Sustainability of the convergence between Polish and EU developed economies in the light of KLEMS growth accounting

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Abstract

The basic research question is whether the convergence between the Polish economy and the developed economies of the EU has a sound basis. The hypothesis is that it is so, which is supported by quite conspicuous evidence arising from KLEMS growth accounting lastly performed in Poland. To demonstrate this, compound values are calculated based on annual datasets from Statistics Poland concerning KLEMS growth accounting for the Polish economy and on annual EU KLEMS datasets. In the first approach these compound values will be used for comparisons between Poland and the other European countries. Further, the annual datasets from Statistics Poland will be used to calculate compound values indicating the distribution of economic growth in Poland according to NACE industries and the structure of this growth by factor contributions at these industry levels. In addition, thanks to a factor decomposition performed in Statistics Poland within the EU Operational Programme 'Technical Assistance' II, regional comparisons based on compound-value calculations according to Polish voivodships also became possible, which back the results of the analysis regarding the entire country. The above-mentioned analyses are preceded by a methodological introduction.

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1 Introduction

The basic research question is whether the convergence between the Polish economy and the developed economies of the EU has a sound basis and the hypothesis is that it is so, which is supported by quite conspicuous evidence arising from KLEMS growth accounting lastly performed in Poland. The convergence should be understood here as an alignment of the level of economic development in the scope of some measurable variables representing this economic development such as the gross domestic product (GDP) or the gross value added (GVA) in real terms *per capita*. It is basically assumed that if the growth rate of this appropriately chosen variable at the aggregate level is for a quite long strand of time much higher for a given country against the other ones, then this convergence will happen indeed.

Based on general statistical observations, it can be affirmed that the above-mentioned convergence between the Polish economy and the developed western economies is indeed taking place, therefore this issue should be considered interesting only if the analysis of the economic growth process is deepened, in this case in order to indicate whether it is a sustainable process or not. This kind of deepened analysis, transcending the views simply derived from generally available statistical data, can be carried out based on data from KLEMS growth accounting just performed by Statistics Poland and on data from a factor decomposition also performed by Statistics Poland within the EU Operational Programme 'Technical Assistance' II, that allows to carry out observations in some chosen spatial aspects and analyse them. Because of KLEMS data availability, considerations of the comparisons will be done against those western countries that carry out the above-mentioned growth accounting.

It should therefore be possible to provide an answer to the question which industries of the economy contribute the most to economic growth at the aggregate level, resulting in the convergence effect. Does this growth result from extensive expansion of employment measured in KLEMS growth accounting in hours worked or is this growth more related with labour quality increase, measured in KLEMS growth accounting as labour composition (notion explained later on[1])? Does the economic growth in industries that can be considered as growth engines in macroeconomic scales result rather from high capital factor contribution and is it ICT capital (computer, communication equipment and software) or rather non-ICT capital? And finally, are the industries contributing the most to economic growth at the aggregate level, therefore contributing also the most to the above-mentioned convergence in the real level of economic activity, industries with a high component of technological and organizational progress – this last "factor" being measured in KLEMS growth accounting as multifactor productivity (MFP), that can be considered as a variant of total factor productivity (TFP)?

The last of the above-mentioned possibilities, i.e. that the economic growth in those industries that contribute to the convergence process is related with high MFP (or TFP) contributions, would mean that the aggregate growth is innovation driven or at least imitation driven, in its slightly less optimistic variant, that consists of effective adoption of technological (and organisational) novelties from abroad, i.e. from more developed economies than the Polish economy. It would also indicate its sustainability, contrary to the resource- or investment-driven kinds of growth, and would confirm the thesis advanced at the beginning of this paper.

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[1] In EU KLEMS the notion of labour composition is used for labour quality, because of the specific method to assess it. In many other KLEMS growth accountings carried out for some other countries, the notion labour quality has been maintained, however.

All these analyses can be additionally complemented to some degree by an analysis of the regional distribution of this growth and the analysis of the regional distribution of production factor contributions to this growth.

2 Methodological basics

The basic methodology of KLEMS growth accounting was developed by Dale Jorgenson and his associates. The main works in this area consist of: Jorgenson (1963), Jorgenson, Griliches (1967), Jorgenson, Gollop, Fraumeni (1987), Jorgenson (1989) and Jorgenson, Ho, Stiroh (2005).[2] This methodology has been summarised by: Timmer et al. (2007) and O'Mahony and Timmer (2009) for the European version (EU KLEMS) of this accounting.[3] Among some newer sources that can be mentioned are the following: Timmer et al. (2010) and Havlik, Leitner, Stehrer (2012). Because this matter is a relative novelty in Poland and because of the necessity to address the Polish specificity in the methodology as far as data availability is concerned, in Statistics Poland separate research work has been carried out, as presented in Kotlewski and Błażej (2016) and Kotlewski and Błażej (2018a).[4] The basic premise in this paper is to use the index, not the econometric, approach in the decomposition of economic growth.[5] Because the decomposition of gross output growth involves some issues related with the contribution of intermediate inputs (which greatly differs between the countries because of large differences in vertical integration of firms, and therefore cannot be relied on in international comparisons of their economies) in most cases only the gross value added growth decomposition is carried out within the KLEMS methodology:

$$\Delta \ln V_{jt} = \bar{\alpha}_{jt} \Delta \ln L_{jt} + \bar{\beta}_{jt} \Delta \ln K_{jt} + \Delta \ln A_{jt} \tag{1}$$

where:

V – gross value added,
L – labour factor services,

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[2] During the preparatory works on the implementation of KLEMS growth accounting by Statistics Poland, the OECD methodology has been studied. See: OECD (2001, 2009 and 2013) and Wölfl (2007).

[3] See also the large overview: Jorgenson (2009).

[4] The results of this research together with a methodological introduction are available online on Statistics Poland site:https://stat.gov.pl/statystyki-eksperymentalne/klems-rachunek-produktywnosci/metodologia-dekompozycji-w-ramach-rachunku-produktywnosci-klems-dla-gospodarki-polskiej,2,1.html. This site is also the source of all data used in calculations and analyses carried out in this paper and concerning the Polish economy. The respective data for the other countries included in the analyses are from EU KLEMS site: http://www.euklems.net/.

[5] There exists a large reference base for the econometric approach and other methods of assessing TFP, which, however, are not adequate for the present study on the sustainability of the convergence based on KLEMS growth accounting. This is because this accounting allows to carry out industry level analyses, e.g. according to NACE sections, which is of basic importance for this paper. According to the authors' knowledge, the decomposition of economic growth being *de rigueur* with statistical data processing rules, and particularly those abiding to the System of National Accounts (SNA), was carried out only once on EU KLEMS platform in the 2007 release that is already obsolete. In the following EU KLEMS releases the datasets for Poland are neither present nor including their most essential element which is the decomposition of economic growth (i.e. of its chosen measure, e.g. the gross value added growth). In Poland, according to the authors' knowledge, the decomposition of economic growth was carried out only once (Gradzewicz et al. 2014 and 2018), without the subdivision into industries such as NACE sections or divisions, however. A parallel paper exploring the possibilities of the econometric models is being published (Górajski, Błażej 2020).

    K – capital factor services,

    A – the residually calculated multifactor productivity (MFP), that can be considered as a variant
        of total factor productivity (TFP),[6] used in the KLEMS methodological framework.

    The parameters α and β are elasticities (of the variable related with the value V_{jt} in respect to the variable related with the values L_{jt} and K_{jt}), which are considered equal to the income shares of the production factors in the gross value added, following the adopted assumptions on perfect competition and constant returns to scale in the economy.[7] These parameters are calculated as the averages between two periods, current and previous: $\bar{\alpha}_{jt} = \left(\alpha_{j,t} + \alpha_{j,t-1} \right)/2$ and similarly for β. All variables are subscribed by j for the activities (in practice NACE activities) and t for the periods (usually annual). Because the term related with A is residually calculated as the subtraction between the other terms in the equation (1), it is always met in practical implementation.

    In the KLEMS methodology, the contribution of the capital factor to gross value added growth is calculated as two sub-contributions – of ICT capital services and non-ICT capital services.[8] The first of them consist of the sum of the contributions of the three following categories of capital: software, computer equipment and communication equipment. Whereas, the second consist of the sum of the contributions of some of the few remaining categories of capital, but to avoid mathematical tool problems the practice is to subtract the contribution of ICT capital services from the contribution of the entire capital services in order to establish the contribution of the latter. Therefore, these contributions of different categories of capital are aggregated with the use of Törnqvist quantity index. They are calculated at lowest adopted aggregations for eight different capital kinds used in the KLEMS methodology for Poland and then added up. The contribution of capital services can be different from the contribution of capital stock, for which the absolute growths of different capital kinds are added up first before calculating the contribution of the received sum, i.e. without weighting at different capital kind levels first. The difference between the contribution of capital services and the contribution of capital stock arises from the fact that some kinds of capital can be relatively better remunerated than the others, which is accompanied by different growth rates of these capital kinds. However, if the market clears itself well and the relative remunerations of different capital kinds are not substantially different from each other, then the difference between the contributions of capital services and the contributions of capital stock becomes insignificant. This seems the case for Poland[9], therefore this distinction shall not be made conspicuous further in the paper.

    Conversely to the contributions of capital services, which are not very different from the contributions of capital stock, a substantial difference between the contributions of labour services and the contributions of labour resource is present in the Polish economy. Here as well the Törnqvist quantity index is used to calculate the contributions of labour services. Different labour kinds (three age groups, three education attainment levels and two sexes gives a differentiation into 18 labour kinds) are firstly multiplied by their weights (i.e. shares), and further added up together. If we subtract from

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[6] Of which the contribution is the so-called Solow's residual. The KLEMS growth accounting is conspicuously inspired by the neoclassical theory of economic growth of Robert Solow (1956, 1957).

[7] The parameter α is the ratio of labour compensation to gross value added and the parameter β is the ratio of capital compensation to gross value added, therefore these are the shares of production factor incomes in the gross value added.

[8] The parameters for these two categories of capital are calculated similarly to those above, i.e. as ratio of ICT capital income to gross value added and as a ratio of non-ICT capital income to gross value added. They sum up to the parameter value for the entire capital β. The parameters for labour services are treated differently, however.

[9] And for many other economies, which can be observed, e.g. on the EU KLEMS site.

the contributions of labour services calculated in this way the contributions of the labour resource, calculated through summing up of its absolute growths without weighting at labour kind levels, then we will receive the values called labour composition contributions. This labour composition is sometimes called labour quality at different platforms than the EU KLEMS platform. The traditionally understood (Solow 1957) contribution of the labour factor is therefore complemented by the contribution of labour quality. This makes the basic difference between the KLEMS type growth decomposition and the Solow type growth decomposition (alongside the much less important difference related with the capital services as mentioned above) in which the contribution of labour quality is not being extracted from the residually calculated TFP.[10] In this way, the contributions of both production factors are divided into two sub-contributions each.[11] This is also the way in which KLEMS growth accounting was performed for Poland and in addition the same sub-division into NACE groups of sections, sections, groups of divisions and divisions was adopted to maintain international regional comparability (different regions of the world are to some degree different methodologically in this respect[12]). Therefore, basically the difference between MFP and TFP arises from that instead of a decomposition of economic growth into the contributions of production-factor resources and TFP the decomposition into the contribution of production-factor services and MFP is being performed.

For Poland, however, the KLEMS growth accounting was performed in two ways – one in which the residential capital (dwellings) is included in the capital factor and the other one in which it is not included, which is important because of the specific issues related with the Polish dwelling market[13] (because of this it would be better not to include the dwelling capital in the calculations, but for international comparisons it must be included, because the other countries do so). Moreover, because in the Polish conditions an additional deepened decomposition of the labour factor was performed, the calculations were carried out for the labour quality understood as labour composition or as labour remuneration level. These two dichotomies have led to the presentation of final results in the following four versions:

A – capital without dwellings, labour quality understood as labour composition,
B – capital with dwellings, labour quality understood as labour composition,
C – capital without dwellings, labour quality understood as remuneration level,
D – capital with dwellings, labour quality understood as remuneration level.

In the case of labour quality understood as labour composition, it is about studying its change caused by the changes in the shares of the 18 different labour kinds, according to sex, three age groups and three education attainment levels. In the case of labour quality understood as remuneration level, it is assumed that independently from labour composition change, the change in remuneration level

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[10] In theory it is assumed that TFP is composed of four components: labour efficiency (mainly labour quality), labour usage (related mainly with the business cycle), capital efficiency and capital usage (Havik et al. 2014). In KLEMS growth accounting labour quality (together with the much less important similar change as far as capital factor is considered) is extracted from TFP as labour composition, and the remaining is called MFP.

[11] However, the same parameter α is used for the two categories of labour contribution, whereas for the two categories of capital the parameters are different. See among others (symbols changed): O'Mahony and Timmer (2009).

[12] Apart from North America, on the World KLEMS platform more regional groups are present: Asia KLEMS, LA (Latin America) KLEMS and EU KLEMS, and also quite a few individual country methodologies, forming the developing World KLEMS system.

[13] The dilemma related with this market is whether the investments in residential capital concern dwellings for rental or for own use, which has for long been an opaque issue in Poland and only recently a normal dwelling market in Poland is finally coalescing.

is also associated with labour quality change,[14] but in this case (as observed) the cycle component is substantial here. A more developed discussion on this issue can be found in Kotlewski and Błażej (2018b). This latter source refers also to the last calculation results. All the results are presented as contributions to aggregated gross value added growth and contributions to gross value added growths at industry levels. Because of the international comparability issue, in the present paper the tables of version B, and particularly of version B' were used as data source for the calculations, since it is in this way that the calculations are done for countries present on the EU KLEMS platform, used as data source for them.[15]

In Statistics Poland, another decomposition has also been performed within the framework of the projects financed from grants received from the EU Operational Programme 'Technical Assistance' (later on referred to as OPTA), of which the results will be used in the present analysis. In the first approach, i.e. within the framework of OPTA I, a decomposition of gross value added growth into the contributions of factor remunerations has been carried out, which did not involve TFP assessment. The values related to the capital factor could be residually calculated (i.e. as subtractions between the other values). The methodology of this accounting has been presented in Kotlewski (2017a). In the second approach, i.e. within the framework of OPTA II, thanks to a separate determination of the input values related with the capital factor (by means of calculations carried out on input data partially presented in Kotlewski (2017b)), it has become possible to perform a decomposition of gross value added growth into the contributions of factor resources (factor stocks) and TFP (Kotlewski 2018a, 2018b and 2019). The basic difference between these accounts and KLEMS growth accounting consists of the lack of the above-mentioned subdivisions into ICT capital and non-ICT capital and the lack of labour quality extraction from TFP, which make these accounts in their version from OPTA II very similar to the primary Robert Solow's decomposition.[16] Thanks to these simplifications, however, it was possible to carry out this Solow type decomposition at the Polish-voivodship level that allows for regional intra-country comparisons (and which is the first case of a decomposition carried out at voivodship level,[17] according to the authors' knowledge). Because the results of both decompositions, i.e. within the frameworks of KLEMS and OPTA II, are very similar at different aggregation levels (in places where the scopes of both accountings cover each other), it seems possible, with a comfortable confidence margin, to refer to the latter in order to complement macroeconomic analyses with regional analyses.[18]

3 Structure of economic growth by production factor contributions

The sole fact of convergence occurrence between the Polish economy and the developed western economies is not particularly studied within the framework of this paper since this fact is directly

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[14] Based on the neoclassical premise that each factor is being remunerated according to its marginal productivity.

[15] This concerns other countries than Poland, present on the internet platform of EU KLEMS, but only those for which the decomposition of economic growth into factor and MFP contributions has been performed.

[16] In Solow's decomposition (1957) logarithm terms are not being used for relative growths and so it is in the case with the above-mentioned decompositions performed within the OPTA I and OPTA II frameworks.

[17] Only for Spain (between the countries mentioned in this work) the KLEMS growth accounts were performed at the individual province level (unfortunately, not for the other ones). This kind of accounting requires complex methodological works and cannot be performed ad hoc based on generally available statistical data. This concerns also the simplified version carried out in Statistics Poland within OPTA I and OPTA II frameworks.

[18] Accounts elaborated within the frameworks of OPTA I and OPTA II were also carried out in parallel for employees and for engaged persons. Also, deviations from country averages were decomposed according to all the adopted cross sections. Therefore, they are of substantial value on their own in comparison with the KLEMS growth accounting.

observable. The KLEMS productivity accounting confirms this fact, which is also observable thanks to other studies, but it also allows to examine closely the structure of the growth resulting in this convergence, as far as the contributions of the production factors is considered. Nevertheless, this analysis is sensible only in the longer run, since it is in this scope of time that substantial and sometimes durable changes do reshape the economic map of the world.

In the present study, all countries have been considered for which the data are available on EU KLEMS internet site, with time series long enough to carry out the appropriate examinations, and for which the decompositions of gross value added growth have been performed and published. The new countries, for which the data on the above-mentioned internet site are appropriate for the present study and which have joined the ten European countries from the previous EU KLEMS release are Denmark, the Czech Republic and Slovakia. It has been considered that this circumstance is beneficial for some comparisons, therefore these countries have also been included in the present study. The current release (2017) on the EU KLEMS site also presents data for the USA, which altogether makes the data framework quite representative for the group of countries of the so-called 'West', as only a few countries are omitted in this quite subjectively defined group, where Canada, Switzerland and Luxembourg should be also present (and a few very small states of insignificant economic importance). For these latter countries, data are missing on the EU KLEMS platform, data have too short time series or data are published without decompositions of gross value added growth, which are basic for the analyses carried out in this paper.

The annual data concerning Poland that served as source data for the calculations were taken from the publication of Kotlewski and Błażej (2018b), resulting from a work of many years on the implementation of KLEMS productivity accounting carried out in Statistics Poland.[19] The time series of KLEMS growth accounting for Poland have a cut-off point in the past, i.e. it is not possible to carry out (according to actual knowledge and data availability[20]) this accounting beyond 2005 because there are some data collection surveys (that could serve as structures to proportionally distribute labour market data) that were not carried out before 2004 (see: Kotlewski, Błażej 2016).[21] At the moment of the elaboration of this paper, the result data for Poland included the year 2016 as the last year of the time series, but for the remaining countries on the EU KLEMS site it is the year 2015, with the exception of Italy, Sweden and the Czech Republic, for which full data with gross value added growth decompositions are available until 2014, which has been indicated in the notes under Table 1 and Figure 1. The initial analysis will be based on Figure 1 and the above-mentioned Table 1 is provided as assistance in the readability of complex graphs from Figure 1.

Two graphs are presented on Figure 1, of which the first concerns the entire available time series of 2005–2015, whereas the second concerns the period of 2010–2015 after the financial crisis of 2007–2009. The main motive behind this approach is that the financial crisis can be considered as an independent phenomenon that substantially disturbed the normal process of economic growth, impacting on different countries differently because of varied immunity of individual countries

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[19] These last data (June 2019) are also available on the Statistics Poland website.

[20] With the exception of EU KLEMS release of 2007, where GVA decomposition was also performed for Poland for the years 1996–2004, thanks to some far reaching assumptions. It was not continued later on in further releases. Presently, it is to some degree obsolete because of subsequent data revisions.

[21] Because in factor contribution decompositions carried out in the frameworks of the EU Operational Programme 'Technical Assistance' I and II (done in Statistics Poland) the labour quality is not extracted, it was possible to extend these projects a few years backwards.

against this crisis, immunity that does not have to be made of the same trump cards as in normal circumstances. It could be that a given economy was particularly immune to the crisis but at the same time not showing strong growth tendencies in normal conditions. Moreover, separating what has happened after the crisis is of its own value, since many recipients expect such an approach and the inclusion of the crisis period in the time series would blur the picture of the situation which is of interest.

It is not difficult to imagine that this may concern in particular the Polish economy, which passed through the crisis of 2007–2009 avoiding recession, which became the subject of separate studies (Gradzewicz et al. 2014, 2018) – it can be ascertained, however, that also after the crisis the Polish economy stands out from the countries included in this study by having the highest compound relative gross value added growth (in the period of 2010–2015). Although some Central and Eastern Europe countries (such as Romania) with fast growing economies after the crisis have not been included (because of the lack of appropriate data calculated within the framework of KLEMS productivity accounting that could be used in the present study) the economic situation of Poland can be considered as overly favourable in the light of available comparisons. One question remains, however, whether the structure of this growth can be considered as equally favourable.

From the theory, it can be acknowledged that there are a few kinds (or types) of economic growth: resource driven, investment driven and innovation driven.[22] Considering all the limitations of a mathematical tool character (arising from the calculation techniques), resource-driven economic growth can be associated mainly with the labour factor contribution,[23] particularly with the contribution of hours worked. It can be observed that resource-driven economic growth, understood in this way, almost disappeared after the crisis – extensive employment growth impacting on economic growth is almost imperceptible on Figure 1 for the period of 2010–2015 for Poland. Because such economic growth is often interpreted as an impoverishing kind of growth, this phenomenon could be interpreted as rather positive. In Poland, however, it is rather about the exhaustion of the resource-driven growth base related to labour supply, because of low population growth and emigration (despite the presence of a still high labour resource in the form of general low activity on the labour market).

At the same time, however, in the light of KLEMS growth accounting, a relative strengthening of the capital factor contribution can be observed after the crisis for the Polish economy. This may be associated with the above-mentioned investment-driven economic growth. In more general terms, the Polish economy is undergoing productive physical capital deepening, which may continue up to some threshold only, unless the investments at some stage start to be accompanied by innovations. In the light of the presented KLEMS results, this situation can be considered as somehow unreassuring, since at the same time an exiguous contribution of ICT capital to economic growth can be observed for both periods 2005–2015 and 2010–2015 on Figure 1 and particularly a dwindled contribution of multifactor productivity (MFP) in the 2010–2015 period, which in the adopted typology should be associated with innovation-driven economic growth.

However, at the same time, the high labour quality (understood as labour composition) contribution can be considered as comforting, which is specific for the Polish economy. This contribution is

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[22] There is also so-called welfare-driven economic growth, which can, however, be associated with the Keynesian, not the neoclassical, current in economics.

[23] The land factor resource, which is not separated in the KLEMS framework and which is of importance only for some few countries, is considered of lesser importance here.

the highest in percentage points of all the countries under consideration. Keeping in mind that the contribution of labour composition in KLEMS productivity accounting has been extracted from the former TFP, it can be noticed that if it were joined back in TFP, then the contribution of the latter in the 2005–2015 period would reach about 40% of all contributions to compound relative gross value added growth. The Polish economy would only be behind the Slovakian economy in this regard. However, in the 2010–2015 period it is not that fine anymore – despite keeping a leading position between the considered countries as far as labour composition is considered, its inclusion in TFP does not result in such a huge contribution of this last entity, as is the case for the entire period of 2005–2015 of the present study. For the time being, however, the convergence of the Polish economy with the economies of the developed western countries continues – its propulsion engine at the aggregate level consists of the contribution of non-ICT capital and the contribution of labour quality, which can be attributed to a quantitative increase in educated personnel in the Polish economy. It could even be that the Polish economy just fits in the world-wide trend observed by Acemoglu (2003) and Klump, McAdam and Willman (2004) consisting in the reasserting importance of labour efficiency growth, accompanied by the diminishing importance of capital efficiency growth.

4 Structure of economic growth in NACE sections of the Polish economy

Technically, a similar analysis as for the individual countries can be carried out for NACE sections in the hope of identifying industries that are levers of economic growth. However, what is important in this instance is the possibility to decompose the gross value added growth in these chosen industries into factor contributions (this concerns factors or their components), which allows to carry out a deeper analysis of the structure of the growth, and therefore intermediately an analysis of convergence characteristics.

The industries of the economy were divided here into NACE Revision 2 sections,[24] since it is according to this classification that the statistical data computations have been carried out. The result data are presented in Figure 2, which because of its complexity has been preceded by Table 2 to ease data reading. In the study, the section A has been omitted, since the use of productivity accounting of this kind in this section is controversial and therefore not practiced.[25] Also, sections that in KLEMS accounting do not belong to the so-called market economy have been omitted, i.e. sections: L, O, P and Q,[26] since their analyses in the framework of a methodology oriented at the market economy do not necessarily produce sensible results, because of direct financing by the state budget of these activities. Sections T and U have been omitted as well because of their little importance in the economy.

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[24] The following NACE Revision 2 sections are considered here: A – Agriculture, forestry and fishing; B – Mining and quarrying; C – Manufacturing; D – Electricity, gas, steam and air conditioning supply; E – Water supply; sewerage, waste management and remediation activities; F – Construction; G – Wholesale and retail trade; repair of motor vehicles and motorcycles; H – Transportation and storage; I – Accommodation and food service activities; J – Information and communication; K – Financial and insurance activities; L – Real estate activities; M – Professional, scientific and technical activities; N – Administrative and support service activities; O – Public administration and defence; compulsory social security; P – Education; Q – Human health and social work activities; R – Arts, entertainment and recreation; S – Other service activities; T – Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use; U – Activities of extraterritorial organisations and bodies.

[25] In section A huge self-employment is present, which is estimated based on assumptions. As a result, the labour factor growth dynamics in section A are very roughly established.

[26] The market economy should be understood as the economy without the state. In KLEMS accounting an approximate definition of this market economy is applied as provided here.

However, NACE Revision 2 sections concerning commercialised activities, despite being under strong public control or strongly supported by the state budget, have been included. These are sections: B, D, E, H and R. They have in general huge capital outlays, to a substantial degree, directly or indirectly, supported by state policies, which is not necessarily conducive to gross value added growth. In section B we can observe negative production growth (related with restructuring of mining activity) despite some investments, therefore the residually calculated MFP contribution is negative. In sections D and E, which concern network services, huge modernisation outlays (probably necessary) do not result in a huge increase in production, therefore here as well the contribution of the residually calculated MFP is negative. A similar situation can be observed in section H – large public outlays for transport infrastructure only partially result in an increase in the flow of transport services, therefore, in this NACE Revision 2 section a negative MFP contribution is also present. Also, a capital-type of financing of cultural activities in section R does not lead to a high increase in production value, which inevitably results in a negative MFP contribution.

These negative MFP contributions are offset by positive ones in the other NACE Revision 2 sections, which is why the decomposition of the relative gross value added growth for total Poland is situated in the middle of the graphs. Moreover, the fact that the above-mentioned market economy is situated to the right from the decomposition for total Poland indicates that the above-mentioned sections L, O, P and Q, not included in this analysis, also contribute altogether negatively to total Poland economic growth and its MFP contribution.

One important analytical observation arising from Figure 2 is that over the period of 2005–2015 the section with the highest MFP contribution is section C. Since this section is the largest section of the Polish economy, therefore its MFP contribution could be the most substantial, particularly in the longer run. And it is so. In this section, technological and organisational progress, in the neoclassical understanding quantitatively interpreted as its contribution effects on gross value added growth in the form of MFP, completely outperforms the contributions of production factor services. It has to be concluded, therefore, that manufacturing is well developing and intensively modernizing, regardless of whether it is because of adopting foreign solutions and novelties, or whether it is because of own innovation activity, and that this modernisation is the basic source of growth here, much larger than capital outlays, which although conspicuous, are much less substantial. The growth of section C is in relative terms the highest between all sections. It can therefore be asserted that the process of reindustrialisation is under way in Poland.

The second NACE Revision 2 section that distinguishes itself by its high MFP contribution is section J. Throughout 2005–2015 the compounded gross value added growth and the compounded MFP contribution in that section are slightly lower than in section C related with manufacturing industry, but this changes in the period of 2010–2015, when the information and communication technologies embrace the role of leader, as far as the relative gross value added growth and the MFP contribution to this growth are considered.

Section I has also increased its importance, indicating the increased role of tourist activities, as well as section S. A more general view can be expressed that in the growth supporting sections MFP contributions are prevalent, being the most important if not altogether basic engines of growth, and that this domination remains in the period of 2010–2015.

However, at the total Poland level these huge MFP contributions are almost entirely levelled by its negative ones in industries not particularly contributing to economic growth, understood here

as gross value added growth. And this effect even strengthened in the period of 2010–2015 (which is clearly noticeable on the total Poland bars on the graphs from Figure 2). On the one hand, it can be advanced that in the light of KLEMS growth accounting the Polish economy develops in a quite effective way, modernising in the growth supporting industries (as far as gross value added growth is considered), with only the share of industries not particularly supporting this growth being too high (which would be rather a government failure supporters point of view). On the other hand, it can be asserted that there is no trouble at all, since the MFP contributions of growth supporting industries cover entirely the negative MFP contributions of industries with public participation[27] and negative MFP contributions of industries that, although important, do not particularly contribute to economic growth (which would be rather a market failure supporters point of view). Fortunately, in the light of the analysis carried out in the previous section of this paper, the Polish economy as a whole still has the highest gross value added growth between all countries included in the present study, which can also be confirmed by many other statistical surveys, not only related with gross value added growth decomposition.

5 Structure of economic growth in Polish voivodships

By resigning from decomposing the capital contribution into two sub-contributions (understood as contributions of capital services) and from the extraction of labour quality from TFP (which is being practiced in KLEMS growth accounting), in the light of the available data from Statistics Poland it was found possible to perform a decomposition of gross value added growth into production factor stocks and TFP,[28] in a way very close to classic Solow's decomposition (1957), carried out at the level of all voivodships, sections and at the same time voivodships and sections,[29] which has been performed for the first time and published by Kotlewski (2019) and which has opened the possibility of carrying out the analyses presented further on. As far as the results of performed KLEMS growth accounting and the results of the present simplified factor decomposition are considered, there are no contradictions but only small fluctuations of tool-like origins (slightly different mathematical methods). That is why the above-mentioned analyses, carried out in the light of KLEMS growth accounting, can be somehow complemented by the findings resulting from the observation of the gross value added growth decomposition carried out at voivodship level. For the needs of the present study, the annual data available on the Statistics Poland website concerning the project performed within the framework of EU Operational Programme 'Technical Assistance' II, were used to calculate compound values in a methodologically identical way as for the previous graphs.

The present analysis has been carried out based on the graphs from Figure 3, which this time has not been complemented by a table, since the results from the figure are easy to read. On the first graph of Figure 3, it can be seen that the differentiation in the levels of relative gross value added growth

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[27] It must be remembered that because of the way these kinds of activities are being treated in national accounts (SNA) and because of not entirely market-like pricing mechanism which is present in these industries, the interpretation of their behaviour in the framework of this growth accounting may not be entirely compatible with such an interpretation concerning typical market industries.

[28] Annual data for compound values calculations in this section of the paper have been taken from: https://stat.gov.pl/statystyka-regionalna/statystyka-dla-polityki-spojnosci/statystyka-dla-polityki-spojnosci-2016-2018/badania/ekonomia/.

[29] In Statistics Poland methodological works are on the way to explore the possibility of performing a full KLEMS growth accounting at the voivodship level.

between the voivodships is much lower than between the countries considered in Figure 1. This matter is not an entirely obvious one. It can be intuitively assessed that for quite a lot of countries there may be a situation in which internal differentiation is larger than the differentiation of their economies against the other countries' economies, also as far as relative gross value added growth is considered. Therefore, it is an important observation. But more importantly, it is particularly conspicuous on the first graph, but to some degree also on the second,[30] that starting from about the middle to the right-hand side, the differences in the rates of gross value added growths are the result of the growing contributions of TFP. For the period of 2010–2015 the ranking of the voivodships being the leaders of growth has somehow changed. The growth rate in the Mazowieckie voivodship overtook the growth rate in the Dolnośląskie voivodship. For the second pair of leaders there was also a rank change. The growth rate in the Małopolskie voivodship overtook the growth rate in the Wielkopolskie voivodship. These effects for entities ameliorating their ranks result mainly from greater relative TFP contributions to this growth. The voivodships from the right-hand side of the graphs also have greater contributions of the labour factor, which means that they also contribute more to employment increase.

Because the labour quality, understood as labour composition, is in this instance included in the TFP, therefore this last entity shows greater contributions on both graphs compared to MFP contributions shown on graphs from Figure 1 and 2. Some specificity can be observed for the Lubuskie voivodship, that may arise from its frontier-like characteristics. To the basic conclusions should be added the observation that the preponderance of the capital contribution to gross value added growth strengthened in the period of 2010–2015 for most of the voivodships, whereas the differences in the growth rates between the different voivodships decreased (i.e. the relative difference between the fastest and slowest economically growing voivodships in the period of 2010–2015 has decreased). Should there exist the possibility to carry out this kind of analysis in the spatial dimension for the countries included in Figure 1,[31] then a hypothesis could be possibly verified that many Polish regions are between the growth leaders as far as the TFP growth rate is considered. This analysis can also be complemented by an industry level analysis similar to that presented in Figure 2 (however, without a decomposition of the capital contribution into sub-contributions and without the extraction of labour quality from TFP). This, however, would require a large "bookish" elaboration. Nevertheless, the observations carried out in this paper allow to deliver an answer to the research question indicated in the introduction to this paper.

6 Conclusion

In the light of KLEMS growth accounting, it can be confirmed that the convergence of the Polish economy with the developed economies of the so-called West is indeed happening. As far as the entire Polish economy is concerned, it is mostly the merit of the capital factor contribution to economic

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[30] That would be so if on the second graph the voivodships were arranged according to the increasing compound relative gross valued added growths. However, this was not done in order to make the second graph fully readable against the first one.

[31] In Europe, a decomposition of economic growth by regions of the given country outside Poland has been carried out only for Spain. There are also no input data available that could serve to independently perform decompositions of economic growth at regional country levels, conformable to the requirements of SNA that are de rigueur in statistical offices.

growth, which would suggest that the economic growth in Poland is investment driven, according to an often referred to typology of economic growth kinds.

But a closer look, thanks to a more detailed decomposition into factor and MFP contributions (alternatively TFP) indicates that in the growth supporting industries the contributions of MFP are predominating. Therefore, these industries develop (as far as gross value added growth is considered) in a modernising way. Hence, the convergence process is sustainable, because it is based on innovation and modernisation (regardless of whether thanks to imitation or own innovation), not on exhaustible resources, and only the share of industries not contributing substantially to economic growth, i.e. the public sector industries and commercialized industries related to state policies, can be considered too large. This can become a future growth resource thanks to the possibility of their limitation, and which is conformable with the liberal stand in economic science. At the same time, however, from less liberal stands, it can be considered that in the Polish economy there exists a beneficial equilibrium between the two above-mentioned groups of industries (growth-supporting and not growth-supporting), in contrast to many other economies, including the European ones.

As far as the spatial distribution of growth in Poland is considered, it can be asserted that the differences became lower in the period 2010–2015 compared to the period 2005–2009. The spatial distribution of economic growth in Poland also confirms the basic importance of TFP for the differentiation of the rate of these growths between the voivodships, which makes the above-mentioned presumption on the sustainability of growth processes in the Polish economy even more likely.

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Appendix

Table 1
Decomposition of compound relative gross valued added growth in the light of KLEMS growth accounting for selected EU KLEMS countries and Poland

	Italy	Finland	Denmark	Spain	France	USA	Netherlands	Austria	Germany	UK	Belgium	Sweden	Czech Rep.	Slovakia	Poland
Decomposition of GVA relative growth into contributions (in percentage points)															
2005–2015															
Compound GVA relative growth	-4.3	4.5	8.7	8.8	11.1	14.1	14.4	14.7	14.8	15.0	15.4	17.5	23.7	49.5	50.1
Hours worked contribution	-4.1	0.6	-0.4	-2.1	2.7	1.6	2.5	1.3	2.8	5.8	4.9	4.9	2.2	5.6	7.4
Labour composition contribution	1.8	1.9	4.6	3.8	3.5	2.1	2.5	0.5	-0.1	2.7	2.4	5.3	3.4	1.0	7.2
ICT capital contribution	0.1	1.3	1.8	2.4	1.6	2.0	1.9	0.9	2.7	1.4	1.9	2.4	2.4	2.6	0.4
Non-ICT capital contribution	3.5	2.2	5.9	8.3	4.9	5.0	1.6	6.1	3.6	3.9	4.8	9.8	18.9	11.2	22.2
MFP contribution	-5.5	-1.5	-3.2	-3.7	-1.6	3.4	5.9	5.8	5.8	1.3	1.4	-4.9	-3.2	29.0	12.9
2010–2015															
Compound GVA relative growth	-1.7	1.5	7.7	-0.9	7.0	10.1	6.2	7.6	12.2	11.9	7.9	13.1	6.7	17.4	19.6
Hours worked contribution	-4.1	-0.9	-1.1	-5.1	1.0	3.2	-0.6	1.1	3.2	4.8	2.3	3.3	0.2	0.6	0.5
Labour composition contribution	0.7	1.6	2.0	2.8	2.9	1.0	1.3	0.2	0.7	2.5	1.4	0.5	1.3	0.9	4.3
ICT capital contribution	-0.1	0.4	0.8	0.8	0.8	0.8	0.7	0.7	0.7	0.5	0.6	0.6	1.1	1.0	0.1
Non-ICT capital contribution	-0.1	0.1	3.8	1.4	1.9	2.9	0.5	2.9	1.6	2.8	1.2	3.6	9.9	4.6	14.0
MFP contribution	1.9	0.4	2.2	-0.9	0.4	2.1	4.3	2.6	5.9	1.3	2.4	5.1	-5.8	10.2	0.7

Table 1, cont'd

	Italy	Finland	Denmark	Spain	France	USA	Netherlands	Austria	Germany	UK	Belgium	Sweden	Czech Rep.	Slovakia	Poland
GVA growth structure (in %)															
2005–2015															
Compound GVA relative growth	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Hours worked contribution	96.2	12.7	-4.0	-24.0	24.2	11.2	17.1	8.6	18.9	38.4	31.7	28.0	9.2	11.3	14.8
Labour composition contribution	-40.8	42.5	52.8	43.5	31.3	14.6	17.4	3.5	-0.4	18.0	15.8	30.2	14.2	2.0	14.4
ICT capital contribution	-1.5	29.3	20.2	27.8	14.6	14.4	13.1	6.4	17.9	9.4	12.1	13.8	10.1	5.3	0.8
Non-ICT capital contribution	-81.4	47.6	67.5	94.3	44.2	35.6	11.3	41.8	24.6	25.7	31.3	55.9	79.9	22.7	44.3
MFP contribution	127.6	-32.0	-36.5	-41.5	-14.2	24.2	41.0	39.6	39.0	8.5	9.1	-27.9	-13.4	58.7	25.7
2010–2015															
Compound GVA relative growth	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Hours worked contribution	234.5	-58.0	-14.3	545.7	14.5	32.0	-9.1	15.2	26.2	40.2	28.8	25.3	3.1	3.6	2.3
Labour composition contribution	-38.5	102.5	25.5	-306.6	41.3	9.8	20.9	2.0	5.9	21.4	17.4	3.6	19.1	5.0	22.0
ICT capital contribution	4.2	23.2	10.8	-87.1	11.3	8.4	11.6	9.2	6.1	4.3	7.4	4.5	16.8	5.9	0.7
Non-ICT capital contribution	7.1	6.6	49.8	-147.9	27.9	29.0	8.0	38.8	13.0	23.2	15.7	27.4	148.9	26.7	71.5
MFP contribution	-107.3	25.7	28.2	95.9	5.1	20.8	68.5	34.8	48.8	11.0	30.6	39.2	-87.9	58.8	3.4

Notes:
For the period of 2005–2015 the order of the countries from the left to the right is according to the increasing compound relative gross value added growth level. For the period of 2010–2015 the order of the period of 2005–2015 has been maintained. For Italy, Sweden and the Czech Republic data have been calculated until 2014 because of missing data for 2015.

Source: own calculations, based on annual data from EU KLEMS internet site and on annual data from Statistics Poland concerning KLEMS productivity accounting for the Polish economy.

Table 2
Decomposition of compound relative gross valued added growth in the light of KLEMS growth accounting for selected industries (NACE sections) of the Polish economy

	B	R	D–E	H	G	I	Total Poland	Market economy	F	K	J	S	M–N	C
Decomposition of GVA relative growth into contributions (in percentage points)														
2005–2015														
Compound GVA relative growth	-22.0	-1.1	15.5	34.5	38.1	49.8	50.1	58.4	60.3	69.6	71.8	77.9	88.0	107.9
Hours worked contribution	-1.1	13.3	4.2	7.8	4.6	16.2	7.4	6.2	12.9	18.1	19.7	15.4	24.1	5.4
Labour composition contribution	2.3	5.9	2.9	-6.4	-4.4	2.1	7.2	6.6	4.1	4.0	-17.4	8.2	10.3	-5.5
ICT capital contribution	-0.1	-0.3	0.1	0.2	-0.3	0.2	0.3	0.4	0.2	1.2	3.5	0.6	1.0	0.0
Non-ICT capital contribution	5.9	141.2	53.2	110.1	6.0	17.0	19.0	16.7	5.1	2.8	2.7	4.3	3.9	15.7
MFP contribution	-29.0	-161.2	-44.9	-77.2	32.1	14.4	16.2	28.4	38.0	43.5	63.3	49.4	48.6	92.3
2010–2015														
Compound GVA relative growth	-0.4	-20.3	10.3	23.0	8.8	25.4	19.6	22.7	23.9	32.4	40.3	38.8	31.1	38.9
Hours worked contribution	1.0	3.6	0.2	1.3	-0.8	1.1	0.5	-0.3	-6.0	2.4	6.8	1.0	9.2	0.1
Labour composition contribution	2.6	4.2	1.7	-0.2	0.8	2.7	4.3	4.0	4.1	3.1	-6.9	3.2	6.0	-0.4
ICT capital contribution	-0.1	-0.8	-0.1	0.0	-0.1	0.0	0.1	0.1	0.1	0.7	1.9	0.3	0.5	-0.1
Non-ICT capital contribution	4.3	89.9	32.5	66.9	4.2	6.4	12.7	10.8	3.7	0.1	2.5	2.6	4.5	8.4
MFP contribution	-8.1	-117.2	-24.1	-45.0	4.7	15.2	2.1	8.1	22.0	26.1	36.0	31.6	10.9	30.8

Table 2, cont'd

GVA growth structure (in %)

|	B	R	D–E	H	G	I	Total Poland	Market economy	F	K	J	S	M–N	C
2005–2015														
Compound GVA relative growth	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Hours worked contribution	5.0	-1193.0	27.0	22.7	12.0	32.5	14.8	10.7	21.5	26.1	27.4	19.8	27.4	5.0
Labour composition contribution	-10.6	-528.1	18.8	-18.5	-11.6	4.2	14.4	11.3	6.9	5.7	-24.2	10.6	11.8	-5.1
ICT capital contribution	0.5	30.4	0.4	0.5	-0.7	0.4	0.6	0.7	0.2	1.7	4.9	0.8	1.2	0.0
Non-ICT capital contribution	-26.9	-12624.0	343.7	318.8	15.9	34.1	37.9	28.7	8.5	4.1	3.7	5.5	4.4	14.6
MFP contribution	132.0	14414.8	-289.9	-223.5	84.4	28.8	32.4	48.7	63.0	62.4	88.2	63.4	55.3	85.5
2010–2015														
Compound GVA relative growth	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Hours worked contribution	-230.4	-17.6	2.0	5.6	-8.7	4.3	2.3	-1.3	-24.9	7.4	16.8	2.7	29.5	0.4
Labour composition contribution	-627.4	-20.7	16.8	-1.0	9.3	10.5	22.0	17.6	17.3	9.6	-17.0	8.3	19.3	-1.0
ICT capital contribution	24.2	3.9	-0.8	0.2	-1.7	0.0	0.5	0.6	0.2	2.3	4.6	0.8	1.6	-0.3
Non-ICT capital contribution	-1034.0	-444.0	315.9	290.6	47.3	25.2	64.6	47.6	15.3	0.4	6.2	6.8	14.5	21.7
MFP contribution	1967.5	578.4	-233.9	-195.5	53.7	60.0	10.5	35.5	92.2	80.5	89.4	81.4	35.1	79.2

Notes:
For the period of 2005–2015 the order of the NACE sections from the left to the right is according to the increasing compound relative gross value added growth level. For the period of 2010–2015 the order of the period of 2005–2015 has been maintained. For comparisons the values for the entire Polish economy ("Total Poland") and for the market economy (according to its definition used in KLEMS accounting) have been added.

Source: own calculations based on annual data from Statistics Poland concerning KLEMS productivity accounting for the Polish economy.

Figure 1

Decomposition of compound relative gross valued added growth in the light of KLEMS growth accounting for selected EU KLEMS countries and Poland (in percentage points)
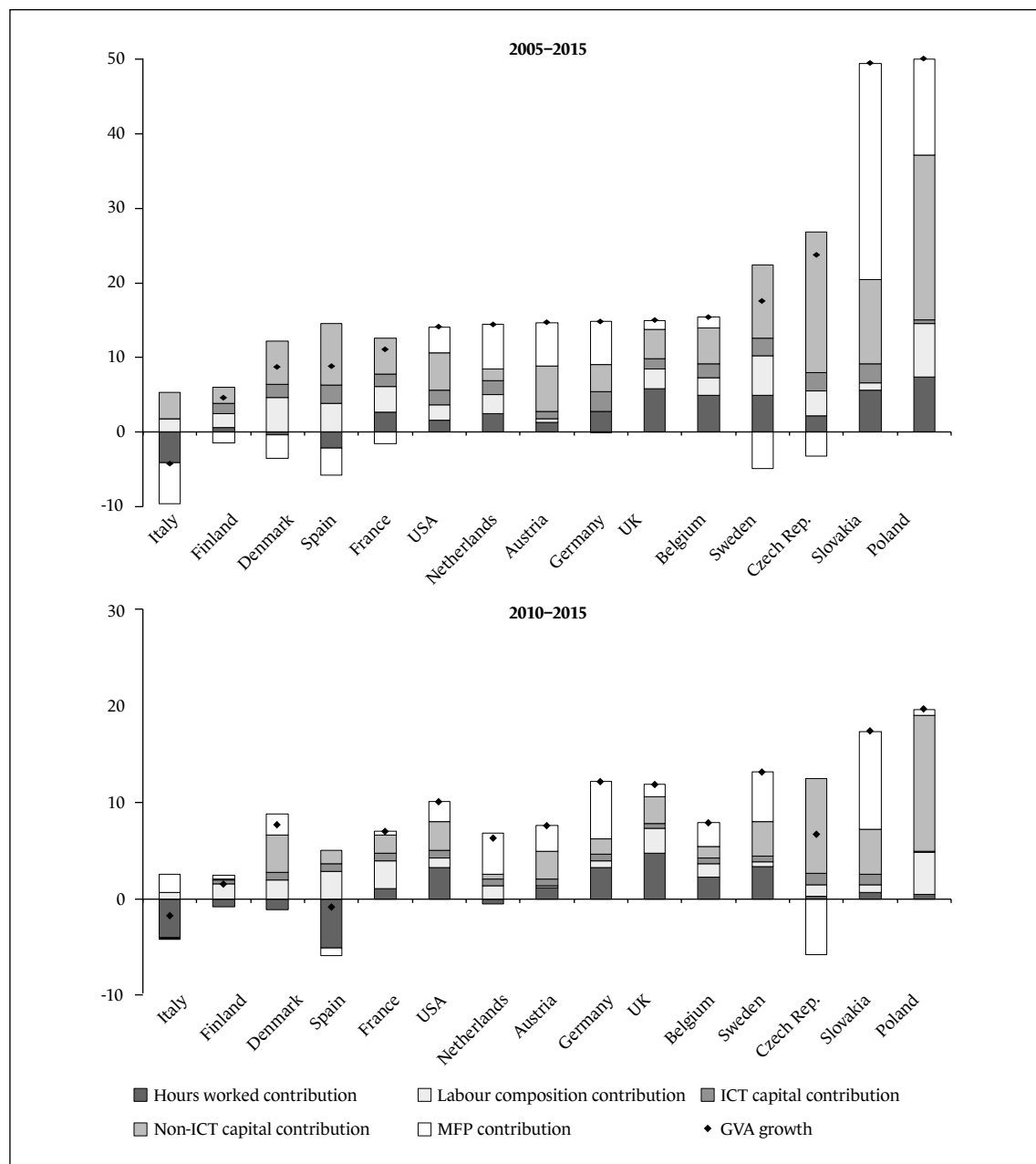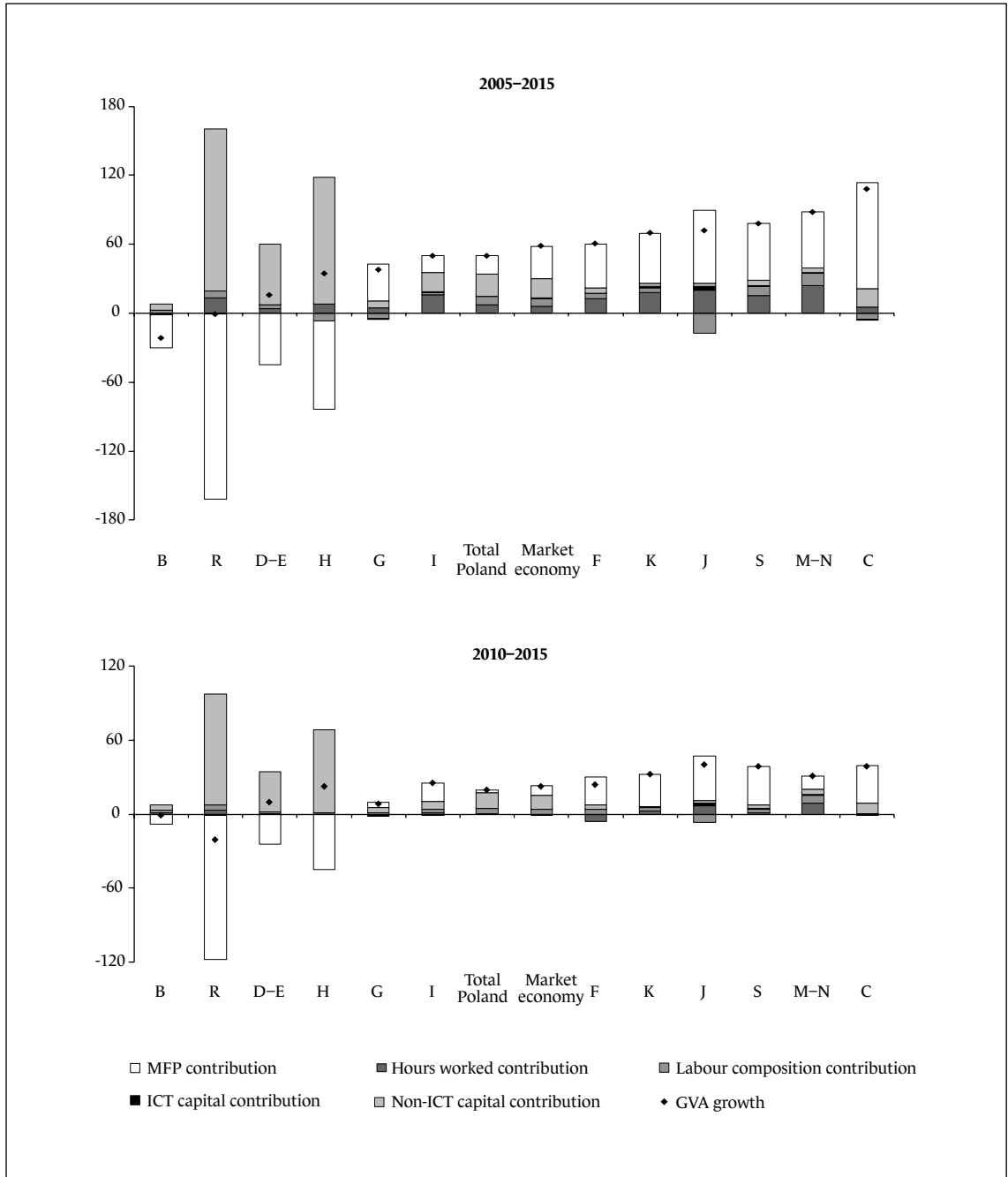

Notes:
The order of the countries is the same as in Table 1. For Italy, Sweden and the Czech Republic data does not include the year 2015.

Source: Table 1.

Figure 2

Decomposition of compound relative gross valued added growth in the light of KLEMS growth accounting for selected industries (NACE sections) of the Polish economy (in percentage points)
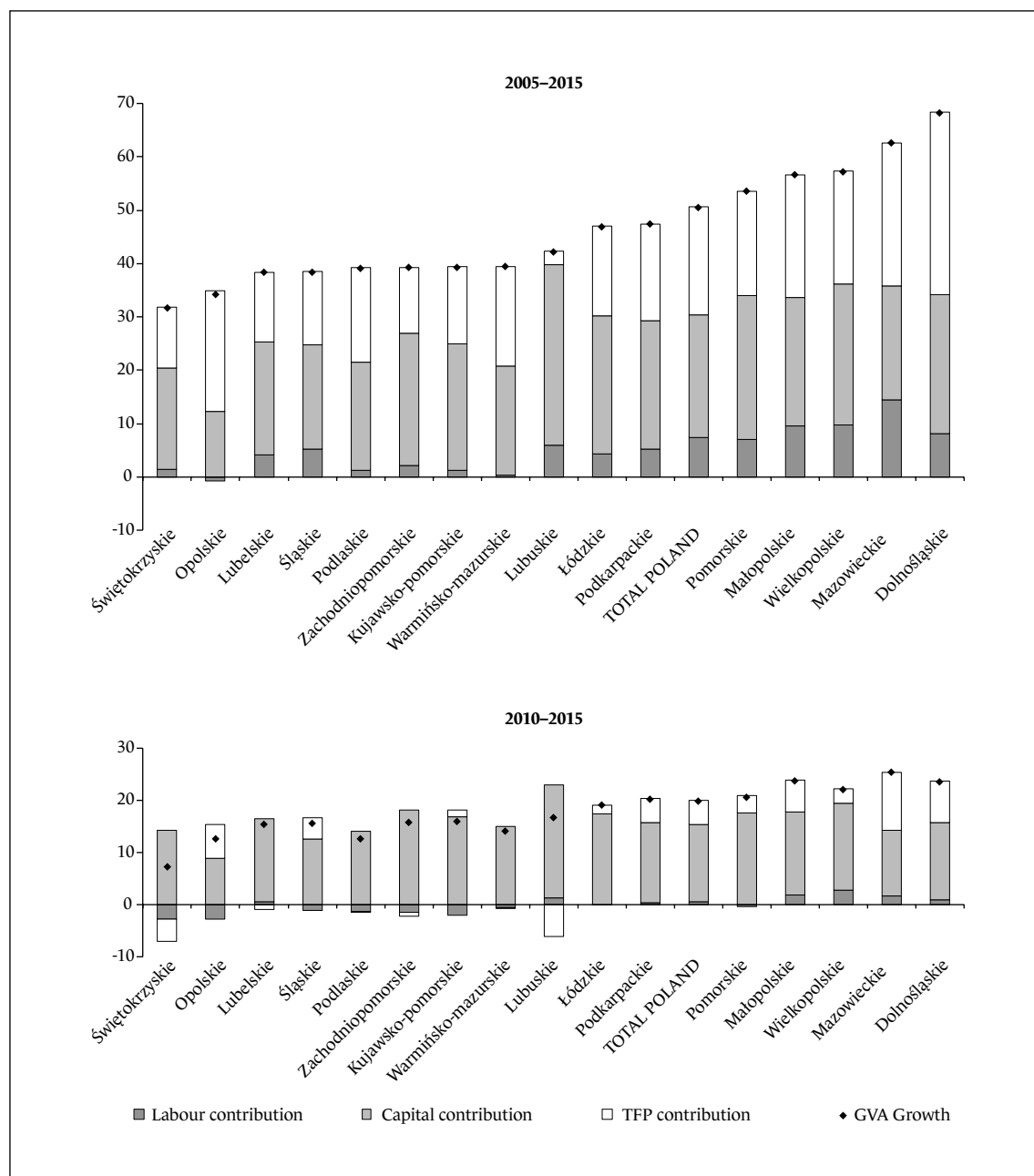

Note: the order of the NACE sections is the same as in Table 2.

Source: Table 2.

Figure 3

Decomposition of compound relative gross value added growth into production factors contributions and TFP contribution by voivodships (in percentage points)

Notes:
For the period of 2005–2015 the order of the voivodships from the left to the right is according to the increasing compound relative gross value added growth level. For the period of 2010–2015 the order of the period of 2005–2015 has been maintained. For comparisons the value for the entire Polish economy ("Total Poland") has been added.

Source: own calculations based on annual data from Statistics Poland, concerning factor decomposition performed within the framework of Operational Programme 'Technical Assistance' II.