The Determinants of Regional Exports in Poland – Panel Data Analysis

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Abstract:

The purpose of this article is to explain the strong diversification in the volume and structure of exports in Polish regions, using a set of potential determinants originating from different foreign trade theories used in country level studies. Two sets of panel models of exports are estimated for 16 regions of Poland in the years 1999–2008. Model I shows that regional export performance is positively dependent on labour productivity, education of population, location in the country’s border region and access to the sea, and negatively – on the importance of agriculture in the region’s economy and labour costs. Model II indicates that exports of agricultural and food products are positively correlated with the importance of agriculture, labour productivity in agriculture and the economy of the region as a whole, availability of employees with an appropriate level of practical skills and access to the sea, and negatively – with population density and location in the country’s border region. Growth of this type of exports is important for improvement of living conditions in many underdeveloped regions of Poland.

JEL classification: R11, R15, F16, C33
Key words: regional studies, regional exports, international trade, panel data

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Introduction

In theory and in empirical studies the fact that export and import streams are not “generated” in one point of space is often ignored. Most of the analyses of exports tend to be conducted in relation to countries or groups of countries but in reality economic events, including exports, have their regional dimension.

By treating regions as small, open economies that are increasingly involved in trade processes, one may attempt to apply theory to study international trade at the regional level. However, there is no doubt that both theoretical basis and empirical studies of international trade in regional terms are in statu nascendi.

The purpose of this article is to explain the strong diversification between Polish regions in the volume and structure of exports, using a set of potential determinants originating from different foreign trade theories used to conduct analyses at the country level. The literature on determinants of exports at the regional level in emerging economies is still scant, so the study for Poland is this article contribution to that literature.

The analysis covers the years 1999–2008. During that period, trade relations between Poland and other countries were subject to dynamic changes, both due to the undergoing transition from a socialist to a market economy and Poland’s accession to the European Union in 2004. The effect of those changes was the increased importance of foreign trade for the Polish economy. In the course of 20 years of transformation, Poland’s GDP increased almost twofold, and the volume of exports increased over eightfold. The ratio of exports to GDP increased to over 40%.

Those changes were reflected to a varied degree in the transformation of the economies of individual regions in Poland, as well as in the scale and structure of their foreign trade:

- Firstly, the regions’ participation in the dynamic growth of Poland’s exports and imports varied. Their contribution to the country’s foreign trade changed over the analysed period, which was the consequence of differences both in the dynamics of structural transformation taking place and in the level of competitiveness.
- Secondly, differences in the so-called export profiles of regional economies widened further.
- Thirdly, differences in the profile of geographical connections were maintained: firms trade to a large degree with the cross-border areas, as a result of which the intensity of export ties of particular regions with the EU Member States increased unevenly.

This article is composed of 4 parts:
- The first part presents a brief review of theoretical concepts useful in the analysis of exports at the regional level.
- The second part describes stylised facts concerning regional differences in foreign trade characteristics in Poland.
- The third, main part contains the estimates of two panel models. Model I explains what the volume of exports in the particular province depends on and what factors influence its changes in time. Model II analyses determinants of exports of agricultural and food products which is important for exports of underdeveloped regions of Poland, but also is particularly relevant in exports of some wealthy regions, including the wealthiest one. The study of this part of exports which is potentially very important for improvement of the
living conditions in underdeveloped regions is the article’s another contribution to the literature on regional export performance.

- The article ends with conclusions.

1. Review of theoretical concepts useful for the analysis of exports at the regional level

The basic difficulty related to the design of an exports model for regions lies in the diversity of factors influencing exports, as well as doubts related to the selection of a right theoretical concept. The overview of literature devoted to the analysis of exports assessed at regional level proves that there is no common standard as to what theoretical strands shall be used. Evaluation of publications on this subject leads us to the conclusion that there are three main concepts to which one may refer: competitiveness concept, international trade theory, and economic activity location theories (with emphasis on new economic geography).

The analysis of export streams is in fact the evaluation of performance-based competitiveness. From this point of view, exports are treated as one of many factors reflecting competitive advantages. Studies of regional competitiveness in the last decade were a dynamically developing research area. In the conceptual layer, the work of the Dutch Ecorys seems particularly interesting (Maarten De Vet, 2004; Maarten De Vet, Baker et al., 2004; Martin, 2006). It presents the determinants of competitiveness in a comprehensive way. Based on the concept of the so-called regional competitiveness hat, a high level of internationalisation of the economy is the domain of the most competitive regions, especially those which may be classified as production regions or growing income regions. The work of the British DTI (Department of Trade and Industry 2000, 2001, 2003, 2004) should also be mentioned in this context. The question of exports in the studies of competitiveness most frequently appears in the context of investigations how the degree of openness of an economy influences its economic situation (Commission of the European Communities, 2008a; Commission of the European Communities, 2008b). The studies indicate that open economies have a higher level of income or note a higher economic growth (see e.g. Sachs, Warner et al., 1995; Dolar, 1992; Edwards, 1998; Frankel and Romer, 1999; Alesina, Spolaore and Wacziarg, 2000; Wacziarg and Welch, 2003; Alcala and Ciccone 2004). Such conclusions are consistent with the classical theory of international trade, according to which reallocation of resources, possible thanks to the specialisation and division of labour, under the conditions of higher competitive pressure (from abroad) leads to higher productivity. An increase in productivity does not necessarily have to result only from the static improvement in effectiveness, but may have also a dynamic nature (see e.g. Ventura, 2005).1

It should be emphasised that higher productivity among exporters may be the consequence of two causalities. The first one goes from exports to productivity and is related e.g. to learning by exporting. The other one goes in the opposite direction – from productivity to exports and reflects the auto-selection effect. Auto-selection means that only the most productive firms have a chance to export because they are capable of overcoming the obstacle which are the fixed costs related to the expansion to foreign markets. Interesting research referring to the above concepts was conducted, inter alia, by Bernard and Jensen (1995, 1999, 2004, 2008a

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1 In countries with a low or moderate development level, transfer of technology explains – according to certain estimates – as much as 90 per cent of technological progress. An important source of such progress is international trade exchange, but not so much exports as first and foremost imports (Keller, 2004). It should be emphasised, however, that exports provide funds thanks to which imports are possible.
and 2008b) and by Bernard, Eaton, Jensen and Kortum (2003). These indicate that exporting firms, in comparison with non-exporters, are much larger, much more productive, pay higher wages to employees, employ more qualified employees, and their operations are characterised by higher technological and capital intensiveness. Another strand in literature underlines the role of export diversity as a factor of regional growth. Export diversification means that the range of products offered is broadened (Dennis and Shepherd 2007; Matthee and Naude 2008) which contributes to overall region’s competitiveness improvements and stabilizes export base (Ali, Alwang and Siegel 1991). Hausmann et.all (2005) conclude that higher productivity goods’ share in exports, contributes to competitiveness of foreign sales, and therefore more benefits from globalization can be achieved. However in times of economic crisis and turbulences on the world market, it seems that the export base shall be properly diversified. It shall not too strongly be biased towards any single industry. Rather the appropriate “product mix” including also food and agricultural commodities, primary products, manufacturing products as well as services shall be obtained.

Modelling regional exports may also be based on concepts strictly related to international trade. Although there are no separate theories referring only and exclusively to exports and imports by regions, one may treat a region as a small open economy and apply tools used for analysing foreign trade of countries to that economy. This direction of studies is developed, inter alia, by Krugman (1991 and 1996), Krugman and Venables, (1990 and 1995) and Krugman, Livas and Elizondo (1996)\(^2\). Those studies indicate, inter alia, that exports and their structure (as well as the influence of exports on economic growth) depend to a large degree on the structure of the economy and proportions of production factors. Another important question raised in the literature is the role of education and human capital in exports determination (see e.g. Tomiura, 2003; Grasjo, 2006; Johansson, 2007; Johansson and Karlsson, 2007). Eff and Livingston (2007) prove that agricultural regions’ mere position as exporters is due to their poor endowment in human capital.

The third trend which may be used as an inspiration for exports analyses is location theory. Export activities, like economic activities in general, are located in specific space. The characteristic feature of distribution of such activity is its concentration in particular places, and the feedback between the attractiveness of the given location and concentration of business entities is of considerable importance here (see e.g. Fujita and Thisse, 1996 or Quigley, 1998). The fundamental question in this respect is whether observed changes in exports contribute more to agglomeration of economic activity (which would lead to polarisation in regional development) or rather create chances for less developed regions to catch up and what are the factors determining which of these models functions (see e.g. Grossman and Helpman, 1995, Fujita, Krugman and Venables, 1999, Ventura, 2005). Processes of cumulative causality due to which the developmental success of a region attracts subsequent exporting entities to it, which over time often leads to the widening of the development gap towards other regions and to the consolidation or deepening of the centre-periphery system, seem to be important in this context. Other important issues concern for example border effects, including the effect of border location on export activity, or asymmetric liberalisation of foreign trade (in the case of Poland, liberalisation in relationships with the EU, and maintaining barriers to trade with Russia, Ukraine, and Belarus). Among the empirical studies on those issues, the following may be mentioned: Coughlin and Fabel (1988), Ericsson and Hayward (1992), McCallum (1995), Leichenko and Erickson (1997), Henderson (2000), Coughlin and Wall (2003) and Coughlin (2004), Simmi (2002); Niebuhr and Stiller (2002); Matthee and Naude (2008); Gries and Naude (2008).

\(^2\) More recent research includes, inter alia, Paluzie (2001) and Shin, Agnew, Breau and Richardson (2006).
2. Regional differences in foreign trade in Poland – stylised facts

The beginning of the process of transformation in Poland in 1989 meant the opening of its economy to foreign trade. International trade, thanks to its systematic increase, became an important factor influencing economic growth and labour market developments. At the same time, the economic situation in Poland became dependent on the economic situation abroad. The accession to the European Union in 2004 strengthened that correlation. As a result of the EU accession, Poland became part of the EU internal market, which meant, inter alia, the elimination of border checks. This resulted in the strong growth in exports, despite the fact that before 2004, the exports of Polish industrial products were conducted within a free trade zone. The rate of this growth was the highest to the New Member States, which joined the EU together with Poland.

The importance of exports did not grow at the same rate in all regions however. As a result, 16 regions (provinces or voivodships)\(^3\) into which Poland is divided differ from one another significantly in terms of the volume of exports (see Map 1).

**Map 1: Characteristics of exports in regional terms: the share in total Polish exports (%) and the per capita value of exports (ths. of EUR) in 2008**

![Map of exports in regional terms](image)

Source: Own calculations on the basis of data from the Central Statistical Office (GUS).

Further, firstly, we indicate the source of data on exports used in this article, and methodological issues related to their analysis, and secondly, stylised facts referring to the

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\(^3\) Based on the principles of territorial division, they constitute NUTS-2 level.
export performance of individual regions. This part of stylised facts which signals the existence of certain economic correlations is verified in the subsequent part of the article using econometric panel data models.

2.1. Data and methodological issues

- Data on exports are provided by Polish Central Statistical Office and covers the period 1999-2008 and 16 provinces. Data are available in geographical and product classifications, at the four-digit Polish Classification of Products and Services, however the database for foreign trade covers only commodities, does not include information on services.
- Two databases are the sources of statistics: Extrastat and Intrastat. The first relates to trade relations with countries outside the EU, the second to the intra-community delivery of goods.
- The allocation of export streams to specific regions is done on the basis of the exporting entity’s registered office location criterion. Turnover of firms acting as intermediaries in foreign trade may be allocated to province “X”. In the case of regional studies, the so-called carry along trade occurs, under which an entity (with its registered office located in “X”) exports products which were in fact manufactured in other locations by other entities. In the data sources used in this article carry along trade is included in exports. We believe that this kind of trade contributes to exporters’ overall competitiveness improvement, as this allows to broaden the products portfolio offered for foreign markets (Bernard, van Beveren and Vandenbussche, 2010). One should also remember, that the competing capacity of a region is decided not only by the capacity to produce, but also to sell.
- A significant part of Polish exports is attributed to enterprises with a share of foreign capital. At the same time, regions differ in terms of importance of foreign capital in exports. Firms with majority foreign ownership often settle commercial transactions based on the so-called transfer prices. Those prices may differ from prices in transactions conducted between independent entities and, thus, “distort the picture” of exports.
- Data on regional exports are also distorted by complicated cooperation links between enterprises, existence of multi-unit firms, differences in imports input, or in the importance of intra-industry trade.
- Only a portion of exports is registered by the GUS. In particular, purchases by individual persons from abroad, very important particularly in border regions, are not registered.
- The total value of exports for Poland is calculated as a sum of exports registered in 16 provinces. The exports flows of entities not registered in Poland are excluded, as it cannot be attributed to any of the 16 provinces.

For those reasons, conclusions presented in this article should be approached with some caution.

2.2. Stylised facts

The analysis of basic facts produces the following stylised facts concerning export performance by individual regions:
• Polish exports are characterised by large regional concentration. Entities based in six provinces (Slask, Mazowsze, Dolny Slask, Wielkopolska, Pomorze and Malopolska) play the leading role in exports. They account for 75% of a whole Polish exports.
• The concentration of exports in those regions progressed until Poland’s accession to the European Union. Since the accession, this tendency has been come to a halt.
• The differences in the volume of exports between regions are related to differences in wealth and in labour productivity among them. With the exception of the Malopolska province, other regions having the largest share in total Polish exports are at the same time provinces with the highest per capita GDP among all regions. In turn, excluding the Malopolska and Wielkopolska provinces, these are regions with the highest value added per one employed person. Four out of the six mentioned provinces (Slask, Wielkopolska, Dolny Slask and Pomorze), as well as the six taken as a whole, have a significantly higher share in exports than in GDP. In turn, six provinces with the lowest share in total Polish exports (Podlasie, Swietokrzyskie, Lubelskie, Opolskie, Warmia and Mazury, and Podkarpacie) overlap with six provinces with the lowest per capita GDP. With the exception of the Warmia and Mazury province and the Opolskie province, these are also the provinces with the lowest value added per one employed person. Each of the six provinces has a lower, in most cases significantly lower, share in exports than in GDP. These two stylised facts support the claim that the level of labour productivity is important for regional export performance.
• A significant difference between regions in terms of the volume of exports is not strongly correlated with the share of industry in value added. Some regions with a large share in total Polish exports are among regions with a high share of industry in value added (Dolny Slask, Slask, Wielkopolska). Other regions are among those in which this share is low (Mazowsze). The situation is similar for regions with a low share in total Polish exports. Differences in the share of exports in sold production of industry are much more important for the differences in the share of individual exports in total Polish exports than differences in the share of industry in value added. Those four regions out of six provinces with the highest share in total Polish exports which have a higher share in exports than in GDP are among the six regions in which industrial enterprises are characterised by the highest percentage of exports output. In turn, besides the Podkarpacie province, other provinces with the lowest share in total Polish exports are among the six regions in which industrial enterprises have the lowest percentage share of exports output.
• Differences between regions in the importance of technologically intensive industries influence differences in the volume of exports between them. Six regions with the largest share in total Polish exports are among the seven regions in which the largest part of exports is attributed to technologically intensive branches (based on the WIFO1 classification⁴). It is between 14.5% in the Malopolska province and 32.4% in the Slask province. In turn, six regions with the lowest share in total Polish exports are among the seven regions in which technologically intensive branches have the lowest share in exports. It is between 1.1% in the Swietokrzyskie province and 10.6% in the Podkarpacie province.
• Exporters are mainly those regions in which agriculture is of lower importance than in the rest of the country. Besides the Malopolska province, the remaining five provinces with the highest share in total Polish exports are among the seven regions with the lowest percentage share of persons employed in agriculture. In turn, four out of six provinces

⁴According to the WIFO1 taxonomy made by the WIFO – Österreichischen Institut für Wirtschaftsforschung (Austrian Institute of Economic Research), industrial sectors are classified in five broader groups: mainstream industries, labor-intensive, capital-intensive, marketing-led and technology-led industries.
with the lowest share in exports overlap with the four provinces with the largest share of persons employed in agriculture (Lubelskie, Podlasie, Swietokrzyskie, Podkarpackie).

- Regions with the highest share in total Polish exports have in majority a lower share in the total exports of agricultural and food products (Slask, Dolny Slask, Pomorze, and Malopolska). Among the regions, which are significant exporters, there are also ones in which an opposite relation exists (the Mazowsze and Malopolska provinces account jointly for over 50% of Polish exports of agricultural and food products). They stand out owing to their high labour productivity in agriculture. In turn, three provinces among six regions with a low share in total Polish exports play a bigger role (Podkarpackie) or a markedly bigger role (Lubelskie, Podlasie) in the exports of agricultural and food products. Other three regions from this group have a similar share in total exports and in the exports of agricultural and food products. What is surprising, three provinces with a larger or significantly larger share in the exports of agricultural and food products than in total exports are among the six provinces with the lowest labour productivity in agriculture. The remaining three provinces are very varied in this respect: one province (Swietokrzyskie) is characterised by low, one (Opolskie) by moderate, and one (Warmia and Mazury) by high labour productivity in agriculture – higher than in any of the provinces which are large exporters.

- With the exception of the Wielkopolska province, other regions with a considerable share in total Polish exports are among six regions with the highest population density, and with the exception of the Wielkopolska province and the Malopolska province, among six regions with the largest percentage share of persons residing in cities. In turn, with the exception of the Podkarpackie province, other regions with a small share in total Polish exports are among the seven regions with the lowest population density. All the six regions are among eight provinces with the lowest percentage of persons residing in cities. In three of them (Opolskie, Podkarpackie, and Warmia and Mazury) there is no city with population exceeding 200,000.

- Labour costs affect the volume of exports across regions. However the differences in wage levels across regions with, respectively, a high and a low share in total Polish exports, are much smaller than those in labour productivity levels. The spread of an average wage slightly exceeds 50%, whereas the spread of gross value added per one employed person is close to 100%.

- Both the per capita value of exports and its growth rate are positively correlated with the share of enterprises with majority foreign ownership in exports. Four out of six provinces with the largest share in total Polish exports are among six regions in which enterprises with majority foreign ownership account for the largest share of exports. In turn, the six provinces with the lowest share in total Polish exports are among the eight regions in which foreign enterprises play an insignificant role. This observation seems to confirm the advantage of foreign enterprise over firms from the host countries in export activity. As theory indicates (see e.g. Dunning and Lundan, 2008), it involves in particular the knowledge of foreign markets, access to the distribution network and experience in operations in international markets. At the same time, it is worth noting that the level of per capita exports in regions with the highest share in total Polish exports is higher than the average with a given involvement of foreign investors in exports. This observation signals that the considerable inter-regional differences in labour productivity are not limited exclusively to domestic enterprises but refers also to enterprises with majority foreign ownership.

- The risk arising out of the excessive dependence of the region on foreign investments, concentrating on an individual sector or originating from an individual country, is not materially correlated with the share of individual regions in total Polish exports. Among
the six regions with a high share in total Polish exports, there are both provinces with a high level of product concentration of exports, measured with the Herfindahl index, and share in 5, 10 and 15 most important groups of products in exports (Slask and Pomorze), and ones in which product concentration is low (Mazowsze and Malopolska). A similar heterogeneity, in terms of product concentration, refers to six provinces with a low share in total Polish exports (this concentration is high exclusively in the Warmia and Mazury province and the Swietokrzyskie province). Differences in the volume of exports between the regions are not correlated with the differences at the level of geographic concentration of exports, measured with the Herfindahl index. What is more, since Poland’s accession to the EU, the concentration decreased in all but two (Opolskie and Lubelskie) provinces.

- With the exception of the Wielkopolska province and the Slask province, regions with a large share in total exports are among the six regions with the highest percentage of persons with higher education. But the Slask and Wielkopolska provinces are among the three regions with the highest ratio of the number of university graduates after 2002 to the population. All six overlap with the six regions with the lowest percentage of persons who ended their education at primary level. In turn, regions with a small share in total Polish exports, with the exception of the Lubelskie and Swietokrzyskie provinces, are among the six regions with the lowest percentage of persons with higher education. Four provinces from this group (Warmia and Mazury, Podlasie, Lubelskie and Swietokrzyskie) overlap with the four regions with the highest percentage of persons who ended their education at primary level.

- The geographical structure of exports of individual regions is connected with their geographical location. Over 70% of exports from regions located in the western part of Poland (Lubuskie, Pomorze Zachodnie, Wielkopolska and Dolny Slask) go to the EU-15 countries. In turn, the eastern regions (Podlasie, Lubelskie, Podkarpacie), have a high share of Russia, Ukraine and Belarus in their exports in comparison with other regions.

3. **Panel models of Polish provinces exports in the years 1999–2008**

In this part of the article, an analysis has been conducted with regard to factors determining the scale and structure of exports at the level of provinces, and of changes of those characteristics in time. The analysis has been based on the estimation of a series of panel data models, in which 16 Polish provinces constituted the cross sectional dimension ($i = 1,\ldots,16$), whereas annual data from the period of 1999–2008 constituted the time dimension ($t = 1,\ldots,10$). Panel models are characterised by a number of advantages in comparison with cross section models. The most important ones from the point of view of this study are the possibility of including the dynamic nature of the analysed relationships and higher number of structural parameters, which estimation is possible by given cross sectional dimension of the sample.

Further, the chapter presents, firstly, methodological issues, and secondly, the results of the estimation.

#### 3.1. Methodology

Based on the results of literature review and compiled stylised facts regarding regional export performance, an estimation of two exports models has been undertaken:

- Model I explains on what factors the value of exports in a given province depends and what are the determinants affecting changes in exports over time;
- Model II analyses the determinants of exports of agricultural and food products, which is
of great importance to the exports of many less developed regions but is also important in the exports of some wealthy regions, including the wealthiest one (Mazowsze).

The motivation for estimating – next to the exports model – also the model of exports of agricultural and food products is related to the observation that the main source of differences in per capita income among regions in Poland are the differences in labour productivity in particular sectors, including but not limited to sectors with the largest share in employment in a given group of regions, and not the differences in the employment structure.

- If the export structure of the regions with a modest share in total country exports did not change, and labour productivity rose to the level present in the region with highest labour productivity, the gap between them with regard to value added per one employed person of the same region would drop by 49.6% in the Podlasie province and by 77.3% in the Warmia and Mazury province.

- Just to compare, the adjustment of the employment structure in the regions of the lowest share in total country exports to the employment structure in the region of the highest labour productivity would reduce the gap by 8.6% in Podlasie province to 36.9% in the Lubelskie province.

Theory shows that there is a two-directional positive dependence between exports and productivity. Growth in the exports of agricultural and food products by agricultural regions, which currently have a slight share in total exports and are much poorer than the rest of the country, should be significant both for their total exports and labour productivity, and consequently – for the living conditions of people.

In the process of selection of adequate specification for both models we encounter several issues.

The first of them relates to the choice between the structural model and the reduced form model. The structural model allows for analysis of interaction between the selected variables, which covers explicitly the channels of this interrelation and integrates it with the description of the economy functioning in general. The reduced model allows analysis of a given relationship without formulating assumptions regarding the mechanisms of that interaction. In the literature, the approach based on reduced models prevails. Therefore, such an approach has also been applied in this article.

Another important issue in the selection of model specification is the adequate definition of the dependent variable. The application of value or natural logarithms of the total exports value (in Model I) and of agricultural and food products (in Model II), due to the fact that such variables are non-stationary, could lead to faulty conclusions regarding the importance of the influence of the analysed exports determinants. The fact that variables are non-stationary may result in spurious regression, i.e. a situation in which standard significance tests reflect the existence of relationship that is not actually present\(^5\). In order to eliminate the problem of non-stationarity, the first differences (or growth rates) of a given variable may be used. This method, however, leads to the removal from the sample of the information regarding the differences in the level of analysed variable between the units (provinces). The solution applied in the analysis of the variables is the reference of their value to other macroeconomic variables:

\(^5\) Kao (1999) reflected, however, that for panel model estimation with the least squares method, the estimation of the structural parameter binding two independent non-stationary variables converges to zero in the case of panel data, whereas in the case of time series it is a random variable. This means that although non-stationary panel data may lead to biased standard errors, the point estimations of the value of parameters are consistent.
• In Model I, the dependent variable is \( \text{exp\_va}_{i,t} \), which is a relationship between the exports value and gross value added in the sector of agriculture, industry and market services in province \( i \) in year \( t \). The higher value of the variable (in the case of comparison between provinces) informs about the higher role of exports in the development of the analysed branches of the economy: growth of the value of the variable means that the value of exports grows faster (or drops slower) than gross value added in a given province.

• In Model II, the dependent variable is \( \text{exp\_agr}_{i,t} \), which is the share of the exports of agricultural and food products in the total exports of province \( i \) in year \( t \). The higher value of the variable informs about the higher role of the exports of agricultural and food products in the region’s exports, whereas its growth – about the higher growth rate of the exports of agricultural and food products than total exports.

The third issue is the selection of explanatory variables. In the analysis, a set of variables referring, on the one hand, to the classical theory of international trade (productivity, employment structure, human capital measured by the level of education), as well as new economic geography (variables characterising the spatial features of particular provinces) have been taken into account. The main limitation in the selection of variables was the availability of data, specifically sufficiently long time series. The final sets of explanatory variables for each of the models have been presented in Table 1 and Table 2, respectively. In all cases the source of the data is the Regional Data Bank provided by Polish Central Statistical Office.

**Table 1. Explanatory variables for Model I**

<table>
<thead>
<tr>
<th>Abbreviated name of the variable</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \text{va}_\text{emp}_{i,t} )</td>
<td>Gross value added per one employed person in the national economy, at fixed prices (deflated with the CPI index) in PLN thousands, in province ( i ) in year ( t ).</td>
</tr>
<tr>
<td>( \text{emp}_\text{agr}_{i,t} )</td>
<td>Share of agricultural employees in the total number of people employed in the national economy, % in province ( i ) in year ( t ).</td>
</tr>
<tr>
<td>( \text{wage}_\text{ratio}_{i,t} )</td>
<td>Ratio of the average wage in province ( i ) and the average wage in Poland, % in year ( t ).</td>
</tr>
<tr>
<td>( \text{edu}_\text{sec}_{i,t} )</td>
<td>Share of people at the age of 15–64 with post-secondary or secondary vocational education in the total number of people at that age, % in province ( i ) in year ( t ).</td>
</tr>
<tr>
<td>( \text{edu}_\text{uni}_{i,t} )</td>
<td>Share of people at the age of 15–64 with higher education in the total number of people at that age, % in province ( i ) in year ( t ).</td>
</tr>
<tr>
<td>( \text{infra}_{i,t} )</td>
<td>Length of paved roads per 100 km², in province ( i ) in year ( t ).</td>
</tr>
<tr>
<td>( \text{border}_{i,t} )</td>
<td>Binary variable assuming the value of 0 for a province that does not border a foreign country and 1 for a province ( i ) bordering a foreign country.</td>
</tr>
<tr>
<td>( \text{border_eu}_{i,t} )</td>
<td>Binary variable reflecting the influence of EU membership and the existence of EU border in case of province ( i ), assuming the value of 1 if both conditions are fulfilled and 0 in other cases, in province ( i ) in year ( t ).</td>
</tr>
<tr>
<td>( \text{sea}_{i} )</td>
<td>Binary variable assuming the value of 0 for a province ( i ) that has no access to the sea and 1 for a seaside province ( i ).</td>
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Source: Own material

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Table 2. Explanatory variables for Model II

<table>
<thead>
<tr>
<th>Abbreviated name of the variable</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>emp_agr_t</td>
<td>Share of agricultural employees in the total number of people employed in the national economy, % in province (i) in year (t).</td>
</tr>
<tr>
<td>va_emp_agr_t</td>
<td>Gross value added generated in agriculture per an agricultural employee, at fixed prices (deflated with the CPI index) in PLN thousands, in province (i) in year (t).</td>
</tr>
<tr>
<td>va_emp_t</td>
<td>Gross value added per one employed person in the national economy, at fixed prices (deflated with the CPI index) in PLN thousands, in province (i) in year (t).</td>
</tr>
<tr>
<td>edu_sec_t</td>
<td>Share of people at the age of 15–64 with post-secondary or secondary vocational education in the total number of people at that age, % in province (i) in year (t).</td>
</tr>
<tr>
<td>density_t</td>
<td>Number of people per 1 km(^2) in province (i) in year (t).</td>
</tr>
<tr>
<td>sea_t</td>
<td>Binary variable assuming the value of 0 for a province (i) that has no access to the sea and 1 for a seaside province (i).</td>
</tr>
<tr>
<td>border_t</td>
<td>Binary variable assuming the value of 0 for a province that does not border a foreign country and 1 for a province bordering a foreign country.</td>
</tr>
<tr>
<td>eu_t</td>
<td>Binary variable assuming the value of 0 for the years 1999–2003 and 1 for the years 2004–2008 (i.e. after EU accession).</td>
</tr>
</tbody>
</table>

Source: Own material.

The models analysed further in this article have the following functional forms:

- **Model I:**

\[
(1)
\]

- **Model II:**

\[
(2)
\]

where the symbols of the particular variables comply with the descriptions presented in Table 1 and Table 2, respectively; \(\varepsilon\) is a error term; subscripts \(i = 1,\ldots,16\) and \(t = 1,\ldots,10\) identify respectively the cross-dimension and time-dimension of the data.

The functional form assuming the absence of individual effects, both fixed and random, has been chosen on purpose. A major part of the variables considered in Models I and II describes differences between the characteristics of the particular provinces and would, therefore, be correlated with individual effects.\(^7\) In practice, this would mean that a major part of the differences in the level of dependent variables across particular provinces could not be assigned to the explanatory variables assumed in the model but would be assigned to the individual effects that are not directly interpreted.

Both Model I and Model II were estimated with the use of four estimation methods:

- **In the first method**, the standard *pooled* type estimator (hereinafter referred to as OLS) has been applied, assuming the homoscedasticity and absence of autocorrelation of error terms between the particular units (provinces), and also absence of autocorrelation of error terms from the various periods within the same unit.
- **In the second method**, the first assumption was abandoned, which resulted in the assumption that there is no autocorrelation of error terms from the various periods within the same unit; the applied estimator (*Panel Corrected Standard Errors*, hereinafter

\(^7\) The estimator applied in the case of correlation between explanatory variables and the individual effects is the estimator proposed by Hausman and Taylor (1981). The condition for applying the estimator based on the instrumental variables method is, however, the determination of the adequate set of instrumental variables that are not correlated with the individual effects.
referred to as PCSE) returns the same point estimations of the structural parameters, however, it modifies the value of standard errors of their estimates, which may change the assessment of the significance of the received estimations.

- In the third method, the panel estimator with corrected standard errors has been applied again, however, the additional assumptions about the absence of autocorrelation of error terms from various periods has been waived; it has been assumed that the scale of autocorrelation differs between time series for particular provinces (hereinafter referred to as PCSE-AR).

- In the fourth method, the set of assumptions of the third method was maintained, however, the method of estimation was changed into the generalised least squares (hereinafter referred to as GLS); in the robustness analysis the assumption regarding the time autocorrelation structure of the error terms has also been changed, assuming that the autocorrelation coefficient is fixed for the whole panel.

### 3.2. Estimation results

The estimation results for the applied methods have been presented in Table 3 and Table 4

#### Table 3. Results of estimation for Model I

<table>
<thead>
<tr>
<th>Variable</th>
<th>OLS</th>
<th>PCSE</th>
<th>PCSE-AR</th>
<th>GLS</th>
</tr>
</thead>
<tbody>
<tr>
<td>va_emp</td>
<td>1.4984***</td>
<td>1.4984***</td>
<td>0.8533***</td>
<td>0.7279***</td>
</tr>
<tr>
<td>emp_agr</td>
<td>-0.4798***</td>
<td>-0.4798***</td>
<td>-0.5704***</td>
<td>-0.3208***</td>
</tr>
<tr>
<td>wage_ratio</td>
<td>-1.2450***</td>
<td>-1.2450***</td>
<td>-0.6158***</td>
<td>-0.3688***</td>
</tr>
<tr>
<td>edu_sec</td>
<td>3.0143***</td>
<td>3.0143***</td>
<td>0.5530</td>
<td>0.3278</td>
</tr>
<tr>
<td>edu_uni</td>
<td>0.0787</td>
<td>0.0787</td>
<td>0.8063**</td>
<td>1.1674***</td>
</tr>
<tr>
<td>infra</td>
<td>-0.0229</td>
<td>-0.0229</td>
<td>0.0022</td>
<td>0.0065</td>
</tr>
<tr>
<td>border</td>
<td>6.4904***</td>
<td>6.4904***</td>
<td>7.5080***</td>
<td>9.1944***</td>
</tr>
<tr>
<td>border_eu</td>
<td>5.9413***</td>
<td>5.9413***</td>
<td>5.9247</td>
<td>2.6411</td>
</tr>
<tr>
<td>sea</td>
<td>4.0508</td>
<td>4.0508</td>
<td>3.0307</td>
<td>6.4142*</td>
</tr>
<tr>
<td>constant</td>
<td>1.7583</td>
<td>1.7583</td>
<td>33.5630**</td>
<td>12.9717</td>
</tr>
<tr>
<td>R² total</td>
<td>0.7152</td>
<td>0.7152</td>
<td>0.6273</td>
<td>NA</td>
</tr>
<tr>
<td>Wald's total significance test (p-value)</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
<td>Number of observations</td>
<td>160</td>
<td>160</td>
<td>160</td>
<td>160</td>
</tr>
</tbody>
</table>

Note: (*), (**), and (***), mean the statistical significance at the level of 10%, 5% and 1%, respectively. Standard errors have been given in brackets.

Source: Own calculations.

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* The generalised least squares method should in this case result in more effective parameters estimations compared to PCSE. Nevertheless, Beck and Katz (1995) mention that the improvement of estimations quality resulting from the application of this estimator is insignificant, and at the same time generates too “optimistic” (too low) estimations of the standard errors of the estimated parameters, which too often leads to considering the significance of the received parameters estimations.
Table 4. Results of estimation for Model II

<table>
<thead>
<tr>
<th>Variable</th>
<th>OLS</th>
<th>PCSE</th>
<th>PCSE-AR</th>
<th>GLS</th>
</tr>
</thead>
<tbody>
<tr>
<td>emp_agr</td>
<td>1.1275***</td>
<td>1.1275***</td>
<td>0.6077***</td>
<td>0.4081***</td>
</tr>
<tr>
<td></td>
<td>(0.0893)</td>
<td>(0.1099)</td>
<td>(0.1546)</td>
<td>(0.0629)</td>
</tr>
<tr>
<td>va_emp_agr</td>
<td>0.6689***</td>
<td>0.6689***</td>
<td>0.2376**</td>
<td>0.1201***</td>
</tr>
<tr>
<td></td>
<td>(0.0965)</td>
<td>(0.0801)</td>
<td>(0.0924)</td>
<td>(0.0576)</td>
</tr>
<tr>
<td>va_emp</td>
<td>0.2539***</td>
<td>0.2539***</td>
<td>0.1119*</td>
<td>0.0523*</td>
</tr>
<tr>
<td></td>
<td>(0.0578)</td>
<td>(0.0494)</td>
<td>(0.0674)</td>
<td>(0.0289)</td>
</tr>
<tr>
<td>edu_sec</td>
<td>0.6689***</td>
<td>0.6689***</td>
<td>0.2378**</td>
<td>0.1201***</td>
</tr>
<tr>
<td></td>
<td>(0.0965)</td>
<td>(0.0801)</td>
<td>(0.0924)</td>
<td>(0.0576)</td>
</tr>
<tr>
<td>density</td>
<td>0.6689***</td>
<td>0.6689***</td>
<td>0.2378**</td>
<td>0.1201***</td>
</tr>
<tr>
<td></td>
<td>(0.0965)</td>
<td>(0.0801)</td>
<td>(0.0924)</td>
<td>(0.0576)</td>
</tr>
<tr>
<td>sea</td>
<td>0.6689***</td>
<td>0.6689***</td>
<td>0.2378**</td>
<td>0.1201***</td>
</tr>
<tr>
<td></td>
<td>(0.0965)</td>
<td>(0.0801)</td>
<td>(0.0924)</td>
<td>(0.0576)</td>
</tr>
<tr>
<td>border</td>
<td>-0.3312</td>
<td>-0.3312</td>
<td>-3.3436**</td>
<td>-5.3261***</td>
</tr>
<tr>
<td></td>
<td>(1.0118)</td>
<td>(1.1555)</td>
<td>(1.4139)</td>
<td>(0.8766)</td>
</tr>
<tr>
<td>we</td>
<td>0.4867</td>
<td>0.4867</td>
<td>0.2659</td>
<td>0.4231</td>
</tr>
<tr>
<td></td>
<td>(0.7605)</td>
<td>(0.7833)</td>
<td>(0.8726)</td>
<td>(0.6411)</td>
</tr>
<tr>
<td>constant</td>
<td>-44.3404***</td>
<td>-44.3404***</td>
<td>-17.6137*</td>
<td>-5.9621</td>
</tr>
<tr>
<td></td>
<td>(8.1087)</td>
<td>(6.8326)</td>
<td>(9.1004)</td>
<td>(4.9538)</td>
</tr>
<tr>
<td>R^2 total</td>
<td>0.6900</td>
<td>0.6900</td>
<td>0.5200</td>
<td>NA</td>
</tr>
<tr>
<td>Number of observations</td>
<td>160</td>
<td>160</td>
<td>160</td>
<td>160</td>
</tr>
</tbody>
</table>

Note: (*), (**) and (***)) mean the statistical significance at the level of 10%, 5% and 1%, respectively. Standard errors have been given in brackets.

Source: Own calculations.

Based on the received estimation results, the following conclusions may be formulated:

As refers to Model I:

- There is a major positive dependence between labour productivity and the ratio of exports to value added. The relationship is maintained regardless of the method of estimation, although the strength of the influence varies depending on the method. The closest to the actual value shall be deemed to be the estimations received for PCSE-AR and GLS estimators (this refers also to the other analysed variables)\(^9\), which means that the growth of labour productivity by PLN 1,000 leads to the growth of the share of exports in value added by about 0.7–0.8 p.p.

- Regardless of the method of estimation, the share of exports in value added is negatively dependent on the share of employment in agriculture – growth of the percentage of people employed in agriculture by 1 p.p. leads to a drop of the ratio of exports to value added by 0.3–0.6 p.p. This result is compliant with intuition, economic theories and stylised facts described before.

- The relationship between wages in a given province and the average wage level in the country has a similar negative impact on the share of exports in value added. Also in this case it is a result compliant with expectations: the wage level is an important factor in the selection of investment location, particularly in the case of export-oriented companies.

- The results regarding the impact of the structure of education on the ratio of exports to value added are ambiguous. Whereas the direction of impact complies with intuition, the lack of robustness of the results to a change of the estimation method is surprising. This may probably result from collinearity between the variables regarding education with the

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\(^9\) Both in PCSE-AR and GLS estimations of the two models (I and II), high values of residuals autocorrelation coefficients were received, which means that estimations received with the use of the methods are more reliable.
variable determining labour productivity (labour productivity may be higher in provinces with a higher share of people with technical and higher education).

- The results of the estimation – regardless of the assumed method – suggest that the length of paved roads per 100 km² has no significant impact on the ratio of exports to value added. This is quite a surprising result – perhaps the most important factor for the potential investor is the quality of roads instead of their density. Unfortunately the data allowing for verification of that hypothesis are not available. Lack of confirmation of the relationship between the ratio of exports to value added and the length of roads per 100 km² may also be a result of the collinearity of this variable with the percentage of people employed in agriculture.

- The fact that a province borders a foreign country in and of itself leads to the growth of the ratio of exports to value added by 6.5–9.2 p.p. The effect is robust to the changes of estimation method, and the result complies with the new theory of exports. Similarly positive albeit statistically significant only for some estimation methods is the influence of EU membership in provinces bordering the EU countries (causing the ratio of exports to value added to grow by 5.9 p.p.), as well as the fact that a given province has access to the sea (growth of the ratio of exports to value added by 4.1–6.4 p.p.).

As refers to Model II:

- The dependence between the share of agricultural and food products exports in total exports and the share of people employed in agriculture in the total number of the employed is statistically significant and positive – growth of the share of people employed in agriculture by 1 p.p. results in the growth of the exports of agricultural and food products in total exports by 0.4–1.2 p.p. This conclusion complies with the theory that the structure of the regional economy determines to a major extent the structure of exports.

- The share of agricultural and food products in total exports is also positively influenced by labour productivity in agriculture. Growth of the latter variable by PLN 1,000 leads to a growth of the share of exports of agricultural and food products in total exports by 0.4–1.1 p.p. This is a result compliant with intuition.

- More surprising is the positive dependence between the share of the exports of agricultural and food products in total exports with total labour productivity. This means that along with the general growth of labour productivity of particular province the share of agricultural and food products in province’s exports increases. To some extend this dependence may reflect the fact (described in section 2.2.) that among the provinces, which are significant exporters of agricultural and food products there are also ones which are internally diversified when it comes to structure of exports: these provinces consist of highly competitive centres (big cities) characterised by a high share of services in value added and high labour productivity and remaining areas focused mainly on agricultural production.

- The share of people with post-secondary or secondary vocational education in the population at the age of 15–64 has a positive impact on the share of agricultural and food products in exports. This may mean that an important factor determining the scale of agricultural and food products exports is the availability of staff with the adequate level of practical skills required e.g. in food – processing industry.

- The higher the population density, the lower the share of agricultural and food products in the exports of the province. This additionally confirms the thesis that the nature of the region is decisive for the exports structure: regions of low population density are usually agricultural regions.

- Interesting is the strong positive impact of access to the sea by the province on the share
of agricultural and food products in exports – it increases the share of agricultural and food products in exports by 3.3 to 4.6 p.p. To some extent this results may reflect the carry along phenomena described in section 2.1: if sea transport is an important transport channel for such products, than intermediaries located in provinces with access to the sea would “suck” the exports of companies located in provinces with no such access. It is also the consequence of many food processing enterprises located in the sea adjacent provinces. This relates to sea-food products but also to other ones – in which sales are export-oriented.

- Bordering a foreign country has a negative influence on the share of agricultural and food products exports in total exports – also in this case there is no obvious justification. It may be supposed that a country border has a stronger impact on other exports categories than on the exports of agricultural and food products.
- Contrary to general belief Poland’s accession to the European Union had no significant impact on the share of agricultural and food products exports in total exports.

4. Conclusions

The purpose of this article is to explain the strong diversification in the volume and structure of exports in Polish regions, using a set of potential determinants originating from different foreign trade theories used in country level studies. Two sets of panel models of exports were estimated for 16 regions of Poland in the years 1999–2008. The purpose of model I estimation was to explain the factor on which exports in particular provinces depend, as well as the factors affecting the change of the value of exports over time. In the case of model II, the purpose was to know determinants for agricultural and food products exports. Such type of exports, on the one hand, has a significant importance for the exports of less developed regions in Poland and, on the other hand, plays a significant role in the exports of some wealthy regions, including the wealthiest one. Thus, it may be supposed that growth of exports may be significantly important for the increase of exports of less developed regions and improvement of the living conditions therein.

The explanatory variables of the models were selected based on literature reviews and the collected stylised data regarding regional export performance (which was supposed to be statistically verified in that manner).

The share of exports in value added of particular regions proved to be positively dependent on: labour productivity, share of people, respectively, with higher education or post-secondary and secondary vocational education in the population between 15 and 64 years of age, location in the country’s border region, access of the region to the sea and, in the case of regions bordering EU countries, accession to the EU. It was negatively dependent on: the percentage of people working in agriculture and the value of labour costs compared to the average for the whole country. The significance of the influence of most of the aforementioned variables on export performance proved to be robust to changes in the estimation methods.

The share of agricultural and food products exports in total exports of the province was positively related to the share of people working in agriculture in total labour force, labour productivity in agriculture and the economy of the region in general, the share of people with post-secondary or secondary vocational education in the population between 15 and 64 years of age, as well as access of the region to the sea. It was negatively related to: population...
density and, which may not be easily interpreted, location in the border region. Finally, contrary to general belief, the accession to the European Union had no significant impact on the share of agricultural and food products exports in total exports. Most of the results were robust to the changes of the estimation methods.

There are two types of contribution this article makes to the literature on regional export performance. Firstly, it analyses data for the emerging economy for which exports determinants at the regional level have not been studied before. Secondly, the analysis is not limited to exports in general but is also conducted for the exports of agricultural and food products. Growth of such exports may, on the one hand, increase total exports and, on the other hand, improve the living conditions of people in many underdeveloped regions of Poland.
References


