Sustainability of the Process of Convergence in Poland

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Abstract: The paper assesses the sustainability of the process of convergence of the Polish economy with the developed western economies as far as the level of development (GDP or GVA) is considered. The basic assumption is that this sustainability depends on the role of MFP in the growth process. If the growth is largely MFP driven, then it should be sustainable (MFP being a variant of TFP used in the KLEMS growth accounting). However, it is at industry level that this analysis should be carried out rather than at the aggregate level, which fact justifies the use of KLEMS growth accounting in the analysis. Also, the way this MFP role is defined is crucial. After applying the standard decomposition of GVA growth the contribution of MFP to that growth is interpreted as far as its share in all contributions to growth is considered. The paper provides a positive response to the issue. In the light of KLEMS growth accounting Poland seams poised to achieve a successful transition towards durable prosperity.

Key words: Convergence, GVA decomposition, MFP contribution, KLEMS

JEL codes: E01, O11, O47.

1. Introduction

There is a wide theoretical literature on the convergence that (according to e.g., Heckscher-Ohlin-Samuelson theory of international trade, to start with) is supposed to be inevitable between the developed and the still developing, not to mention the underdeveloped, countries. This convergence can be differently defined and may concern different areas of economic activity and the institutions, but it is the level of economic development, usually measured as gross domestic product or gross value added (both per capita), which will be considered in the present paper.

One of the reasons for choosing these measures, although they are imperfect, is that data are quantitative and comprehensively collected. Within this scope, surprisingly, the general observation is such that those measures do show that something quite different happens in the real world – only some, and quite few, developing countries find the way to overcome the gap between their economic development level and the level of the developed countries. One possible explanation of this contradiction lies in the institutional framework, i.e., that ineffective institutions prevent many developing economies to achieve a successful transition to a high development level, that would otherwise arrive inevitably. But inefficient institutions not always can be traced directly (at least, not always quantitively) and usually they become conspicuous only through economic performance insufficiency. So, observing economic phenomena with the use of growth accounting methods has an explanation potential here.

Moreover, some contenders assume that institutional factors are secondary or dependent on the economic condition of the given country, and the true reason for not achieving a durable transition to the club of the developed countries is structural. The given country is simply lagging behind, as far as the issue of structural change in the economy is considered. Therefore, after episodes of rapid growths economic collapses follow, which means that any gain on the path towards economic prosperity is being waisted in the longer run. Only when rapid growth is sustainable the successful transition to the club of the so-called rich is achievable. But this point of view gives even more potential to the growth-accounting-based methods as explanation devices for the issue of not achieving the expected convergence.

There are many structural issues, but quite many of them are observable with the use of the growth-accounting-based methods, particularly the KLEMS growth accounting. It is because the KLEMS type growth decompositions are done at the industry level. Given that, and after KLEMS

economic productivity datasets have been published for Poland by the statistical office (Statistics Poland), it is presently feasible to analyze much further this issue for the Polish economy, i.e., to bring closer the answer to the question whether this economy is undergoing the convergence as above mentioned and whether this convergence is sustainable.

In the following section the basic methodology of the paper's study will be explained. In the next section calculations' results will be presented and will be discussed. The paper will end with a conclusion section.

2. Methodology of the study

The decomposition of economic growth into the contributions of two basic production factors (labor and capital) has been initiated originally by Solow (1957), following a specific development of his economic growth theory (Solow, 1956). The application of this theory in regularly carried out productivity accounts was related with the introduction of Leontief concepts (1966) in statistics. Because of the relative complexity of numerous calculations to be performed its practical implementation was only possible with the advent of the computer era. The present version of economic growth accounting in the form of KLEMS growth accounting was developed mainly by Jorgenson and associates (Jorgenson & Griliches, 1967; Jorgenson, Gollop, Fraumeni, 1987; Jorgenson, Ho, Stiroh, 2005).[1] It is a methodology that is basically consistent with OECD (2001) methodology and together with it remains one of the two most often performed ways of carrying out economic growth accounts using the so-called index method, very strongly advised by Diewert (1976, 1978, 1992, 2004 and 2005)[2], a well-known expert of the trade. The starting point, then, will be the so-called Solow's decomposition:

$$\frac{\Delta Y}{Y} = \frac{\Delta A}{A} + \alpha \frac{\Delta K}{K} + \beta \frac{\Delta L}{L} \tag{1}$$

where *Y is* the GDP, *L* – the labor factor, considered as physical counted hours (later strictly defined as hours worked), *K* – the capital factor, considered as capital stock value. The weights α and β are elasticities, that can be specified as shares of factor remunerations in total income, which

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[1] It is worth to see also: Jorgenson (1963 and 1989). The basic KLEMS methodology was well summarized in: Timmer et al. (2007) and O'Mahony & Timmer (2009). In Poland the KLEMS methodology was adopted by Statistics Poland after solving some country-specific issues (Kotlewski & Błażej, 2018 and 2020).
[2] There exists also the so-called econometric method developed by, e.g.: Ackerberg, Caves, Frazer (2015); Levinsohn & Petrin (2003) and Olley & Pakes (1996).

requires, according to the theory, the adoption of the assumptions about the existence of perfect competition and constant returns to scale in the economy – moreover, these assumptions allow to use the formula $\beta = 1 - \alpha$ in (1). *A* is the so-called total factor productivity (TFP). The contribution of TFP, i.e., *ΔA/A* is calculated residually by subtracting the other values in (1) – it is the so-called Solow's residual. In this way, there is no direct need to establish the value of *A,* which remains an abstract category and its interpretation was (and to some degree still is) an issue. Solow interpreted it as technological progress. Presently, it is usually interpreted as technological or organizational progress disembodied in labor or capital.[3]

Because the Törnqvist procedure (quantity index) is used for aggregation when the Solow-type decomposition is carried out at industry level this formula (1) was replaced in the KLEMS type growth accounting by its trans-log approximation:

$$\Delta ln V_{jt} = \Delta ln A^V_{jt} + \overline{\alpha_{jt}}\Delta ln K_{jt} + \overline{\beta_{jt}}\Delta ln L_{jt} \tag{2}$$

which is consistent with this procedure. It has been established that in this procedure average shares between two time periods *t* and *t-1* should be used, according to formula $\bar{\alpha}_t = (\alpha_t + \alpha_{t-1})/2$ and similarly for $\bar{\beta}_t$ – subscript *j* for industries, present in (2) has been omitted here for simplicity. By definition, these shares are shares in the gross value added (GVA) here and it is the growth of GVA (V_{jt}) that is present on the left-hand side of formula (2). For each year and each industry (for instance represented by NACE or ISIC sections and divisions) the formula (2) should be used independently. Thanks to its trans-log shape the formula (2) is strictly conformable with the original Cobb-Douglas production function.[4] The formula (2) can be developed by introducing an additional variable, related with the intermediate inputs, to the original production function. The result is an extended decomposition conformable with this developed production function:

$$\Delta ln O_{jt} = \Delta ln A^O_{jt} + \overline{\alpha_{jt}}\Delta ln K_{jt} + \overline{\beta_{jt}}\Delta ln L_{jt} + \overline{\gamma_{jt}}\Delta ln X_{jt} \tag{3}$$

In such an extended decomposition, the variable standing on the left-hand side represents the gross output (O_{jt}), and on the right-hand side – the terms related with the factors (capital – K_{jt}, labor – L_{jt})

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[3] This will be stipulated later on again.
[4] However, in the instance when growths are high (much over 10%) the logarithm values become discrepant with the classic relative growths from formula (1).

and in addition a term related with intermediate inputs (otherwise called intermediate consumption – X_{jt}), not to mention the residual term related with productivity. The formula (2) is consistent with this extended decomposition of gross output growth, thanks to the fact that the growth term from (2) on the left-hand side concerns the growth of GVA, not GDP, and so it is in the KLEMS growth accounting. This turn is not however an issue of major importance for the present study. However, it must be noticed that the shares ($\overline{\alpha_{jt}}$, $\overline{\beta_{jt}}$ and $\overline{\gamma_{jt}}$) in (3) are shares in gross output, whereas the shares in (2) are shares in GVA (they have not been differentiated in order not to complicate too much the symbols used). In the theory developed after Solow it was established that only the decomposition of gross output growth (with an additional factor-alike contribution in the form of intermediate inputs' contribution to gross output growth) allows to establish technological or organizational progress disembodied in labor or capital. This gross-output-based MFP contribution is different than the gross-value-added-based MFP contribution, but in an ideal situation they should be related by the ratio between the value of gross output and GVA. Otherwise, the formula (2) can allow to establish the contribution to growth of technological or organizational progress disembodied in labor or capital only approximately – it can be inconsistent (not related by a known ratio as above mentioned) because of the phenomenon of substitution between the production factors (labor and capital) and the intermediate inputs. That is why the contribution of the *A* variable in (2) is presently rather considered as the industry capacity to capture the value, to participate in the income (OECD, 2001, 23). But this understanding of the residual productivity contribution to growth is even more appropriate for the present study, because of the rationale presented below.

One of the reasons is that behind all processes, that need to be examined, drivers (causative powers) stand. It can be ascertained that the main driver in question is TFP or MFP[5], and particularly their growing contributions to the economic growth, that will be identified here as GVA growth. It is because the increased contribution of labor (i.e., physical labor, particularly understood as hours worked) to growth can be related with a resource-driven kind[6] of economic growth or an impoverishing one and the contribution of capital to growth with an investment-driven (or capital-driven) kind of economic growth, and they are both exhaustible. Whereas the contribution of MFP to growth can be highly related with the category of innovation-driven

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[5] The difference between the two is of no prime importance for the present study. Later on, only MFP will be used in the study because of data availability within the KLEMS framework.
[6] Based on the availability of cheap resources, of which the labor resource is generally the most important.

economic growth (of which the horizon seams inexhaustible). The greater is the share of MFP, the more the economy is competitive, also because of higher value-capture capability of such an economy. In a situation of similar economic growth rates for two symmetric[7] countries, that with higher MFP contribution to growth is more sustainable, because its economy is becoming less prone to impoverishing effects related with the labor factor contribution and to growth exhaustion effects related with capital diminishing returns.

Moreover, the high level of productivity can be related to high weighted average profitability in the given NACE activity and the residual gross-value-added-based productivity contribution to GVA growth is often associated with the value capture capability increase (OECD, 2001) of the given NACE activity (in contrast to gross-output-based productivity contribution). In such activities, there are more high-profit firms and particularly profit-level-rising firms (as growths are considered in this methodology). More profitable firms are relatively more expansive, and this expansion is sustainable (because of the wide profit margin), particularly if the contribution of productivity to growth is high against the contribution of basic production factors (because the profit margin is increasing then). It is because high profitability attracts new financial capital both to firms and to the given industry as a whole and this is reinforced by expected profitability increases in the future. Because of the above-mentioned microeconomic fundamentals, a higher and growing productivity (i.e., growing productivity contribution to GVA growth here) should translate into higher economic growth rate of the given activity in the long run. Therefore, the information provided by the study of productivity should be helpful in identifying sustainable economic growth and should be helpful in assessing whether a given fast growing economy is poised for a successful convergence with the developed economies.

The use of gross output decomposition as in (3) and therefore the gross-output-based MFP is associated with data issues. Data insufficiency causes that for most countries, for which KLEMS growth accounting is performed, only the GVA decomposition according to formula (2) is being done. Fortunately, the GVA decomposition remains the central backbone of KLEMS growth accounting, providing the most important information about the economy. Therefore, despite its limitations, it remains the basis for most analyses based on the method of decomposition in the framework of this accounting. Performing GVA growth decomposition as in (2) instead of (3)

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[7] With similar sizes and levels of development.

facilitates also international comparisons, since the issue of huge differences in the vertical integration of firms between the countries related with intermediate inputs is lifted. Therefore, for the present study oriented to international comparisons the choice of GVA decomposition in the framework of KLEMS growth accounting seems to be even more justified.

What is important to notice is that in the KLEMS growth accounting different definitions of production factor contributions are applied – instead of contributions of factor stocks, as in the Solow's decomposition, the notions of contributions of factor services are applied in formulae (2) and (3). It is because the Törnqvist quantity index is used in the aggregation of factor values. Because of that, the residual productivity contribution term is the multifactor productivity (MFP) contribution, which can be considered as a more 'modern' kind of the Solow's residual than TFP contribution. Therefore, the present study will be further based on MFP-kind of productivity contributions analyses. The issue of whether TFP or MFP kind of productivity is better for the present study will not be raised in the present study however, since it is secondary (both results should provide similar qualitative outcomes).

Some values had to be calculated especially for the present study. At first, the idea to present data as simple averages over some years was adopted, but this method is to some extent controversial, because it gives the same weight to all yearly vintages of economic growth and the related contributions. This can become a problem if the time series are quite long. Therefore, preference has been given for the calculations made on a compound basis, that give more weight to later vintages of economic growth, which can be considered as a more appropriate procedure here. Chaining was used according to the following formulae:

$$\Delta lnV_{(1,n)} = \prod_{t=1}^{n}(1 + \Delta lnV_t) - 1 \tag{4}$$

$$\Delta lnA_{(1,n)}^V = \prod_{t=1}^{n}(1 + \Delta lnA_t^V) - 1$$

where *V* stands for GVA in discrete time periods *t* or the entire time span *(1,n)* and A^V stands for gross-value-added-based multifactor productivity (MFP) in discrete time periods *t* or the entire time span *(1,n)*. The reason for using compound values over some span of time, besides the fact that the study concerns the long-run issue of convergence, is also to avoid the blurring effects of short-run and country-specific situations for the present study and therefore to extract the important general information.

There is also the possibility to calculate this compound MFP contribution differently by first calculating the compound contributions of production factors, i.e., labor (hours worked and labor composition) and capital (ICT and non-ICT capital) and then subtracting them from GVA compound growth, so in the tables of the Appendix both values are provided. This second method is represented by the following equations:

$$\Delta lnV_{(1,n)} = \prod_{t=1}^{n}(1 + \Delta lnV_t) - 1$$

$$FC_{\Delta lnV_{(1,n)}} = \prod_{t=1}^{n}(1 + v_t^F \Delta lnF_t) - 1 \qquad (5)$$

$$\Delta lnA_{(1,n)}^V = \Delta lnV_{(1,n)} - \sum_F FC_{\Delta lnV_{(1,n)}}$$

where all symbols are same as in (4), and F stands for factors such as hours worked, labor composition, ICT capital or non-ICT capital; FC – for factor contribution to GVA growth $\Delta lnV_{(1,n)}$. v with appropriate subscripts and superscripts are the shares of the given factor F in the GVA V in the given discrete time periods t. $\Delta lnA_{(1,n)}^V$ stands for value-added-based multifactor productivity (MFP) contribution in the given time span *(1, n)*, and it is calculated residually as a subtraction between the compound GVA growth ($\Delta lnV_{(1,n)}$) and the compound sum of factor contributions ($\sum_F FC_{\Delta lnV_{(1,n)}}$) to that growth. The MFP contributions are calculated here residually for the entire time span in order to avoid mathematical tool problems[8]. This second method was in fact applied here because it allows to avoid visible discrepancies on the graphs in the Appendix[9].

3. Result presentation

The results of the compound values calculations have been presented in the table in the Appendix. Data were taken from the EU KLEMS database (2017 release). Therefore, only those countries were included for which data on GVA decomposition are available for the 2005-2015 time series (with a plausible exception of Czechia, Italy and Sweden for which a one-year shorter time series was adopted – 2005-2014). The economic growths are understood here as GVA growths. These growths are decomposed into contributions according to the KLEMS growth

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[8] Chaining causes that all the compound contribution values do not add up to GVA growth.
[9] If all values are positive, then it can be visible on the graphs that the sum of all factor contributions and MFP contribution sometimes do not match exactly the GVA growth level.

accounting methodology prior to the calculations done for the present study following the methodology presented in the previous section. The compound factor contributions were added up and an additional column in the table was provided.

A wide-industry approach has been applied here, at section level from the NACE 2 classification system. Agriculture, forestry, and fishing (NACE section A) has been omitted because the KLEMS methodology (as all decomposition methodologies based on the neoclassical economic theory) is considered to be controversial for this specific economic activity. Also, activities not belonging to the so-called 'market economy' according to the standard approach in the KLEMS framework, have been omitted – these are: real estate activities, public administration and defense, and compulsory social security, education and human health and social work activities (NACE sections L, O, P and Q). The activities of households as employers and undifferentiated goods- and services-producing activities of households for own use and the activities of extraterritorial organizations and bodies (NACE sections T and U), have been omitted too, because of their little importance.

Based on data from the table graphs were prepared showing features that will be analyzed. In all graphs the order of the NACE Rev. 2 wide industries from left to right is according to the growing speed of GVA compound relative growth. The basic idea is, according to the rationale presented in the previous section, that if the ranking of the industries, as far as the speed of GVA growth is considered, is mostly determined by the contribution of MFP, then GVA growth is sustainable in the long run (also in case it is negative or very subdued, which then can indicate a sustainability of the sluggish growth or even a durability of economic deterioration). The use of compound values over the chosen period 2005-2015 (it was chosen in order to reconcile the available data from EU KLEMS site with the available data from Statistics Poland) should allow to pass over many outlier observations for individual years and some temporary impacts. Also, the use of wide industries instead of lower KLEMS aggregations should help in avoiding many outlier observations. Qualitative analysis was adopted instead of a quantitative one (based on correlation formulae) because of insurmountable tool problems.

For Austria it can be seen that there is some connection between the speed of economic growth (GVA growth) of the considered industries and MFP contribution, with the notable exceptions of M-N industry, and also G and B industries – growth is therefore quite sustainable, although not

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exceptionally fast. For Belgium this cannot be observed, however. In case of Czechia this connection is conspicuous particularly in the ranking of collapsing industries with negative GVA growths over the adopted period (NACE sections I, D-E, H, S, R and F aligned in a series on the graph) – this feature should also be considered as sustaining economic growth since it means that unproductive industries are generally shrinking the more, the more their residual MFP productivity is also shrinking, but on the condition that these negative-growth industries do not overwhelm the positive-growth ones. This restructuring process can also be observed for Denmark, but to a lesser extent. The lack of a clear orderly connection between GVA growth and MFP contribution means that these changes for Finland are not sustaining GVA growth. For France, there exist such a connection to some extent but rather impacting the ranking of the industries as negative MFP contributions spread over quite many of them. A better connection can be observed for Germany, and so is the situation of this country. A clear connection can be observed for Italy, but since both GVA growth and MFP contributions are mostly negative the overall picture represents a durable setback rather than a sustainable growth. Much better is the situation in the Netherlands – with some exceptions the ranking generally depends on MFP contribution, often a positive one. Exceptionally good is the situation in Slovakia – the connection between MFP contribution and GVA growth is clearly conspicuous, and these are very large GVA growths and MFP contributions, mostly positive. The overall growth of the Slovakian economy is therefore fast and sustainable. Such a connection for the adopted compound period is not clearly observed for Spain unfortunately. It is present for Sweden, both on the negative and positive ranking ends, but with exceptions. A moderate sustainability of GVA growth can be plausibly adopted also for the United Kingdom and the United States. For Poland the above-mentioned connection is best between all the considered countries and very similar to Slovakia, and just as for this latter country GVA growths and MFP contributions are largely positive. The Polish economy is therefore developing fast, and this growth should be considered as sustainable just as for the Slovakian economy. This overall picture is not a complete one, but there arises a plausible statement that in the light of the rationale presented in the previous section there is a substantiation for the adoption of the view that the convergence between the Polish economy level of development (understood as GVA level) and the developed western economies' level is sustainable. It is because the economy is not only growing but also restructuring – high productivity industries are expanding, whereas low

productivity ones are shrinking, which creates more room for further economic growth in the future.

4. Conclusion

The adoption of the KLEMS methodology for studying whether the convergence process between the different economies is on track, as far as GVA growth is considered, seams sound. It is because it allows to pass over many blurring information and is reducing all possible impacts to the same quantitative platform, while at the same time allowing to carry out the analysis at industry level.

The basic assumption that was adopted in the present study is that it is the importance of MFP contribution that is decisive for assessing the sustainability of economic growth and therefore of the convergence of some developing economies with the already developed ones, and that for this purpose the value-added-based MFP contribution to growth is a more appropriate entity than the gross-output-based MFP – it is so because it relates more to the value capture capabilities of the considered industries.

If high-value-capture industries are growing faster than low-value-capture industries, then the economy is restructuring towards a greater value-capture capability in the future. This indicates that the growth process is sustainable and therefore if it is at the same time fast enough the convergence is on track – both the speed of the growth process and its sustainability are required however for the convergence to be ascertained. Since this condition is plainly fulfilled by Poland the issue in question seams solved – the Polish economy is converging with the developed economies and this process is a durable achievement.

References

Ackerberg D. **Caves** K. **Frazer** G. (2015). Identification Properties of Recent Production Function Estimators. *Econometrica,* 83(6), 2411-2451.

Diewert W. E. (1976). Exact and Superlative index numbers. *Journal of Econometrics*, 4(2), 115-145.

Diewert W. E. (1978). Superlative Index Numbers and Consistency in Aggregation. *Econometrica*, 46(4), 883-900.

Diewert W. E. (1992). The Measurement of Productivity. *Bulletin of Economic Research*, 44(3), 163-198.

Diewert W. E. (2004). Basic Index Number Theory. In: *Consumer price index manual: theory and practice.* International Monetary Fund, Chapter 15.

Diewert W. E. (2005). Issues in the Measurement of Capital Services, Depreciation, Asset Price Changes and Interest Rates. In: *Measuring capital in the new economy* (pp. 479-542), **Corrado** C. **Haltinger** J. **Sichel** D. (ed.). University of Chicago Press.

Jorgenson D.W. (1963). Capital Theory and Investment Behavior. *The American Economic Review*, 53(2), 247–259.

Jorgenson D.W. (1989). Productivity and Economic Growth. In: R.E. **Berndt**, E.J. **Triplett** (ed.), *Fifty years of economic measurement: the jubilee of the conference on research in income and wealth*, University of Chicago Press, pp. 19–118.

Jorgenson D.W. **Gollop** F.M. **Fraumeni** B.M. (1987). *Productivity and US economic growth.* Harvard University Press.

Jorgenson D.W. **Griliches** Z. (1967). The explanation of Productivity Change. *The Review of Economic Studies*, 34(3), 249–283.

Jorgenson D.W. **Ho** M.S. **Stiroh** K.J. (2005). *Information technology and the American growth resurgence.* MIT Press.

Kotlewski D. & **Błażej** M. (2018). Implementation of KLEMS Economic Productivity Accounts in Poland. *Folia Oeconomica*, 2/2018, 7-18.

Kotlewski D. & **Błażej** M. (2020). KLEMS Growth Accounting Implemented in Poland. *Statistics in Transition*, 21(1), 95-122.

Leontief W. (1966). *Input-Output Economics*, Oxford University Press 1986.

Levinsohn J. & **Petrin** A. (2003). Estimating Production Functions Using Inputs to Control for Unobservables. *Review of Economic Studies*, 70, 317–41.

O'Mahony M. & **Timmer** M. (2009). Output, Input and Productivity Measures at the Industry Level: The EU KLEMS Database. *The Economic Journal,* 119 (June), F374-F403.

OECD (2001). *Measuring Productivity*.

Olley G. S. & **Pakes** A. (1996). The Dynamics of Productivity in the Telecommunications Equipment Industry. *Econometrica,* 64(6), 1263-1297.

Solow R.M. (1956). A Contribution to the Theory of Economic Growth. *The Quarterly Journal of Economics*, 70(1), 65–94.

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

Timmer M. **van Moergastel** T. **Stuivenwold** E. **Ypma** G. **O'Mahony** M. **Kangasniemi** M. (2007). *EU KLEMS growth and productivity accounts. Version 1.0. part I. Methodology*. EU KLEMS Consortium.

Appendix

Table

Decomposition of compound GVA growth into compound contributions over 2005-2015, by selected NACE sections

Country	NACE section	Compound GVA growth	Compound H contribution	Compound LC contribution	Compound KIT contribution	Compound KNIT contribution	Compound MFP contribution***	Residual MFP contribution**** 7=1-(2+3+4+5)	Sum of compound factors' contribution 8=2+3+4+5
		1	2	3	4	5	6	7	8
Austria	D-E	-23.2	0.2	-1.3	3.3	4.0	-27.7	-29.3	6.1
	F	-18.0	3.2	-3.1	0.3	-0.5	-17.8	-17.9	-0.2
	H	-1.3	-6.4	-1.1	1.2	7.2	-1.6	-2.1	0.9
	B	1.3	-2.7	-0.6	0.6	56.4	-35.7	-52.4	53.7
	S	4.6	4.8	1.4	0.6	2.6	-5.6	-4.8	9.4
	G	11.0	-3.0	0.9	1.4	1.2	10.1	10.4	0.5
	R	13.2	6.8	-0.4	0.6	2.5	2.7	3.7	9.5
	ME**	14.2	0.3	1.1	1.1	5.5	5.8	6.2	8.0
	TE*	14.7	1.3	0.5	0.9	6.1	5.3	5.8	8.8
	I	17.1	3.9	0.9	0.1	4.3	7.1	8.0	9.1
	J	23.9	9.1	4.5	-2.0	3.7	6.6	8.6	15.3
	C	24.4	-2.9	1.9	0.9	10.0	14.3	14.5	9.9
	K	29.0	-2.0	3.3	2.3	-1.8	26.7	27.3	1.7
	M-N	40.1	20.2	2.7	2.8	11.4	-0.4	3.0	37.1
Belgium	I	-8.3	0.0	1.0	0.1	3.2	-12.4	-12.6	4.3
	B	-7.0	-13.1	3.9	-2.7	-7.3	19.4	12.2	-19.2
	G	2.7	-2.0	2.9	2.6	8.8	-8.7	-9.5	12.2
	D-E	4.5	10.4	-0.4	1.3	5.8	-11.3	-12.5	17.0
	R	7.2	9.9	2.7	2.4	9.4	-15.1	-17.2	24.4
	H	8.9	-2.8	4.4	0.7	1.3	5.3	5.3	3.6
	C	10.9	-12.4	3.7	0.8	-3.0	24.6	21.7	-10.8
	TE*	15.4	4.9	2.4	1.9	4.8	0.7	1.4	14.0
	ME**	17.0	3.7	1.9	2.5	3.6	4.5	5.4	11.6
	K	18.4	-4.3	3.4	2.0	-6.9	25.5	24.2	-5.9
	S	24.5	15.8	9.0	2.1	0.1	-3.7	-2.5	27.0
	F	29.2	8.7	1.9	1.5	16.8	-1.4	0.4	28.8
	J	39.4	12.7	2.9	8.5	6.9	3.8	8.4	31.0
	M-N	40.6	27.2	2.3	5.3	4.8	-1.5	1.1	39.5
Czechia	B	-34.7	-10.5	3.5	4.7	-20.9	-19.7	-11.5	-23.2
	I	-34.6	-0.9	1.1	1.5	12.3	-43.7	-48.7	14.1
	D-E	-28.5	-0.8	0.1	11.5	5.7	-40.4	-45.0	16.4
	H	-18.7	-0.2	2.6	0.4	17.2	-33.0	-38.7	20.0
	S	-13.0	4.9	6.3	2.5	6.0	-29.2	-32.7	19.7
	R	-6.2	4.4	5.2	1.8	12.7	-26.4	-30.2	24.1
	F	-0.1	-5.0	5.9	1.8	7.5	-9.6	-10.2	10.2
	M-N	13.2	7.0	8.9	1.1	34.8	-30.0	-38.6	51.8
	TE*	23.7	2.2	3.4	2.4	18.9	-3.7	-3.2	26.9
	ME**	27.5	1.8	4.2	2.9	18.2	-0.9	0.4	27.1
	G	53.4	4.4	3.2	1.5	13.7	24.3	30.7	22.8
	J	57.3	13.6	1.3	5.7	67.5	-33.5	-30.7	88.0
	K	63.9	8.6	0.6	1.1	24.3	-2.4	29.2	34.6
	C	64.7	-0.3	5.1	2.9	14.7	35.4	42.2	22.4

Note I: *TE – total economy, **ME – market economy, ***MFP compound contribution calculated according to formula (4), **** MFP compound contribution calculated according to formula (5).

Note II: For Czechia, Italy and Sweden the time series are one year shorter, i.e., 2005-2014; for Spain NACE section R and S are joint in a single R-S aggregate.

Source: own elaboration based on EU KLEMS data, 2017 release, http://www.euklems.net/; and Statistics Poland data, https://stat.gov.pl/en/experimental-statistics/klems-economic-productivity-accounts/ .

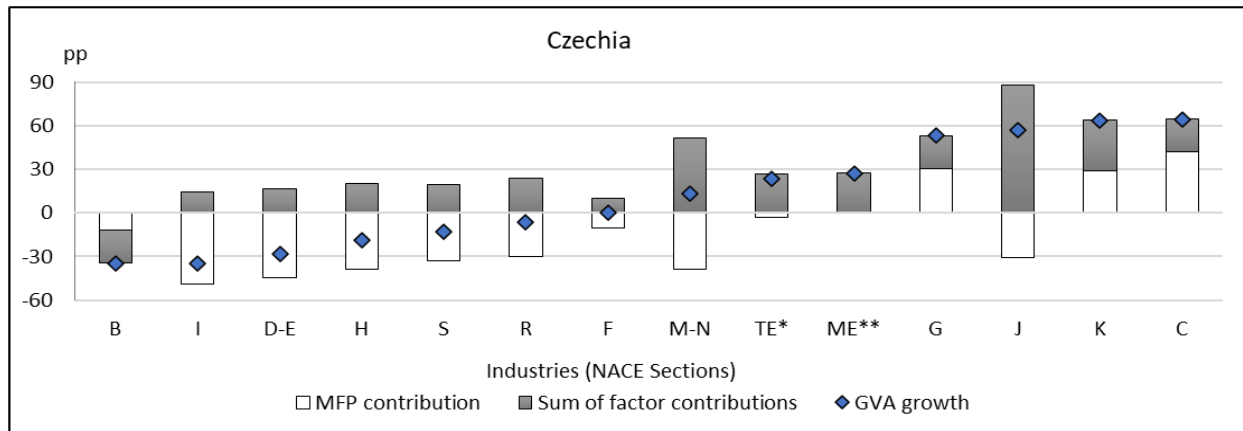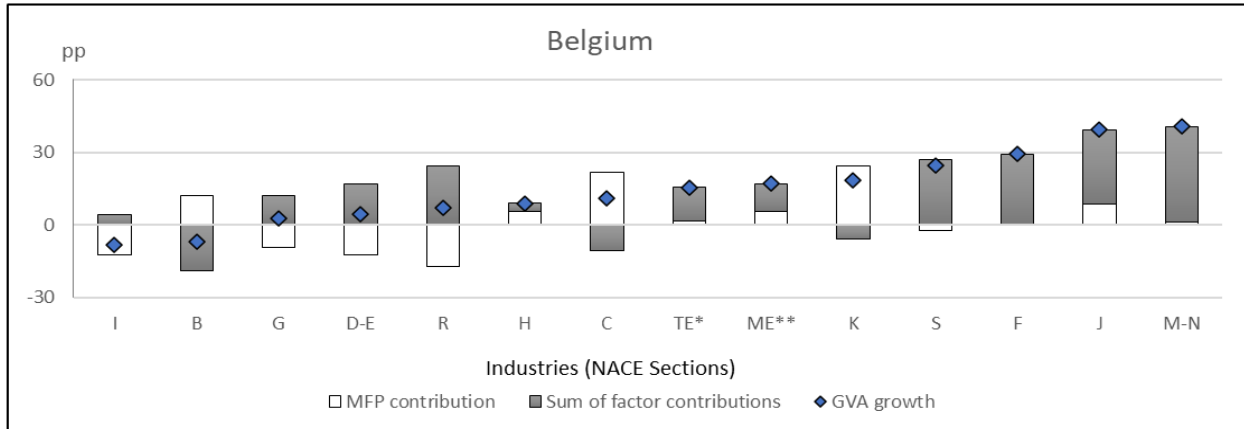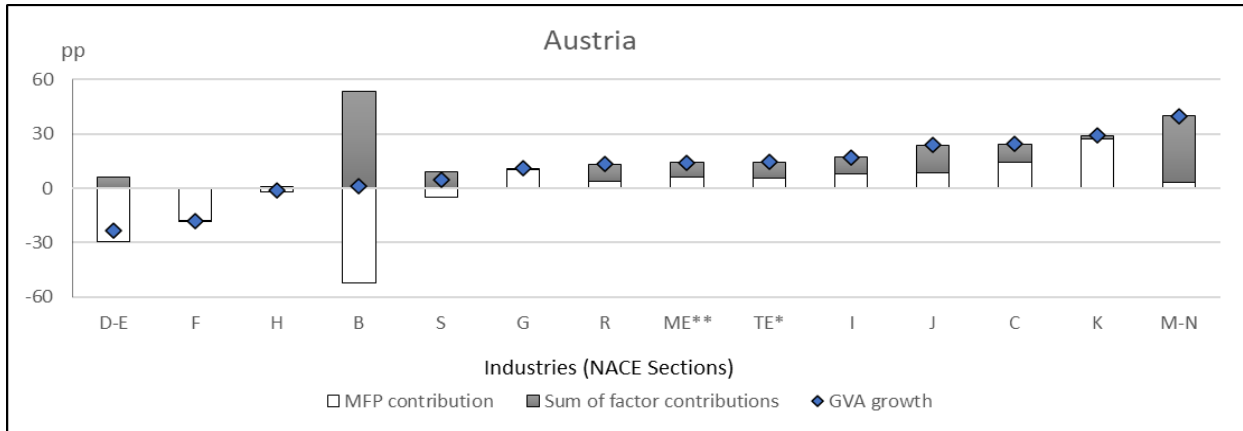|		1	2	3	4	5	6	7	8
Denmark	B	-65.5	-0.4	0.2	0.9	11.5	-70.0	-77.8	12.2
	D-E	-12.5	0.5	-0.5	1.0	4.5	-18.0	-18.1	5.6
	S	-8.6	-9.6	13.7	0.5	0.4	-12.5	-13.6	5.0
	H	-7.8	-8.5	6.5	1.0	9.0	-14.9	-15.9	8.1
	F	0.1	-7.6	14.2	2.0	0.8	-7.8	-9.2	9.3
	R	1.7	6.9	-4.8	3.7	-7.2	3.6	3.2	-1.5
	TE*	8.7	-0.4	4.6	1.8	5.9	-3.2	-3.2	11.9
	ME**	8.7	-2.3	6.4	2.1	3.3	-0.8	-0.7	9.4
	C	11.5	-16.1	3.5	1.6	3.7	21.5	18.7	-7.3
	G	15.8	-0.3	0.5	0.7	0.6	13.6	14.3	1.5
	I	17.9	21.2	10.3	1.0	-1.1	-11.9	-13.5	31.3
	M-N	20.5	21.9	14.5	1.7	3.3	-18.4	-20.8	41.3
	K	24.3	1.2	8.3	6.8	5.1	0.4	2.8	21.5
	J	94.4	4.9	11.2	5.0	1.8	57.5	71.6	22.8
Finland	C	-17.3	-13.0	2.9	1.6	-6.0	-1.5	-2.7	-14.5
	I	-14.9	5.2	-0.2	0.5	0.5	-19.6	-21.0	6.1
	H	-2.7	-6.7	-0.1	0.2	-0.8	4.2	4.6	-7.4
	F	1.3	6.4	1.0	0.4	3.6	-9.3	-10.1	11.4
	TE*	4.5	0.6	1.9	1.3	2.2	-1.2	-1.5	6.0
	ME**	4.7	-1.1	1.7	1.8	-1.3	4.2	3.6	1.1
	B	6.3	3.8	2.1	3.4	49.7	-36.3	-52.7	59.0
	R	6.7	18.0	0.8	1.2	3.1	-14.1	-16.4	23.1
	D-E	8.7	2.1	1.8	2.2	21.0	-16.0	-18.3	27.0
	S	12.0	23.8	1.7	0.7	0.6	-12.6	-14.7	26.7
	G	12.4	-3.1	-0.4	1.5	-4.2	20.4	18.7	-6.3
	K	14.7	1.6	3.1	0.9	-3.9	12.8	13.1	1.6
	M-N	14.9	27.7	-0.7	2.0	0.2	-11.5	-14.4	29.3
	J	51.0	2.8	6.6	7.5	-6.3	37.1	40.5	10.6
France	B	-34.4	-7.6	7.2	0.0	-15.3	-22.3	-18.8	-15.7
	D-E	-15.3	3.0	0.5	2.1	14.0	-30.2	-34.9	19.6
	F	-12.2	7.5	3.6	0.6	1.2	-22.7	-25.1	12.9
	C	5.8	-13.1	8.0	0.0	3.0	9.3	7.9	-2.1
	S	7.4	18.1	4.6	1.7	0.0	-14.9	-17.0	24.4
	G	9.4	1.6	3.4	1.1	2.3	0.6	0.9	8.4
	ME**	9.9	2.1	4.8	2.3	4.0	-3.4	-3.3	13.2
	H	10.3	-0.9	4.3	1.4	5.5	-0.2	0.1	10.2
	TE*	11.1	2.7	3.5	1.6	4.9	-1.9	-1.6	12.6
	I	11.7	13.3	1.3	0.1	3.1	-5.7	-6.1	17.7
	M-N	14.9	12.5	5.4	3.1	4.9	-10.3	-11.0	25.9
	R	20.6	17.7	2.2	1.1	5.6	-6.3	-6.0	26.6
	K	26.1	5.2	3.2	7.0	6.2	2.4	4.5	21.7
	J	39.3	7.5	6.4	10.6	7.8	2.6	7.0	32.3
Germany	B	-28.3	-35.8	-4.5	-8.1	-0.4	25.7	20.5	-48.8
	S	-6.6	-4.9	-0.3	1.4	1.3	-4.2	-4.1	-2.5
	F	-0.4	1.7	-0.7	0.3	1.2	-2.8	-2.9	2.5
	K	1.6	-6.9	0.0	1.8	-2.9	9.9	9.5	-7.9
	I	2.4	6.0	-0.2	0.4	0.2	-3.7	-4.0	6.4
	D-E	4.4	0.5	-0.4	4.4	-1.7	2.1	1.6	2.8
	H	12.6	4.5	-1.9	2.7	8.7	-1.4	-1.4	14.1
	R	12.9	8.5	0.8	4.4	3.3	-4.4	-4.1	17.0
	M-N	14.2	19.1	-0.8	9.2	8.5	-18.7	-21.8	36.0
	TE*	14.8	2.8	-0.1	2.7	3.6	5.2	5.8	9.0
	ME**	14.9	2.3	0.2	3.3	2.8	5.9	6.3	8.6
	G	15.2	-3.3	0.6	3.0	1.7	12.9	13.2	2.0
	C	16.5	-0.6	1.1	1.1	2.5	13.2	12.3	4.2
	J	62.5	6.1	-0.1	8.6	-0.3	42.4	48.2	14.3

		1	2	3	4	5	6	7	8
Italy	F	-29.9	-15.0	3.2	0.1	-0.8	-19.7	-17.3	-12.6
	D-E	-22.2	0.1	1.9	0.0	5.3	-27.6	-29.5	7.3
	M-N	-11.4	7.7	0.2	0.1	2.8	-20.4	-22.2	10.8
	C	-11.4	-15.7	5.1	-0.1	2.0	-0.9	-2.7	-8.6
	H	-8.0	-3.6	1.6	0.0	2.8	-8.6	-9.0	0.9
	ME**	-6.4	-5.3	2.0	0.0	1.9	-4.8	-5.1	-1.4
	TE*	-4.3	-4.1	1.8	0.1	3.5	-5.2	-5.5	1.2
	G	-2.8	-5.7	0.8	-0.1	0.5	1.9	1.6	-4.5
	S	1.3	8.9	3.4	0.2	3.4	-13.4	-14.5	15.8
	R	1.4	6.2	5.8	-0.6	0.6	-9.7	-10.5	12.0
	I	4.9	6.8	-6.7	-0.1	0.7	4.5	4.2	0.7
	B	9.6	-5.5	0.9	0.1	7.8	6.0	6.2	3.3
	J	10.5	-3.3	2.1	1.6	7.0	2.9	3.0	7.4
	K	22.2	-0.6	0.8	-0.3	0.6	21.8	21.8	0.4
Netherlands	B	-38.1	-0.1	1.0	-0.3	34.5	-55.6	-73.2	35.1
	I	-9.9	13.1	-4.5	0.2	1.0	-17.6	-19.7	9.8
	F	-1.5	-11.9	4.8	-0.2	0.5	6.8	5.2	-6.7
	S	0.8	16.0	0.5	-7.7	1.0	-8.2	-9.1	10.0
	C	5.0	-7.6	3.9	1.1	0.1	8.1	7.4	-2.4
	K	10.6	-5.4	4.0	5.6	-11.5	20.2	18.0	-7.3
	R	10.7	24.3	-2.2	3.4	0.7	-13.3	-15.4	26.1
	ME**	13.1	1.6	3.3	1.9	0.4	5.5	5.9	7.2
	TE*	14.4	2.5	2.5	1.9	1.6	5.3	5.9	8.5
	H	19.2	-4.4	2.0	0.8	5.5	14.9	15.3	4.0
	D-E	19.5	3.4	-1.1	4.0	23.9	-9.9	-10.6	30.1
	G	23.3	-1.1	2.7	1.7	-2.3	22.3	22.3	1.1
	M-N	26.9	20.0	5.7	2.3	0.7	-2.6	-1.7	28.6
	J	32.3	9.7	4.3	6.2	-7.8	18.6	20.0	12.3
Slovakia	D-E	-31.4	-6.0	1.8	9.6	14.9	-44.5	-51.7	20.3
	I	-2.0	32.2	0.8	-0.1	13.2	-37.8	-48.2	46.2
	S	0.7	1.9	-6.0	-0.5	8.7	-5.1	-3.3	4.0
	G	11.7	8.5	4.4	2.3	13.1	-13.9	-16.4	28.1
	B	25.9	-12.5	-1.7	-0.3	29.5	-10.7	11.0	14.9
	J	45.7	18.9	-1.7	12.4	1.4	3.6	14.8	31.0
	F	48.4	10.4	-3.4	0.3	20.3	16.9	20.8	27.6
	TE*	49.5	5.6	1.0	2.6	17.8	16.5	22.5	27.0
	H	57.6	5.3	2.7	3.9	23.1	7.2	22.6	35.0
	ME**	59.1	6.3	0.7	2.5	19.0	22.8	30.7	28.4
	K	68.6	14.0	-2.9	1.5	-1.9	47.1	57.9	10.7
	C	103.3	-1.2	0.7	0.4	21.5	71.0	82.0	21.4
	M-N	113.7	28.6	-1.2	0.9	31.7	26.8	53.6	60.1
	R	171.2	4.8	-1.6	3.2	44.6	46.8	120.1	51.1
Spain	F	-43.5	-40.9	5.2	-0.1	7.4	-16.5	-15.1	-28.4
	B	-41.4	-22.5	1.4	0.8	9.4	-32.5	-30.5	-10.9
	I	-8.6	9.0	0.8	1.1	0.1	-18.5	-19.7	11.0
	C	-5.4	-20.0	3.7	1.1	-1.1	14.1	10.8	-16.3
	K	-3.3	-3.6	2.1	1.7	18.3	-18.4	-21.7	18.5
	H	1.5	-6.5	5.9	2.8	6.1	-6.3	-6.8	8.3
	ME**	1.8	-7.0	3.7	2.5	7.1	-3.9	-4.7	6.5
	D-E	5.0	5.2	-0.1	7.2	49.0	-38.6	-56.2	61.3
	TE*	8.8	-2.1	3.8	2.4	8.3	-3.4	-3.7	12.4
	R-S	17.4	21.8	7.8	3.6	6.8	-19.8	-22.6	40.0
	G	21.9	0.5	3.1	1.8	6.9	8.2	9.7	12.2
	M-N	38.1	22.9	6.9	6.0	7.2	-7.2	-4.9	43.0
	J	43.9	7.7	2.7	9.8	1.4	16.9	22.3	21.6

		1	2	3	4	5	6	7	8
Sweden	B	-43.7	0.9	-0.8	1.7	102.7	-76.1	-148.2	104.5
	F	-6.3	17.5	-4.1	0.5	16.2	-29.5	-36.4	30.1
	C	2.0	-9.1	-0.7	1.4	3.5	8.9	6.8	-4.9
	D-E	5.6	4.4	-1.3	6.6	21.5	-21.6	-25.6	31.2
	H	11.0	-1.2	1.1	1.7	16.3	-6.0	-6.8	17.8
	R	12.8	11.7	6.6	4.0	12.0	-20.4	-21.4	34.2
	S	16.2	-1.4	15.6	0.4	2.3	-2.7	-0.6	16.8
	TE*	17.5	4.9	5.3	2.4	9.8	-5.3	-4.9	22.4
	ME**	20.6	4.2	1.5	3.0	10.0	1.0	1.9	18.7
	I	20.8	25.4	-0.4	1.3	4.9	-9.3	-10.5	31.2
	G	33.2	8.5	0.0	3.1	8.8	9.7	12.8	20.4
	K	37.9	1.1	4.6	12.5	5.0	10.2	14.8	23.1
	M-N	48.2	19.8	6.0	3.6	15.3	-1.8	3.5	44.6
	J	63.9	6.2	4.6	5.1	6.1	33.4	41.9	22.0
United Kingdom	B	-45.3	2.0	3.0	0.8	9.0	-54.1	-60.1	14.8
	C	-3.8	-14.5	0.5	0.5	-1.2	12.8	11.0	-14.8
	R	-2.0	10.3	2.1	1.5	13.9	-24.9	-29.8	27.8
	F	-1.4	4.3	-1.8	0.2	1.2	-5.8	-5.3	3.9
	D-E	1.6	17.7	-7.6	2.3	36.9	-34.3	-47.8	49.3
	H	2.9	1.1	7.8	1.8	0.6	-8.0	-8.4	11.3
	K	6.7	0.6	6.0	4.5	3.0	-7.3	-7.3	14.0
	ME**	14.4	4.6	2.5	1.9	3.5	1.5	1.9	12.5
	TE*	15.0	5.8	2.7	1.4	3.9	0.7	1.3	13.7
	G	15.5	-0.3	4.1	2.1	6.5	2.6	3.1	12.4
	I	16.7	12.5	0.9	0.5	5.5	-3.1	-2.7	19.4
	S	26.6	12.3	0.0	1.1	3.1	7.9	10.1	16.5
	J	38.3	13.0	2.9	3.6	-2.6	17.6	21.4	16.9
	M-N	61.8	22.2	3.6	2.1	3.1	23.2	30.8	31.0
United States	F	-20.6	-8.9	3.8	0.2	2.5	-18.8	-18.1	-2.5
	S	-7.9	-1.0	1.3	0.7	1.6	-10.2	-10.5	2.6
	D-E	-0.8	2.3	1.1	1.2	12.7	-15.9	-18.1	17.3
	H	2.9	5.3	1.1	0.4	4.6	-8.0	-8.6	11.5
	I	7.5	11.1	0.6	0.8	4.3	-8.3	-9.2	16.7
	C	9.2	-7.0	2.2	1.5	8.1	4.8	4.4	4.8
	G	11.2	0.1	1.2	3.0	2.6	4.2	4.3	6.9
	ME**	11.8	-0.2	1.9	2.7	4.6	2.5	2.9	8.9
	TE*	14.1	1.6	2.1	2.0	5.0	2.8	3.4	10.7
	K	14.9	0.9	4.7	4.2	4.2	-0.3	0.9	14.0
	R	22.1	4.2	1.7	0.7	2.7	11.2	12.7	9.4
	M-N	30.5	12.8	3.5	3.8	4.8	3.2	5.7	24.8
	J	56.4	5.2	3.3	13.8	4.8	21.7	29.4	27.0
	B	77.8	8.6	0.4	1.7	6.5	48.7	60.6	17.2
Poland	B	-22.0	-1.2	2.2	-0.1	6.4	-29.5	-29.3	7.3
	R	-1.2	13.4	5.8	-0.4	158.7	-73.3	-178.7	177.5
	D-E	15.5	4.1	2.8	0.1	58.6	-33.6	-50.1	65.6
	H	35.5	9.5	4.4	0.2	123.0	-49.3	-101.7	137.1
	G	38.1	4.4	4.8	-0.3	6.6	18.8	22.6	15.5
	I	49.8	16.5	2.1	0.2	18.5	5.1	12.5	37.3
	TE*	50.1	7.4	7.0	0.3	20.7	8.4	14.7	35.4
	ME**	58.4	6.2	6.4	0.4	18.3	18.9	27.2	31.2
	F	60.3	13.0	3.8	0.2	5.6	29.7	37.9	22.5
	K	69.6	18.0	3.9	1.2	3.2	32.7	43.3	26.3
	J	71.8	20.3	4.8	3.7	3.1	28.4	40.0	31.9
	S	77.9	15.1	8.0	0.6	4.6	32.9	49.7	28.3
	M-N	88.0	25.1	10.4	1.2	4.2	30.2	47.2	40.8
	C	107.9	5.4	8.0	0.0	17.2	58.2	77.4	30.5

Graphs

**Decomposition of compound GVA growth into MFP contribution and added factors'
contribution over 2005-2015, by selected NACE sections**

Austria

Belgium

Czechia

Note I: *TE – total economy, **ME – market economy, ***MFP compound contribution calculated according to
formula (4), **** MFP compound contribution calculated according to formula (5).

Note II: For Czechia, Italy and Sweden the time series are one year shorter, i.e., 2005-2014; for Spain NACE section
R and S are joint in a single R-S aggregate.

*Source: own elaboration based on EU KLEMS data, 2017 release, http://www.euklems.net/; and Statistics Poland
data, https://stat.gov.pl/en/experimental-statistics/klems-economic-productivity-accounts/*

Denmark

Industries (NACE Sections)
□ MFP contribution   ■ Sum of factor contributions   ◆ GVA growth

Finland

Industries (NACE Sections)
□ MFP contribution   ■ Sum of factor contributions   ◆ GVA growth

France

Industries (NACE Sections)
□ MFP contribution   ■ Sum of factor contributions   ◆ GVA growth

Germany

Industries (NACE Sections)
□ MFP contribution   ■ Sum of factor contributions   ◆ GVA growth

Italy

Netherlands

Slovakia

Spain

Sweden

pp

MFP contribution ☐ Sum of factor contributions ▨ GVA growth ◆

Industries (NACE Sections)

United Kingdom

pp

MFP contribution ☐ Sum of factor contributions ▨ GVA growth ◆

Industries (NACE Sections)

United States

pp

MFP contribution ☐ Sum of factor contributions ▨ GVA growth ◆

Industries (NACE Sections)

Poland

pp

MFP contribution ☐ Sum of factor contributions ▨ GVA growth ◆

Industries (NACE Sections)