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Productivity Growth in Romania

A Firm-Level Analysis

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Abstract

This paper examines productivity growth in Romania using balance sheet data for a census of Romanian firms in 2011–17. Three measures of productivity are estimated: labor productivity, revenue total factor productivity, and revenue total factor productivity adjusted for markups. Drawing from these measures, the paper follows a two-step approach to answer two fundamental questions: (i) who are the firms—and what are their key characteristics—driving and dragging productivity growth in Romania? and (ii) what are the drivers behind productivity expansion? A first step of the analysis characterizes productivity leaders and laggards, finding that companies at the domestic productivity frontier are older and larger, have higher capital intensity, and pay higher wages. Domestic market leaders charge higher markups, especially in manufacturing, but are not becoming more efficient. A second step of the analysis decomposes aggregate productivity growth and finds that reallocation of market shares to more efficient players has been the main driver in manufacturing but not in services, which are typically more sheltered from competition. At the same time, individual firms are becoming less productive, suggesting that there is scope to improve firm capabilities, particularly in services. These findings suggest a policy agenda for Romania centered on removing distortions to competition and boosting human capital.

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Productivity Growth in Romania: A Firm-Level Analysis[1]

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1. Introduction

Productivity, defined as the technical efficiency with which firms transform inputs into production, is the ultimate driver of economic growth. As Paul Krugman noted in 1994 "Productivity isn't everything, but, in the long run, it is almost everything. A country's ability to improve its standard of living over time depends almost entirely on its ability to raise its output per worker."

In theory, differences in output per worker (labor productivity - LP) across countries can be driven by two key sources: (i) capital deepening - which can be divided into two sub-components, the part related to ICT capital and the portion related to all other types of capital; and (ii) efficiency gains obtained through technological change (i.e. total factor productivity – TFP - growth). Empirical evidence suggests that almost half of the difference in per capita income between countries around the world is explained by differences in TFP (Easterly and Levine, 2001; Caselli, 2005; Hsieh and Klenow, 2010). Therefore, it is key to boost TFP to accelerate convergence to high income levels.

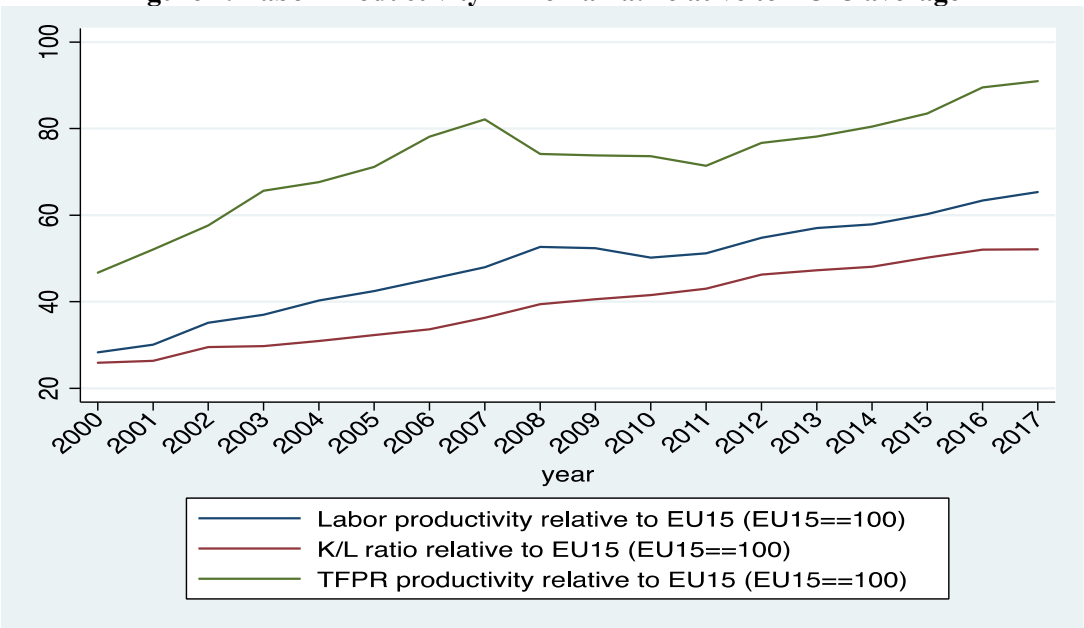
Aggregate productivity growth can be decomposed into a number of factors. First, incumbent firms can become more productive - i.e. they can increase the amount of output they produce with a given amount of inputs (the *within* component) - by upgrading their internal capabilities through innovation, adoption of new technologies and use of better managerial practices. Second, resource allocation - and therefore, economic activity and market shares - across firms and industries can improve when more productive existing firms gain market shares (*between-firms* component), new and more productive firms enter the market (*entry* component) and less productive firms exit the market (*exit* component).

Romania offers an interesting example of a country that has dramatically improved its standard of living in a short period of time, with income per capita rising from 26% of EU-28 average in 2000 to 63 percent in 2017.

In the course of the 2000s Romania's labor productivity quickly converged with that of its wealthier EU partners. As of 2017, the level of labor productivity in Romania was 65.3% of the (unweighted) average of the older Member States (EU-15), up from 28.3% in 2000. The pace of convergence, however, slowed dramatically in the post-crisis period, with the compound average growth rate (CAGR) of labor productivity plummeting to 3.1% in 2009-2017 from 9% in the 2000-2008 period (Figure 1).[2] Both capital accumulation (the capital-labor ratio) and revenue total factor productivity (TFPR) have been driving labor productivity improvements. The CAGR of capital intensity over the 2000-2017 period was 4.2%, slightly faster than the 4% CAGR for TFPR. Prior to the crisis (from 2000 to 2008), the CAGR of TFPR was 5.9%, somewhat faster than the pace of growth of the capital-labor ratio (5.4%). After the crisis (2009–17), the trend reversed, with capital intensity experiencing a CAGR of 5.5% and TFP growth slowing to 4.5%.

[2] In the post-crisis period, the CGAR of Romania's labor productivity slightly accelerated from 1.21 percent in 2009-2012 to 4.53 percent in 2013-2017.

Figure 1. Labor Productivity in Romania: relative to EU15 average



Source: Own elaboration based on Penn Table 9.0

Note (1): Labor productivity is output-side real GDP at current purchasing power parities (PPPs, in millions of 2011 US$), divided by the number of persons engaged (in millions); the capital: labor ratio is defined as capital stock at current PPPs (in millions of 2011 US$) divided by the number of persons engaged (in millions); country level TFP is reported as TFP level at current PPPs (USA=1). All values are converted as a proportion of EU 15 (unweighted) average.

Note (2): EU15 countries are Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden and United Kingdom.

To understand the drivers of aggregate productivity trends, it is important to dive into firm level analysis. Aggregate TFP numbers may be misleading. First, they might be affected by measurement problems, especially related with the emergence of information and communication technologies (ICT) that are difficult to capture in output statistics (Brynjolffsson, Rock, and Syverson, 2017). Second, aggregate TFP is estimated as the residual of an aggregate production function for the whole economy, which ignores technological differences across sectors within countries. Third, and probably more relevant for the current analysis, aggregate TFP figures mask a lot of heterogeneity in firm level behavior. Because of their intrinsic characteristics, firms are different from each other and also differ in terms of performance, even within very narrowly defined industries (Syverson, 2004). These differences could persist either because of supply factors such as management skills, R&D or investment patterns (Bartelsman and Doms, 2000) or due to demand-side factors related to product differentiation, customer-producer relationship, geographical segmentation, among others.

Against this backdrop, this paper uses balance sheet data from a census of Romanian firms for the period 2011-2017 to construct three measures of productivity: labor productivity (LP), revenue total factor productivity (TFPR), and revenue total factor productivity adjusted for markups (TFPR-adjusted). This last measure corrects the price effects conflated in TFPR by using firm-year varying markups, following the methodology proposed in De Loecker and Warzynski (2012).

Drawing from these measures, the paper follows a two-step approach to answer two fundamental questions: i) who are the firms – and their key characteristics - driving and dragging productivity growth in Romania? and ii) what are the drivers behind productivity expansion?

To answer the first question, the first step of the analysis aims at characterizing Romania's domestic productivity leaders and laggards. The post-crisis period witnessed a widening productivity gulf between leading and lagging firms, both within and across countries (Andrews, Criscuolo and Gal, 2016). In this regard, OECD (2015) suggests a distinction between three types of firms: the globally most productive, the most productive domestic firms, and laggard firms. The global frontier comprises large and skills-intensive firms, often multinationals, that account for a substantial portion of global patents and trademarks and undertake innovation that pushes out the global productivity frontier. Domestic frontier firms are the most productive in the domestic economy within their industries, are open to international engagement, are relatively young, and are more likely to innovate. Laggard firms are more focused on local markets and relatively less productive in their industry within the domestic economy. The analysis for Romania finds that domestic frontier firms are larger, have higher capital intensity, pay higher wages but are also older and charge higher markups.

To address the second question, the second step of the analysis aims at identifying the drivers of productivity growth in the period 2011-2017. Among the usual productivity growth drivers, the analysis focuses on the *within* and *between* components, as the data set does not allow to compute reliable estimates of entry and exit. Our findings suggest that reallocation of market shares to more efficient players has been the main driver of productivity growth in manufacturing but not in services, which are typically more sheltered from competition. At the same time, individual firms are becoming less productive, suggesting that there is scope to improve firm capabilities, particularly in services.

The rest of this paper is organized as follows. The next section presents the data and the methodology used to estimate the three measures of productivity used in the analysis. The third section presents the analysis of domestic productivity leaders and laggards and of the decomposition of aggregate productivity growth. The final section concludes.

2. Data and Methodology

The analysis draws from balance sheets collected by the Romanian National Agency for Fiscal Administration (Agenția Națională de Administrare Fiscală). This data set covers the 2011-2017 period and contains key information to compute productivity at the firm level –such as value added, number of employees, costs of labor and different material inputs, fixed tangible and intangible assets, among others. The list of variables included in the data set is presented in Annex A. Given the focus of the study, firms outside the business economy were excluded. The business economy, defined following the Eurostat definition, covers all industry, construction and market services sectors (sectors NACE rev. 2 B to N, plus sector S95). The final list of 2-digit sectors included in the analysis is presented in Annex A. For firms that move across sectors, the industry mode (most common industry) along the period is used. Since exit is overrepresented (as firms might stop reporting balance sheets while still being in operation) and firms' year of incorporation does not always coincide with the year a firm starts reporting balance sheets, the analysis is restricted to a balanced panel of 183,856 surviving firms (24,433 in manufacturing and 159,423 in services). All nominal variables are expressed in Romanian Lei 2010 prices (using the Eurostat GDP implicit price deflator). Table 1 shows that the value added composition of these surviving companies is highly skewed towards services, which account for 80% of total value added in 2017 (which excludes mining and agriculture).

Table 1. Main Economic Sectors (% of total value added in the sample)

	% over total value added
Manufacturing total	**19.60**
Top 10 (manufacturing)	**14.55**
Manuf. motor vehicles	4.12
Manuf. food	2.31
Manuf. rubber and plastic	1.40
Manuf. fabricated metal products	1.30
Manuf. basic metals	1.02
Manuf. other non-metallic mineral products	0.95
Manuf. machinery and equipment	0.91
Manuf. wearing apparel	0.85
Manuf. beverages	0.85
Manuf. electrical equipment	0.83
Services total	**80.4**
Top 10 (services)	**68.6**
Wholesale trade	27.83
Retail trade	19.60
Wholesale and retail trade of motor vehicles	5.29
Land transport	4.20
Electricity gas steam and air conditioning	2.40
Telecommunications	2.24
Construction of buildings	2.19
Warehousing and support activities for transportation	1.86
Computer programming	1.56
Specialized construction activities	1.38

Three productivity measures are computed.

- **Labor productivity (LP)**: defined as value added[3] per (full time) employee.

- **Revenue Total Factor Productivity (TFPR)**; defined as the portion of firm-level revenue or sales that cannot be explained by the contribution of capital, labor, energy, and other inputs. For estimation purposes, a firm *i's* production function at year *t* is represented by a flexible Translog technology as follows:

$$\begin{aligned} y_{it} &= \alpha_1 m_{it} + \alpha_2 l_{it} + \alpha_3 k_{it} + \alpha_4 m_{it}^2 + \alpha_5 l_{it}^2 + \alpha_6 k_{it}^2 \\ &+ \alpha_7 m_{it} l_{it} + \alpha_8 m_{it} k_{it} + \alpha_9 l_{it} k_{it} + \alpha_0 + \omega_{it} + \varepsilon_{it} \end{aligned} \tag{1}$$

[3] Value added is defined as revenues minus cost of raw materials.

where all the variables are in natural logarithms and y_{it} is the firm's annual total revenue from operations, m_{it} is the total expenditure on intermediate materials, k_{it} is the capital stock (sum of tangible and intangible assets) and l_{it} is the total number of hours worked per year (the natural logarithm of the product of the number of employees times the number of months worked times the number of hours worked per month). Against this backdrop, TFPR is identified as any change in firms' revenue not caused by variations in the inputs of production. More specifically, in equation (1) TFPR (in logs) is identified by

$$TFPR_{it} = \alpha_0 + \omega_{it} + \varepsilon_{it} \tag{2}$$

The term ω_{it} is known by the firm, but not by the econometrician, which generates a problem of simultaneity between the inputs and productivity. The last term is assumed to be a completely random productivity shock non-anticipated by the firms when making their input choices. The Ackerberg, Caves and Frazer (2015) approach is followed to solve the endogeneity problem and the anticipated productivity shock is divided into two terms,

$$\omega_{it} = g(\omega_{it-1}) + \xi_{it} \tag{4}$$

where the first term, $g(\omega_{it-1})$, is the inertia of the productivity process, i.e. highly productive firms at *t-1* will also have a high productivity level at *t* (present).[4] This is the term that firms know when making their input choices. The second term, ξ_{it}, is the innovation of the productivity process and is the key of the estimation process. It can be interpreted as any change in the level of productivity that is completely new at time *t* and uncorrelated with past productivity.

Since the innovation is uncorrelated with past productivity, it is also uncorrelated with the optimal choices of the variable inputs, i.e. materials and labor, made at moment *t*-1. Moreover, since capital is a fixed input and it takes time to change its level, we can also assume that the innovation of productivity is uncorrelated with the capital input choices made at moment *t*. This set of assumptions allows forming a set of moment conditions as follows:

$$E(\xi_{it} l_{it-1}) = E(\xi_{it} m_{it-1}) = E(\xi_{it} k_{it}) = 0 \tag{5}$$ [5]

which states that we can use the orthogonality between lagged flexible inputs and contemporaneous capital, on the one hand, and productivity innovation on the other to identify (estimate) the parameters of the production function in equation (1). To account for differences in production technologies across sectors, the TFPR estimation – as discussed above - allows for heterogeneous sector-specific (NACE 2-digit) production functions.[6]

[4] Following the terminology used in the literature, it is assumed that productivity follows a first-order Markov process in the sense that it only depends on its own past values.
[5] A moment condition is a statistical equality that holds in the population under study.
[6] Observations with revenue, employment, capital (tangible assets and intangibles) and cost of raw materials with value zero or value lower than zero are excluded from the TFPR estimation.

Being a revenue-based measure, the TFPR as estimated above is not free of price effects; this means this proxy of efficiency might capture not only technical efficiency but also market power, differences in quality and other factors affecting demand for the product.[7]

- **Revenue Total Factor Productivity Adjusted for Markups (TFPR-adjusted):** to mitigate the price effects described above, the TFPR is corrected by firm-year varying markups as follows:[8]

$$TFPR_{it}^{adj} = TFPR_{it} - \ln(markup_{it}).$$

where TFPR is expressed in logs and $markup$ is estimated using the approach presented by De Loecker and Warzynski (2012). In this case, markup – defined as the ratio of price over marginal cost – is derived from the first order condition of the firm's minimization problem with respect to the flexible input (material). Specifically, it is computed as the input-output elasticity of material divided by the ratio of material cost to corrected-revenue, where corrected revenue is obtained by dividing revenue by the exponential of the unanticipated shock of production, which is, in turn, obtained as a residual in the estimation of the production function, as follows:

$$markup_{it} = \frac{\widehat{\beta_M^j}}{Mshare_{it}}$$

where $\widehat{\beta_M^J}$ is the estimated material coefficient in sector j where firm i operates and is estimated as

$$\hat{\beta}_M^j = \frac{1}{N_j} \sum_{\nabla i \in j} \left(\hat{\alpha}_1 + 2\hat{\alpha}_4 m_{it} + \hat{\alpha}_7 l_{it} + \hat{\alpha}_8 m_{it} \right)$$

and

$$Mshare_{it} = \frac{P^M M_{it}}{\left(Y_{it} / \exp(\varepsilon_{it}) \right)}$$

where $P^M M_{it}$ is total cost of raw materials, Y_{it} is total revenue and ε_{it} is the unanticipated productivity shock (see equation 2).

The procedure proposed in De Loecker and Warzynski (2012) yields estimates of markup that depend on the same parameters as the estimates of TFPR. That is, firms with high TFPR due to a low estimate of the elasticity of materials will also have a higher markup. Hence, the estimate of $TFPR^{adj}$ tries to take into account this issue. However, other possible factors making TFPR high, different than the elasticity of materials or the market share, are not accounted for in the $TFPR^{adj}$ measure (e.g. innovation, product quality, etc.). In this sense, the $TFPR^{adj}$ is not a perfect measure of the true technical efficiency, but just a proxy of it that accounts for market share and the effect

[7] See Cusolito and Maloney (2018) for a specific discussion on how the traditional TFPR measure conflates both demand and supply factors, and how ignoring these can bias the analysis of productivity growth drivers.

[8] In this case, the TFP adjusted measure is partially free of price effects because it might still carry quality/demand effects. Also, the "partial" price correction done through the method applied here – via firm -year level markup – does not use price firm level data, which are not available in the data set.

of materials elasticity, while other factors like the effect of product quality or innovation are not taken into account.

3. Analysis

Drawing from the estimation of the productivity measures described above, firm level results suggest a heterogeneous productivity 'story' across industries in Romania. Figure 2 presents the evolution of median values of different productivity measures estimated with the panel data (see Annex B for more details). Apart from a common growth pattern in terms of labor productivity, manufacturing and services seem to have experienced distinct trends in terms of the efficiency with which firms manage labor, capital and materials. In manufacturing, median TFPR experienced positive growth, which could suggest increased efficiency. However, this trend does not seem to be sustained when the markup effect is discounted, suggesting that technical efficiency has, in fact, decreased in the 2011-2017 period. For services, the median values of both TFPR and TFPR-adjusted experienced negative growth over time.

Even within industries, there are signs of increasing heterogeneity across firms. Figure 3 explores another moment of the productivity distribution: the dispersion (defined as the standard deviation of TFPR). It shows a decreasing dispersion of labor productivity, suggesting that the gap in labor efficiency is diminishing for both manufacturing and services. At the same time, dispersion in terms of total factor productivity - adjusted and non-adjusted TFPR - has been increasing over time. This can be explained by several factors, including not only policy distortions, but also differences in technology, quality, markups, adjustment costs to capital coupled with volatility in sales, or even different levels of experimentation (Cusolito and Maloney, 2018). Irrespective of the underlying drivers, the data show unequivocal evidence that firms are becoming increasingly heterogenous in terms of total factor productivity, which reinforces the need to go beyond the average firm and explore firm heterogeneity.

Figure 2. Average Annual Growth Rate (%) of Median Productivity Values, 2017-2011 (manufacturing vs services)

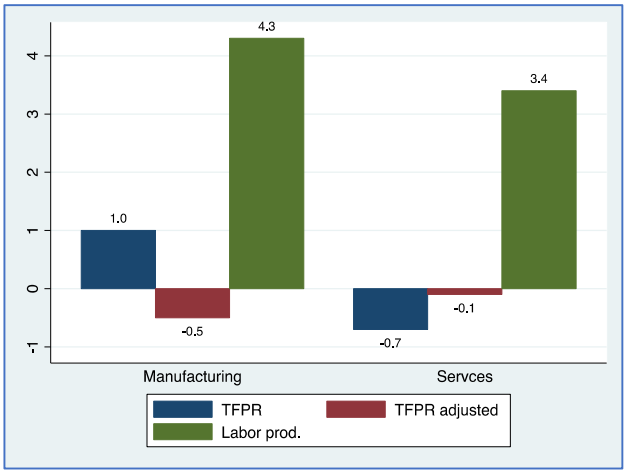
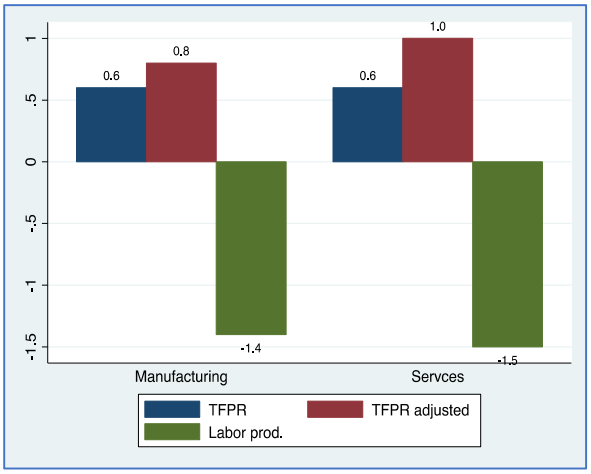


Figure 3. Average Annual Growth Rate (%) of Productivity Dispersion Values, 2017-2011 (manufacturing vs services)



3.1 Productivity leaders and laggards

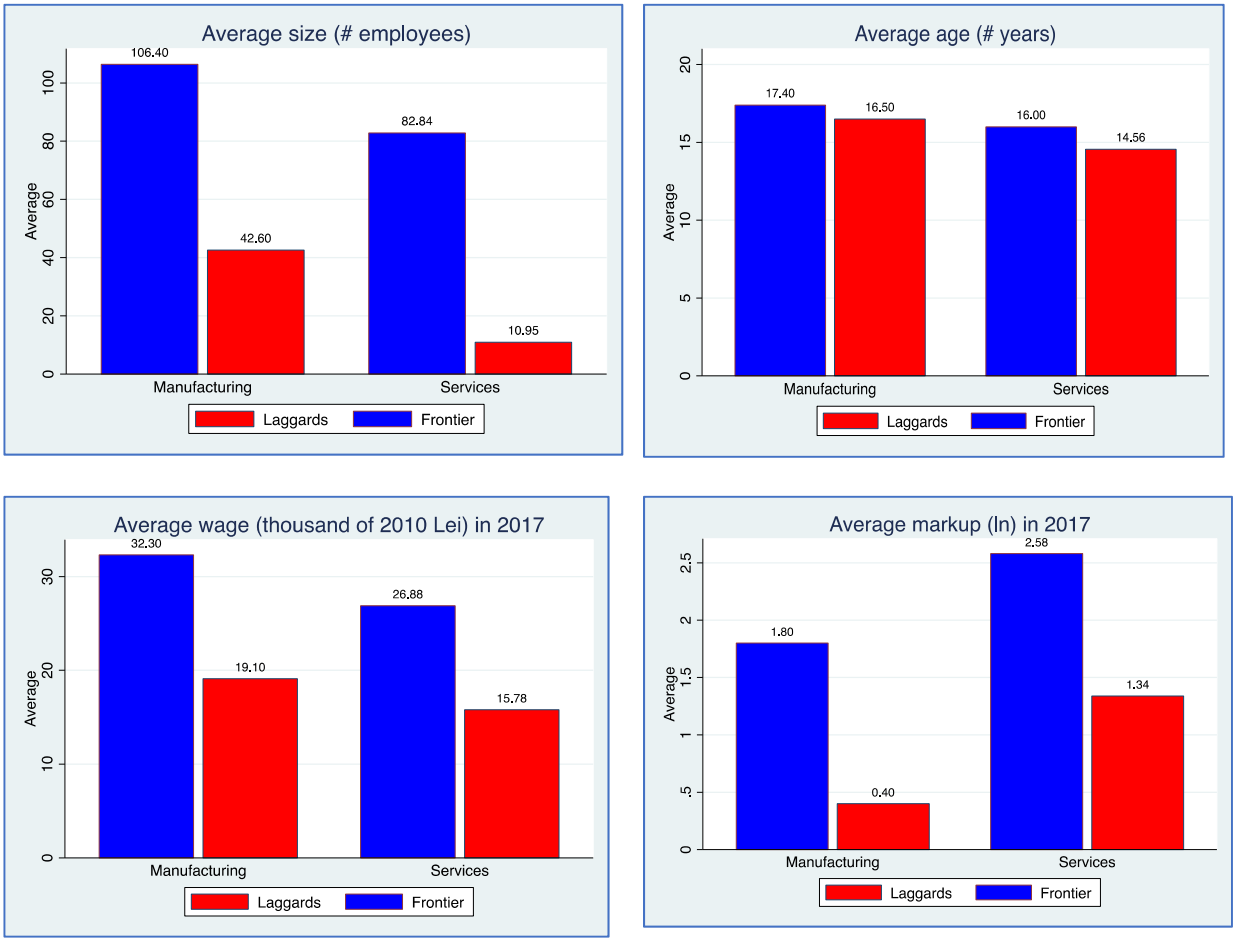
To shed light on firm heterogeneity and further explore the diverse performance of firms operating in Romania, domestic frontier and laggard companies are identified following the approach of Andrews, Criscuolo and Gal (2016). Domestic frontier companies are identified as the top 5% - in terms of LP, TFPR, or TFPR-adjusted - per year and 2-digit sector. Neither the number of companies nor the set of frontier firms is fixed over time, which allows to capture turbulence at the domestic frontier (as laggard companies in a given year can enter the domestic frontier the following year). The group of laggard companies is also allowed to change over time, reflecting churning at the frontier.

Figure 4 shows cross sectional differences in the average characteristics of domestic frontier and laggard firms – with domestic frontier measured in terms of TFPR - along key dimensions (age, size, capital intensity and markup) for 2017, the latest year of observation. All reported average differences – frontier relative to laggards – are statistically significant.[9]

Results show that, on average, firms that are at the domestic TFPR frontier are significantly larger (in terms of employment) than laggards both in manufacturing and services. Domestic frontier firms also pay higher salaries – ranging from 32,300 to 26,880 (in 2010 Romanian Leis) for manufacturing and services, respectively - and are more capital intensive, irrespective of the industry. Finally, firms at the domestic frontier charge higher markups (3.4 to 4 times higher, depending on the industry) than laggard companies.

[9] A t-test comparing average variables across laggard and frontier groups (for both manufacturing and services) rejects equality at least at 5%.

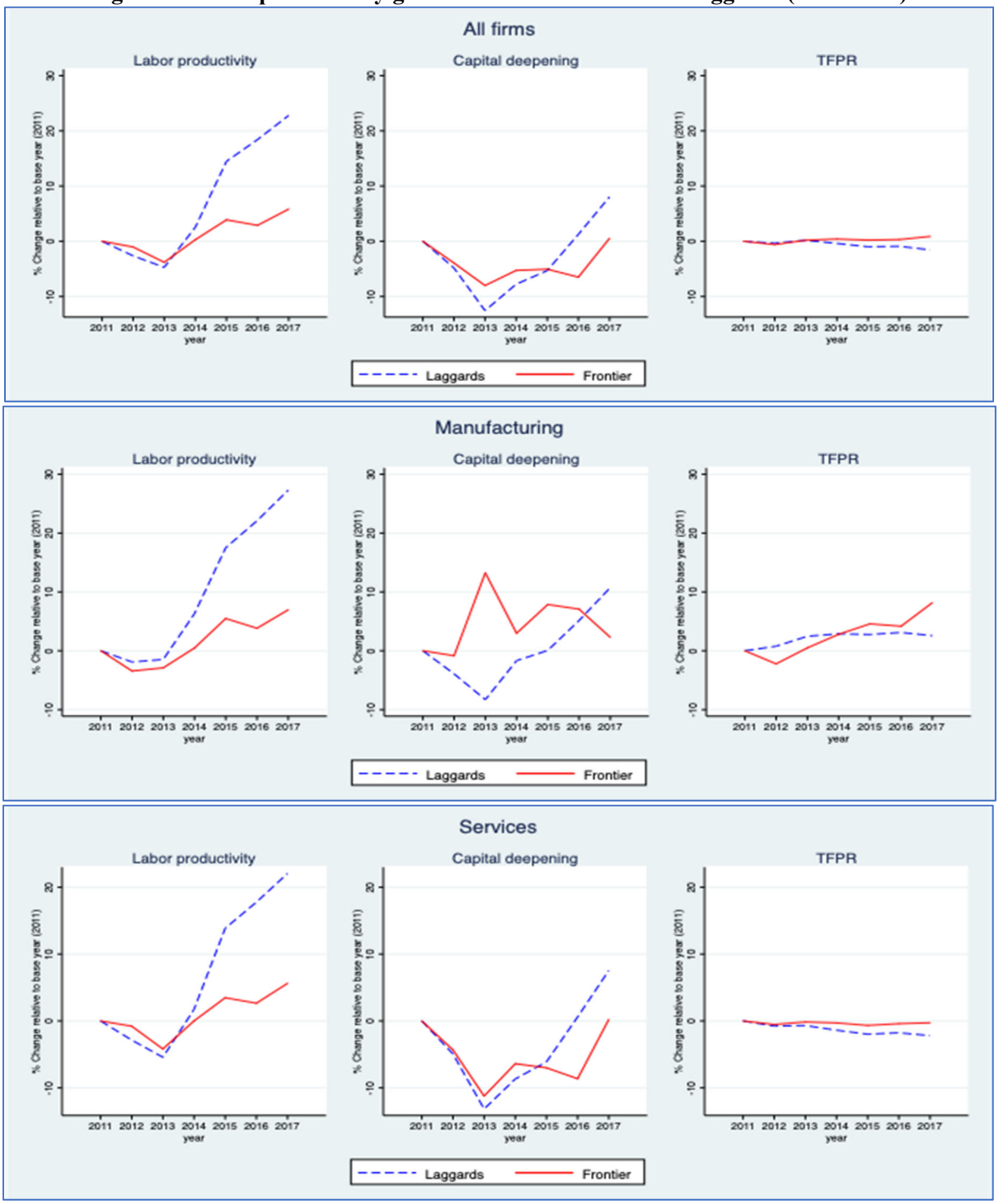
Figure 4 – Average differences in firm characteristics in 2017



Note (1): Domestic frontier firms are identified as the top 5% in terms of TFPR productivity level, within each 2-digit sector nd year.

To assess divergence in productivity behavior, Figure 5 shows the evolution of the (unweighted) average of log labor productivity across domestic frontier and laggard companies, for all firms under analysis, and separately for firms in manufacturing and services. In this case, the domestic frontier is defined as the top 5% performers in terms of labor productivity (within each 2-digit sector and year). Because labor productivity growth can be achieved through either higher capital intensity or revenue based TFP, the figures plot not only the labor productivity growth evolution itself but also these two components. Overall, the data suggest that the labor productivity of laggard firms has been increasing faster than that of frontier firms, especially after 2013. This catching up process has been driven mostly by capital deepening rather than gains in (revenue-based) total factor productivity (TFPR). This applies both to manufacturing and services industries.

Figure 5. Labor productivity growth: domestic frontier vs laggards (2011-2017)



Note (1)*:* Domestic frontier firms are identified as the top 5% performers in terms of labor productivity, within each 2-digit sector (in manufacturing/services industry) and year. The domestic frontier line captures the average of log labor productivity for the top 5% companies (by 2-digit sector, within manufacturing/services, and year). Laggards line captures the average log productivity of all other firms. Note (2): The vertical axes represent log-differences from the starting year.

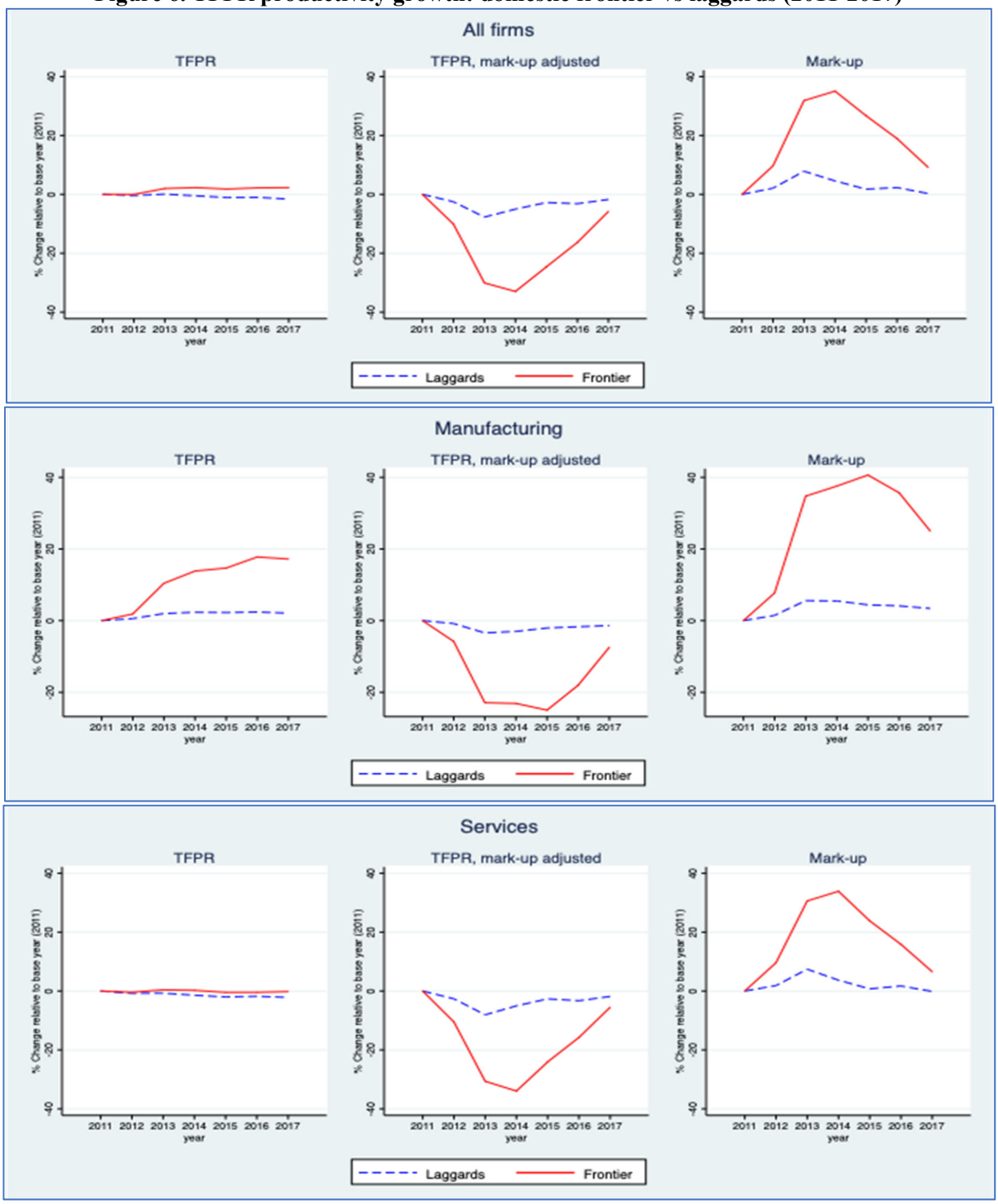
The big nuance is revealed when focusing the analysis on TFPR performance. In this case, because the TFPR measure is based on revenue data, the differential growth performance between laggard and frontier firms might reflect disparities between these groups in terms of ability to charge higher markups, instead of differences in technical efficiency. Figure 6 shows the evolution of the (unweighted) average of log TFPR across domestic frontier and laggard companies, as well as the evolution of TFPR-adjusted (a proxy of technical efficiency) and markup performance for all firms together, and manufacturing and service firms separately. In this case, the domestic frontier is defined as the top 5% performers in terms of TFPR (within each 2-digit sector and year).

For manufacturing, the data suggest an increasing divergence in TFPR growth between domestic frontier and laggard companies. This widening gap in growth performance appears to be driven mostly by domestic frontier companies charging increasingly higher markups (relative to non-domestic frontier firms) rather than by gains in technical efficiency (proxied by TFPR markup-adjusted). The higher markup performance of domestic manufacturing leaders might come either from higher market power or differences in quality and demand of their products, rather than from their ability to successfully invest in and combine new technology to succeed in the market.

This overall trend for the whole manufacturing industry is observed for most NACE 2-digit sectors under manufacturing.[10] However, there are some exceptional cases where markups of domestic productivity leaders tend to grow more slowly than those of laggards. These are: manufacturing of textiles; manufacturing of other transport equipment; manufacturing of wood; printing; and manufacturing of rubber and plastic. Among them, the examples of manufacturing of textiles and manufacturing of other transport equipment are particularly striking as these sectors are more exposed to international competition given their integration in GVCs. The slower growth of the markup of domestic productivity leaders relative to laggards might reflect either a decrease in market power or a deterioration of product quality.

[10] Results for the labor productivity growth decomposition at the NACE 2-digit level within manufacturing are available upon request.

Figure 6. TFPR productivity growth: domestic frontier vs laggards (2011-2017)



Note (1): Domestic frontier firms are identified as the top 5% performers in terms of TFPR productivity, within each 2-digit sector (in manufacturing/services industry) and year. The domestic frontier line captures the average of log TFPRR productivity for the top 5% companies (by 2-digit sector, within manufacturing/services, and year). Laggards line captures the average log TFPR productivity of all other firms. Note (2): The vertical axes represent log-differences from the starting year.

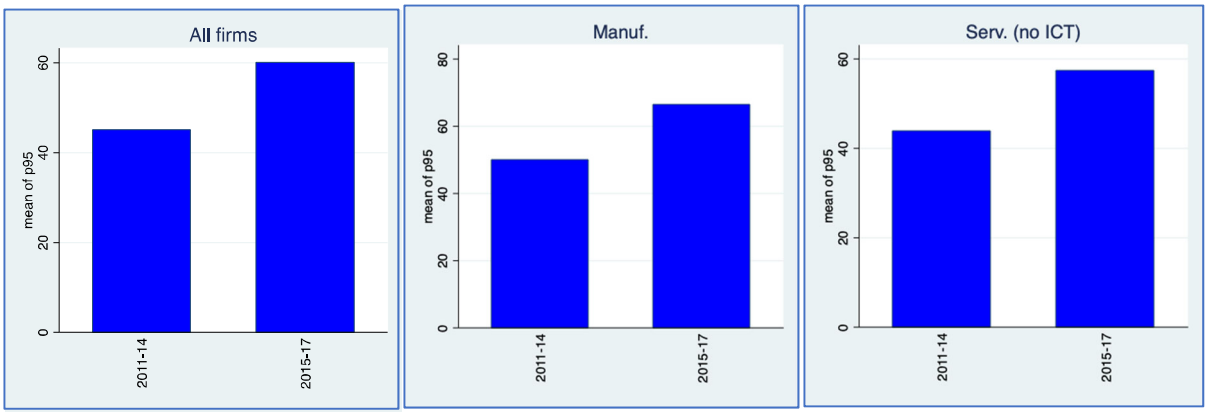
For services, the (unweighted) average gap in growth of TFPR between domestic frontier and laggard companies is almost inexistent over the period under analysis, and, again, this result is driven by markup performance of domestic leader companies, which tend to increase their markups faster than laggards. This overall trend observed for the whole service industry is observed for most of NACE 2-digit sectors.[11] This is particularly true for: water collection, treatment and supply; civil engineering; retail trade; land transport; telecommunications; computer programming; legal and accounting activities; activities of head offices; architectural and engineering activities; and rental and leasing activities. The example of legal and accounting activities is particularly relevant; in this case, analysis of OECD Product Market Regulation (PMR) data show that regulatory barriers to entry or conduct seem to be excessively stringent when compared to other countries in the region.[12] This could suggest reduced market contestability, so the differential growth performance of markups between domestic leaders and laggards could be reflecting an increase in market power.

Data also suggest an increasing persistence of incumbent firms at the domestic frontier. As shown in Figure 7, the average proportion of firms classified as domestic frontier companies at time t that continue in the domestic frontier in t+1 increases over time. For manufacturing and services together, in 2011-2014, on average 50% of domestic frontier firms were already in the domestic frontier the year before. By 2015-17 this figure had risen to 60%. The same rising trend is observed for manufacturing and services separately. This result holds even when the domestic frontier is measured in terms of TFPR-adjusted for markup. Overall, this might reflect a decline in contestability of markets that either reduces the pressure on domestic frontier firms to adopt better technologies or decreases the incentives for laggard companies to adopt frontier technologies.

[11] Results for the labor productivity growth decomposition at the NACE 2-digit level within services are available upon request.

[12] In the case of lawyers and accountants, Romania shows very restrictive entry regulation when compared to other European countries. For instance, lawyers are subject to burdensome accreditation requirements (specifically in terms of additional licensing by state/public authorities), and they also have – as well as accountants and architects - to go through a mandatory professional examination and a compulsory two-year relevant practice to become a full member of the profession. In addition, a compulsory chamber membership is applied to accountants and lawyers (also to architects) and accountants are also required to have two years of higher education (besides a 3-year college degree) to enter the profession. In terms of conduct regulations, lawyers are subject to price controls (min/max set prices), can only operate under a restricted legal form of business (they are not allowed to provide services as public limited companies), and are not allowed to advertise or do marketing.

Figure 7. Average proportion of domestic frontier firms in time t that were already in the domestic frontier in t-1



Note (1): The figure shows the proportion of firms classified as domestic frontier firms at time t - i.e. in the top 5% of the industry TFPR distribution – according to their status one year earlier (t-1).

3.2 Decomposing productivity growth

In principle, productivity growth can be decomposed into three components: within, between and selection (entry/exit). As highlighted in Cusolito and Maloney (2018), the first component reflects the ability of incumbent firms to become more productive and is related to the upgrading of firms' internal capabilities (by innovating, adopting new technologies, and applying best managerial practices). The "between" component is associated with the reallocation of factors of production and economic activity towards more efficient firms. The selection component reflects entry of more productive firms and/or exit of less productive firms relative to the industry average.

As the data set used here for Romania focuses on surviving companies, the analysis can cover only the within and between components. Against this backdrop, and as a first (and indirect) attempt to detect the main drivers of productivity growth, Figure 8 shows average employment growth differentials across the quartiles of the firm TFPR-adjusted distribution. As an indirect way to measure misallocation, the logic of this simple exercise is as follows: if labor is efficiently allocated across firms in the same sector, then employment in more productive firms should grow larger, while employment in less productive firms should shrink. Indeed, results show that employment has been expanding faster in firms belonging to more productive quartiles (not to firms with more market power, as the analysis uses markup-adjusted TFPR), which suggests that labor reallocation has been productivity enhancing. Some nuances are revealed when splitting the economy across manufacturing and services (Figure 9). In this case, services show signs of misallocation as firms in the least productive quartile in terms of TFPR-adjusted performance are expanding employment faster than the ones in the most productive quartile.

Figure 8. Average employment growth across the firm TFPR markup adjusted distribution; all firms: deviation from the 2011-2017 average

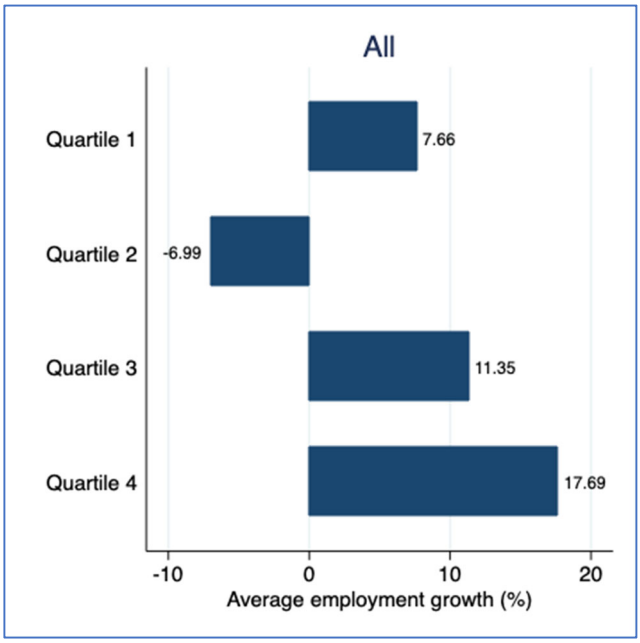
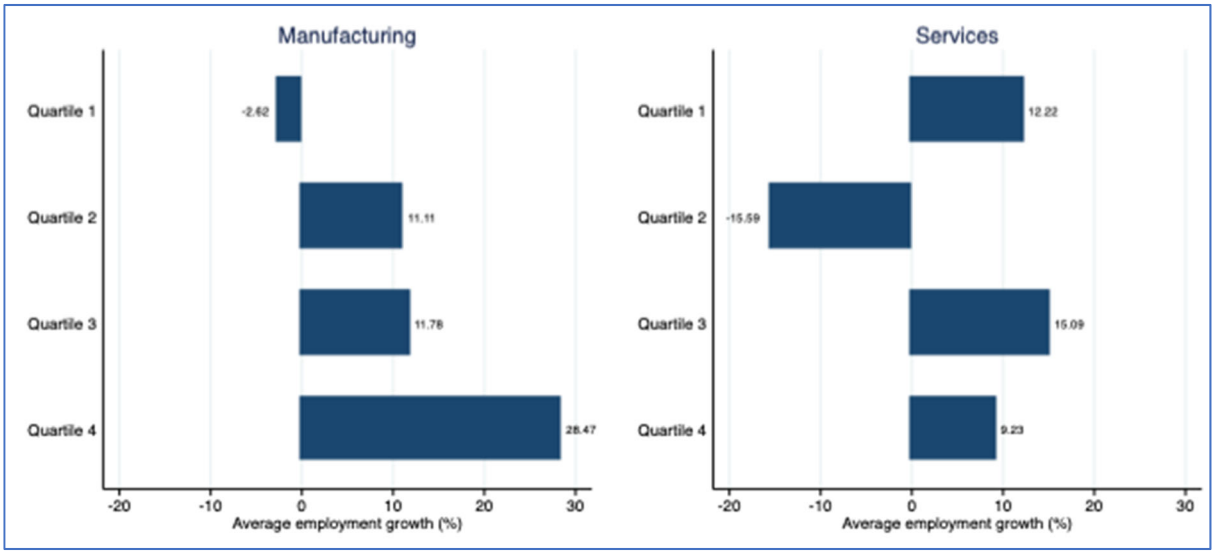


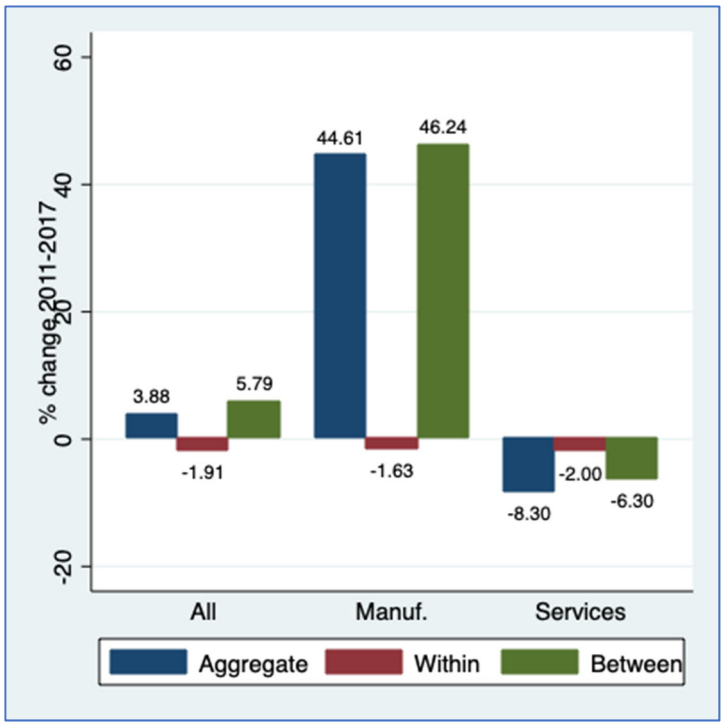
Figure 9. Average employment growth across the firm TFPR markup adjusted distribution; manufacturing vs services: deviation from the 2011-2017 average



A direct way to measure allocative efficiency is offered by the Olley and Pakes (1996) decomposition. The decomposition goes beyond the reallocation ('between') component and includes the 'within' margin. It measures the difference between size — here measured by a firm's market share in the industry/sector in terms of value added — and productivity to gauge the efficiency with which output is allocated across firms, by industry and sector. Results suggest that the reallocation element is indeed the main driver of productivity expansion for the whole economy in the 2011-2017 period (Figure 10). On average, TFPR-adjusted has grown by 3.88% per year in

the period, mostly driven by the positive reallocation component. Meanwhile, the within component is shown to be negative, reflecting a weak managerial skills, internal capabilities or innovation capacity.[13] When breaking down by industry, the 'between' component is positive only for manufacturing. For services, which are typically more sheltered from competitive pressures given the lower exposure to foreign competition and more stringent product market regulations, the reallocation margin is negative, suggesting that more productive firms are not conquering larger market shares.

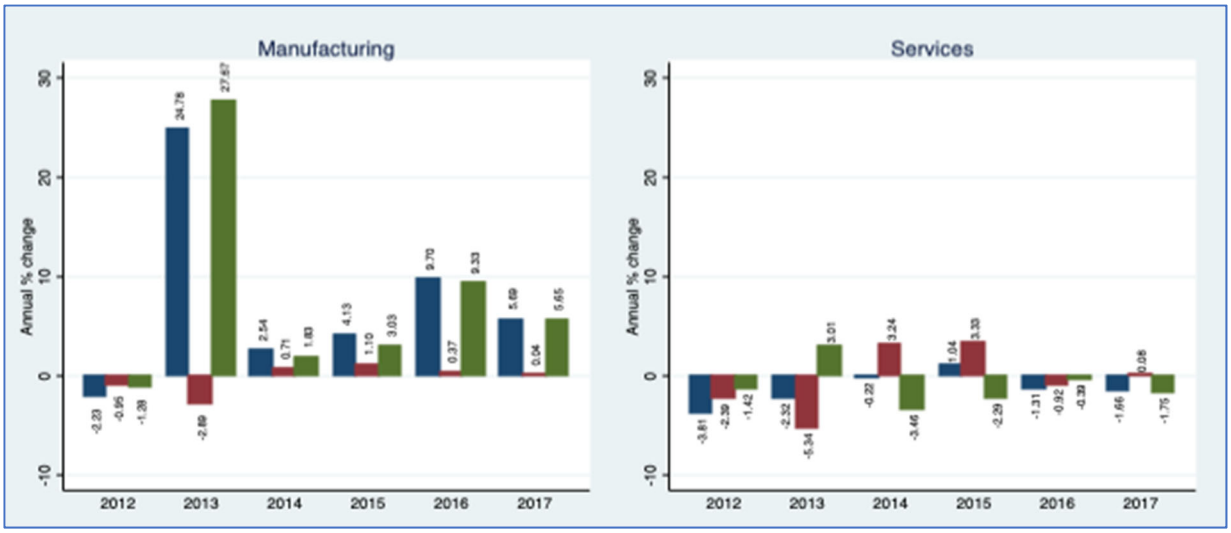
Figure 10. Olley and Pakes decomposition of TFPR markup adjusted (2011-2017, accumulated % change)



Annual data show a clear picture for manufacturing, confirming that the reallocation process has been productivity enhancing for all years, except 2012, while the within margin was negative only until 2013. For services, the 'within' and "between' components alternate in magnitude and sign (Figure 11).

[13] As shown in the Romania Systematic Country Diagnostic (World Bank, 2018), Romanian firms lag in different dimensions of innovation, for instance given the low number of patents applications to the European Patent Office and the low R&D expenditures. In addition, Romania shows poor performance – when compared to EU peers - in terms of reliance on professional management.

Figure 11. Olley and Pakes decomposition of TFPR markup adjusted (2011-2017 annual % change)



Some nuances are revealed at the NACE 2-digit level.[14] Within manufacturing, the only sectors for which aggregate productivity growth and the between component are both positive are manufacturing of wood, manufacturing of machinery and equipment, and manufacturing of motor vehicles. Within the services industry, most 2-digit sectors experience the same pattern observed for the service industry as a whole, with negative aggregate productivity growth and negative within and between components. The exceptions are: sewerage; civil engineering; retail trade; water transport; architectural and engineering activities; scientific research and development; and employment activities.

4. Conclusions

This paper aimed at conducting a firm level productivity analysis to explore firm heterogeneity in Romania while answering two key questions: i) who are the firms – and their key characteristics - driving and dragging productivity growth? ii) what are the drivers behind productivity expansion?

For the first question, the results suggest that companies at the domestic productivity frontier are older, larger, pay higher salaries, charge higher markups and have higher capital intensity. The data also suggest that the labor productivity of laggard firms has been increasing faster than that of domestic frontier ones, especially after 2013; and this catching up process has been driven mostly by capital deepening rather than gains in (revenue-based) total factor productivity (TFPR). When disentangling the gap between domestic frontier and laggard companies in terms of growth of TFPR, the results suggest there is a widening gap for manufacturing and this appears to be driven mostly by domestic frontier companies charging increasingly higher markups (relative to non-frontier firms) rather than by gains in technical efficiency (proxied by TFPR markup-

[14] Results for Olley and Pakes decomposition at the NACE 2-digit level (within manufacturing and services) are available upon request.

adjusted). This would suggest that the higher markup performance of domestic manufacturing productivity leaders might come either from higher market power or differences in quality and demand of their products, rather than from their ability to successfully invest in and combine new technology to succeed in the market. For services, the average gap in growth of TFPR between domestic frontier and laggard companies is almost inexistent over the period under analysis, and again this result is driven by markup performance of domestic leader companies, who tend to increase their markups faster than laggards.

As for the drivers of productivity growth, the Olley and Pakes decomposition results show that the between component was relatively more important than the within margin to explain productivity growth in the 2011-2017 period; but it is positive only for manufacturing. For services - that are typically more sheltered from competitive pressure, with lower exposure to foreign competition and more stringent product market regulations - the reallocation margin is negative on average, suggesting that the most productive firms are not capturing larger market shares. When breaking the analysis by year, the results show a small and mostly positive within component for manufacturing, while the same component for services displays an unsteady performance, alternating signs throughout the whole period under analysis. This suggests that individual firms are becoming less productive, with space to improve firm capabilities (management quality, technological learning, etc.), particularly in services. The high contribution of reallocation for manufacturing and the unsteady performance of the reallocation and within components for services might reflect inefficiencies arising from remaining regulatory barriers in services. Other possible explanations include a more efficient allocation of resources in tradable sectors (manufacturing) triggered by EU accession in 2007 and by the cleansing effect of the 2008 crisis.

These findings can be useful to outline the contours of a comprehensive productivity policy for Romania. Policies aimed at streamlining the operating environment for firms – by addressing market failures and removing distortions – and policies designed to boost human capital and innovation are equally important. Removing constraints to resource allocation can be achieved, for instance, by streamlining product market regulation, ensuring competitive neutrality in markets where SOEs and the private sector compete (or could compete), reducing informality and removing (non-tariff) barriers to trade. Removing constraints to human capital accumulation is also key and can be achieved by improving education and reducing skills mismatches.

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Annex A – List of 2-digit sectors

	nace2d sectors
1	Manuf. motor vehicles
2	Manuf. food
3	Manuf. rubber and plastic
4	Manuf. fabricated metal products
5	Manuf. basic metals
6	Manuf. other non-metallic mineral pds.
7	Manuf. machinery and equipment
8	Manuf. wearing apparel
9	Manuf. beverages
10	Manuf. electrical equipment
11	Manuf. wood
12	Manuf. chemicals
13	Manuf. Computer electronic and optical
14	Manuf. furniture
15	Manuf. leather
16	Manuf. textiles
17	Manuf. other transport equipment
18	Manuf. coke & ref. petroleum
19	Repair of machinery and equipment
20	Manuf. pharmaceutical
21	Manuf. paper
22	Printing
23	Other manufacturing
24	Wholesale trade
25	Retail trade
26	Wholesale and retail trade of motor vehicles
27	Land transport
28	Electricity gas steam and air conditioning
29	Telecommunications
30	Construction of buildings
31	Warehousing and support activities for transportation
32	Computer programming
33	Specialised construction activities
34	Architectural and engineering activities
35	Real estate activities
36	Civil engineering
37	Advertising and market research

38	Waste collection
39	Food and beverage service activities
40	Activities of head offices
41	Office administrative
42	Accommodation
43	Water collection treatment and supply
44	Postal and courier activities
45	Travel agency
46	Rental and leasing activities
47	Security and investigation activities
48	Publishing activities
49	Employment activities
50	Programming and broadcasting activities
51	Legal and accounting activities
52	Services to buildings and landscape activities
53	Information service activities
54	Scientific research and development
55	Air transport
56	Activities auxiliary to financial services
57	Other professional scientific and technical activities
58	Motion picture video and television programme production
59	Repair of computers
60	Financial service activities
61	Water transport
62	Veterinary activities
63	Remediation activities
64	Sewerage

Annex B. Evolution of Productivity Moments

			TFPR (ln)			Adjusted TFPR (ln)			Labor prod. (ln)		
year	sector	Number of firms	Mean	Median	Dispersion	Mean	Median	Dispersion	Mean	Median	Dispersion
2011	Manufacturing	24,433	6.605	6.668	0.970	6.182	6.437	1.215	10.298	10.306	1.227
2012	Manufacturing	24,433	6.611	6.68	0.970	6.171	6.426	1.225	10.278	10.282	1.214
2013	Manufacturing	24,433	6.629	6.704	0.975	6.137	6.38	1.255	10.282	10.298	1.230
2014	Manufacturing	24,433	6.634	6.715	0.988	6.141	6.383	1.270	10.358	10.369	1.209
2015	Manufacturing	24,433	6.633	6.715	0.990	6.15	6.407	1.268	10.467	10.464	1.168
2016	Manufacturing	24,433	6.636	6.728	0.999	6.157	6.412	1.259	10.509	10.503	1.136
2017	Manufacturing	24,433	6.633	6.727	1.005	6.165	6.41	1.263	10.561	10.566	1.141
2011	Services	159,423	7.164	7.388	1.372	5.768	5.962	1.945	10.805	10.797	1.414
2012	Services	159,423	7.157	7.38	1.385	5.737	5.925	1.963	10.777	10.763	1.408
2013	Services	159,423	7.158	7.377	1.388	5.676	5.853	1.986	10.751	10.725	1.395
2014	Services	159,423	7.151	7.369	1.398	5.703	5.881	1.995	10.821	10.803	1.394
2015	Services	159,423	7.145	7.36	1.404	5.731	5.917	1.998	10.938	10.921	1.349
2016	Services	159,423	7.147	7.358	1.406	5.729	5.931	2.002	10.975	10.958	1.326
2017	Services	159,423	7.143	7.346	1.411	5.748	5.955	2.006	11.017	11.004	1.326
2011	All	183,856	7.084	7.175	1.337	5.827	6.043	1.865	10.734	10.718	1.400
2012	All	183,856	7.081	7.179	1.348	5.797	6.01	1.885	10.709	10.687	1.394
2013	All	183,856	7.086	7.185	1.352	5.738	5.944	1.911	10.688	10.656	1.383
2014	All	183,856	7.081	7.187	1.362	5.762	5.968	1.919	10.759	10.734	1.380
2015	All	183,856	7.075	7.184	1.366	5.788	5.998	1.920	10.874	10.849	1.336
2016	All	183,856	7.076	7.184	1.368	5.788	6.009	1.921	10.911	10.885	1.311
2017	All	183,856	7.07	7.182	1.372	5.808	6.031	1.924	10.954	10.933	1.311