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Substitution between production factors and intermediate inputs in the light of KLEMS growth accounting for Poland

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Abstract. The generally adopted view is that the gross-output-based MFP is the most correct in terms of methodology, and the value-added-based MFP is its imperfect substitute performed when some data are missing. In this paper, however, performing both of them and comparing their results is proposed as a valuable means to studying the development of outsourcing in the economy. The paper presents the elaboration of the methodology for the latter, which is its main contribution to the field. The case of the Polish economy is used as an applicative example (covering the period between 2005 and 2016), as KLEMS growth accounting has recently been implemented in Poland. The results demonstrate that around the year 2011, the expansion of outsourcing ceased. Since outsourcing was one of the main processes of the Polish transition, this observation can be considered as an indication of the maturing of the market economy in Poland. Moreover, KLEMS growth accounting makes it possible to study this issue through NACE activities, i.e. at the industry level. It shows that manufacturing (section C of NACE) is predominantly responsible for the situation described above, which is the main empirical finding of the study. The dominant role of manufacturing is also confirmed by some other sectoral observations of lesser importance. The methodology developed in this paper can potentially be applied to other countries for which both kinds of MFP are performed.

Keywords: gross value added, gross output, decomposition, production factors, KLEMS, productivity

JEL: O40, O47

1. Introduction

The article aims to discuss one particular aspect arising from the implementation of KLEMS growth accounting in Poland, and from the possibility to calculate both the value-added-based and the gross-output-based multifactor productivity (MFP). This aspect is a methodology developed in the paper for the purpose of comparing the two kinds of MFP and enabling the following discussion.

Although Poland is present in various releases of the EU KLEMS database, no decomposition of gross-value-added growth or gross-output growth into intermediate inputs contribution, primary production factor (i.e. labour and capital) contributions, or MFP contribution has ever been performed, because of insufficient input data (apart from 2007 EU KLEMS release, presently outdated). The reason is, on the one hand, that not enough data have been sent to Eurostat (although Poland

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has more data which theoretically could be sent, but they are not due to a partly voluntary character of co-operation agreements within Eurostat), and on the other, that innovative data imputation is sometimes necessary, as some data are not straightforwardly available in Poland. A growth accounting for Poland with a decomposition as mentioned above was performed by researchers appointed by the National Bank of Poland (NBP),[1] on the basis of a slightly different methodology (Gradzewicz et al., 2014, 2018), but not at the sectoral or industry level. To the authors' best knowledge, no one else has ever performed a decom-position of the above-mentioned kind at the industry level for Poland (apart from the KLEMS 2007 release).[2]

Lastly, some new source of input data, concerning intermediate inputs in prices, became available. This in turn allowed the performance of a gross output decomposition into the contributions of intermediate inputs, labour services, capital services and MFP, the latter being the gross-output-based type (as opposed to a gross-value-added-based type), also calculated residually. With that in mind, it is now possible to compare the two kinds of MFP, but on condition that the two computing regimes are consistent with each other. To meet this requirement, the paper presents as first the methodology adopted for the two types of the MFP calculation and their comparison.

The basic assumption of the study presented in the paper is that the two kinds of MFP should be exactly equal in the situation where there is no substitution between production factors and intermediate consumption, or, speaking precisely, one kind of MFP should be exactly convertible into the other through a standardised procedure shown e.g. in Timmer et al. (2007a, p. 16). However, in the real economy, this substitution happens. One of its forms is the possibility to outsource some activities instead of employing new persons, or even to replace existing employees with new outsourced services from external firms, so instead of the labour factor contribution growth we observe intermediate inputs growth. In such a situation, a difference appears between the two kinds of MFP; in other words, one kind of MFP is then not exactly convertible into the other kind. Since some services are provided by external firms, not only the labour factor is outsourced, but also the capital factor associated with given labour tasks. The capital factor can also be directly outsourced

[1] The Polish central bank.

[2] The EU KLEMS dataset release of 2007 includes a decomposition for Poland with labour services' contribution subdivided into hours worked and labour composition contributions, but with no subdivision of capital services' contribution into ICT and non-ICT capital contributions. The 2007 release covers the period of 1996–2004, so the time span directly preceding the time span of the present study. To be able to perform the former, data were often extensively imputed (Timmer et al., 2007b, pp. 121–129), to a far greater degree than in the present study (due to greater data shortages). The comparison of these two studies can possibly serve as the subject for further analysis.

by leasing. For example, instead of buying machines, they can be leased from external firms. Therefore, instead of capital contribution growth we observe intermediate inputs growth. This substitution effect is however observable to a lesser extent in statistics if there is vertical integration between companies in a given economy. Therefore, even though a signal observation can be provided that is not necessarily quantitatively comparable between different countries, it nevertheless is valuable. The initial hypothesis was that this signal observation is feasible thanks to the computation methodology proposed further.

When comparing the two kinds of MFP, it was assumed that they are both valuable analytical tools.[3] Suppose the gross output and intermediate consumption data are of good quality, and the tool effects associated with additional computations are negligible. In such a case, the additional procedure of gross output growth decomposition can generate significant analytical benefits related to the monitoring of outsourcing activities and to the monitoring of the blurred boundary between capital investments and intermediate consumption outlays (i.e. in the context of frequently changing accountancy and tax regulations and their random interpretations by the revenue administration, and due to some other related circumstances). Since the monitoring of outsourcing has a much stronger impact on the results, the analysis of the substitution between the contributions of primary production factors and the contribution of intermediate inputs involves mainly the analysis of the change in the scale of outsourcing deployment.[4]

The change in outsourcing is, however, particularly intensive when structural changes in an economy accelerate. For a transition economy or any economy undergoing major changes, outsourcing change should become more conspicuous. Therefore, appropriately devised comparisons between the gross-output-based MFP and the gross-value-added-based MFP can be used, to some extent, to trace a transition a given economy. The non-tool difference between the two MFPs can be considered a litmus test for the structural and market-oriented change. If no specific issues are involved, this assumption seems plausible, although strong. In the case of a transition economy like Poland, it seems particularly sensible to assume that the ceasing of the main structural (and other market-oriented) changes can be associated with the maturation of the market economy in this country, and this phenomenon can be traced, at least to some degree, by using the method of

[3] This is consistent with the Organisation for Economic Co-operation and Development (OECD, 2001, p. 31) and e.g. Phelps (2010). The problem is discussed more extensively in Schreyer and Pilat (2001, p. 129 and following) and e.g. Hall (1989).

[4] This is consistent with the OECD (2001, p. 29). Non-proportional technological change concerning the factors and intermediate consumption should also be taken into consideration here (OECD, 2001, p. 28), although to a lesser degree.

comparison between the two kinds of MFP. Moreover, this analysis can become interesting at the industry level.

The methodological framework for the comparison between the gross-output-based and the gross-value-added-based multifactor productivity is outlined in the second section of this paper. In the third section, these results are discussed in the context of the aggregate economy, and some interpretations are provided. In the fourth section a sample analysis at the industry level is presented. The fifth section consists of the conclusions. As they are debatable to a large extent, these outcomes remain open to further analyses and discussion.

2. The adopted methodology

The basic methodology for this study roots in the growth accounting methodology developed by Dale W. Jorgenson and associates, as outlined in Jorgenson (1963), Jorgenson and Griliches (1967), Jorgenson et al. (1987), Jorgenson (1989) and Jorgenson et al. (2005).[5] This underlying methodology has been summarised by Timmer et al. (2007a), and O'Mahony and Timmer (2009) for the EU KLEMS.[6] For Poland, it has been developed and presented in Kotlewski and Błażej (2018, 2020). From now on, only the basic formulae that will be referred to later will be provided. One of them concerns the standard decomposition of gross output growth into the contributions of intermediate inputs, production factor (labour and capital) services, and MFP:

$$\Delta \ln Y_{jt} = \bar{v}_{jt}^{X} \Delta \ln X_{jt} + \bar{v}_{jt}^{K} \Delta \ln K_{jt} + \bar{v}_{jt}^{L} \Delta \ln L_{jt} + \Delta \ln A_{jt}^{Y}, \qquad (1)$$

where Y is gross output, X – intermediate consumption, K – capital services,[7] L – labour services,[8] and A^Y stands for multifactor productivity (denominated as gross-output-based). These values are subscripted by j for industries and t for years.

[5] In the preparatory works for KLEMS implementation in Poland, the OECD growth accounting methodology was studied as well for possible insights; see OECD (2001, 2009, 2013) and Wölfl and Hajkova (2007).

[6] See also the overview of the subject: Jorgenson (2009).

[7] It is assumed that the values of capital services are proportional to the values of capital stocks if these are separated into different kinds of capital stocks at the industry level, which means that although capital stocks and capital services are different entities, their growths are assumed to be equal at this level. These different kinds of capital stocks are then aggregated by means of the Törnqvist quantity index at the industry level. Based on: OECD (2001, p. 61), Timmer et al. (2007a, p. 32–33), OECD (2009, p. 60) and Timmer et al. (2010, eq. (3.6)).

[8] It is assumed that the values of labour services are proportional to the amounts of physical work engaged (in hours worked), if it is divided into different kinds of labour according to age, level of education and sex. In the KLEMS framework there are 3 age levels, 3 education attainment levels and 2 sexes, which gives (3 x 3 x 2) 18 kinds of labour.

$\bar{v}$ with appropriate subscripts are average value shares[9] of the intermediate consumption and production factors in the gross output (defined in the superscripts by X, K and L) for two discrete periods $t-1$ and t, which are calculated through linear interpolation as $\bar{v} = (v_{t-1} + v_t)/2$ (for simplicity the subscripts of formula (1) have been omitted here). Since the growth of A^Y is residually calculated, equation (1) is consistently satisfied. In performing KLEMS growth accounting, the methodology is often reduced to a gross-value-added growth decomposition following the standard equation:

$$\Delta \ln V_{jt} = \bar{w}_{jt}^K \Delta \ln K_{jt} + \bar{w}_{jt}^L \Delta \ln L_{jt} + \Delta \ln A_{jt}^V, \quad (2)$$

where V is the gross value added and A^V stands for MFP (denominated as gross-value-added-based[10]). $\bar{w}$ with appropriate subscripts are average value shares of production factor services in gross value added (defined in the superscripts as K and L) for two discrete periods $t-1$ and t, which are calculated through linear interpolation in a similar way as $\bar{v}$ for the previous formula (1). The other symbols are the same as in Equation (1). Replacing the decomposition (1) by (2) solves some data problems and increases the international comparability between countries.[11] In practice, the contribution of MFP $\Delta \ln A_{jt}^V$ is residually calculated as the subtraction between the other values, so Equation (2) is always satisfied, just like Equation (1). Therefore, there is no need to directly measure the levels of A in both of them.

The more universally performed (in the KLEMS growth accounting) decomposition of gross-value-added growth, as mentioned above in formula (2), can be extended into a decomposition of gross-output growth, as mentioned above in formula (1), on condition that the 'deflators' for the intermediate consumption are available also at the industry level – they are usually calculated as ratios between values expressed in current prices and values expressed in constant prices. For many countries (possibly for most of them), the decomposition of gross output growth based on formula (1) is not performed, while the growth decomposition based on formula (2) is, which results from the unavailability of some necessary data expressed in current and constant prices. For a few years, however, in Poland, the Department of National Accounts of Statistics Poland has published statistical data containing the information that allows the performance of the necessary calculations.

[9] All value shares referred to in the paper were taken from the national accounts, but they were adjusted for the self-employed before having been used in the calculations.
[10] It can be considered as a variant of total factor productivity (TFP).
[11] Because of different degrees of vertical integration of firms in different countries, which hinders the international comparability among the countries, as far as the intermediate consumption is considered.

To perform the calculations properly, they should remain consistent with the calculations already carried out for the gross-value-added growth decomposition, i.e., the values already calculated for this decomposition should be inserted into new formulae. Some mathematical tool discrepancies will then be reduced. To do so, some values from formula (2) have to be transposed into formula (1), as follows:

$$\Delta \ln Y_{jt} = \bar{v}_{jt}^{X} \Delta \ln X_{jt} + \overline{\left(\frac{V_{Jt}}{Y_{Jt}}\right)} \bar{w}_{jt}^{K} \Delta \ln K_{jt} + \overline{\left(\frac{V_{Jt}}{Y_{Jt}}\right)} \bar{w}_{jt}^{L} \Delta \ln L_{jt} + \Delta \ln A_{jt}^{Y}. \quad (3)$$

As can be seen in formula (3), the components taken from formula (2) are the components related to the primary production factor services, i.e. labour and capital services. These components must be multiplied by the ratios between gross value added and gross output at the j industry level. Moreover, they should be the averages for two discrete periods, $t-1$ and t, which are calculated through linear interpolation in a similar way to the shares for the previous formulae (1) and (2). The justification for the adoption of this linear interpolation is the same as for the shares, i.e., to make the approximation more precise.

The contributions of production factors services from formula (3) should therefore be further decomposed in KLEMS growth accounting as follows:

$$\overline{\left(\frac{V_{Jt}}{Y_{Jt}}\right)} \bar{w}_{jt}^{K} \Delta \ln K_{jt} = \overline{\left(\frac{V_{Jt}}{Y_{Jt}}\right)} \bar{w}_{jt}^{KIT} \Delta \ln KIT_{jt} + \overline{\left(\frac{V_{Jt}}{Y_{Jt}}\right)} \bar{w}_{jt}^{KNIT} \Delta \ln KNIT_{jt}, \quad (4)$$

$$\overline{\left(\frac{V_{Jt}}{Y_{Jt}}\right)} \bar{w}_{jt}^{L} \Delta \ln L_{jt} = \overline{\left(\frac{V_{Jt}}{Y_{Jt}}\right)} \bar{w}_{jt}^{L} \Delta \ln H_{jt} + \overline{\left(\frac{V_{Jt}}{Y_{Jt}}\right)} \bar{w}_{jt}^{L} \Delta \ln LC_{jt}. \quad (5)$$

In formula (4), *KIT* denotes the ICT capital and *KNIT* the non-ICT capital, whereas in formula (5), *H* represents the hours worked and *LC* the labour quality, otherwise called labour composition.

The contribution of MFP to the gross output relative growth (i.e. the contribution of gross-output-based MFP) from formula (1) and (3) can be made comparable with the contribution of MFP to the relative gross value added growth (i.e. the contribution of gross-value-added-based MFP) from formula (2), if it is multiplied by the inverse ratio between gross value added and gross output at the industry j level taken from formula (3):[12]

$$\Delta \ln A_{jt}^{V*} = \overline{\left(\frac{Y_{Jt}}{V_{Jt}}\right)} \Delta \ln A_{jt}^{Y}. \quad (6)$$

[12] This is consistent with the OECD (2001, pp. 25–27) and Timmer et al. (2007a, p. 16).

The asterisk indicates that the value (A_{jt}^{V*}) from the left-hand side of formula (6) is the value derived from the gross-output-based MFP (A_{jt}^{Y}), which can be equal to gross-value-added-based MFP (A_{jt}^{V}) on condition that there is no substitution between the production factor services and intermediate consumption.[13] Then, if some mathematical tool discrepancies are ignored, the following approximation becomes abiding:

$$\Delta \ln A_{jt}^{V*} \approx \Delta \ln A_{jt}^{V}. \tag{7}$$

It means that the resulting value for the MFP contribution to the gross-value-added growth received from the conversion of gross-output-based MFP, from the left-hand side of formulae (6) and (7), should in principle be identical to the MFP residually calculated from the gross-value-added growth decomposition, from the right-hand side of formula (7). If it is not so, the phenomenon of the substitution between the primary[14] production factors and the intermediate consumption should be considered as substantial.

3. Discussion on the results

Suppose the above-mentioned substitution between the production factors (and more precisely, production factor services) and intermediate consumption is substantial. In such a case, it can be asserted that substantial changes are underway in the economy, as far as the outsourcing is considered. This concerns primarily the labour factor, but also, although to a lesser degree, the independent capital factor substitution by intermediate consumption should be considered here.

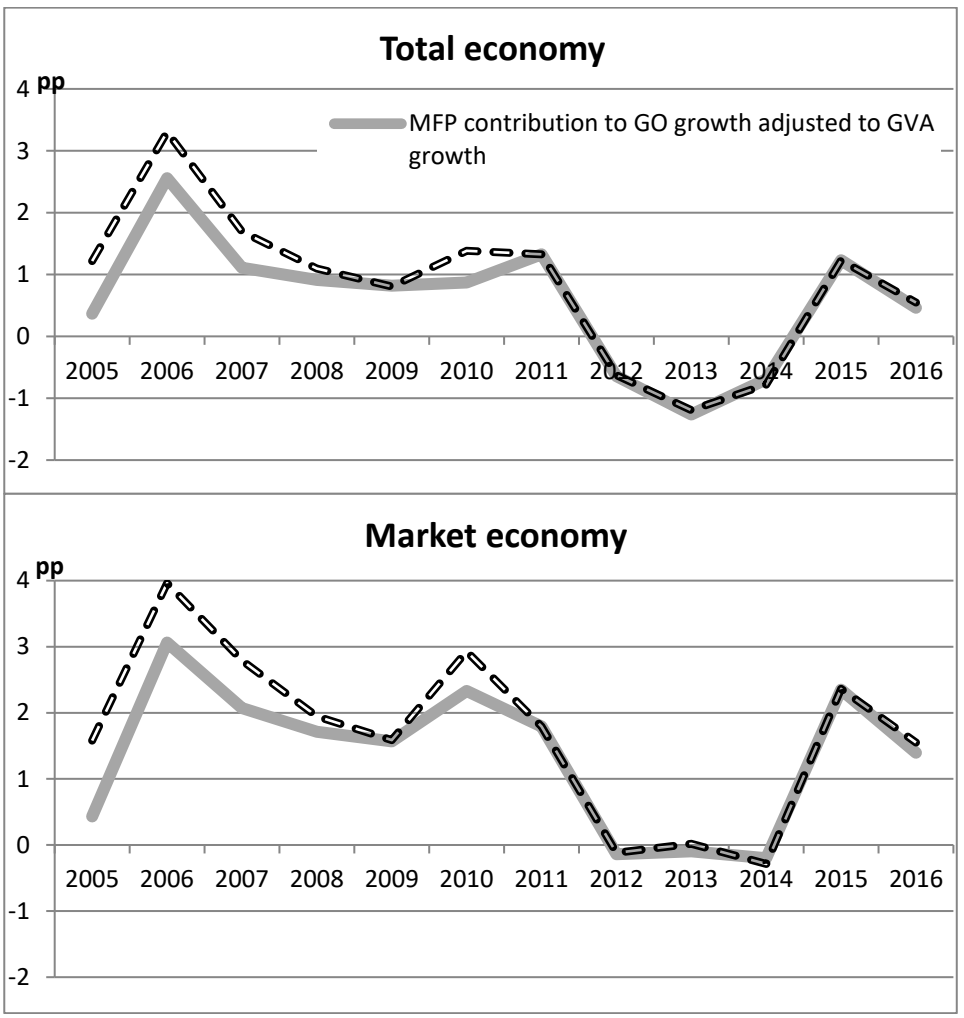
The most essential issue, however, is that the above-mentioned processes can be traced within the framework of KLEMS growth accounting, both at the aggregate and industry levels. If the quality of data on intermediate consumption and on gross output is satisfactory, and the mathematical tool effects associated with the necessity of performing additional calculations are negligible, then the additional computations associated with gross output growth decomposition can be beneficial for the economic analysis. They allow the monitoring of outsourcing in the economy from the perspective of the aggregate economy. Within the framework of KLEMS growth accounting, this can also be done at the industry level. Finally, these

[13] Or that there are no changes in vertical integration impacting MFP growth. This analysis is consistent with the analysis carried out by Gu (2016, pp. 10–11).

[14] The question which factors can be considered as primary is not being answered here. The authors follow the approach presented e.g. by Hulten (2009).

processes could be observed in even greater detail if intermediate inputs were divided into three categories, i.e. energy, materials and services.[15]

Figure 1. MFP contribution to GVA growth calculated straightforward (value-added based) compared to MFP contribution to GO growth (gross-output-based) adjusted to GVA growth for the aggregate and market economies (in percentage points)



Note. Market economy is defined in a standard way as the total economy without NACE sections L, O, P and Q.
Source: authors' work based on Główny Urząd Statystyczny (GUS, 2019).

The comparison of the two values for the MFP contribution from Equation (7) is informative, as shown in Figure 1. It allows the observation of the evolution of the

[15] The research associated with this potential subdivision is under way in Statistics Poland.

above-mentioned substitution processes over time. On the basis of Figure 1, it can be asserted that from 2011 onward, the process of the substitution of production factors (labour services and capital services) by intermediate inputs has gradually ceased, which raises the question why it has been so. The fact that the year 2009 stands out as an exception can be associated with the Financial Crisis shock (2007–2009) that temporarily stopped the change (i.e. transition) processes (which started to slow down already in 2008, as shown on both graphs in Figure 1). Thus, to some extent, it can be considered as an additional confirmation of the validity of the calculus and its underlying methodological content, because it anchors the studied phenomenon to a known empiric situation. The fact that this issue can be interpreted in a similar way for the category of the market economy (as seen on the lower graph in Figure 1), reinforces the likelihood of these findings, and additionally suggests that this phenomenon is not generated by the industries controlled and supported by the central government.

Moreover, in the case of a transition economy such as Poland, the outsourcing expansion, thought as the major component of the substitution process described earlier, can be considered a litmus test (sensor device) for the ongoing changes towards a mature market economy. This is because the Polish pre-transition economy consisted of huge state-owned companies to a much greater extent than nowadays. They had to be 'unbundled', divided and sold to the private sector, which led to the reduction of vertical integration between firms and, subsequently, to the 'unveiling' of outsourced activities between the formerly integrated firms. Moreover, the free-market forces afterwards forced these unbundled, divided and privatised firms to further outsource some of their activities, this time without the public intervention. Bringing this outsourcing expansion (from a macroeconomic (aggregate) perspective) to an end in 2011 meant that the two processes, i.e. the privatisation with unbundling and the free-market expansion of externally provided services ceased to take place. This, however, has to be understood as reaching an equilibrium between two converse processes, i.e. outsourcing and vertical integration. As such, this is consistent with the basic growth theory.[16]

The fact that the substitution process of the contributions of production factor services by the contribution of intermediate inputs might contain more content than only the outsourcing, reinforces the earlier assertion about the litmus test. It seems that the Polish economy has achieved some degree of maturity as a market economy, and in 2011 the country entered a stability phase. There seems to be no other

[16] The growth theory based on the initial growth model of Solow (1956) is a market-equilibrium-based theory. The basic Solow's decomposition (1957), being the predecessor of KLEMS decompositions, is rooted in this theory.

plausible explanation for this phenomenon (the change in the above-mentioned substitution). Therefore, we can continue the analysis by looking at separate industries, which, if orderly, can reinforce this conclusion even more.

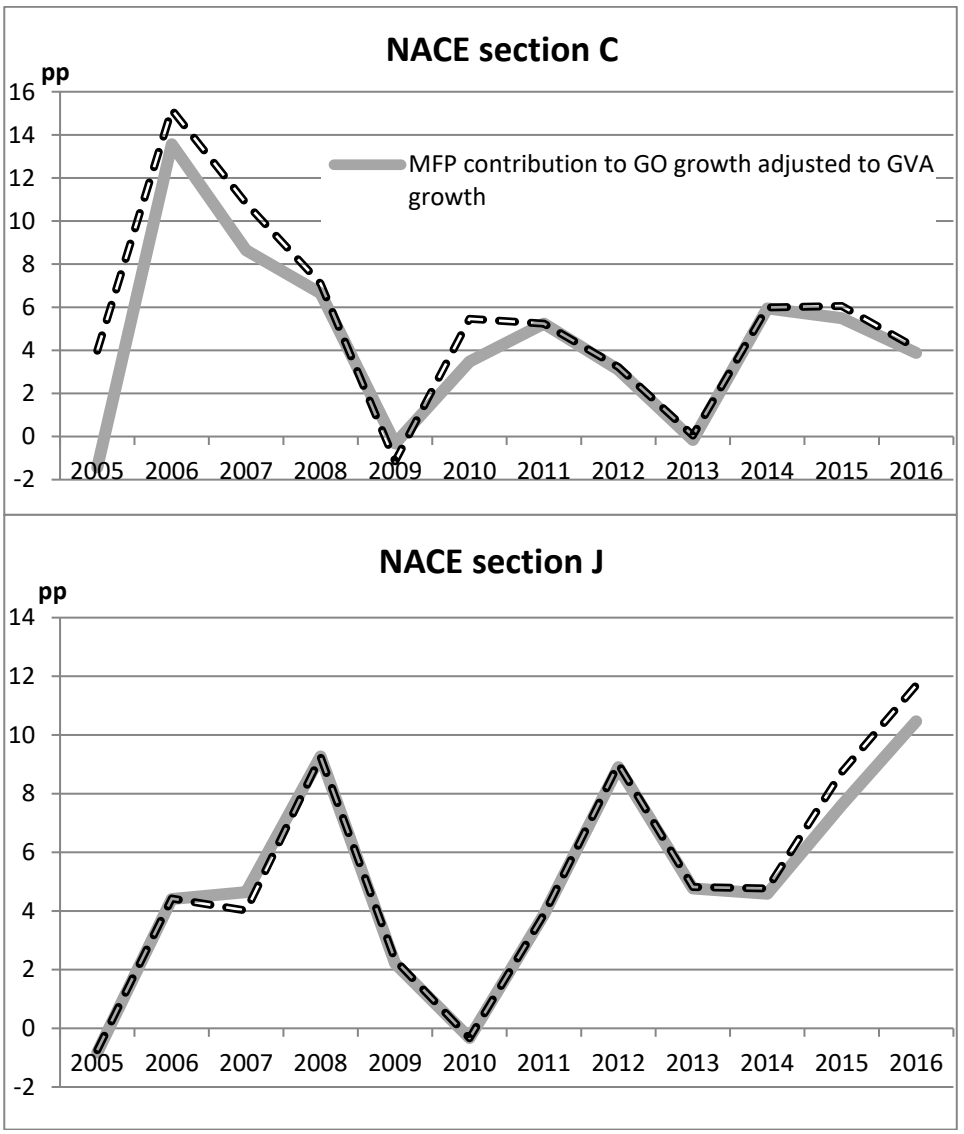
4. Sectoral analysis

In the analysis carried out by industries at NACE 2 (Nomenclature statistique des Activités économiques dans la Communauté Européenne) sections level (European equivalent of Standard international trade classification (SITC 4)), what is worth acknowledging is the fact that the contribution to the above-mentioned substitution of primary production factors by intermediate consumption is originating almost entirely in the C section of NACE 2, i.e. in the manufacturing group of industries, which can be considered a 'heavy weight' NACE section, accounting for almost a quarter of the Polish economy (which is not surprising, though, as manufacturing plays an important role in many economies). We can see it happening on the upper graph on Figure 2. Similarly to the entire economy, the substitution between the factors and intermediate consumption in manufacturing is observed until the year 2011 (with a break between 2008 and 2009), and disappears afterwards.

Another section of NACE rev. 2 which is of interest for this analysis is section J, consisting of industries related to ICT (information and communications technology) industries.[17] It can be seen that the change caused by the expansion of outsourcing, understood as the main medium of substitution, concerns mainly the two last years covered by the analysis, i.e. 2015 and 2016. This suggests that the structural change within the ICT section has only started to get deployed. Therefore, either a specific delay for the Polish economy in the deployment of ICT industries is observed, or a more general, worldwide change is just showing its first effects in Poland.

[17] Appendix I provides graphs for all NACE sections.

Figure 2. MFP contribution to GVA growth calculated straightforward (value-added-based) compared to MFP contribution to GO growth (gross-output-based) adjusted to GVA growth for NACE rev. 2 sections C and J (in percentage points)



Source: authors' work based on GUS (2019).

The analyses for other NACE 2 sections are much less informative. Usually, the process of substitution is inexistent or relatively insignificant there. In sections B and D–E, the economic policy decisions of the central government impacting the vertical integration within those industries are responsible for the small scale of the

substitution between the primary factors and intermediate inputs. In section F, before the year 2008, a small-scale vertical integration is ongoing, i.e. the process that is converse to the process of outsourcing. Some small substitution change is observed for the H and I sections of NACE 2, for the latter of which (accommodation and gastronomy) some vertical integration is observed in the years 2015–2016. Some minor changes are observed in sections O, P, Q and R–S, mainly associated with sovereign policy.

Given these findings, and for the sake of carrying out this research exhaustively, we performed gross-output-based and gross-value-added-based MFP comparisons at NACE rev. 2 division level for sections C and J. However, the results are greatly distributed with mathematical tools and outlier effects, which accumulate to such an extent that they become visible. Their common feature is, however, that the discrepancies between the two kinds of MFP disappear almost entirely after the year 2011, and they are minor, which confirms to some extent the validity of the calculus that was performed.

5. Conclusions

The estimation of the level of MFP can be performed in two primary ways. One is based on the decomposition of gross-value-added growth, and the other on the decomposition of gross output growth. It is a well-known fact, and there has been substantial discussion going on about which method is better. The gross-value-added-based MFP seems to be more fit for international comparisons, since the differences in vertical integration between countries have no significant impact on it. The gross-output-based MFP is free from the substitution impact between the production factors and intermediate consumption. So, if additional computations related to the gross-output-based MFP are not conducive to any substantial mathematical tool effects, and data on intermediate consumption are readily available and of good quality, the possibility of converting it into the MFP contribution to gross value added (instead of gross output) seems to be solving the theoretical issue of gross-value-added-based MFP being impacted by the above-mentioned substitution. It is so because the gross-output-based MFP is considered the correct one according to the adopted theory.

However, this issue can be viewed from another perspective. The two kinds of MFP can be considered as equally valid, but of a slightly different essence. If so, they can be both used in economic analyses related to observing the change in vertical integration in the economy – vertical integration being the process opposite to outsourcing. If there is no substantial change in the level of vertical integration in

a given aggregation, the difference between the values yielded by the two kinds of MFP appears negligible at that aggregation level, and can therefore be treated as a 'litmus test' for either the expansion or contracting of outsourcing. Since it seems reasonable to assume that the change in the level of outsourcing is strongly related to structural or transitional changes in economies, it can be used for monitoring whether a given economy is undergoing these major changes, or has already moved beyond them. This issue is also relating to tax regulations concerning the business sector, therefore it seems advisable for economic policies not to interfere in such a way as to disturb the market equilibrium between outsourcing and vertical integration.

In the case of Poland, the 'sensor device' based on the two kinds of MFP can be used to assess whether the economy has matured to the level of a standard market economy, and to observe some new developments in this regard. In the light of the KLEMS growth accounting recently implemented in Poland, it seems that most of the changes associated with the transition to the market economy finished in 2011, as far as outsourcing and the related issues are considered. It is also confirmed at the level of industry aggregations, since it concerns mainly manufacturing represented by NACE rev. 2 section C, which underwent a particularly deep transition in Poland. One notable exception is NACE rev. 2 section J, associated with information and communication technology (ICT-related group of industries), where this sort of changes has just begun to accelerate.

The methodology developed in this paper for the purpose of regular computations is novel, although based on known and well-explained processes. It seems capable of being successfully applied to studying other economies for which data necessary to compute the two kinds of MFP are available.

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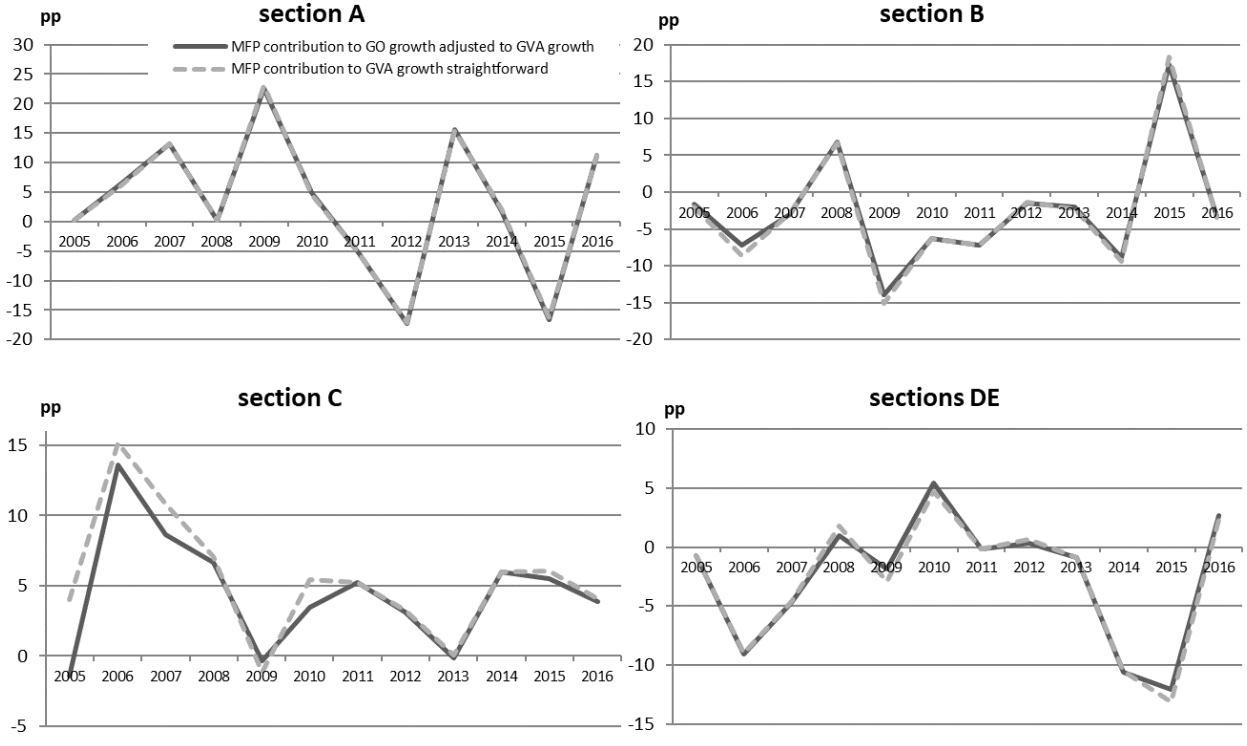
APPENDIX (I)

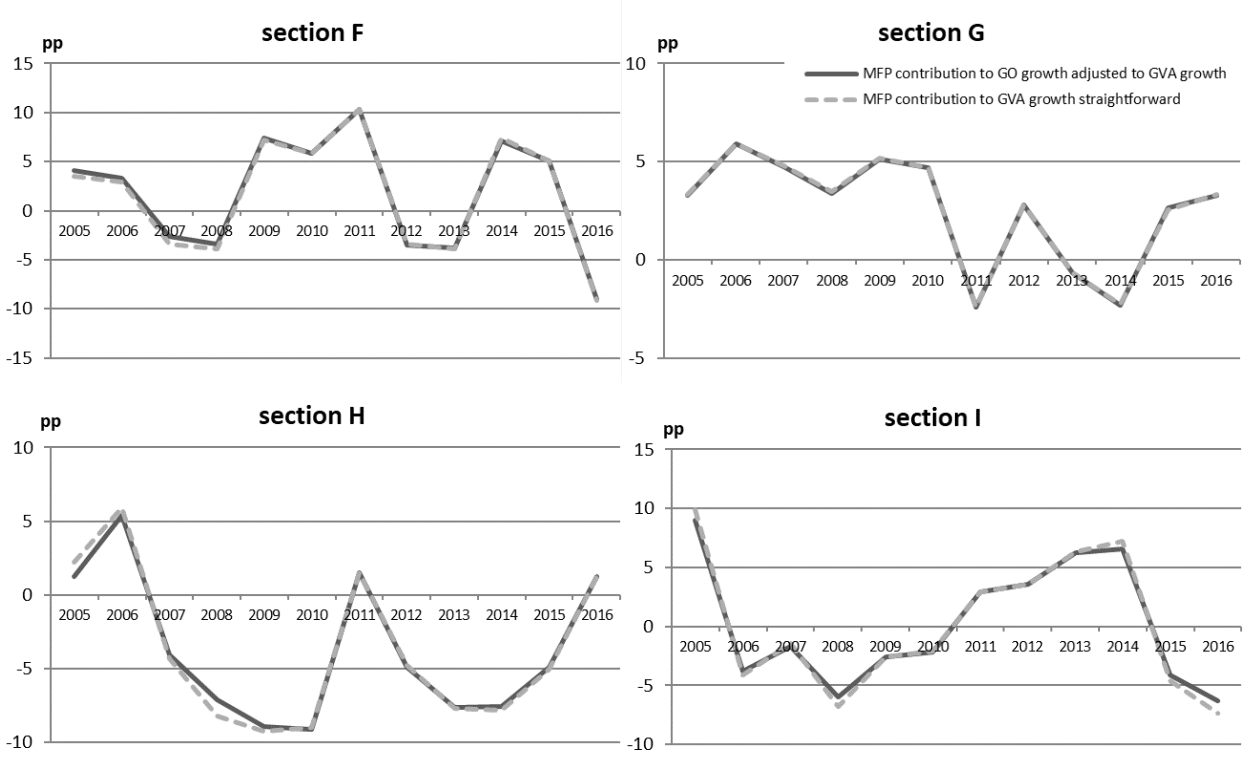
MFP contribution to GVA growth calculated straightforward (value-added-based) compared to MFP contribution to GO growth (gross-output-based) adjusted to GVA growth for NACE rev. 2 sections A, B, C and D-E (in percentage points)



Source: authors' work based on GUS (2019).

APPENDIX (II)

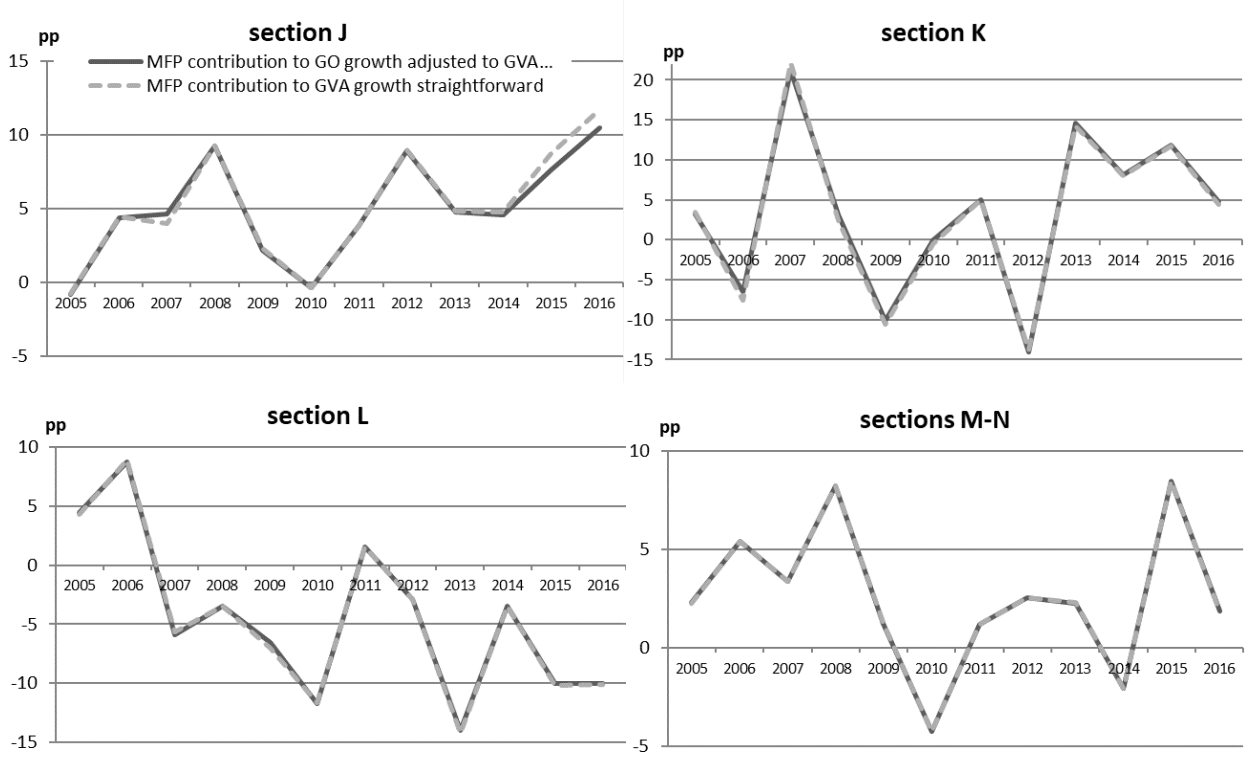
MFP contribution to GVA growth calculated straightforward (value-added-based) compared to MFP contribution to GO growth (gross-output-based) adjusted to GVA growth for NACE rev. 2 sections F, G, H and I (in percentage points)



Source: authors' work based on GUS (2019).

APPENDIX (III)

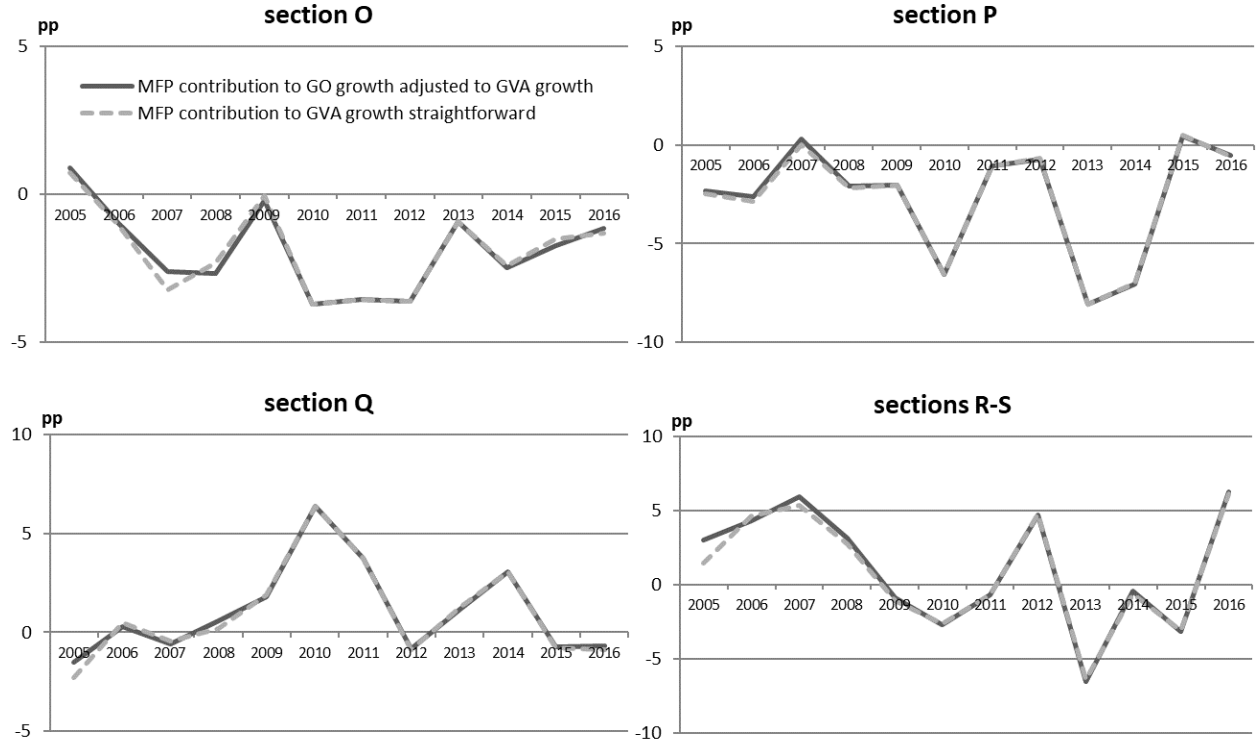
MFP contribution to GVA growth calculated straightforward (value-added-based) compared to MFP contribution to GO growth (gross-output-based) adjusted to GVA growth for NACE rev. 2 sections J, K, L and M-N (in percentage points)



Source: authors' work based on GUS (2019).

APPENDIX (IV)

MFP contribution to GVA growth calculated straightforward (value-added-based) compared to MFP contribution to GO growth (gross-output-based) adjusted to GVA growth for NACE rev. 2 sections O, P, Q and R-S (in percentage points)



Source: authors' work based on GUS (2019).