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Structural change and economic growth: Causality relationships in the case of Poland

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Abstract

Research background: Structural change and economic growth characterise any process of economic development and have relevant research background. However, the research on identification of a character of relationships between the phenomena are not conclusive. Researchers either find that economic growth induces structural change and the process is demand-driven or that structural change determines economic growth and the dependencies are supply-driven or that the relation is two-directional with overlapping interdependencies. Moreover, the association may be shaped differently depending on specific development conditions of each economy and transform over time.
Purpose of the article: The aim of the study is to investigate the relationships between economic growth and structural change in the sectional composition of employment in Poland using state-level quarterly data for 2008–2022. It empirically verifies whether economic growth determines structural change or changes in economic structure influence growth in this specific national context, giving insights into a character of the developmental interdependencies. However, the Polish case is only an example of developmental feedbacks that may specify any catching-up economy. Diagnosing the dominating character of the economic

relation is of high importance for any modern transforming country and identifying any limitations to the interdependencies may make it possible to avoid the middle-income trap.
Methods: The paper examines the causality using Granger-test and analyses the relationships with VAR models. It uses some alternative measures of structural change, namely Norm of Absolute Value (NAV), Modified Lilien Index (MLI), and Clark Index (CI) to catch labour reallocation across sections of economic activity (NACE Rev. 2). They are then adopted in lead-lag models of relationships with economic growth.
Findings & value added: The study browses the classical three-sectoral approach to structural transformation using a more detailed structural layout to capture its modern character. Moreover, it compares alternative measures of structural change to derive more detailed conclusions. Methodologically, the study highlights the need for in-depth research into structural change with finer aggregation and measures with different properties. The paper is focused on a specific situation in the Polish economy, for which the relationships have not yet been verified. However, the findings are more universal and may be interesting for any catching-up economy that plans its development policy and needs to focus either on demand- or supply side-relationships. The results suggest rather unidirectional causality running from economic growth to structural change and thus a demand-driven character of the structural modernisation of the Polish economy. This implies the necessity to build stronger inter-sectoral linkages that enable spillover effects that can accelerate growth and induce mutually reinforcing mechanisms of development.

Introduction

Although there is a significant, long-term body of literature that focuses on economic growth and structural change (e.g., Kuznets, 1966; Baumol, 1967; Chenery, 1971; Wacziarg, 2001; Saviotti *et al*., 2020; Comin *et al*., 2021; Hartwig & Krämer, 2023; Jia *et al*., 2023; Sengupta *et al*., 2023; Margarian, 2024; Tasneem & Khan, 2024), the research into the relationships between the phenomena is still inconclusive. There is some research arguing that only economic growth causes structural change (e.g., Kongsamut *et al*., 2001; Meckl, 2002), some that structural change influences economic growth (e.g., Peneder, 2002; Nordhaus, 2006; Hartwig, 2010; Saviotti *et al*., 2020; Bondarev & Greiner, 2022; Sengupta *et al*., 2023; Kong *et al*., 2024) as well as some determining bidirectional causality (e.g., Dietrich, 2009; Akhter *et al*., 2022). Moreover, it is also ambiguous whether the association is negative or positive as it may differ respectively to the detailed sectors considered (e.g., Mahmood & Linden, 2017; Soni & Subrahmanya, 2020; Loubassou Nganga, 2021; Trofimov, 2024). Thus, a research gap exists as the literature provides no generally agreed-upon answer to the question about the direction of the relationship between structural change and economic growth and also does not diagnose structural change in its modern

complexity. The studies are usually limited to a traditional three-sectoral description of structural change (e.g., Sahadevan, 2020), and rarely use more detailed disaggregation of the economic system (although there is growing interest in sector diversification issues — e.g., Saviotti *et al*., 2020; Duernecker & Sanchez-Martinez, 2021). Meanwhile, to follow the modern trends of structural change with knowledge-based and technologically advanced sectors becoming the leading ones (e.g., Jia *et al*., 2023 point to a role of data elements), it is necessary to go beyond the three-sectoral division, which is the task this paper tries to fulfil.

The phenomena of economic growth and structural change and their mutual feedback play a fundamental role in ensuring sustainable development, and it is necessary for economic planning to acquire their interactions. Specifying the linkages or diagnosing a lack of such connections enable actions that could push the economic system into a mutually reinforcing mechanism, leading to development. It is especially important that many researchers stress the benefits of structural change not only for economic growth but also for society and the environment (Bondarev & Greiner, 2022; Kong *et al*., 2024).

The relationships seem to be especially important in catching-up, transition economies. They have to decide about their unique structural development path, enabling them not only to limit the gap in the short term but also to avoid the middle-income trap that sets them up as an imitator with accelerated growth, but still not able to ensure the highest living standards in the long term. The problem seems to be universal as in any convergence clubs around the world, there are some catching-up economies that are trying to sustainably accelerate their growth.

In considering all the discrepancies, the aim of the study is to empirically investigate the casual relationships between economic growth and structural change in the case of Poland. Even within the highly integrated area of the European Union, as each country possesses unique developmental conditions, the interrelation may differ across national or regional economies (Margarian, 2024). In the last period, the Polish economy is distinguished among EU countries by relatively high dynamics of economic growth as well as structural change. Such a situation allows a reduction in the developmental gap in relation to the 'old' EU member states; however, it also induces a risk of distortions in the equilibrium that provides a long-term welfare. It justifies the analyses of the directions and dynamics of changes in the economic structure and production levels as well as interre-

lations between the phenomena. Although the paper uses Poland as a case study, the results may also shed light on some more universal developmental threats that other catching-up economies may face. Poland's experience may thus constitute a source of knowledge about potential difficulties or practiced solutions supporting development.

To fulfil the aim of the study, data from the Eurostat database were used. A structure of employment was specified and structural change indices (SCI) calculated. To investigate the structural transformation in more detail than in the three-sectoral classical approach, and to define its modern character, a sectional classification was used. This kind of attitude to economic structure specification is not the rule but rather the exception in the literature. Meanwhile, highly aggregated data are not appropriate for expressing a modern structural transformation based on new technology and knowledge-economy conditions, which is a process that requires a more detailed data set. In the specification of an economic model and in understanding the interrelationships among the structural changes and economic growth, tools of VAR analysis were used, such as Granger Causality (Granger, 1969).

The paper contributes mainly to an empirical strand of the research into relationships between economic growth and structural change focusing on the kind of interactions that may be experienced in a catching-up, transition economy. It diagnoses a dominating pattern of economic connections: a demand- or a supply-side causality. The implication of such a diagnosis may be crucial for developmental policy, especially in transition countries that are endangered by the middle-income trap. However, the paper also deals with the theoretical/methodological literature gap — it focuses on structural change described by more detailed coverage than the traditional three-sectoral attitude. Simultaneously, it uses one measure of structural change in all of its elements, instead of diagnosing the links separately for each sector. The attitude makes it possible to define the modern character of the transformation and limits the subjectivity of the choice of one representative leading sector. Additionally, some alternative measures of structural change are adopted to diagnose the character of transformation in-depth.

The paper is organised as follows. Literature Review lists the research into the relationships between economic growth and structural change. The Research methods section gives the attitudes to structural change measurement, data, and the procedures used to estimate models of interactions

between economic growth and structural change. The Results section examines the causality and the lead-lag relationships in the Polish economy and checks the robustness of the results. The Discussion section compares the findings with the results obtained by other researchers and gives some policy recommendations. The Conclusions finalizes the work undertaken in this study.

Literature review

Although the roots of the study on the relationships between economic growth and structural change can be found in the thoughts of classical economists, such as Turgot (1973) or Smith (1776) (cf. Dietrich, 2009, p. 2; Silva & Teixeira, 2008, p. 280), relatively limited attention has been paid to the topic and the role of structural change in the process of economic development is still insufficiently recognised (Krüger, 2008; Silva & Teixeira, 2008; Herrendorf *et al.*, 2013; cf. Gabardo *et al.*, 2018, p. 2). It results in a need to deepen the research about structural change — economic growth relationships, which is addressed by scholars who either discuss some theoretical models of growth with incorporated structural features (e.g., Saviotti *et al.*, 2020; Bondarev & Greiner, 2022; Jia *et al.*, 2023; Sengupta *et al.*, 2023) or empirically verify the relationships within modern conditions (e.g., Rijesh, 2023; Yoruk *et al.*, 2023; Margarian & Hundt, 2023; Kong *et al.*, 2024; Margarian, 2024; Tasneem & Khan, 2024).

For the first time, structural change has gained special attention along with the conceptualisation of three-sectoral theories by Fisher (1935), Clark (1940), and Fourastié (1949), developed later by Wolfe (1955), Baumol (1967), and Fuchs (1965), whose collective seminal contributions in the vein of structural change are referred to as 'the Classics' (Schettkat & Yocarini, 2003; cf. Sahadevan, 2020, p. 48). Since then, the structuralist approach to development economics, as pioneered by Rosenstein-Rodan (1943) and Lewis (1954), proves that economic growth is linked to structural change (Loubassou Nganga, 2021, p. 340). Kuznets (1966), Chenery (1971), Rostow (1990), and many others made conclusions about the essential role of sectoral composition in the course of economic development (Ren *et al.*, 2022, p. 6365; Riaz *et al.*, 2020; Trofimov, 2024).

This strand of work is still developing. Some deal with the hypothesis of structural convergence (e.g., Wacziarg, 2001; Sassi, 2011; Iordan *et al.*, 2017;

Jena & Barua, 2020), some focus on productivity dynamics (e.g., Klodt, 1995; Vu, 2017; Duernecker & Sanchez-Martinez, 2021; Kuosmanen & Kuosmanen, 2024), some are devoted to specialization-diversification issues (e.g., Krugman, 1991; Kallioras & Petrakos, 2010; Zeira & Zoabi, 2015; Saviotti *et al*., 2020), or to the identification of patterns and determinants of modern structural change (e.g., Sahadevan, 2020; Dietrich, 2009; Gabardo *et al*., 2020; Comin *et al*., 2021).

Although the existence of the interrelations between economic growth and structural change is widely accepted in economic theory, there is still no consensus about the character of the interrelations and the direction of causalities (Dietrich, 2009, p. 2). Some authors adopt a demand-side approach (also known as the income or utility-based explanation) and argue that economic growth determines structural change, while others use the supply-side attitude (also known as productivity channel or relative-price effect) to claim that structural changes influence economic growth.

The direction of influence from economic growth to structural change is explained by Engel's theory of the hierarchy of needs transformed into sectorally diversified income elasticities. These sectoral non-homogeneities, as in the Fisher (1935) and Clark (1940) theories, leads to reallocation of labour resources. Many authors rely on this channel to explain the process of structural change, including Echevarria (1997), Kongsamut *et al*. (2001) (cf. Gabardo *et al*., 2018, p. 3) or Comin *et al*. (2021). Going further, Meckl (2002) claims that only economic growth promotes structural change and that there is no feedback on the growth process itself (cf. Dietrich, 2009, p. 4).

Some other authors hold a supply-side view of Baumol (1967) and Fuchs (1965), and perceive structural change as a source of change in production dynamics through sectorally diversified technological progress. When labour resources are allocated for less dynamic sectors, economic growth is reduced, as in Baumol's hypothesis. The 'cost disease' arises when the wage level in a high demand sector grows faster than labour productivity and results in growing prices. The assumptions of cost disease are confirmed by Nordhaus (2006), Hartwig (2010) (cf. Duernecker, Sanchez-Martinez, 2021, p. 3; Dietrich, 2009, pp. 5–6) or Hartwig and Krämer (2023). However, many studies have shown that the sectoral transfer of labour promotes national economic growth (e.g., Peneder, 2002; cf. Ren *et al*., 2022, p. 6365). This happens when the shift of labour goes from the lower to the higher productivity sectors (Vu, 2017, p. 2). Therefore,

when adopting the supply-side attitude to explaining the influence of structural change on economic growth, it is not possible to unambiguously specify whether the relation is positive or negative.

Many studies integrate the demand and supply-side attitudes (e.g., Gabardo *et al*., 2020; Sengupta *et al*., 2023), and empirically examine a feedback relationship between economic growth and structural change (e.g., Dietrich, 2009; Trofimov, 2023). The findings are still inconclusive as some authors stress the main contribution of the income effects (e.g., Comin *et al*., 2021), while some others draw conclusions on the relevance of the 'cost disease' (e.g., Hartwig & Krämer, 2023). As Krüger (2008) pointed out, the strand of research on the feedback effects should deserve much more attention in the future (cf. Gabardo *et al*., 2018, p. 4).

Moreover, as structural transformation is often context-specific (Ray & Subhasankar, 2021), recent studies focus on countries at different stages of development (Ren *et al*., 2022, p. 6366). Studies have been conducted in developed countries (e.g., Dietrich, 2009; Hartwig, 2010; Mendoza, 2023; Kuosmanen & Kuosmanen, 2024) and developing countries (e.g., Ray & Subhasankar, 2021; Loubassou Nganga, 2021; Norbu *et al*., 2021; Akhter *et al*., 2022; Tasneem & Khan, 2024). However, it seems that the relationship is hardly investigated for the case of Central and Eastern European countries as well as the individual countries of the region, such as Poland. Some analyses on in the importance of structural change for aggregate productivity growth in the 'new' EU Member States, such as those by Kuusk *et al*. (2017), and Duernecker and Sanchez-Martinez (2021, p. 5), stand as exceptions, along with studies into the role of structural convergence in income convergence in the EU (Jena & Barua, 2020), analysis of the role of structural changes in regional differentiation in Latvia (Mihnenoka & Senfelde, 2017), cause-and-effect relations of structural changes and economic growth for Serbia (Ćorović *et al*., 2021), convergence of structures for Bulgaria, Romania and Croatia (Velichkov & Damyanov, 2021), and patterns and drivers of structural changes in Germany, Hungary, Poland, Romania and Ukraine (Yakymova, 2020). Nevertheless, the previous studies focus on problems of convergence between countries and differences induced by the level of development, rather than on identifying the dominating linkages in the economy. The paper fills an empirical gap by providing the results of causality testing in the special case of Poland. However, its findings could be useful for any catching-up economy, that has to transform its economic structures simultaneously with increasing the living standards. Moreover,

a wide range of the literature usually adopts the traditional attitude to measuring structural change, while an important additional value of the paper lies in its finer disaggregation of structural changes in the economy, which browses the traditional three-sectoral approach. Additionally, the paper uses alternative measures of structural change, which is an exception in the previous research.

Research method

Structural change measurement

The present study adopts a classical approach to analysing structural change, as it focuses on the reallocation of labour resources. However, it goes beyond the traditional three-sectoral attitude (adopted e.g. by Dietrich, 2009; Mahmood & Linden, 2017; Soni & Subrahmanya, 2020; Sahadevan, 2020; Loubassou Nganga, 2021) and considers the finer aggregation of activities, i.e., into the 20 sections of the NACE Rev. 2 classification (sections A–T) (e.g., Duernecker & Sanchez-Martinez (2021) along with three-sectoral analyses, also used 9 service sub-sectors achieving a division into 11 sectors, while Trofimov (2024) divides economy into only 4 sectors; on the other hand much more detailed divisions are used with the input-output approach — e.g. Norbu *et al*. (2021), Mendoza (2023)). Therefore, it makes it possible to distinguish the heterogeneity of activities and modern directions in structural development.

Furthermore, the study tries to simultaneously consider any reallocation of labour within the economy, and uses aggregate measures of structural change. The literature offers numerous indicators, known as structural change index (SCI), e.g., Norm of Absolute Values (NAV), Lilien-index (LI), modified Lilien index (MLI), Euclidean Norm (EN), Clark Index (CI), or Effective Structural Change (ESC) index (Dietrich, 2009, pp. 12–14; Vu, 2017). The work is based on NAV as the simplest measure widely used in similar research, and alternatively — in the robustness analysis — on MLI and CI, which reveal opposite properties.

The measures are respectively specified by the formulas:

$$\mathrm{NAV} = \frac{\sum_{i=1}^{k} |\alpha_{it} - \alpha_{i(t-1)}|}{2} \tag{1}$$

$$\mathrm{MLI} = \sqrt{\sum_{i=1}^{k} \alpha_{it} * \alpha_{i(t-1)} * \left(\ln \frac{\alpha_{it}}{\alpha_{i(t-1)}}\right)^2} \tag{2}$$

$$\mathrm{CI} = \sqrt{\frac{1}{k} \sum_{i=1}^{k} \left(\frac{\alpha_{it} - \alpha_{i(t-1)}}{\alpha_{it} + \alpha_{i(t-1)}}\right)^2} \tag{3}$$

where:

α	a share of a section in the employment structure,
i	a section (A–T NACE Rev. 2), (i = 1, ..., k)
t	time period (Q1 2008 – Q3 2022).

The property of NAV is its proportional reaction to any change in sectoral composition, which means that larger shifts in a few sectors have the same impact on the index value as smaller changes in many sectors. Structural change as measured by NAV reflects the average share of movements of the sectors as a percentage of the whole economy. MLI measures the standard deviation of the sectoral growth rates and reacts proportionally to both the size and dynamics of each sector. In contrary, CI stresses the changes in structural elements with relatively low shares (Dietrich, 2009, pp. 13–14; Sahadevan, 2020, pp. 53–55).

Data

The study uses data for Poland available in the Eurostat database, and covers:

- quarterly data on employment by sections of economic activity in the period Q1 2008 – Q3 2022 (Eurostat, Employment… http), which allowed the calculation of the sectional structure of employment for 59 periods and then structural change (with NAV, MLI, and CI) compared to the same quarters in the previous year with a reduction in the number of observations to 55;
- quarterly data on economic growth in the period Q1 2008 – Q3 2022 (Eurostat, Main GDP… http), which was measured by percentage change in Gross Domestic Product at market prices per capita in chain linked volumes compared to the same period in the previous year.

The research period was limited by data availability. The structure of employment in the sections is presented in a layout introduced in 2008 by the NACE Rev. 2 classification.

Causality-testing and VAR models

The compound character of relationships between economic growth and structural change suggests verification of the hypothesis about two-directional causality, i.e., the coexistence of the demand-side as well as the supply-side channel for the interactions. However, there are four possibilities about the investigated relationships:

- bidirectional causality, i.e., feedback relation;
- unidirectional relation from economic growth to structural change, indicating demand-side influence;
- unidirectional relation from structural change to economic growth, indicating supply-side association;
- no proven causality.

The paper uses the test of Granger causality as a conventional procedure to study causal relations between time series variables. The idea of causality, introduced by Granger (1969), assumes that X causes Y, if actual values in Y can be predicted more accurately when using past values of X than without them. It is reflected in a formula:

$$y_t = \alpha_{0i} + \sum_{i=1}^{p} \alpha_{1i} y_{t-i} + \sum_{i=1}^{p} \alpha_{2i} x_{t-i} + \varepsilon_{yt} \qquad (4),$$

where:

y_t, x_t	variables (SCI and growth),
t	period (55 periods),
i	time lag (p = 5), i = 1, …, p
α	parameters of a model.

When a group of parameters for a lag variable in a model is significant, it proves the existence of causality. It requires testing hypothesis H_o: $\alpha_{21} = \alpha_{22} = \cdots = \alpha_{2p} = 0$, which assumes no causality.

Estimation of the VAR model is necessary to test the relationships between economic growth and structural change, and to verify the direction of causality. In the paper it is preceded by stationarity testing (using ADF and KPSS tests) as a required feature of the processes used in the Granger test and cointegration checking (by Johansen tests). When estimating the VAR model, the choice of optimal lags is done based on information criteria (AIC, BIC, and HQC). Finally, having the models estimated, the F-test allows the verification of causality. These steps were conducted in the following part of the study.

Results

Structural change and economic growth in Poland — a general view

Structural change in employment distribution across NACE sections in Poland in 2008–2022 were characterised by significant fluctuations, with noticeable intensification over time (Figure 1). It was specified mainly by intensive deagrarisation, and deindustrialisation determined by the decline of manufacturing as an area of labour absorption. Simultaneously, a share of modern service activities, such as professional activities, healthcare, or information and communication increased in the employment structure (Figure 2).

Although changes observed in Poland are consistent with trends towards a knowledge-based service economy, the structure of employment should be considered as traditional. Manufacturing still accounts for the largest part of employment, followed by trade — which is a classic form of service activity. The absorption of labour is also significant in such traditional fields of activity as agriculture, construction, and transportation, as well as non-market activities, i.e., education, public administration, and healthcare (Figure 3).

Meanwhile, the economic growth in Poland has an average level of about 3.5% a year. It is a relatively favourable result concerning the intensity of global crises in this period, including the financial crisis from the second half of 2007, the recession of 2012–2013 and untypical conditions during the pandemic. The dynamic of real production in Poland, despite its fluctuations, has usually been positive. Periods of stagnation or decline in production levels have not been numerous and rather short-lasting (Figure. 1).

In comparing economic growth and the pace of structural change, it is possible to perceive rather a negative relation between them. Periods of higher production dynamics were usually those with slower structural changes in employment, and vice versa. However, the pattern is not clear due to the numerous discrepancies and fluctuations, and therefore needs an in-depth diagnosis.

Causality between structural change and economic growth

To identify the causality between structural change and economic growth, the processes have to be stationary and this assumption was verified using ADF and KPSS unit root tests. The ADF test showed non-stationarity of both processes, while the KPSS test suggested stationarity. The ambiguity in the results gave bases to modify the original data. Their first differences were stationary, as shown by both tests and thus used in the model. Moreover, cointegration was not confirmed by the Johansen test.

In terms of the results, the VAR model was estimated to identify dynamic relationships between structural change and economic growth (tab. 1). The lags in the models were specified based on the information criteria. Two information criteria, i.e., AIC and HQC, achieve the lowest value for 5 order lags, while BIC criterion — for 1 lag. Therefore, a lag of 5 was applied in the VAR model.

The estimations indicate that both processes, i.e., economic growth and structural change, are self-reducing. Three-quarters lagged structural change limits the actual transformation of the employment structure. Similarly, a self-reducing influence is observed for economic growth after 4 and 5 quarters.

In the case of the model explaining structural change, both significant coefficients indicate that intensified changes in production and employment after 2–3 quarters limits further structural change. Structural change thus stabilises after any kind of initial impulse.

For the investigated relationship between economic growth and structural change it is especially important that 2-quarters lagged economic growth slows the dynamics of actual sectional reallocation. The negative coefficient of 2-lagged economic growth could have its economically favourable explanation. The accelerated economic growth after half a year reduces structural change as a sectional structure of labour successfully adjusting to market demand. It signals optimal resource allocation. In the opposite case, when the dynamics of production is reduced, it stimulates a search for optimal structures of resource allocation and therefore accelerates structural changes in employment.

However, the model explaining economic growth shows that the process is not determined by structural change, as none of the coefficients of

structural change were significant. Therefore, the models indicate only a one-way relationship from economic growth towards structural change.

To further verify the causality between economic growth and structural change, the Granger test was used. As the test is vulnerable to lag length, it was carried out with varied assumptions about the lag (from 1 to 5) (tab. 2).

The results provided consistent evidence of the direction of the relationships between economic growth and structural change. The causal relationship was unidirectional and ran from the former to the later. Economic growth allowed better explanation of the observed structural changes in the sectional allocation of labour. The influence appeared to be relatively stable and independent of the lag length assumed in the model.

Meanwhile, the analyses did not identify causality in the opposite direction. The influence of structural change on economic growth were not confirmed in any model. Such a situation may indicate weaknesses in the supply channel related to technological progress under the Polish conditions of the last few years.

Robustness checking

To assess the robustness of the results, MLI and CI were used as alternative measures of structural change (Figure 4). Although they are strictly correlated with the basic NAV measure (correlation coefficient with MLI is 0.9467, and with CI is 0.5300), their properties show some specificity of structural change. In MLI, the sectional contribution is weighted by their shares, and thus the measure reacts stronger when the employment allocation concerns the biggest sections, while CI highlights changes in the smallest sections.

The alternative measures were used in the VAR model estimations to check the causality between economic growth and structural change. Different lag lengths were adopted to compare the results (tab. 3).

When using MLI, no causality was found from structural change to economic growth. This suggests that the supply-side of the interaction in Polish conditions is not strong or it is disturbed by mutually contradicting phenomenon. In the case of CI, some short-term determinations have been identified (for lags 1–3). These may result from changes in employment concerning the smallest sections which are caught by the CI measure. The most neglected kinds of activity may thus determine the economic growth processes and constitute a main source of productivity dynamics.

Concerning causality from economic growth to structural change, the results are also not robust. In the models with MLI the causality is confirmed only in the case of 3-period lags, while in the models with CI only for 4 and 5-period lags. Thus, it may be concluded that economic growth determines changes in the smallest sections after longer periods than in the case of sections with higher shares in employment.

In summing up, the robustness check was not confirmative. The initial results must therefore be further verified.

Discussion

Previous research and the value added of the paper

The results are not directly comparable to those of other authors as they relate to the Polish case. However, there has been some similar work on the problem of causality relationships between structural change and economic growth.

The results where structural change is measured with SCI are the most comparable. In this vein, Sahadevan (2020) examined Granger causality in Indian regions, finding a unidirectional relation running from structural change to growth, while Dietrich (2009) researched the relationships for 7 OECD countries, concluding about heterogeneous patterns for the interactions going from economic growth to structural change as well as the other way round. However, as Dietrich measured structural change either in terms of employment or real value added, and his results are, at least partially, consistent with those presented in this study for Poland, Sahadevan focused only on the structure of value added. Relationships between economic growth and labour reallocation examined in the present study are more compound due to possible sectoral differences in labour productivity, and it could be the reason for the discrepancies in the results.

Moreover, both researchers focused only on three-sectoral structures. The present study is distinctive with its finer aggregation level, which could influence its results. As Duernecker and Sanchez-Martinez (2021, p. 35) suggest, the effect of structural change is underestimated under the three-sector split. The classification used here is driven by the necessity to investigate the modern transformation of developed economies with prevailing heterogeneous service activities. A more disaggregated classifica-

tion than the three-sectoral system is used by Stamer (1998), Aiginger (2001), Ansari (1992) (cf. Dietrich, 2009, p. 7) and Duernecker and Sanchez-Martinez (2021). However, due to the ambiguity of the results, it is important to search continuously for new classification layouts.

It is also useful to compare the achieved results with studies testing the causality separately for each sector. Such work has been conducted by Linden and Mahmood (2007) and Mahmood and Linden (2017), finding unidirectional causality from the growth of GDP pc to agriculture share growth and two-way causality for industry and services in 15 Schengen countries. They made conclusions about the decisive for growth role of the industry sector and supported Baumol's theory. On the other hand, Soni and Subrahmanya (2020) confirmed unidirectional Granger causality from industry growth to GDP growth, and from services growth to GDP growth, and found that services had a stronger impact than industry on economic growth in India. The contradicting trends in each economic activity, found by numerous authors, may be also a reason for unidentified causality running from structural change to economic growth in the present study for Poland.

Summing up, it should be stressed that the research results confirm that interactions between economic growth and structural change are an important part of the processes of economic development, including in the case of Poland. The findings reveal that the dominant character of those relationships is demand-driven, which is in line with the results of Comin *et al*. (2021). It could reflect the strong market-orientation of Polish enterprises and their flexibility in adjusting to current market needs. Moreover, the diagnosed direction of influence also suggests the high flexibility of the labour market that reacts to changes in demand. It may be perceived as a strong distinguishing aspect of the Polish economy and exemplifies a positive feature of any catching-up economy.

The value added in the research is the finer aggregation of activities that accounts for structural changes. Moreover, comparing measures that differently react to changes in bigger and smaller elements of the structure makes it possible to draw conclusions on some additional features of economic relationships. Such a methodological approach seems to be necessary when researching structural change in-depth. The presented results show that the flexibility to changes in economic growth is initially higher in more mature bigger parts of the Polish economy, while it takes more time for the smallest sections to overcome barriers with access to human capital

resources. This characteristic seems to be universal as activities employing more people usually also have easier access to human resources than more specialised branches. This results from the more general abilities of the human resources used in bigger sections of the economy as well as adjustment of the profile of their qualifications to a more widespread kind of activity.

Moreover, the study has not confirmed the general causality running from structural change to economic growth in Poland, which suggests that supply-side relations could create strong barriers to development. However, in the case of Poland the results also suggest that sources of economic growth can be found in the kinds of activities that are in their initial phase of development. Diagnosing which part of the economy accounts for the highest productivity growth is an important task in any catching-up economy. Another research challenge is to specify limitations to productivity growth in the rest of the activities and, finally, the economy as a whole.

Policy implications

The findings of the research carry important implications for public policies, which stem from both the strengths and weaknesses of the Polish economy.

Firstly, in Poland measures supporting demand should be efficient in stimulating structural change and thus a required direction of development. Either direct (e.g. using government spending) or indirect (e.g. subsidising private consumption or investments) intervention may result in significant growth of the specific activity. The Polish case shows the potential of any demand-driven economy; however, it also signals possible problems induced by either an inflexible labour market or limited access to human capital, which implies the necessity of investing in highly qualified human resources and counteracting the phenomenon of brain drain observed in any catching-up economy.

Secondly, there is a strong need to reconstruct the supply-side relationship in the Polish economy, as structural change appears not to support economic growth. Although some economic activities are characterised by high productivity dynamics, the effect is not significant enough to accelerate the growth of the whole economy. One explanation seems to be connected with factor market rigidities, which limits the reallocation of resources towards the most productive sectors. The task for policy is to sup-

port access to capital and labour in the most modern, technologically advanced and knowledge-intensive kinds of activity. This requires efficient support for research and development as well as investments in human capital or easier access to capital for the most risky but promising projects (e.g. initiatives supporting start-ups).

Another potential limiting factor for economic growth could be also found in the lack of interlinkages between sectors in the economy that could stimulate spillover effects. These weak inter-industry ties and lack of mutual trust in market relations need support. Some ongoing initiatives, such as industrial clusters with public support, appears to be insufficient for spreading benchmark solutions and technology diffusion. Similar problems are experienced by many other catching-up economies and a lack of backward, forward, and inter-sectoral linkages is diagnosed as a reason for slow economic growth by Norbu *et al*. (2021), Margarian (2024), and Tasneem and Khan (2024). The creation of extensive value chains and cooperation initiatives is thus an important challenge for economic policy.

Conclusions

The paper verifies the relationship between economic growth and structural change in the Polish case, finding that the causality is unidirectional and is running from economic growth to structural change. The interrelation is thus of a demand-driven character and its negative sign suggests that accelerated economic growth after half a year reduces the sectional allocation of labour. It may have its positive explanation in the finished market adjustments of sectional structure of employment to demand and thus in high flexibility of the Polish economy. Generally, the results allow us to conclude that structural change dynamics could be better recognised concerning prescending changes in a pace of economic growth.

Moreover, the research shows that structural change does not cause economic growth, which may indicate weaknesses in the supply channel related to technological progress under the Polish conditions of the last years. In the paper neither Baumol's negative effect nor the opposite situation that stimulates economic growth were confirmed. This may result from mutually contradicting trends and weak inter-industry linkages. Therefore, any supply-side channel on the interaction under Polish conditions is not strong enough to noticeably shape the pattern of development.

Moreover, it might be possible that individual positive sectional trends in productivity dynamics face rigidities in labour reallocation or other factors of production accessibility and thus are not decisive for the acceleration of economic growth. Their identification is thus a field for future research, as it may be essential for economic policy aimed at dynamizing technological progress and economic welfare.

Although, the findings relate solely to Poland as a case study, diagnosing the dominating character of economic interactions in the path between economic growth and structural change may be of high importance for any catching-up economy. A lack of supply-side relations, as in the Polish case, could be a sign of weak inter-industry linkages that would produce spillover effects and may accelerate economic growth. A lack of demand-side relations may be a starting point to diagnose factor market rigidities and low flexibility of the economy. Any of these problems may negatively influence economic development and put the economy into the middle-income trap. It needs public policy aimed at creating of backward and forward linkages in the economy, easing supply-side bottlenecks, developing human capital, supporting improving technological advancement, and limiting market rigidities.

Nevertheless, there are certain deficiencies in the conducted research. First of all, the study focuses solely on the Polish case. It finds existence of demand-side interactions. However, the specificity of each economy makes it impossible to treat this diagnosis as universal for catching-up economies. It must be verified in each case to form a proper diagnosis and implement appropriate policy measures. The paper pays attention to necessity of identifying the causality in a line economic growth — structural change.

Moreover, the presented results appeared to be vulnerable to the choice of a structural change measure and the model specification, and thus require further verification. In terms of supply-side relations, the robustness analysis suggests that the determinants of economic growth in Poland could be found in labour reallocation among sections with relatively small shares in the employment structure. Moreover, concerning the demand-side, some in-time differences between sectional reaction to economic growth changes were noted, indicating later response in the smallest sections. Thus future research should focus on labour movements that change the role of neglected forms of economic activity, as these emerging sectors may concentrate potential that can be directed towards accelerated growth.

From a methodological point of view, the results based on different measures of structural change draw attention to the need for in-depth research that simultaneously uses alternative indicators. Taken together, they make it possible to determine the specificity of transition concerning the role of change in different elements of a structure. Nevertheless, diagnoses of individual sectors are still of high importance. The problem of incorporating both aspects of structural change — namely transformation of the whole economy and its individual elements — is still an open research challenge, as is the choice of the disaggregation level, which in the study was investigated beyond the three-sectoral approach. However, the availability of classification of economic activities comparable in a long term, that could constitute a basis for assessing finer structural change remains an important limitation.

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Compliance with ethical standards

This article does not contain any studies with human participants or animals performed by the authors. Extracting and inspecting publicly accessible files (scholarly sources) as evidence, before the research began no institutional ethics approval was required.

Data availability statement

All data generated or analyzed are included in the published article. The raw data supporting the conclusion of this article will be made available by the authors, without undue reservation. The raw anonymized data can be provided by emailing the primary author.

Author contributions

All listed authors have made a substantial, direct and intellectual contribution to the work, and approved it for publication. The authors take full responsibility for the accuracy and the integrity of the source analysis.

Conflict of interest statement

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

Annex

Table 1. Results of the VAR models estimation (robust heteroscedasticity)

	d_NAV		d_growth	
	coefficient	**p-value**	**coefficient**	**p-value**
const	0.000129889	0.8086	0.198191	0.6166
d_NAV_1	−0.188813	0.2134	−69.4957	0.4285
d_NAV_2	−0.129021	0.4045	−74.5860	0.5493
d_NAV_3	−0.369527**	0.0322	−80.2960	0.4315
d_NAV_4	−0.101507	0.5077	43.9254	0.5625
d_NAV_5	−0.180949	0.2258	−32.3235	0.6819
d_growth_1	0.000181777	0.3246	−0.283336	0.1785
d_growth_2	−0.000289181**	0.0311	0.115690	0.3510
d_growth_3	−0.000286851	0.1938	0.163437	0.1506
d_growth_4	−0.000330043	0.1557	−0.553022***	0.0019
d_growth_5	−0.000356916	0.1197	−0.391455**	0.0305
R^2	0.297466		0.431824	
p-value for F test	0.000717		0.013068	
DW	2.106650		1.967046	

Source: own research based on Eurostat data.

Table 2. Results of the Granger test for causality

	lag=1	**lag=2**	**lag=3**	**lag=4**	**lag=5**
d_growth Granger causes d_NAV	yes F(1, 50) = 11.797 [0.0012]***	yes F(2, 47) = 6.8341 [0.0025]***	yes F(3, 44) = 5.8643 [0.0018]***	yes F(4, 41) = 3.3425 [0.0185]**	yes F(5, 38) = 6.7834 [0.0001]***
d_NAV Granger causes d_growth	no F(1, 50) = 0.038541 [0.8452]	no F(2, 47) = 0.71811 [0.4929]	no F(3, 44) = 1.3793 [0.2616]	no F(4, 41) = 0.20625 [0.9335]	no F(5, 38) = 0.38967 [0.8528]

Note: p-values in parentheses

Source: own research based on Eurostat data.

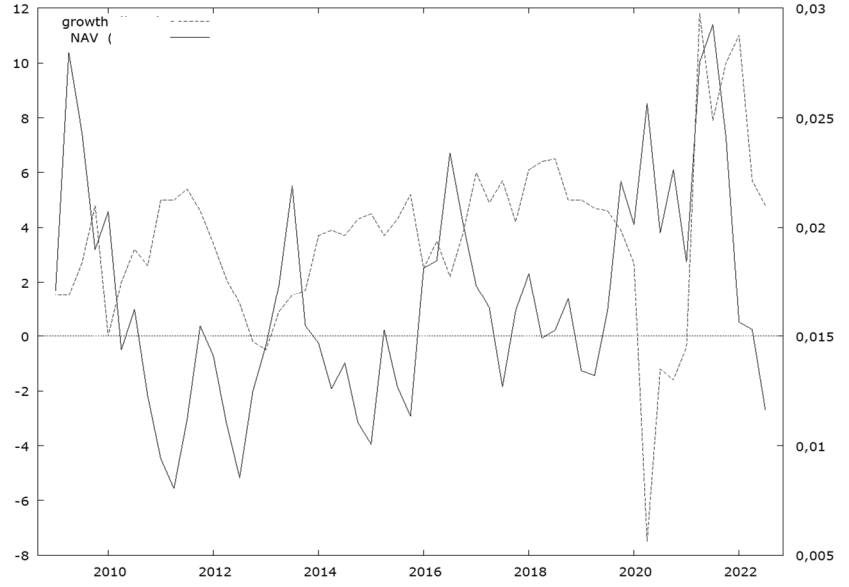
Table 3. Results of the Granger test for causality with the alternative SCIs

	lag=1	**lag=2**	**lag=3**	**lag=4**	**lag=5**
d_growth Granger causes d_MLI	no F (1, 50) = 1.3723 [0.2470]	no F (2, 47) = 0.80705 [0.4523]	yes F (3, 44) = 3.3306 [0.0279]**	no F (4, 41) = 2.3263 [0.0724]*	no F (5, 38) = 1.5343 [0.2023]
d_growth Granger causes d_CI	no F (1, 50) = 0.0022405 [0.9624]	no F (2, 47) = 0.32913 [0.7212]	no F (3, 44) = 1.3050 [0.2848]	yes F (4, 41) = 3.8367 [0.0097]***	yes F (5, 38) = 3.2281 [0.0159]**
d_MLI Granger causes d_growth	no F (1, 50) = 0.0012776 [0.9716]	no F (2, 47) = 0.44946 [0.6407]	no F (3, 44) = 0.52816 [0.6653]	no F (4, 41) = 0.61201 [0.6564]	no F (5, 38) = 0.73898 [0.5990]
d_CI Granger causes d_growth	yes F (1, 50) = 5.7649 [0.0201]**	yes F (2, 47) = 3.1220 [0.0533]*	yes F (3, 44) = 2.4323 [0.0776]*	no F (4, 41) = 1.872 [0.1337]	no F (5, 38) = 1.0054 [0.4278]

Note: p-values in parentheses

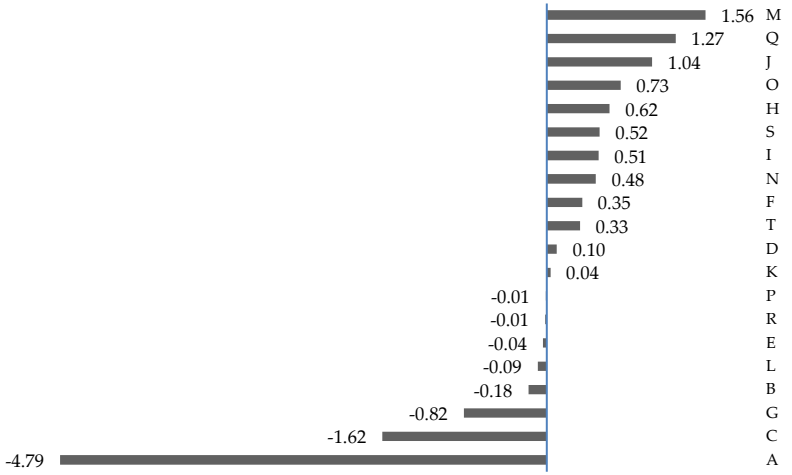
Source: own research based on Eurostat data.

Figure 1. NAV values of structural change (right axis) and economic growth (left axis) in Poland in Q1 2008 – Q3 2022



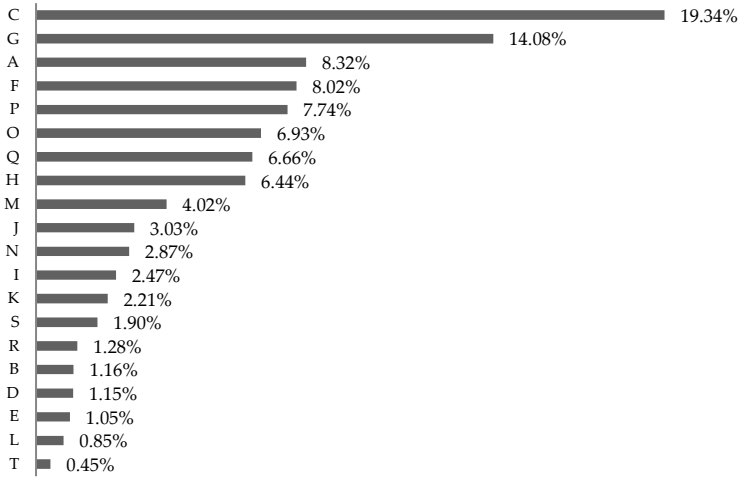
Source: own research based on Eurostat data.

Figure 2. Structural change (percentage points change in the shares of sections A-T in total employment) in Poland between Q1 2008 – Q3 2022



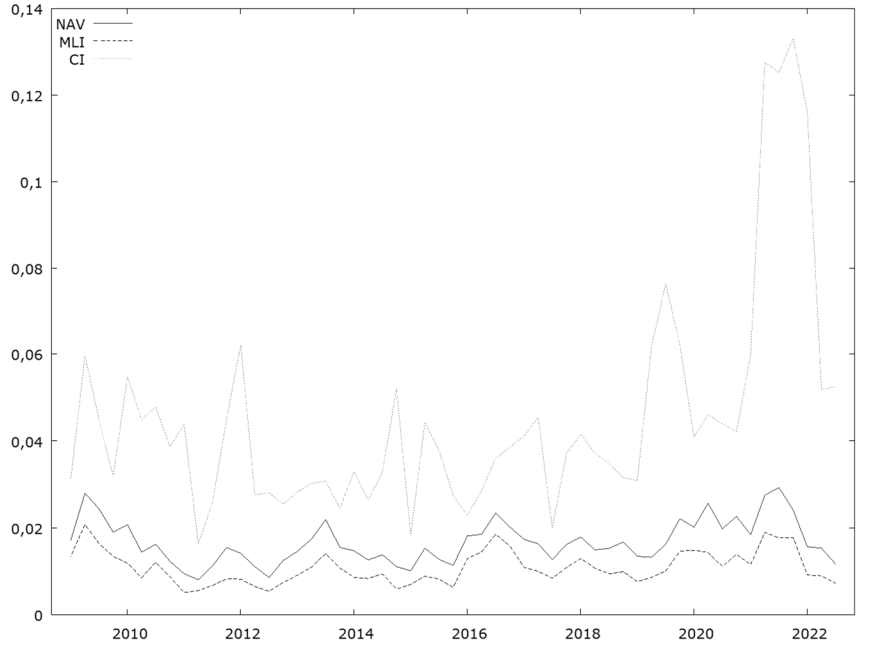
Source: own research based on Eurostat data.

Figure 3. Sectional employment structure in Poland in Q3 2022



Source: own research based on Eurostat data.

Figure 4. Alternative measures of structural change in employment in Poland



Source: own research based on Eurostat data.