lisbon in Portugal), construction (in many regions in Spain), trade and hotels in Portugal and real estate in southern England (Table 3). In Eastern Europe, on the other hand, the pattern is mostly characterized by the monopoly of public functions and the development of trade services (Table 3). The risk in this case is to interpret increasing wages in public occupations as output quality improvements.

The pattern of "reallocation towards high quality/monopolistic-competitive sectors" encompasses a highly numerous group of regions. It mainly occurs in regions where the increase in employment towards sectors with increasing prices is related with a technological progress component. It is the case for Denmark, with finance, for Lyon, Grenoble, Lille in France, Amsterdam and Rotterdam in the Netherlands, with professional and scientific

[17]If in a country no region joins a particular pattern, no sector is identified.

activities in urbanized regions, for large cities in Germany and Austria (Hannover, Cologne, Dresden, Vienna), with the public administration, where technological progress that accompanies such advantages takes the form of organizational changes (Figure 1 and Table 3). Lastly, this pattern mainly occurs in touristic regions in Italy and Greece where employment is reallocated towards activities related to tourism.

Finally, "price competitiveness" takes place in those sectors with negative values of the "quality/monopolistic competition *stricto sensu*", namely, those sectors selling at decreasing prices. Interestingly enough, regions in this pattern also register a negative value in terms of technological progress. This pattern emerges in the South of Italy and in central and northern England (Figure 1). In Italy this is led by the energy sector, linked probably to the enhanced competition imposed by new institutional rules (Table 3). In the UK, this pattern is driven by professional activities, mainly located in peripheral British regions, where price competitiveness strategy may be dictated by the strong competition of professional activities located in London (Table 3). Lastly, some Greek regions compete on lowering prices in the real estate sector, also as a strategy to increase tourism. Interestingly enough, the only area in new member countries falling in this class is the Budapest metro area in Hungary, exploiting a price competitiveness strategy in the information and communication sector (Table 3): in fact, the area is the location of a high number of software houses, controlled by both internal and external capital.

5 | CONCLUSIONS AND POLICY IMPLICATIONS

In the introduction of this paper, we discussed how the productivity paradox still remains one of the unsolved issues in economic analysis. This work contributes to the debate by claiming that labour productivity growth through technical change represents just one of the multiple sources on which economic systems build their competitiveness. Ignoring them necessarily leads to a misleading quantification of productivity growth, and therefore of regional competitiveness.

Based on this theoretical starting point, the paper proposed a classification of the potential sources of regional competitiveness, together with a methodology for their empirical measurement. In a macroeconomic context, in both a spatial and an a-spatial approach, measurement of GDP and productivity at constant prices has definitely a relevance in terms of employment potential; on the other hand, a measurement in terms of pricing capability, namely of GDP and productivity at current prices, is more relevant in terms of income and income distribution, particularly across space. Pricing, or the capability of selling at favourable prices and, in a spatial context, at favourable terms-of-trade, depends on a wide variety of market powers, nowadays almost completely built on technological and organizational knowledge, continuous innovation and fast improvement of product quality.

Product quality in a large sense finds only a partial measurement in statistics at constant prices. In this paper, a method for extracting a quantitative measure of quality/market power from present statistics is provided, to be added to traditional measures of technical progress in order to enlarge the (theoretical and empirical) concept of productivity. This element represents in our opinion an original contribution to the above mentioned debate on productivity slowdown.

Furthermore, a well-known dynamic process allowing an increase of aggregate productivity, namely intersectoral reallocation of resources, is revisited here, in the double form of a selective evolution towards sectors characterized by high/increasing volume productivity ("technical change *stricto sensu*") and towards high/increasing pricing capability ("quality/market power").

The methodology proposed is utilized to interpret dynamic patterns of regional productivity growth in the EU in the period 2013–2017. The results are quite promising, in spite of the lack of statistics on sectoral pricing at the regional level (sectoral price deflators). They present a picture of a highly diversified Europe at the regional level in terms of the prevailing competitiveness strategies, suggesting that regions require differentiated policies to foster their competitiveness, which go beyond what emerges from a national approach.

First, Central and Eastern European regions do not always follow a pure strategy of price competitiveness, like the one prevailing in Poland, as we are inclined to expect. In particular the most urbanized ones undertook highly selective strategies, increasing quality and prices in monopolistic competitive sectors, accompanied at the same time by technological progress. This takes place especially in metropolitan and capital areas, like Ljubljana, Bucharest, and Warsaw. In other Eastern regions, on the other hand, a reallocation towards more productive sectors prevails (many Romanian and Polish regions), as a result of employment shifts from agricultural activities towards other sectors, in particular wholesale and retail, accommodation and trade. This variegated picture suggests that most of these regions are accomplishing a diversified process of sectoral transition, and policy actions should support their re-orientation and further progress towards a modern industrial economy.

Second, technological progress *stricto sensu* (inside specific sectors) remains the dominant competitiveness strategy of manufacturing regions, mainly in Western countries (Germany, Northern Italy, parts of France) and in non-metropolitan Northern Hungary. What is rather interesting is that such a strategy emerges as a complementary feature reinforcing quality-related ones. This result is the outcome of the present 4.0 technological revolution, in which technological advances cannot be separated from quality improvements. The digital transition supported by the EU and by most national governments is confirmed as an appropriate strategy to re-launch manufacturing areas in Europe.

Third, reallocation towards higher productivity sectors is present in a few scattered regions. In the case of western countries, it is mainly the result of a shift towards service sectors like professional activities and scientific research, real estate and trade. In fact, this process, which is typical of large metropolitan areas, is actually present in these areas in Western Europe (Camagni et al., 2022), but in this work it is overshadowed by the level of analysis conducted on wider (NUTS 2) regions. On the negative side, the shift might happen in the direction of low-value added service activities and this might imply a potential threat in the long run. Reindustrialization policies could be in some regions a way to mitigate such a threat (Capello & Cerisola, 2022a, 2022b).

Finally, an interesting and positive result is that price competitiveness remains a competitive strategy for a few regions, suggesting that Europe is evolving towards more advanced, selective and modern strategies, leaving developing countries to compete merely on prices.

The conceptual and methodological effort presented in this paper allows us to identify these advanced, often intertwined, regional strategies. Their identification is fundamental not only for developing local industrial policies tailored on regions' production specificities, but also for improving scientific interpretation of novel, still little-known, processes. In the era of virtual reality, communication and image, product quality may develop far from a purely functional dimension, generating new forms of market exploitation and of income distribution in space.

In policy terms, all this leads to the reflection that the digital transition policy launched by the EU and the national governments is for sure useful for the competitiveness of Europe as a whole, and for the modernization of European country economies, since it allows a "quality/monopolistic competitiveness" strategy. However, this technological revolution takes place in a situation of spatial concentration of the ability to exploit new 4.0 technologies and to develop new advanced services with a global reach (and a consequent rich remuneration). This condition is destined to create new territorial disparities in the relationship between core and peripheral/internal areas and between large metropolitan areas and medium and small cities. All this calls for appropriate policies, particularly in the sphere of education, to support the strategic adoption of 4.0 technologies by catching up regions, and mitigate such new sources of territorial inequalities.

Will the full development of the digital revolution bring the present productivity slowdown to an end in advanced countries, through process innovation, enhanced product quality and development of new activities? Much will depend on the width of production and the speed of adoption of the new technologies, as the productivity increases that they will generate might remain restricted to a minoritarian share of total production. Secondly, a slow industrial transformation might resolve in a fall of employment, a social condition that would push the parallel growth of a gig economy characterized by low productivity and wage levels. For sure, further work is needed to explore these potential futures in more depth.

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APPENDIX A

A1 | Robustness checks

This Appendix reports evidence on some empirical issues emerging from the analysis of the main paper.

The first issue concerns the potential effect of a shock in the market of energy prices the price indexes employed in our analysis. In the presence of such a shock, an increase in output's price could mirror, rather than a quality/ monopolistic competitive effect, just an increase in the cost of basic inputs. In the period analysed (2013–2017) we rule out this hypothesis, given the evolution of energy prices for non-household users. The data, reported in Table A1, show that, setting the level of prices in 2013 equal to 100, the price of oil, electricity and gas significantly reduced until 2017.

TABLE A1 Gas and energy price trend for non-household consumers between 2013 and 2017 (2013 = 100) in EU27 countries

	2013	2014	2015	2016	2017
Natural gas (Band I4: 100000 GJ < Consumption < 1,000,000 GJ)	100.00	89.00	73.35	71.39	73.84
Electricity (Band IE: 20000 MWh < Consumption < 70,000 MWh)	100.00	97.74	95.12	88.59	85.98
Crude oil	100.00	90.88	47.71	38.95	49.16

Note: all taxes and levies included.
Source: Eurostat (natural gas and electricity), OECD (crude oil).

TABLE A2 The "quality / monopolistic competitive effect": ANOVA between capitals and other regions

	Mean (capital city regions)	Mean (other regions)	F-test	Prob > F
Quality/ monopolistic competitive effect	2.680	2.189	3.100*	0.079
Quality / monopolistic competitive effect *stricto sensu*	2.679	2.199	3.170*	0.076
Reallocation twd high quality/ monopolistic competitive sectors	0.001	−0.010	0.009	0.767

***p < 0.01, **p < 0.05, *p < 0.1.

The second issue concerns the association between urbanization and the "quality/monopolistic competitive effect" we proceeded as follows. First, we calculated the term ΔY^{*} of Equation (9) for each region, considering only those sectors whose price index increased more than the overall national inflation. Then, as a second step, we performed an ANOVA aimed at testing whether this indicator is significantly different when comparing the NUTS 2 regions hosting the country-capital city against the others. This test indicates whether, if we consider only those sectors able to increase their prices more than the average over the period 2013–2017, their effect is significantly higher in urbanized areas than elsewhere. Results are reported in Table A2.

Results reported in the table show that there is a statistically significant difference between capital and non-capital regions when considering the quality/ monopolistic competitive effect (i.e., ΔY^{*} of Equation (9) occurred in the period under study. Interestingly, this effect does not depend on a higher reallocation of labour force, within capital regions, towards high quality/monopolistic competitive sectors (i.e., the second term of Equation (9), as shown by the non-significant ANOVA test in Table A2 (third row). Rather, the quality/monopolistic competitive effect was higher in urban areas due to their initial specialization in quality/monopolistic competitive sectors (i.e., the first term of Equation (9), as shown by the statistically significant ANOVA test in Table A2 (second row).

The third issue involves the choice of the period under study. As discussed in the main paper, this choice is justified by the exclusion of the generalized economic slowdown following the financial crisis of 2008. In this section, we report some evidence of the correlation between the two main effects of our analysis when measured over different time-span. We proceeded as follows. First, we calculated both ΔY and ΔY^{*} (Equation (4) over the period 2008–2017. They measure, respectively, the aggregate productivity growth at constant (sectoral) prices (ΔY) and the quality/ monopolistic competitive effect (ΔY^{*}). Second, we measured the correlation between these indicators and those presented in the main paper, that is, ΔY and ΔY^{*} calculated over the shorter period 2013–2017. Results are reported in Table A3.

The findings reported in Table A3 show that the effects on which we classified regions according to alternative patterns of competitiveness are positively and highly significantly correlated if we extend the period of analysis to a longer time span (2008–2013). This implies that what observed between 2013 and 2017 is not an extemporaneous and random behaviour of regions.

TABLE A3 Correlation between technological progress and quality / monopolistic competitive effects in 2008–2017 and in 2013–2017

	Pearson correlation coefficient
Whole sample	
Aggregate productivity growth at constant (sectoral) prices	0.697***
Quality/ monopolistic competitive effect	0.536***
Western countries	
Aggregate productivity growth at constant (sectoral) prices	0.743***
Quality/ monopolistic competitive effect	0.494***
CEEC countries	
Aggregate productivity growth at constant (sectoral) prices	0.548***
Quality/ monopolistic competitive effect	0.697***

***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

APPENDIX B

B.1 | Concerning Equation (9) and its identity nature

Starting from Equation (9):

$$\Delta Y^* = \sum_{i=1}^{N} \theta_{i,t0} \Delta y_i^* \quad + \quad \sum_{i=1}^{N} \Delta\theta_i \; y_{i,t1}^*,$$

substituting $y_{i,t1}^*$ by the equivalent Δy_i^*, the price increase in the period 0–1, and replacing it by its components indicated in Equation (8) we get:

$$\Delta Y^* = \sum_{i=1}^{N} \theta_{i,t0} d_{i,1|0} - d_{agg} \sum_{i=1}^{N} \theta_{i,t0} + \sum_{i=1}^{N} \Delta\theta_i d_{i,1|0} - d_{agg} \sum_{i=1}^{N} \Delta\theta_i.$$

Given that:

$\sum_{i=1}^{N} \theta_{i,t0} = 1$ and that $\sum_{i=1}^{N} \Delta\theta_i = 0$,we get:

$$\Delta Y^* = \sum_{i=1}^{N} d_{i,1|0} (\theta_{i,t0} + \Delta\theta_i) - d_{agg},$$

and

$$\Delta Y^* = \sum_{i=1}^{N} d_{i,1|0} \theta_{i,t1} - d_{agg}.$$

All sectors and firms present in $t = 1$ sell at the final price in that year, which implies the increase $d_{i,1|0}$ with respect to time 0.

APPENDIX C

The Table C1 reports the list of regions included in the different patterns, and showed in Figure 1.

TABLE C1 List of regions in the different taxonomies

Competitive pattern	List of NUTS 2 regions
Technological progress *stricto sensu*	BE10; BE21; BE22; BE33; BG31; BG32; CZ01; CZ06; DE13; DE14; DE21; DE22; DE23; DE24; DE25; DE26; DE27; DE30; DE60; DE80; DED4; DEE0; DK03; EE00; EL53; ES21; ES63; ES64; FI1B; FRC1; FRF3; FRG0; FRI2; FRI3; FRJ2; FRK1; FRL0; HU21; HU22; HU23; HU31; HU33; ITC4; ITH3; ITH4; ITI3; LT02; PL22; PL71; SK02; UKC2; UKD3; UKD6; UKD7; UKG2; UKH1; UKH2; UKH3; UKI7; UKJ3; UKK1; UKK3; UKK4; UKM6; UKM7; UKN0
Reallocation towards higher productivity sectors	BE31; DE50; DE72; DE91; DEB1; DK01; DK04; EL51; EL61; EL62; FI19; FI1C; FI1D; FI20; FR10; FRH0; FRM0; HR03; HR04; ITF1; ITF3; ITF6; LT01; LV00; PL41; PL42; PL61; PL62; PL82; PT16; PT30; RO11; RO22; RO31; SE32; SK01; UKD4; UKM9
Quality/monopolistic competition *stricto sensu*	BE23; BE24; BE25; BE34; BE35; BG41; BG42; CY00; CZ03; CZ04; CZ05; CZ07; CZ08; DE73; DEB2; DEG0; EL52; ES11; ES12; ES13; ES22; ES23; ES24; ES30; ES41; ES42; ES43; ES51; ES52; ES53; ES61; ES62; ES70; FRI1; HU32; LU00; PL21; PL43; PL51; PL52; PL72; PL84; PL90; PT11; PT15; PT17; PT18; RO21; RO41; SI03; SI04; SK03; SK04; UKF1; UKI3; UKJ2; UKJ4; UKK2; UKL1; UKM8

(Continues)

TABLE C1 (Continued)

Competitive pattern	List of NUTS 2 regions
Reallocation towards high quality/ monopolistic-competitive sectors	AT11; AT12; AT13; AT21; AT22; AT31; AT32; AT33; AT34; BE32; BG33; BG34; CZ02; DE11; DE12; DE40; DE71; DE92; DE93; DE94; DEA1; DEA2; DEA3; DEA4; DEA5; DEB3; DEC0; DED2; DED5; DEF0; DK02; DK05; EL42; EL43; EL54; EL63; EL64; EL65; FRB0; FRC2; FRD1; FRD2; FRE1; FRE2; FRF1; FRF2; FRJ1; FRK2; ITC1; ITC2; ITC3; ITH1; ITH5; ITI1; ITI2; NL12; NL13; NL21; NL22; NL23; NL31; NL32; NL33; NL34; NL41; NL42; PL63; PL81; RO12; RO32; RO42; SE12; SE21; SE22; SE23; SE31; SE33; UKC1; UKG3
Price competitiveness	EL30; EL41; HU11; HU12; ITF2; ITF4; ITF5; ITG1; ITG2; ITH2; ITI4; NL11; NL11; PT20; PT20; SE11; SE11; UKD1; UKE1; UKE2; UKE3; UKE4; UKF2; UKF3; UKG1; UKI4; UKI5; UKI6; UKJ1; UKL2; UKM5

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Resumen. La variación de la productividad laboral a precios constantes es el principal indicador de la competitividad regional. Sin embargo, oculta y pasa por alto algunas fuentes relevantes de competitividad que pueden explicar en parte la paradoja de Solow. En primer lugar, mezcla las mejoras de productividad derivadas del progreso tecnológico con las derivadas de la deslocalización de actividades hacia sectores más productivos. En segundo lugar, pasa por alto en parte las novedades y las cualidades incorporadas a los nuevos productos y los efectos del poder del mercado. Este artículo propone una metodología para desentrañar los diferentes efectos y aplicarla al desarrollo reciente de las regiones europeas. Los resultados ponen de manifiesto la gran heterogeneidad de las estrategias competitivas de las regiones y la persistente discrepancia entre las orientales y las occidentales.

抄録: 不変価格での労働生産性の変化は、地域の競争力の主要な指標である。しかし、それはソローのパラドックスを部分的に説明する可能性がある競争力の重要な源泉を隠し、看過するものである。不変価格での労働生産性の変化では、第一に、技術進歩による生産性の向上と、より生産性の高い部門に作業工程を移管することによる生産性の向上が混在しており、第二に、新製品に内在する斬新さや品質、市場支配力の影響が部分的に見落とされている。本稿では、異なる効果を分離し、ヨーロッパ地域における最近の発展に適用する方法論を提案する。結果から、地域の競争戦略の異質性が高いことと、東部における戦略と西部における戦略の相違が持続していることが強調される。