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Sectoral Approach in Output Growth Decomposition and its Determinants in Europe

Maja Bacovic ♦[1]

[1] Prof. Dr., University of Montenegro, Faculty of Economics (Montenegro)
✉ majab@ucg.ac.me

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Abstract:

The structural changes in Europe have occurred over the last several decades, reducing output share in the goods sector, while increasing its share in overall services. Applying the growth accounting approach, we decomposed output growth in the economy while following the sectoral approach, in ten individual sectors in twenty-six European countries, from 2000 to 2019. Our analysis shows that total factor productivity has accounted for almost half of the European countries' growth in output in the last two decades, with the other half primarily accounted for by increases in fixed asset growth and employment growth, while its variations among sectors are significant. The output growth in the services sector is significantly more driven by employment growth than in the goods sector, leading to overall employment growth in the economy. Applying the panel pooled OLS model, we found that the relevance of expenditures for research

♦**Corresponding author:** University of Montenegro, Faculty of Economics (Montenegro).
[✉ majab@ucg.ac.me]

and development is high and positive in all sectors, but higher in industry and knowledge-intensive services (information and communication, scientific activities) compared to all sectors average. To the best knowledge of the author, this is the first study presenting output growth decomposition estimates at the sectoral level for a selected group of countries, but also the first study presenting estimates of TFP in the total economy for a selected time period. In addition, this is the first study that presents the relevance of investment in research and development at the sectoral level in this specific time period and group of countries. Results of the study may be used in defining national policies priorities, as there are varieties among sectors in terms of their impact on employment and economic growth.
Keywords: Output Growth Decomposition, Sectoral Approach, Total Factor Productivity, Research and Development.
JEL Codes: O47, O52.

1. Introduction

The structural changes in Europe have occurred over the last several decades, reducing output share in the goods sector, while increasing its share in overall services. The sectoral approach in the analysis of economic growth is relevant as it might be determined by its productive structure. Analysis at the sample of twenty-six European countries in the last two-decade period shows that the average output share in agriculture declined from 2.7% in 2000 to 2.18% in 2019; in the industry from 21.63% to 20.27% respectively; in construction from 6.36% to 5.4%, while it increased in the overall services sector from 71.1% to 72.5%. The fastest-growing services sectors are knowledge-intensive, such as information and communication, with output share growth from 3.3% in 2000 to 6.6% in 2019, and professional, scientific and technical activities, from 7.9% to 10.4% respectively[1].

The sectoral perspective in economic analysis is directly linked to structural changes. Kratena (2005), points out "the shift of resources, output and employment between different sectors accompanying the process of economic growth has been recognised as a possible challenge for adjustment in industrialised economies". Moro (2015), suggested that both the growth rate and volatility of an economy might be related to its productive structure.

[1] Source: Author's calculation based on Eurostat data.

In economic analysis, it is generally accepted that productivity growth is a major source of economic growth and welfare development. As in Margaritis et.al (2005), "labour productivity has accounted for roughly half of the growth in per capita GDP in OECD countries over the last two decades of the XX century, with the other half primarily accounted for by increases in labour utilisation (changes are the demographics, unemployment and labour force participation rates)". Nelson (2000) points out that "in the early 1950s, empirical work made it clear that growth of total factor productivity accounted for the lion's share of the measured increases in output per worker. Technological advancement has been proposed as a major force behind TFP growth'. Further, quoting work by Schmookler (1952), Schultz (1953), Fabricant (1954), Kendrick (1956) and Abramovitz (1956), concluded that "the growth output experienced in the United States after World War II was significantly greater than reasonably can be ascribed to input growth". It was explained by technological advancement, changing composition of the labour, investments in human capital and reallocation of resources from lower to higher productivity activities and economies of scale.

Observing structural changes toward rapid growth in the services sectors in European countries, this research aims to decompose output growth applying growth accounting approach, in all countries from the sample (twenty-six European countries) for the period from 2000 to 2019, at the economic level but also the individual sector level, into the following components: capital growth, labour growth, capacity utilisation growth and TFP growth. Therefore, we will be able to investigate whether the expansion of a specific sector is capital, labour or TFP growth driven. In addition, as the expansion of scientific and technical knowledge that raises the productivity of labour and other inputs of production have been seen as a source of persistent growth in income per person, applying a panel pooled OLS (fixed effects) model, we estimate the significance of the investment in research and development at the sectoral level.

In this study, we use a sample of twenty-six European countries[2] and the period from 2000 to 2019. The sample was reduced to twenty-six countries because of data availability.

The growth accounting approach was applied to estimate production

[2] Belgium, Czech republic, Denmark, Germany, Estonia, Ireland, Greece, France, Italy, Cyprus, Latvia, Lithuania, Luxemburg, Hungary, Malta, Netherlands, Austria, Poland, Portugal, Romania, Slovenia, Slovakia, Finland, Sweden, Norway United Kingdom.

input growth and total factor productivity (TFP) in the total economy and at the sectoral level, for ten sectors: agriculture, forestry and fishing; industry (except construction); construction; wholesale and retail trade, transport, accommodation and food service activities; financial and insurance activities; information and communication; real estate activities; professional, scientific and technical activities; administrative and support service activities; public administration, defence, education, human health and social work activities; arts, entertainment and recreation; other service activities; activities of the household and extra-territorial organisations and bodies.

Estimation of the contribution from inputs and total factor productivity growth is important because of its contribution to long-term income per capita growth. From the computation methodological point of view, since the work of Abramovitz (1956) and Solow (1957), the growth accounting approach has been applied in a significant number of studies.

To the best knowledge of the author, this is the first study presenting output growth decomposition estimates at the sectoral level for a selected group of countries, but also the first study presenting estimates of TFP in the total economy for a selected time period. In addition, this is the first study that presents the relevance of investment in research and development at the sectoral level in this specific time period and group of countries.

This study is comprised of six sections. After the introduction, the second part provides an overview of the research available in the literature. The third section relates to the empirical analysis of structural changes and growth in Europe. The following section relates to the data, research methodology and empirical results. The fifth section provides comparisons with the results from other studies. The concluding remarks and recommendations for future research are presented in the final section.

2. Literature review

Due to its relevance, the availability of the literature on sources of growth and structural changes is vast. We list only selection from the most recent, tackling the issues studied in this paper.

On the importance of total factor productivity (TFP) progress, there is much evidence in the literature. Barro (1998) points out that technological progress is, in fact, crucial to the long-term per capita growth that the U.S. economy has been able to sustain for two centuries. Based on an extensive literature review, Kim and Loayza (2017), categorised TFP determinants into five components: innovations, education, market efficiency, physical infrastructure and institutional infrastructure. In their research, they

concluded that "variation of TFP across countries for the last three decades is explained the most by the physical infrastructure index, followed by the education index and the market efficiency index at a similar level, the innovation index and the institutional infrastructure index".

Romer (2001) stressed that the growth of knowledge is the most important determinant of output growth for the last century. Becker (1993) concluded that "It is clear that all countries which have managed persistent growth in income have also had large increases in the education and training of their labour force. The systematic application of scientific knowledge to the production of goods has greatly increased the value of education, technical schooling, and on-the-job training as the growth of knowledge has been embodied in people – in scientists, scholars, technicians, managers, and other contributors to output".

In their study, Eichler et al. (2006) found that "higher taxes reduce productivity growth, increase innovation resources, and better intercontinental accessibility leads to higher productivity growth". Productivity growth is also influenced by global trends, industrial structures and spatial spillover effects.

Holmes and Schmitz (2010), found that industries experiencing dramatic changes in their competitive environment were forced to increase productivity, or only plants that have large productivity gains survive competition increases.

Wu, Guo, and Marinova (2017) presented new evidence on TFP and economic growth in China and found that "productivity growth is the main driver of economic growth in all three sectors: agriculture, manufacturing and services". They also found that technological progress influenced TFP growth significantly.

The availability of literature on structural transformation and its impact on growth is also vast. Morro (2015), studied the impact of the sectoral composition of gross domestic product on cross-country differences in GDP growth and volatility, and concluded that "an increase in the share of services in GDP reduces both aggregate total factor productivity (TFP) growth and volatility, thus reducing GDP growth and volatility". Foster-McGregor and Verspagen (2017) presented a study on decomposing TFP growth in manufacturing and services, with a sample of 40 countries and a period from 1995 to 2009. Their research has shown that "TFP growth in manufacturing tends to outpace that in services in most economies". They found that some exceptions exist, particularly in Asian countries, suggesting that "productivity growth in services need not always be lower than that in manufacturing". McMillan, Rodrik and Verduzco-Gallo (2014), analysing

structural changes in Africa and Latin America, found that labour flows from low productivity to high productivity activities are a key driver of development. In addition, since 1990, structural change has been growth reducing, with labour moving from low to high-productive sectors.

Levenko et.al (2019) presented a study on TFP growth accounting in eleven countries from Central and Eastern Europe, for the period 1996-2016. Their study showed that on average, TFP growth accounted for one-third of GDP growth, while capital deepening accounted for approximately half. The growth accounting methodology was also applied in research by Baier, Dwyer and Tamura (2006), using a sample of 145 countries and data for more than a hundred years for 23 countries in the sample, showing that total factor productivity explains 14% of average output growth per worker. By total factor productivity, they mean "changes in technology, institutional change, failure of the twin assumption of constant returns to scale and competitive factor markets, and other factors". Bacovic (2021) presented a study on the total factor productivity in middle-income Balkan countries, applying a sectoral approach.

Buera and Kaboski (2012) found a positive relationship between high-skilled labour and the services sector. They developed a theory in which "demand shifts toward more skill-intensive output as productivity rises, increasing the importance of market services relative to home production. Their theory predicts a rising level of skills, skills premium and the relative price of services that are linked to this skill premium".

3. The output, employment and labour productivity in Europe – an empirical analysis

3.1. Sector's definition, data and sample

Following NACE classification, sectors are defined as follows: agriculture, forestry and fishing (later agriculture), industry, construction and service sectors disaggregated into seven subsectors: wholesale and retail trade, transport, accommodation and food service activities; financial and insurance activities; information and communication; real estate activities; professional, scientific and technical activities; administrative and support service activities; public administration, defence, education, human health and social work activities; arts, entertainment and recreation; other service activities; activities of the household and extra-territorial organizations and bodies. All data were extracted from the Eurostat database. A detailed presentation of the indicators used in this research is presented in section 4.1. Analysis was based on the sample of 26 European countries, from 2000

to 2019.[3]

3.2. Dynamics of the structural changes in Europe's output, labour productivity and employment

Based on annual data on gross value added (output) in all NACE activities and specific sectors, from a sample of twenty-six European countries, from 2000 to 2019, we estimated the average share of the gross value added (GVA) in specific sectors concerning the economy's gross value added. We observed that industry, trade (including transportation and tourism) and public administration have the largest share in total output, followed by construction and other services (finance, ICT, real estate). Sectors of public administration and trade, followed by industry are the largest employers, with the higher share of employed in relation to total employment. Labour productivity (measured as output per person employed) is the highest in the finance, information and communications and industry sector (above total average), while the lowest is in agriculture (Table 1).

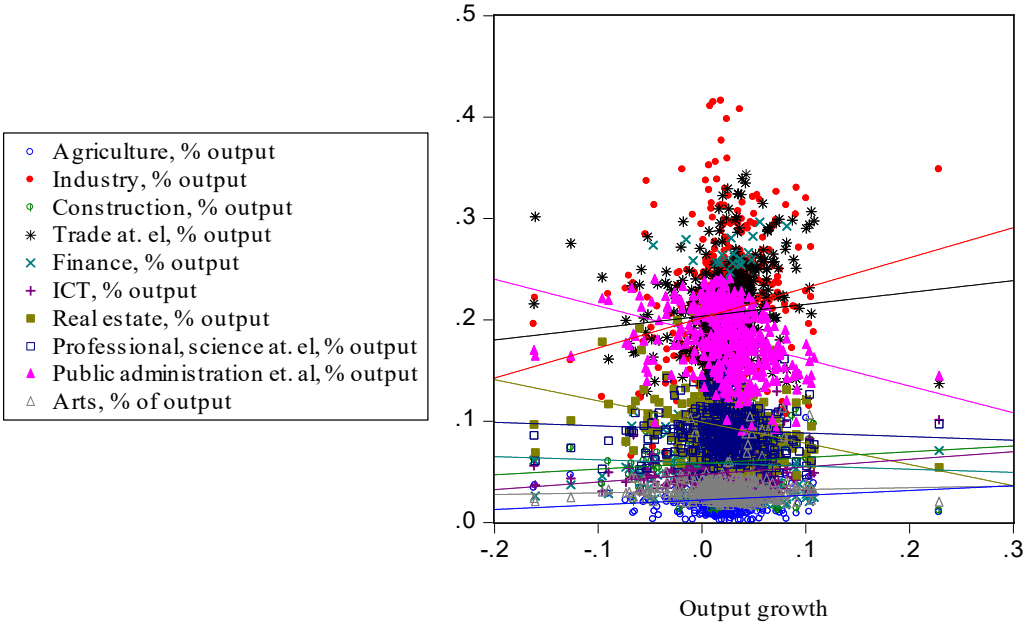
[3] All data are available on request.

Table 1. Structure of Europe's output and employment; labour productivity, sample average, 2000-2019

	Share in total output	Share in total employment	Labour productivity (thousand 2010 constant euro)	
	average annual 2000-2019	average annual 2000-2019	average annual 2000-2019	All = 100
All NACE activities	100.00%	100.00%	45,83	1.00
Agriculture, forestry and fishing	2.42%	6.62%	23,39	0.51
Industry (except construction)	20.38%	17.85%	57,70	1.26
Construction	6.05%	7.31%	36,16	0.79
Wholesale and retail trade, transport, accommodation and food service activities	20.89%	24.70%	37,11	0.81
Financial and insurance activities	5.89%	2.91%	91,57	2.00
Information and communication	4.90%	2.67%	81,57	1.78
Real estate activities	9.54%	0.99%	-	-
Professional, scientific and technical activities; administrative and support service activities	9.16%	9.87%	41,91	0.91
Public administration, defence, education, human health and social work activities	18.01%	22.32%	36,66	0.80
Arts, entertainment and recreation; other service activities; activities of the household and extra-	3.12%	4.77%	28,70	0.63
Observations	498	459	459	459

Source: Author's calculations, based on Eurostat data (common sample)

Structural changes in Europe have an impact on GDP growth. As in Panel 1, industry growth has the strongest impact on GDP growth, while several services sectors also positively determine it, as information and communication, trade, finance and professional, scientific and technical services. The growth of the share of public administration in total output has a strong negative impact on GDP growth.



Panel 1. Structural changes and output growth, 1920-2019
Source: Author's calculations (based on Eurostat data)

Descriptive statistics analysis shows that investigation of the sources of output growth on a sectoral level is important, to understand future development trends.

4. Data, methods and empirical results

4.1. Data

Data used in the research were extracted from the Eurostat database (data on country's level), with annual frequency. Following indicators were used: gross value added (all NACE activities, chain-linked volumes (2010), million euro), also for individual activities: agriculture, forestry and fishing; industry (except construction); construction; wholesale and retail trade, transport, accommodation and food service activities; financial and insurance activities; information and communication; real estate activities; professional, scientific and technical activities; administrative and support service activities; public administration, defence, education, human health and social work activities; arts, entertainment and recreation; other service

activities; activities of the household and extra-territorial organizations and bodies[4].

Following NACE classification, data on total fixed assets (current replacement costs, million euro)[5] were adjusted to chain-linked volumes (2010), million euro, applying price index (implicit deflator), 2010=100, euro, for all activities individually. Employment data (total employment domestic concept) were used also classified in accordance with NACE[6]. Data on expenditures for research and development (originally extracted as share in GDP)[7], were adjusted to its nominal values (constant prices, 2010 euro).

4.2. Methodology - Growth accounting approach

Applying the growth accounting approach, we will decompose output growth rates in all sectors and ten individual sectors (as listed in section 3.1), into four components: capital stock growth, employment growth, capital utilization growth and total factor productivity growth.

The growth accounting approach was selected due to its many advantages. "The growth accounting approach provides a filing system that is complete, in the sense that all phenomena that affect economic growth must do so through input factor quantities, relative factor intensities or total factor productivity growth, either singly or in combination. Second, the results of the growth accounting exercise may point to areas where parametric studies are likely to be fruitful" (Norsworthy, 2005).

As in Levenko et.al (2019), the starting point is a general specification of aggregate production function:

$$Y_t = A_t F_t(h_t K_t, L_t) \quad (1)$$

Where Y_t stands for output in the period t, K_t is the capital stock in the period t, $h_t \in (0,1)$ is the rate of capital utilization in the period t; L_t is employment and A_t is Total Factor Productivity (TFP).

[4] National accounts aggregates by industry (up to NACE A*64) [nama_10_a64], extracted on 03/03/2021.

[5] Cross-classification of fixed assets by industry and by asset (stocks) [nama_10_nfa_st], extracted on 04/03/2021.

[6] National accounts employment data by industry (up to NACE A*64) [nama_10_a64_e], extracted on 04/03/2021.

[7] Intramural R & D expenditure (GERD) by sectors of performance [rd_e_gerdtot], extracted on 04/03/2021.

If production function is time differenced and perfect competition and constant returns to scale are assumed, the growth rate of output is equal to (Levenko et.al, 2019):

$$\frac{\Delta Y_t}{Y_{t-1}} \approx (1-\alpha_t^k)\frac{\Delta L_t}{L_{t-1}} + \alpha_t^k \frac{\Delta K_t}{K_{t-1}} + \alpha_t^k \frac{\Delta h_t}{h_{t-1}} + \frac{\Delta A_t}{A_{t-1}} \quad (2)$$

The operator Δ denotes the first difference, and α_t^k is the elasticity of output to capital utilized in the period t. the equation (2) "decomposes output growth into components steaming from growth in employment, growth in available capital, growth in capital utilization and TFP growth" (Levenko et.al, 2019).

As in Bacovic (2021), at the sectoral level, the specification of aggregate production function is:

$$Y_{t,i} = A_{t,i}F_{t,i}(h_{t,i}K_{t,i}, L_{t,i}) \quad (3)$$

The variable $Y_{t,i}$ is value added (output) in the period t in sector *i, i=1, 10*(1 - agriculture, forestry and fishing; 2- industry (except construction); 3 - construction; 4 - wholesale and retail trade, transport, accommodation and food service activities; 5 - financial and insurance activities; 6 - information and communication; 7 - real estate activities; 8 - professional, scientific and technical activities; administrative and support service activities; 9 - public administration, defence, education, human health and social work activities; 10 - arts, entertainment and recreation; other service activities; activities of the household and extra-territorial organizations and bodies). $K_{t,i}$ is the sector's capital stock (fixed asset) available at the beginning of the period t in sector i, while $h_{t,i} \in (0,1)$ is the rate of capital utilization in the period t so $h_t K_{t,i}$ is the capital actually utilized for the production of $Y_{t,i}$; $L_{t,i}$ is employment in sector *i* and $A_{t,i}$ is Total Factor Productivity (TFP) in sector *i*.

The growth rate of output is equal to:

$$\frac{\Delta Y_{t,i}}{Y_{t-1,i}} \approx \left(1-\alpha_{t,i}^k\right)\frac{\Delta L_{t,i}}{L_{t-1,i}} + \alpha_{t,i}^k \frac{\Delta K_{t,i}}{K_{t-1,i}} + \alpha_{t,i}^k \frac{\Delta h_{t,i}}{h_{t-1,i}} + \frac{\Delta A_{t,i}}{A_{t-1,i}} \quad (4)$$

Data for output, capital stock (total fixed asset) and employment were available, while capital utilization must be computed. In case of missing data on capital utilization, there are few options. Levenko et.al (2019), used the capacity utilization in manufacturing as a proxy for the utilization of capital in the entire economy, but we will follow Solow's

approach and use change in the unemployment rate (Solow, 1957) as a unique indicator in the estimation of TFP on total economy and sectoral level.

In this research, we applied constant estimates for output to capital elasticity, equal to 0.33, as suggested as typical value by Romer (2001), on total economy and sectoral level, assuming that:

$$\alpha_{t,i}^{k} = \alpha_{t}^{k} \tag{5}$$

4.3. Model, panel pooled OLS (simple and fixed effects)

We may express aggregate production of an economy as a function of capital stock, labour and TFP:

$$Y_t = A_t K_t^{\alpha} L_t^{\beta}, 0 < \alpha + \beta < 1 \tag{6}$$

where Y_t represents the aggregate production of the economy at the time t, A_t is the total factor productivity, and K_t and L_t represent the capital stock and labour, respectively. The constants α and β represent the share of capital and labour in income.

Further, we will express TFP as a function of investment in research and development R_t and other exogenous factors C_t:

$$A_t = f(R_t, C_t) = R_t^{\vartheta} C_t \tag{7}$$

After combining equations 6 and 7, we express the production function as:

$$Y_t = C_t K_t^{\alpha} L_t^{\beta} R_t^{\vartheta} \tag{8}$$

where α, β and φ represent the elasticities of production with respect to the inputs of production: K_t, L_t and R_t.

After taking natural logs, the following equation is obtained:

$$LY_t = c + \alpha LK_t + \delta LL_t + \vartheta LR_t + \varepsilon_t, \tag{9}$$

Where c is the intercept, α, β and φ are constant elasticities and ε_t is the error term.

4.4. Empirical results

4.4.1. Growth accounting method

Applying the growth accounting method, presented in section 4.2, on a sample of twenty-six European countries and the period from the year 2000 to 2019, we decomposed output growth rates in all NACE activities and ten individual NACE activities[8] (Table 2). We estimated contribution to gross value added growth from capital stock growth, employment growth and total factor productivity growth, for the total economy and respective services sectors. In this section, we will present the average value for all variables.

Average annual output growth (gross value added) in the overall sample from 2000 to 2019 was 2.27%, fixed asset growth 1.99%, employment growth 0.72% and total factor productivity growth 1.12%[9]. Comparative analysis of gross value added growth in all NACE activities (total economy) and respective sectors show that output growth was higher in relation to all sectors mean in information and communication sector (IT), professional, scientific and technical activities (PST) and trade, transport and accommodation (TTA), while in other sectors was below the average. Fixed asset growth (capital stock growth) was also the highest in those sectors (but also above average in agriculture and industry), while IT and PST activities generated the highest employment growth. Total factor productivity growth was the largest in the IT sector, followed by industry and financial and insurance activities.

[8] **N**omenclature statistique des **a**ctivités économiques dans la **C**ommunauté **e**uropéenne
[9] Capacity utilization growth was (-0.01%) in all sectors

Table 2. Output growth decomposition in Europe, 2000-2019

	Gross value added growth	Fixed Asset growth		Employment growth		TFP growth
	mean	mean	0.33%	mean	0.67%	mean
All NACE activities	2.27%	1.99%	0.66%	0.72%	0.48%	1.12%
Agriculture, forestry and fishing	0.75%	2.44%	0.81%	-2.10%	-1.41%	1.34%
Industry (except construction)	1.93%	2.21%	0.73%	-0.81%	-0.54%	1.73%
Construction	1.03%	1.29%	0.42%	0.63%	0.42%	0.18%
Wholesale and retail trade, transport, accommodation and food service activities	2.30%	2.34%	0.77%	1.00%	0.67%	0.87%
Financial and insurance activities	2.21%	0.66%	0.22%	0.53%	0.36%	1.63%
Information and communication	4.99%	3.57%	1.18%	2.56%	1.71%	2.09%
Real estate activities	2.06%	1.20%	0.40%	2.43%	1.63%	0.03%
Professional, scientific and technical activities; administrative and support service activities	3.82%	3.77%	1.24%	3.50%	2.35%	0.22%
Public administration, defence, education, human health and social work activities	1.20%	1.03%	0.34%	1.22%	0.82%	0.04%
Arts, entertainment and recreation; other service activities	1.63%	1.71%	0.56%	1.61%	1.08%	-0.02%
Observations	399	399	399	399	399	399

Source: Author's computation

Decomposition of output growth for total economy and respective sectors has shown different significance from the production inputs (capital stock, employment and total factor productivity) if apply sectoral approach (Table 3).

Table 3. Share of the source of growth

	Fixed Asset growth	Employment growth	TFP growth
All NACE activities	28.9%	21.2%	50.0%
Agriculture, forestry and fishing	107.7%	-188.2%	180.5%
Industry (except construction)	37.9%	-28.0%	90.2%
Construction	41.0%	40.7%	18.2%
Wholesale and retail trade, transport, accommodation and food service activities	33.6%	29.2%	37.2%
Financial and insurance activities	9.8%	16.1%	74.0%
Information and communication	23.6%	34.4%	42.0%
Real estate activities	19.2%	78.9%	1.9%
Professional, scientific and technical activities; administrative and support service activities	32.6%	61.5%	5.9%
Public administration, defence, education, human health and social work activities	28.3%	67.9%	3.8%
Arts, entertainment and recreation; other service activities; activities of the household and extra-territorial organizations and bodies	34.7%	66.1%	-0.8%

Source: Author's computation

Our analysis has shown that total factor productivity determined almost half of the output growth in European countries over the last two decades, with the other half primarily determined by increases in fixed asset growth and employment growth. Similar findings were presented by Margaritis et.al (2005), showing that "labour productivity has accounted for roughly half of the growth in per capita GDP in OECD countries over the same period, with the other half primarily accounted for by increases in labour utilisation (changes in the demographics, unemployment and labour force participation rates)".

On a sectoral level, contribution to growth varies. In agriculture and industry employment growth was negative, while it is a significant source of growth in services. Opposite, TFP growth was the most significant source of growth in agriculture and industry, but also in financial and insurance activities. Capital growth was the most relevant source of growth in agriculture but contributed lesser to the growth in the services sector.

4.4.2. Panel pooled OLS (simple and fixed effects) model

The properties of the variables (defined in section 4.1) were examined by determining the existence of unit-roots. The Hausman test is used in order to choose between the fixed effects model and the random-

effects model in panel data.

Estimation results of Equation 9 (Table 4) show that growth in the capital stock (total fixed asset) by one unit leads to the output growth by 0.21, while the same rate of employment growth leads to the output growth by 0.84. An increase in expenditures for research and development by one percentage point determines output growth by 0.05 points. Growth in exogenous components of TFP is to 0.9%. Result obtained corresponds to the one estimated applying growth accounting approach, presented in the previous section.

Table 4. Estimation results (equation 9), panel fixed effects OLS

Dependent Variable:LY_t
Sample (adjusted): 2001 2019
Cross-sections included: 26
Total panel (balanced) observations: 468

Variable	Coefficient	Std. Error
LK_t	0.212717***	0.036243
LL_t	0.842992***	0.062394
LR_t	0.058221***	0.012915
C	0.009205***	0.001382

*** p<.01, ** p<.05, * p<.1

Source: Author's estimations

Estimation of Equation 9 at the industry level shows that the impact from expenditures for research and development is higher in the industry sector compared to the total economy (0.08), the exogenous component of TFP growth also (1.29%)[10], as presented in Table 5.

Table 5. Estimation results (equation 9), applied in the industry sector (panel pooled OLS)

Dependent Variable: $LY_{industry,t}$
Sample (adjusted): 2001 2019
Cross-sections included: 24
Total panel (balanced) observations: 424

Variable	Coefficient	Std. Error
$LK_{industry,t}$	0.266830***	0.054682
$LL_{industry,t}$	0.568351***	0.081894
LR_t	0.088898**	0.028636
C	0.012962***	0.003208

*** p<.01, ** p<.05, * p<.1

Source: Author's estimations

Exogenous components of TFP growth is the highest in the

[10] Result obtained corresponds to the one estimated applying growth accounting approach, presented in the previous section.

information and communication services sector (3.23%), which is higher than the value estimated applying the growth accounting approach, but with a comparable trend (information and communication sectors is the one with the highest TFP growth). Contribution from expenditures for research and development is higher in the information and communication sector in relation to the total economy, which is expected as this is the knowledge-intensive sector. Results are presented in Table 6.

Table 6. Estimation results (equation 9), applied in the ICT sector (panel fixed effects OLS)

Dependent Variable: $LY_{ict,t}$
Sample (adjusted): 2001 2019
Cross-sections included: 25
Total panel (balanced) observations: 446

Variable	Coefficient	Std. Error
$LK_{ict,t}$	0.339460***	0.041459
$LL_{ict,t}$	0.104957**	0.051201
LR_t	0.073761***	0.025753
C	0.032395***	0.003081

*** p<.01, ** p<.05, * p<.1

Source: Author's estimations

Contribution from expenditures for research and development is the highest in the sector of professional, scientific and technical services, as expected (Table 7). Exogenous components of TFP growth determines output growth in this sector at a slower rate than in the total economy.

Table 7. Estimation results (equation 9), applied in the sector of professional, scientific and technical services (panel fixed effects OLS)

Dependent Variable: $LY_{pst,t}$
Sample (adjusted): 2001 2019
Cross-sections included: 23
Total panel (balanced) observations: 407

Variable	Coefficient	Std. Error
$LK_{pst,t}$	0.252440***	0.030831
$LL_{ipst,t}$E	0.423837***	0.061037
LR_t	0.149740***	0.026578
C	0.007116**	0.003480

*** p<.01, ** p<.05, * p<.1

Source: Author's estimations

4.4.3. Comparisons with results with other studies

Measuring Total factor productivity applying the growth accounting approach has its difficulties. Fairly innocuous deference in assumptions can lead to very different estimates of TFP growth. (Prem notes, 2000) That is why is important to emphasize the sensitivity of the results by changing assumptions.

Although earlier research on output growth decomposition applying the growth accounting method does not cover the same sample and time frame, some overlaps make comparison possible. Work done by Foster-McGregor and Verspagen (2017) and Levenko et.al (2019) are the most comparable one, in terms of a time frame but also methodology and sample (eighteen countries from our sample match the sample in Foster-McGregor and Verspagen study, while seven countries from our sample match the sample in the study by Levenko et.al).

Despite different methodological approaches and time covered, results from all studies are similar for most countries (Table 8) and show a high degree of consistency. Results from both studies on the sectoral level show higher TFP growth in the industry than in the services sector.

Table 8. Comparisons of the results with the study by Foster-McGregor and Verspagen (2017) and Levenko et.al (2019)

	Bacovic (2021)		Foster-McGregor, Verspagen (2017)	Levenko et.al (2019)
	2001-2019 average annual growth	2001-2019 cumulative growth	1995-2009 cumulative growth	1996-2016 average annual growth
Belgium	0.40%	7.53%	3.96%	0.63%
Czechia	1.88%	35.78%	23.99%	
Germany	0.39%	7.44%	9.19%	
Estonia	2.04%	38.75%	34.14%	1.77%
Ireland	1.36%	25.78%	7.00%	
Greece	-0.15%	-2.93%	3.67%	
France	0.11%	2.17%	17.94%	
Italy	-0.48%	-9.16%	-5.04%	
Lithuania	3.28%	62.28%	29.36%	1.24%
Luxembourg	-0.18%	-3.40%	6.01%	
Hungary	1.57%	29.81%	30.20%	0.89%
Poland	2.43%	46.16%	52.30%	1.80%
Slovenia	1.47%	27.92%	29.24%	1.22%
Slovakia	2.61%	49.61%	27.10%	0.96%
Finland	0.07%	1.27%	19.60%	
Sweden	0.44%	8.35%	16.98%	
United Kingdom	0.28%	5.29%	13.13%	

Source: Author's calculations, Foster-McGregor and Verspagen (2017), Levenko et.al (2019)

5. Conclusion

The structural changes in Europe have occurred over the last several decades, reducing output share in the goods sector, while increasing its share in overall services. The sectoral perspective in economic analysis is important as both the growth rate and volatility of an economy might be related to its productive structure. Estimation of the contribution from inputs and total factor productivity growth at the sectoral level provides valuable insights into the impact of structural changes on the overall growth.

Applying the growth accounting approach, we decomposed output growth rates in twenty-six European countries from the year 2000 to 2019, in all sectors aggregated, and ten individual services sectors (agriculture, industry, construction and seven services sectors). Output growth was

decomposed into 4 components: capital stock growth, employment growth, capital utilization growth and total factor productivity growth.

Computation of the share of the source of growth in total growth in the economy and specific sectors has shown that the total factor productivity is the major source of growth, accounting for 50% in all sectors, but more significant in agriculture and industry. Employment growth is the most significant source of growth in services. The capital stock growth has the largest relevance in agriculture, industry and construction.

Applying the panel pooled OLS model, we found that the relevance of expenditures for research and development is high and positive in all sectors, but higher in industry and knowledge-intensive services (information and communication, scientific activities) compared to all sectors average.

Therefore, a sectoral approach in growth analysis is important, as there is no typical behaviour in all economic sectors. Also, as concluded earlier, services sector growth is the key driving force behind employment growth, as average annual employment growth was even negative in agriculture and industry.

Results of the study may be used in defining national policies priorities, as there are varieties among sectors in terms of their impact on employment and economic growth. Further research should focus to explain what determines structural changes. Variations in wages and income from different sectors may be a possible answer but need further investigation.

References

Abramovitz, M. (1956). Resource and Output Trends in the United States Since 1870. In M. Abramovitz, *Resource and Output Trends in the United States Since 1870,* 1-23. NBER. https://doi.org/10.2307/3498218

Arratibel, O., Heinz, F., Martin, R., Przybyla, M., Rawdanowicz, L., Serafini, R., & Zumer, T. (2007). *Determinants of growth in the Central and Eastern European EU member states – a production function approach.* Frankfurt: European Central bank (ECB Occasional Paper, No. 61).

Bacovic, M. (2021). Total factor productivity growth in upper middle-income Balkan countries from 2000-2017, total economy and sectoral approach: growth accounting method. *Argumenta Oeconomica, 1*(46) - *forthcoming*.

Baier, S., Dwyer, G., & Tamura, R. (2006). How important are capital and total factor productivity for economic growth? *Economic Inquiry 44*(1), 23-49. https://doi.org/10.1093/ei/cbj003

Becker, S. G. (1993). *Human Capital: A Theoretical and Empirical Analysis with Special Reference to Education* (3rd ed.) 15-28. Chicago: The University of Chicago Press.https://doi.org/10.7208/chicago/9780226041223.001.0001

Buera, F., & Kaboski, J. (2012). The Rise of the Service Economy. *American Economic Review, 102*(6), 2540-2569.https://doi.org/10.1257/aer.102.6.2540

Chala, V. (2015). The peculiarities of trade specialization in creative industries in the Central and Eastern European countries. *Eastern Journal of European Studies, 6*(1*)*, 91-109.

Dombi, A. (2013). Economic Growth and Development in Central and Eastern Europe after the Transformation. *Public Finance Quarterly, 58*(4), 452-468.

Eichler, M., Grass, M., Blochliger, H., & Ott, H. (2006). *Determinants of Productivity Growth.* Basel: BAK.

Foster-McGregor, N., & Verspagen, B. (2017). Decomposing Total Factor Productivity Growth in Manufacturing and Services. *Asian Development Review, 34*(1), 88-115.https://doi.org/10.1162/adev_a_00082

Holmes, T. J., & Schmitz. , J. A. (2010). Competition and Productivity: A Review of Evidence. *Annual Review of Economics, 2*, 619-642.

Holtgrewe, U. (2015). *Services Research along the Service Process: An overview study to support UNI Europa's.* Vienna: Forba.

Kim, Y. E., & Loayza, N. V. (2017, October 25). *Productivity and its Determinants: Innovation, Education, Efficiency, Infrastructure, and Institutions.*http://pubdocs.worldbank.org/en/378031511165998244/Productivity-and-its-determinants-25-October-2017.pdf

Konan, D. E., & Maskus, K. (2016). *Quantifying the Impact of Services Liberalization in a Developing Country.* World Bank Policy Research Working Paper, no 3193. https://doi.org/10.1596/1813-9450-3193

Kratena, K. (2005). Sectoral Economy: Do sectors Really Matter? *Estudios de Economia Aplicada, 23*(2), 289-298.

Krenz, A. (2014). Services sectors concentration and countries specialization patterns in the European Union: A comparative analysis with a special focus on France, Germany, Greece and the UK. *Regional and Sectoral Economic Studies, 14*(1*)*, 23-32.

Levenko, N., Kaspar, O., & Karsten, S. (2019). Total factor productivity growth in Central and Eastern Europe before, during and after the global financial crisis. *Post-Communist Economies*, *31*(2), 137-160 https://doi.org/10.1080/14631377.2018.1460713

Margaritis, D., Scrimgeour, F., Cameron, M., & Tressler, J. (2005). Productivity and Economic Growth in Australia, New Zealand and Ireland. *Agenda: A Journal of Policy Analysis and Reform, 12*(4), 291–308. https://doi.org/10.22459/ag.12.04.2005.01

Morro, A. (2015). Structural Change, Growth and Volatility. *American Economic Journal: Macroeconomics, 7*(3), 259-294.

Nelson, R. R. (2000). *The Sources of Economic Growth.* Cambridge, Massachusetts/London, England: Harvard University Press.

Norsworthy, J. (2005). Growth Accounting and Productivity Measurement. *Review of Income and Wealth 30*(3), 309-329. https://doi.org/10.1111/j.1475-4991.1984.tb00554.x

Prem notes. (2000). *Measuring growth in total factor productivity.* Washington, D.C.: The World bank.

Romer, D. (2001). *Advanced Macroeconomics.* New York: McGraw-Hill Higher Education.

Solow, M. R. (1957). Technical Change and the Aggregate Production Function. *The Review of Economics and Statistics, 39*(3), 312-320.

Wu, Y., Guo, X., & Marinova, D. (2017). Productivity, Innovation and China's Economic Growth. In L. Song, R. Garnaut, C. Fang, & L. Johnston, *China's New Sources of Economic Growth.* ANU Press. https://doi.org/10.22459/cnseg.07.2017.09