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Export Diversification in the Product Space and Regional Growth: Evidence from Russia

by

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Abstract

This study investigates the relationship between export structure and economic growth in Russian regions. We hypothesize that it is not industry variety *per se* but the variety of related industries located relatively close to each other in the product space that significantly contributes to economic growth in Russian regions. The empirical analysis presented in the paper confirms that the density of the product space around the products for which a region had a comparative advantage determined the economic development in Russian regions in the 2003-2008 period. We conclude that the presence of a local related variety of industries in a region is one of the most important regional factors in economic development.

Keywords: export, economic growth, Russian regions

JEL Classification: F14, R11

1. Introduction

Policymakers in many countries consider export diversification to be one of the key sources of sustainable economic and continuous growth in household consumption standards. This concept primarily refers to developing countries, resource-based economies, and countries that are on the path toward a deep market transformation in which overcoming narrow product specialization in manufacturing and exports is considered a standard recipe for economic recovery and prosperity. This idea became crucially important during the period of the global financial crisis of 2008-2009 and the post-crisis recovery period, when the correlation between the level and duration of the recession on the one hand and the level of diversification in production and exports on the other hand was found to be sustained and negative for a large group of countries (Bacchetta et al., 2007; Haddad et al., 2012).

This study investigates the relationship between the level of export diversification and economic growth rates in Russian regions using a database on exports provided by the Federal Custom Service of Russia for the years 2003-2008. Based on “narrow” and “wide” versions of the approach provided in a number of papers (Hausmann et al., 2007; Hausmann, Klinger, 2007; Hidalgo et al., 2007), we test the hypothesis of the impact of unrelated and related variety in exports on the economic growth of the Russian regions during the 2003-2008 period of high growth rates. To the best of our knowledge, this is the first time that the density of the product space around products in which a region has a comparative advantage is shown to determine economic growth rates in Russian regions. This result coincides with the results obtained for Italy (Boschma, Iammarino, 2009) and Spain (Boschma et. al., 2010) with regard to the correlation between industry relatedness in the production structure of regions, on the one hand, and the growth of the value added, on the other hand.

Effects of export diversification: a problem statement

International trade theory still lacks any broad theoretical concept that would support the positive impact of export diversification on economic development in the world economy. In contrast, classical (Ricardian) and neoclassical (Heckscher-Ohlin-Samuelson and Ricardo-Viner) theories of international trade, based on the concept of comparative advantage, state that deeper specialization, not diversification of the export basket, provide the growth of the national income and, therefore, the growth of the level of household wealth in the economy (Dutt et al., 2008).

Although a number of the modern international trade models allow for product differentiation (see, for example, a group of models based on the model of international trade under monopolistic competition developed by Krugman), the source of the benefits in international trade is still based on the narrowing of the diversification level rather than on its widening in comparison with the level (of diversification in production) achieved in a closed economy (Krugman, 1981).

In the dynamic models of international trade without international knowledge spillovers, the general result of international trade states the persistence of trade patterns, which is determined solely by the relative endowments of production factors (Grossman, Helpman, 1990, 1991a). Moreover, deepening diversification is limited due to the existence of closed, self-reinforcing effects of initial specialization, which may lead to a "development trap" when specialization is based on sectors with a low degree of processing (Krugman, 1987). In contrast, when knowledge spillovers can be instantly diffused at no cost, the most likely outcome is a changing trade structure following the changing comparative advantage of a country. In models in which the process of knowledge creation and knowledge diffusion is seen as endogenous, trade specialization is changing toward higher-quality products, whereas developed countries shift to the production of advanced products, and the specialization of developing countries is based on simulation of the technologies of the developed countries (Grossman, Helpman, 1991b; Glass, 1997).

Arguments in favor of export diversification gain significant support with the emergence of new theories of development economics, which hypothesize that economic diversification, not specialization, can have a positive impact on the economic growth and development of the economy. Pioneering papers in this regard include the Prebisch-Singer thesis (Prebisch, 1950; Singer, 1950) and the "Big Push" arguments (Rosenstein-Rodan, 1943). However, a deep theoretical explanation for a positive relationship between the level of export diversification and economic growth has been proposed only in macro-economic concepts of endogenous economic growth, which take into account the effects of learning-by-doing and learning-by-exporting and consider the increase in export diversity and the shift from trade in primary products to high-tech products a benefit for the economy because these lead to improved production technologies in new export industries and positive spillovers in other industries (Aghion, Howitt, 1998; Barro, Sala-i-Martin, 2003). Arguments in favor of export diversification have been developed in a number of recent theoretical concepts, including the concept of the "resource curse" (Sachs, Warner, 1997) and the portfolio concept of economic development. In particular, the latter draws attention to the link between export diversification and the development of the financial sector, on the one hand, and economic growth, on the other hand (Acemoglu, Zilibotti, 1997).

Are all of the stages of economic development favorable for export diversification? Is any diversity in the export basket beneficial to economic development? The answers to these fundamental questions have recently become increasingly important. Consequently, many debates on economic theory and policy concerning the role of economic openness in the economic development of countries and regions in the world economy have revolved around these issues.

The answer to the first question should consider the fact that the economic histories of resource-rich countries provide some examples in which the development of resource sectors may be accompanied by high growth rates and may provide sustainable economic development for the economy. Examples include the experience of the United States (Wright, Czelusta, 2002), Sweden and Finland (Blomstrom, Kokko, 2003), and Chile (Herzer, Nowak-Lehman, 2004).

In addition, a number of empirical studies in recent years have shown that the export structure may evolve while undergoing several phases, from a low degree of diversification to a higher degree; once the financial market reaches a certain stage of development, it may shift again to a lower phase of diversification and, consequently, greater specialization (Saint-Paul, 2002; Imbs, Wacziarg, 2003; Cadot et al., 2007; Koren, Tenreyro, 2004; Hesse, 2007). That is, the dynamics of the specialization in international trade with regard to economic development are not linear and demonstrate a U-shaped relationship.

The answer to the second question is provided through several concepts. Models of endogenous growth assert that export diversification toward high-tech industrial products is beneficial for an economy because the production of advanced products is associated with positive intra- and inter-industry spillovers, providing a significant impact on economic growth (Matsuyama, 1992). The concept of the "resource curse" and the portfolio concept of economic development consider manufacturing products beneficial for export diversification because the manufacturing sector, from the “resource curse” perspective, creates significantly fewer incentives for rent-seeking behavior in comparison with the primary sector (Sachs, Warner, 2001), and, according to the portfolio concept, is significantly less pro-cyclical. It is therefore associated with less price volatility, and higher expected returns (Bertinelli et al., 2009). Because the volatility of the economic environment, first, is negatively correlated with economic growth (Aghion et al., 2009) and, second, does not promote export diversification (Broda, Weinstein, 2010; Besedes, Prusa 2006a; Besedes, Prusa, 2006b; Martincus, Carballo, 2009), manufacturing industries appear favorable for export diversification and economic development within the portfolio concept.

The conclusions of macroeconomic concepts of endogenous growth, the concept of the "resource curse", and the portfolio concept of economic development, although persuasive, are broad and unspecific, especially in case of their application to economic policy. Indeed, there are many examples in economic history when a country failed to enter the world markets of high-tech products and ultimately found it profitable to enter the markets of relatively low-tech goods to achieve the goals of sustainable economic growth (see, for example, the case of Chile, which failed to launch a project to enter the IT market and succeeded with a cluster project in the salmon industry; Yakovlev, Gonchar, 2004).

Which group of manufacturing products should expand the export basket? This question is not idle when we consider the specific country, for which the costs of entry to foreign markets (including, naturally, the costs of production of the goods) vary significantly depending on the specific types of manufactured goods, insofar as countries differ in resource endowments and goods differ in the proportions of resources (resource intensity) required for their production.

One of the possible answers to the question is based on the need to foster the export of those goods for which demand in the world market is rapidly growing (Alexander, Warwick, 2007). Although this idea has apparent explanatory power for a group of developed countries as well as a group of rapidly growing economies of Southeast Asia, it cannot be considered the common rule because it takes into account only the "benefits" or "income" from diversification and ignores the comparative advantage of countries. Thus, it does not take into account the costs of entering new markets.

Another possible answer is presented in recent papers by Hausmann, Hwang, Rodrik, Klinger, and Hidalgo (Hausmann et al., 2007; Hausmann, Klinger, 2007; Hidalgo et al., 2007) and is based on the assumption that the economic development of countries is not determined by the set of exported goods (in terms of the level of value added, or the life cycle, or the dynamics of demand in the world market) rather than by the set of particular exported goods. The narrow version of the approach is based on the observation that countries that export goods associated with higher implied productivity levels grow faster, whereas a high implied productivity level of products is associated with income level and is determined by the presence of each product in the export baskets of countries with high income levels. An important characteristic of those goods with high productivity is an elastic demand for them on the world market, so the country can export such products in large volumes without a significant negative impact on the terms of trade (Hausmann et al., 2007). The wide version of the approach adds to the analysis the factor of the location of exported goods in the product space. This analysis suggests that the most effective export diversification is diversification in which there is an expansion of production and exports of those goods that, first, have higher implied productivity levels and, second, are situated relatively "close" to the current export basket of the country in the product space (Hausman, Klinger, 2007). Thus, the approach of Hausmann-Hwang-Rodrik-Klinger-Hidalgo (hereinafter, the approach of H-H-R-K-H) explicitly takes into account both the “benefits” and “costs” of diversification while examining the effects of export diversification. In this sense, this approach is much more balanced than the above-mentioned theoretical and empirical approaches.

The analysis of the evolution of export baskets in countries in the world economy concludes that countries shift their export specialization to those goods that are associated with existing goods in the export basket (Hausmann, Klinger, 2006). In this regard, the location of the country in the "product space" often has a fundamentally important impact on the potential and the effect of export diversification (Hidalgo et al., 2007).

The H-H-R-K-H approach introduced the idea of the "relatedness of goods or industries" to the theory of international trade by drawing on the theory of agglomeration economies, the focus of which has been a question of the sources and destinations of agglomeration effects. Specifically, this theory examines what type of externalities, intra- or inter-industry, has a greater impact on the activity of firms within a limited space (Glaeser et al., 1992; Feldman, Audretsch, 1999). In the first approach, firms benefit and learn from spillovers (MAR externalities) only if they are located in regions with industrial specialization (Marshall, 1890; Arrow, 1962; Romer, 1986). According to the second approach, only regions with diversified production structure have higher rates of economic growth because spillovers frequently occur across sectors (Jacobs’ externalities, Jacobs, 1969).

However, the H-H-R-K-H literature and the regional studies literature significantly differ while studying how the shifts in resources from low- to high-income sectors affect income convergence (or divergence). The H-H-R-K-H literature points out that there is a room for improvement for any specialization pattern that country may end up with and that specialization patterns can substantially differ in terms of productivity and, thus, certain specialization patterns lead to higher economic growth rates than the others, while the regional studies literature focuses on structural transformation and its role in the evolution of income across regions. At some point, it is reasonable to argue that the mechanisms through which resources reallocate between industries and, thus, predetermine specialization pattern, are more distinct at the regional rather than at the national level.

Additionally, a few arguments for the investigation of industry relatedness at the regional level should be mentioned. First, resource mobility is higher between than within countries at least because of lower barriers to factor mobility. Likewise, high barriers to international factor mobility can significantly constrain inflow and outflow of resources in the economy, thus, study at the regional level seems to be of higher concern. Second, because of the spatial dependency across regions industry relatedness can generate externalities which are, again, greater at the regional than at the national level.

Several empirical works explore the impact of related variety in industries on economic growth at the regional (subnational) level (see Table 1). In general, most studies reveal the positive impact of related variety on economic development regardless of the data used for the calculation of variety. Indeed, for Italy and Spain, related variety was calculated using data on regional exports, and for the Netherlands and the UK, it was calculated using data on industrial production. Another study examined the dynamics of the production structure in regions of Sweden, with results that supported the conclusion that the probability of the emergence of new industries was associated with their degree of relatedness to the current industrial structure of the region (Neffke et al., 2011).

Table 1. Impact of related variety on economic growth: recent empirical results

Country	Value added	Employment	Labor productivity
Finland** (Hartog, Boschma, Sotarauta, 2012)	?	0/+	?
Spain* *(Boschma, Minondo, Navarro, 2012)*	+	0	0
The United Kingdom** *(Bishop, Gripaios, 2010)*	?	0	?
Italy* *(Boschma, Iammarino, 2009)*	+	+	+
Netherlands** *(Frenken, Oort, Verburg, 2007)*	?	+	0

Note: "+" indicates a positive statistically significant impact; "-" indicates a negative statistically significant impact; "0" indicates a statistically insignificant impact; "?" indicates that the relationship has not been considered.
* indicates studies in which related variety is based on the data on exports; ** indicates studies in which related variety is based on the data on industrial production.

As demonstrated in these empirical studies, relatedness across industries may foster economic growth and may lead to the emergence of new industries. The current industrial structure of exports in a country predetermines the future state of the export structure in that country, and the current set of assets determines which new industries can be developed in the future (Hidalgo et al., 2007; Hausmann, Klinger, 2007; Hausmann, Hidalgo, 2010).

Thus, the relatedness of industries, regardless of the specifics of measurement (only export industries or a complete set of all goods and services produced in the region/country) impacts economic development. The analysis of the methodological issues of these empirical studies raises the following question: what type of data (only data on exports or data on the full set of goods produced in a region) yields more accurate results? Obviously, for each region, there is a set of goods that is produced and consumed only domestically and, thus, is not exported. Consequently, an analysis of industry relatedness based on data on exports will lead to a biased estimates due to the low tradability of most service industries (Boschma, Minondo, Navarro, 2010). However, the complementarity of knowledge between industries can be approximated by the structure of exports because export industries are predominantly subject to higher international competition and serve as the main drivers of the creation and dissemination of knowledge, innovations, and economic growth (e.g., Dosi, 1988; Fagerberg, 1988).

In the next part of the empirical study, we analyze the effects of unrelated and related variety in industries in the export basket on the economic development of the Russian regions in 2003-2008, while the latter we measure by three standard indicators: value added growth, employment growth and labor productivity growth. The main empirical contribution of the paper is to provide a rigorous investigation on weak instruments in cross-section economic growth models testing for industry relatedness. As a preliminary to our conclusion, we find that export sophistication is, indeed, an endogenous variable and that a cross-section model of economic growth with regard to export sophistication should be estimated with valid instruments.

The remainder of this article is organized as follows. Section 2 presents our measure of unrelated and related variety in export products, describes the dataset used and discusses the recent evolution in export basket productivity in Russian regions. Section 3 presents the empirical approach employed and presents the empirical results. Section 4 concludes.

2. Recent trends in export performance in Russian regions

2.1. Measuring unrelated and related variety in export products

For the empirical analysis of the impact of export diversification on economic development in Russian regions, we use the H-H-R-K-H approach, which has been used in many other papers (Vitola, Davidsons, 2008; Hidalgo, 2009; Minondo, 2010; Hausmann, Klinger, 2010). According to this approach, the implied productivity level of an industry, i, called *PRODY*, is calculated as a weighted average of exporting regions' gross regional product per capita (GRP per capita), where the weights are the revealed comparative advantage of each exporting region:

$$PRODY_{i,t} = \sum_c \left[\frac{x_{c,i,t}/\sum_i x_{c,i,t}}{\sum_c \left(x_{c,i,t}/\sum_i x_{c,i,t}\right)} \times GRPpercapita_{c,t}\right]. \tag{1}$$

This measure of productivity (or industry sophistication) is then used to estimate the productivity of a region's export basket (or the sophistication of a region's export basket), called EXPY, which is a weighted average of the *PRODY* of each industry, i, that region c exports, where the weights are each industry's share:

$$\mathrm{EXPY}_{c,t} = \sum_i \left(\frac{x_{c,i,t}}{\sum_i x_{c,i,t}} \times \mathrm{PRODY}_{i,t}\right). \tag{2}$$

More recent literature indicates some limitations of the narrow version of the H-H-R-K-H approach. For instance, Minondo (2010) argues that this methodology does not control for quality differences within a product category when measuring a good's productivity level. A comparably strong notion is that the approach does not take into account the distance between industries in the product space. To improve the estimation of the implied productivity levels of industries, we employ the wide version of the approach, based on the idea of different distances between industries.

In the economic literature, various measures of industry relatedness have been developed, such as (1) the use of a standard product classification, such as the Standard Industrial Classification (Frenken et al., 2007) or the Harmonized System (Boschma, Minondo, Navarro, 2010); (2) the use of a cluster-based approach (Porter, 1998); and (3) the use of a proximity indicator (Hidalgo et al., 2007). The empirical results argue that the third approach provides an advantage when compared to the previous measures because it allows access to the largest number of cases in which there is a positive and statistically significant relationship between related variety and regional growth (Boschma, Minondo, Navarro, 2010).

Following the wide version of the H-H-R-K-H approach (see, e.g., Hidalgo et al., 2007), we calculate the distance between industries *i* and *j* as the probability that regions export both *i* and *j*. Algebraically, the measure equals

$$\varphi_{i,j,t} = min\{P(x_{i,t}|x_{j,t}), P(x_{i,t}|x_{j,t})\}, \tag{3}$$

where for any region *c*

$$x_{c,i,t} = \begin{cases} 1, & if\ RCA_{i,c,t} > 1 \\ 0, & if\ RCA_{i,c,t} \leq 1 \end{cases}, \tag{4}$$

where $P(x_{i,t}|x_{j,t})$ is the conditional probability of having demonstrated a comparative advantage in industry *i* given that the region has demonstrated a comparative advantage in industry *j*, and $P(x_{j,t}|x_{i,t})$ is the conditional probability of having demonstrated a comparative advantage in industry *j* given that the region has demonstrated a comparative advantage in industry *i*.

Furthermore, using the *PRODY* and the proximity indicators and following Hausmann, Klinger (2006) and Hausmann, Klinger (2010), we compute the region's potential export capability as the average weighted *PRODY* of all industries to be potentially produced and exported in a region, using *proximity* as the weight and denoting it by Omega:

$$\Omega_{c,t} = \sum_i \sum_j \left[\frac{\varphi_{i,j,t}}{\sum_i \varphi_{i,j,t}} (1 - x_{c,j,t}) x_{c,i,t} PRODY_{j,t}\right]. \tag{5}$$

More precisely, the indicator of potential capabilities, Ω, is a weighted average of the *PRODY* of those industry groups without a comparative advantage $(x_{c,j,t} = 0)$, which is simultaneously determined by the existing structure of comparative advantages $(x_{c,i,t} = 1)$, where the weights are the proximity measures.

We estimate the impact of industry relatedness in the export basket on the economic development of the Russian regions using three dependent variables: value-added growth, labor-productivity growth, and employment growth, corresponding to recent empirical studies (Boschma, Iammarino, 2009; Boschma, Minondo, Navarro, 2010). This approach allows us to conduct a comparative analysis of the results.

We use the database of the Federal Customs Service of Russia. These data include information on exports by individual firms and industries at the four-digit level and cover the period from 2003 to 2008. After manipulating these data, we obtain the aggregated database of exports from 77 Russian regions with the related general customs treatment of exports. We lastly combine this database with the socio-economic indicators of development for the Russian regions as given by the Federal State Statistics Service.

The statistics provided by the Federal Customs Service are based on the data on region-exporters of particular goods and, thus, cannot be fully matched with statistics on the data of region-producers of those goods. This situation imposes certain limitations on the interpretation of the results. At the same time, a merger of the data on international and interregional trade for Russian regions does not seem an appropriate solution for several reasons. First, competition in the international market is much higher than competition in the inter-regional market. Thus, for each export flow (international and inter-regional), competition determines different incentives. Second, intra-regional trade between Russian regions is predominantly determined by the specifics of planning and the allocation of production forces during the Soviet period, violating the assumption of formation under the impact of market forces, which is typical of international trade. Third, the lack of actual inter-regional trade statistics with relevant disaggregation corresponding to the data on international trade makes it impossible to simultaneously consider international and inter-regional export statistics. Lastly, fourth, we tend to assume that a significant discrepancy is presented between a region-producer and a region-exporter (for example, in the "classical" case in which the export of primary products, especially oil and oil products, is declared by developed multifunctional regions, such as Moscow and the Moscow region, due to institutional reasons of the hosting head offices of oil companies) in a limited number of cases and is at least partially eliminated by the use of data with detailed industrial classification and by the methodology for calculating the "distance" between industries (see equation 3).

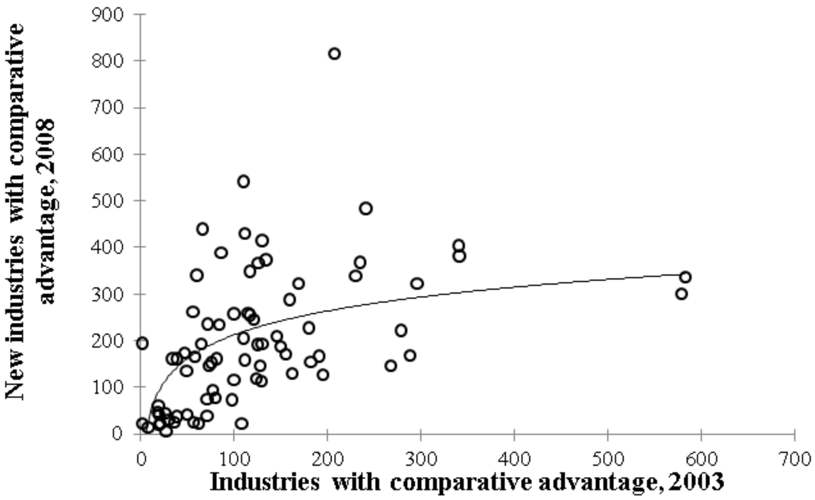
Some comments are needed regarding the relevant time chosen. As noted, the period of the late 1990s to early 2000s is accompanied by a group of factors of economic growth that prevailed in Russia after the 1998 crisis (the weak ruble, excess production capacity, low prices on energy products), which created favorable conditions for the overstated economic growth in many regions, especially in the depressed industrial centers (World Bank, 2007). The impact of these factors weakened gradually, so the economic growth in Russian regions was increasingly driven by internal factors. Indeed, a comparison of the growth rates of industrial production in the periods of 1999-2003 and 2004-2006 shows a significant increase in the dispersion of the economic growth distribution across regions (World Bank, 2008).

2.2. Export performance in unrelated and related products in Russian regions

Figure 1 below represents the relationship between existing and new industries with a comparative advantage. The figure shows a positive correlation between the number of industries in which a region has a comparative advantage and the subsequent number of industries with a comparative advantage that will arise in the following five years.

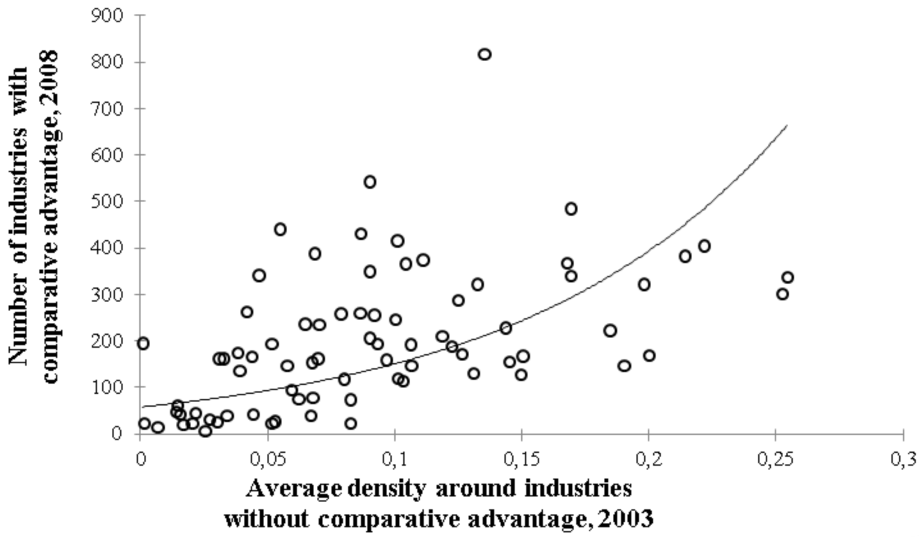
Thus, the question arises whether this identified relationship can be explained by the density around industries with a comparative advantage in the product space. That is, does the product density around products with an existing comparative advantage affect the emergence of new industries with a comparative advantage? Figure 2 allows us to verify this hypothesis.

Figure 1. Existing and new industries with comparative advantage in 2003-2008



Source: Authors' own calculations

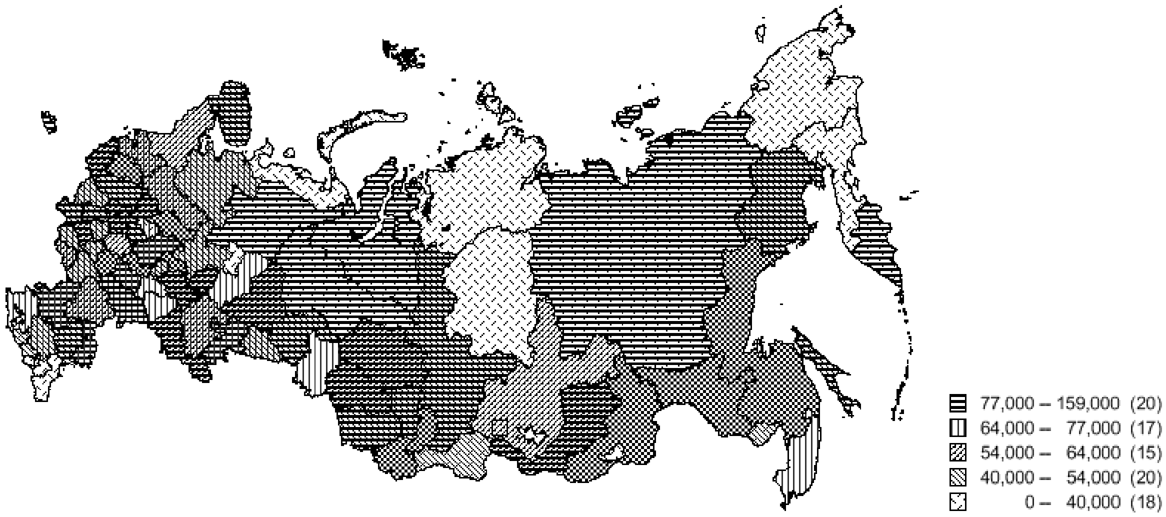
Figure 2. Density around industries without a comparative advantage and number of industries with a comparative advantage



Source: Authors' own calculations

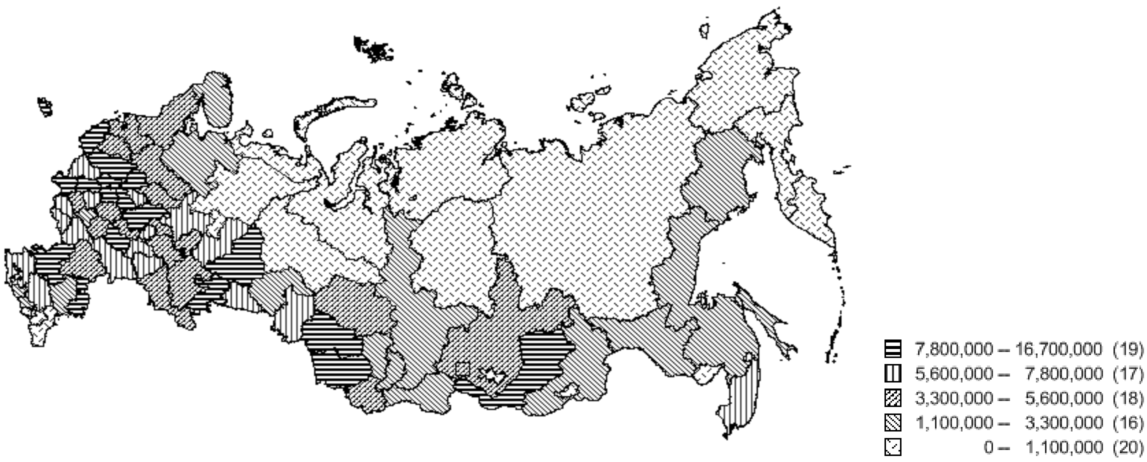
Figures 3a and 3b depict the computed export productivity and potential export productivity of the Russian regions. The figures show that many regions significantly change their relative position versus their neighbors in terms of *EXPY* and Ω values. For instance, although the initially computed export productivity of the resource-oriented Russian regions Khanty-Mansi Autonomous Okrug and Yamalo-Nenets Autonomous Okrug is significantly overestimated because they have the highest GRP per capita of all regions, the potential export capability, based on the relatedness measure, allows us to adjust this overvalued measure relative to other regions. Because oil and oil products are not located in the center of the product space of the Russian export basket, resource-dependent regions have restricted the potential for export diversification and, therefore, have limited prospects for economic growth.

Figure 3a. Export productivity in Russian regions in 2003, USD



Source: Authors' own calculations

Figure 3b. Potential export capability in Russian regions in 2003, USD



Source: Authors' own calculations

The estimation of the potential export productivity allows for a decrease in the relative export capabilities of resource-dependent regions as well as an increase in the export capabilities of those regions that do not have a high GRP per capita but that export products located in dense parts of the product space (see Table 2).

Table 2. Lowest and highest values of export productivity in Russian regions, 2003

Export productivity			
Regions with the lowest value		**Regions with the highest value**	
Adygea, Republic of	24279.8	Orenburg Oblast	100147.3
Tuva Republic	30200.4	Sakha (Yakutia) Republic	100066.7
Karachay-Cherkess Republic	32216.8	Yamalo-Nenets Autonomous Okrug	98506.8
Kabardino-Balkar Republic	34830.7	Khanty–Mansi Autonomous Okrug – Yugra	95709.3
Ivanovo Oblast	37758.4	Magadan Oblast	95600.9
Potential export productivity			
Regions with the lowest value		**Regions with the highest value**	
Khanty–Mansi Autonomous Okrug – Yugra	60574.5	Moscow Oblast	16628996
Yamalo-Nenets Autonomous Okrug	92461.4	Saint Petersburg	16408123
Sakha (Yakutia) Republic	427586.6	Novosibirsk Oblast	14220336
Komi Republic	891496.7	Sverdlovsk Oblast	13639250
Adygea, Republic of	960711.3	Kaluga Oblast	12901897

Source: Authors' own calculations

As shown in Table 2, resource-oriented regions that export products of the oil and energy complex and some mineral resources have the highest export productivity EXPY measures. Regions with the lowest current export performance are mainly depressed areas with a large share of agrarian complex and low international competitiveness. Reconsideration of export productivity levels with the measure of density of the product space Ω significantly reduces the estimated export productivity of the first group of regions and retains the export productivity of the second group of regions at a low level. The most advanced multi-product regions obtain the highest score for the potential performance of exports because the diversified structure of their export activities allows them to be closer to the dense parts of the product space and forces them to further diversify toward products with a high productivity level.

3. Empirics on the effect of relatedness in export basket on economic growth

Our baseline specification is a simple linear cross-section model of economic growth:

$$\Delta Y_{c,t+5} = \beta_0 + \beta_1 Y_{c,t} + \beta_2 X_{c,t} + \beta_3 Urban_{c,t} + \beta_4 EDU_{c,t} + \varepsilon_{c,t}, \quad (6)$$

where $\Delta y_{i,t+5}$ is the growth rate, which reflects the economic development in region *c* over the five-year interval 2003-2008; $y_{i,t}$ is the value of the indicator reflecting the economic development in a region at the initial time *t* in 2003; $x_{c,t}$ is an indicator assessing the "real" or "potential" performance of exports in region *c* in 2003; $Urban_{c,t}$ is a variable that reflects the effects of urbanization in region *c* in 2003 (at the initial time), and as a proxy, we use data on the density of the population in the region, people per 1 km[2]; $EDU_{c,t}$ is the human capital in region *c* at the time (in 2003) proxied by the number of people enrolled in higher educational institutions per 10,000 population.

Following recent empirical studies (Boschma, Iammarino, 2009; Boschma, Minondo, Navarro, 2010), we estimate the impact of related variety on economic growth in Russian regions using three dependent variables: value-added growth, labor-productivity growth, and employment growth, where growth is defined as the average year-to-year rates of growth within the considered five-year interval.

Several studies note that there is a two-way relationship between export diversification and economic growth. Thus, export diversification leads to economic growth, and economic growth leads to export diversification (Imbs, Wacziarg, 2003). Assuming that the random shocks affecting economic growth also affect the dynamics and structure of exports, we consider both variables of export sophistication, EXPY and Ω, to be endogenous.

The econometric model requires the inclusion of instrumental variables with certain properties. We use as instruments (1) density around the products without an identified comparative advantage in region *c* in year *t* and (2) the latitude of the capital city in region *c*. Given the policy of the spatial planning of production forces during the Soviet period, the structure of Russian production was formed without a significant effect of market factors. We assume that the export structure (and, therefore, current and potential export performance) is predominantly determined by Soviet spatial planning policy rather than by the rate and level of economic development. Moreover, the idea of using geographical variables as instruments is supported by recent empirical studies on the determinants of economic development. Although a number of studies support the hypothesis of the existence of direct effects of geographical location on development (Sachs, Warner, 1997; Sachs, 2003), thus prohibiting the use of geographic variables as instruments, a number of other studies find an indirect effect of geography on economic development through institutions. It is argued that the role of geography is secondary, and the role of institutions is primary (Hall, Jones, 1999; Easterly, Levine, 2003; Rodrik et al., 2004).

In a simultaneous-equations framework, we can write the model we just fit as the following:

$$\Delta Y_{c,t+5} = \beta_0 + \beta_1 Y_{c,t} + \beta_2 X_{c,t} + \beta_3 Urban_{c,t} + \beta_4 Edu_{c,t} + \varepsilon_{c,t} \quad (7)$$

$$X_{c,t} = \gamma_0 + \gamma_1 NoRCA_{c,t} + \gamma_2 Latitude_{c,t} + \gamma_3 Y_{c,t} + \gamma_4 Urban_{c,t} + \gamma_5 Edu_{c,t} + \\ + u_{c,t}, \quad (8)$$

where $NoRCA_{c,t}$ is the density around the product without a comparative advantage in region *c* in year *t,* and $Latitude_{c,t}$ is the geographical latitude of the capital city of region *c*[1].

We include additional control variables in the second specification, such as the distances from the capital city to one of the largest Russian sea ports:

[1] We test for the existence of only an indirect impact of geography on economic development in Russian regions and directly include latitude as a control variable in the first regression equation. The results reveal that latitude has no statistically significant effect on economic growth.

$$\Delta Y_{c,t+5} = \beta_0 + \beta_1 Y_{c,t} + \beta_2 X_{c,t} + \beta_3 Urban_{c,t} + \beta_4 Edu_{c,t} + \beta_5 1.Port_{c,t} + \beta_6 2.Port_{c,t} + \beta_7 3.Port_{c.t} + \varepsilon_{c,t} \tag{9}$$

$$X_{c,t} = \gamma_0 + \gamma_1 NoRCA_{c,t} + \gamma_2 1.Port_{c,t} + \gamma_3 2.Port_{c,t} + \gamma_4 3.Port_{c.t} + \gamma_5 Y_{c,t} + \gamma_6 Urban_{c,t} + \gamma_7 Edu_{c,t} + u_{c,t}, \tag{10}$$

where $i.Port_{c,t}$, *i*=1,2,3 is the distance from the capital city of region *c* to the sea port (Saint-Petersburg, Novorossiysk, Primorsk). Although additional control variables are also geographical distances and should refer to the instrumental variables, we assume that these variables reflect many more factors and allow for the consideration of both direct and indirect impacts of geography on economic development. Among the factors that are affected by geographical variables are agglomeration economies, positive effects from the mobility of different types of resources, and effects from the availability of access to additional, previously unavailable resources.

To deal with endogenous variable we first employ 2SLS estimation, which is the core method in the cross-section empirical studies on economic growth. As pointed in recent papers, 2SLS is the most efficient estimator in the presence of independent homoscedastic standard errors, while using GMM provides no particular advantage. However, since the assumption of homoscedasticity of standard errors is not straight forward, we use GMM estimator with the heteroscedasticity correction, specifying the use of the efficient weighting matrix that accounts for possible heteroskedasticity (Wooldridge, 2001; Viera, Damasceno, 2011).

One of the possible problems associated with instrumental variables is the identification of weak instruments since they will lead to higher standard errors and finite sample bias, that, in turn, will result in less precise coefficients. To deal with the problem of weak instruments we follow Cameron, Trivedi (2008) and implement tests for weak instruments developed by Stock, Yogo (2005) in the cross section analysis.
Table 3 represents the econometric results for the first specification. The estimates show that the calculated measures for export productivity, *EXPY* and Ω, are statistically significant for the growth of value added and labor productivity in Russian regions and, at the same time, are not significant for employment growth. The results of the endogeneity test confirm the endogeneity of current and potential export productivity. The overidentification test was implemented to check whether the instruments were valid. For most of specifications (except the models of employment growth 6 and 12), we find that the instruments are valid. When examining the weak instruments, we reveal that the instruments are weak for models with export productivity *EXPY* (according to Staiger, Stock, 1997; Stock, Yogo, 2005). To test the robustness of the results, first, we use the second specification, in which we add control variables (distances to the major Russian seaports). Second, we exclude from the sample regions with the highest value of *EXPY* because, as noted above, the latter may be significantly overestimated. The obtained results are presented in Table 3.

According to Table 4, the second set of empirical results demonstrates that export productivity based on an unrelated diversity measure is statistically insignificant for economic growth in the Russian regions after controlling for distance to the ports and the reduction of the sample by eliminating the regions with the most "overvalued" export productivity. At the same time, we confirm a statistically significant and positive relationship between potential export productivity and economic growth in Russian regions measured by value added and productivity. Moreover, the results of additional tests reject the null of exogeneity of potential export productivity and reveal no identification of weak instruments.[2]

Table 3. Cross-section economic growth models: 2SLS and GMM models

	Value added growth		Labor productivity growth		Employment growth		Value added growth		Labor productivity growth		Employment growth	
	2SLS	2SLS	2SLS	2SLS	2SLS	2SLS	GMM	GMM	GMM	GMM	GMM	GMM
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Value added	-0.89**	-0.107					-0.855**	-0.087				
	(0.404)	(0.103)					(0.377)	(0.099)				
Labor productivity			-0.710*	-0.123					-0.774**	-0.096		
			(0.376)	(0.124)					(0.367)	(0.122)		
Employment					0.018	-0.007					0.022	-0.006
					(0.017)	(0.010)					(0.017)	(0.010)
EXPY	1.681**		1.138		-0.102		1.606**		1.264*		-0.108	
	(0.821)		(0.728)		(0.095)		(0.767)		(0.706)		(0.096)	
Potential export productivity		0.201**		0.148		0.017		0.204**		0.160*		0.018
		(0.093)		(0.093)		(0.012)		(0.093)		(0.093)		(0.012)
Population density	0.008***	0.004**	0.008***	0.005**	-0.000	0.000	0.008***	0.004**	0.008***	0.005**	-0.000	0.000
	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)	(0.000)	(0.002)	(0.002)	(0.002)	(0.002)	(0.000)	(0.000)
Number of Students per 10,000 Population	0.028	-0.002	0.238	0.007	-0.006**	-0.003***	0.267	-0.001	0.025	0.008	-0.006**	-0.004***
	(0.023)	(0.010)	(0.019)	(0.011)	(0.003)	(0.001)	(0.022)	(0.010)	(0.019)	(0.011)	(0.003)	(0.001)
Cons	-6.098	0.918	-1.655	1.837	2.030**	0.795***	-5.656	0.658	-2.291	1.332	2.080**	0.774***
	(5.565)	(2.072)	(4.574)	(2.396)	(0.962)	(0.139)	(5.245)	(2.055)	(4.584)	(2.376)	(0.980)	(0.139)
Obs	72	72	72	72	72	72	72	72	72	72	72	72
Durbin-Wu-Hausman test (prob)	0.034	0.019	0.088	0.033	0.092	0.033	0.037	0.024	0.073	0.045	0.074	0.021
Hansen’s J (prob)	0.773	0.49	0.610	0.346	0.140	0.090	0.773	0.49	0.610	0.346	0.140	0.090
Weak instrument tests:												
Robust F	3.426	32.405	3.255	32.707	1.946	13.323	3.426	32.405	3.255	32.707	1.946	13.323
Min Eigenvalue Statistics	2.947	37.217	3.474	38.69	1.703	14.635	2.947	37.217	3.474	38.69	1.703	14.635
2SLS Size of Nominal 5% Wald Test	19.93	19.93	19.93	19.93	19.93	19.93	19.93	19.93	19.93	19.93	19.93	19.93

Durbin-Wu-Hausman test (prob): Null hypothesis of exogenous variables
Hansen’s J (prob): Null hypothesis of valid instruments
Robust F = Null Hypothesis (coefficients for instruments are jointly equal to zero)
MinEigenvalue Statistics (Stock, Yogo, 2005) Null hypothesis of weak Instruments
Tests for weak Instruments are the same for 2SLS and GMM in each model
Instruments: product density for products without RCA, latitude of the capital city in a region
*, **, and *** indicate significance at 10%, 5%, and 1%, respectively

In general, our results are consistent with previous studies investigating the effects of relatedness among industries on economic development. Indeed, the identified positive impact on related variety in export industries on value added growth in the Russian regions is consistent with the results for Italy (Boschma, Iammarino, 2009) and Spain (Boschma et al., 2010). The obtained results also confirm the presence of a statistically significant and positive relationship between the relatedness of export industries and the growth of labor productivity, which was revealed in the data for Italy (Boschma, Iammarino, 2009). In addition, this finding is in contrast to the study of Spain (Boschma et al., 2010), however, the latter employs a linear probability-OLS model with the dependent variable taking value

[2] We conduct similar tests for the consistency of the results for the first specification. When we cut the sample and eliminate regions with the highest productivity levels, the results reveal that export productivity *EXPY* is statistically insignificant, whereas potential export productivity Ω remains statistically significant for the value added growth and employment growth in the Russian regions.

1 if province has revealed comparative advantage in industry in at year t+5 and zero otherwise. In a study of the impact of related variety in inner manufacturing production on economic growth in the Netherlands, the identified relationships are quite similar to those for Spain and are statistically not significant (Frenken et al., 2007).

Table 4. Cross-section economic growth models and geography: GMM models

	Value added growth				Labor productivity growth			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Value added	-0.970** (0.412)	-0.591* (0.344)	-0.079 (0.099)	-0.078 (0.077)				
Labor productivity					-0.959** (0.415)	-0.523 (0.335)	-0.081 (0.122)	-0.064 (0.108)
Export productivity	1.849** (0.821)	1.147 (0.741)			1.635** (0.782)	0.908 (0.668)		
Potential Export productivity			0.206** (0.087)	0.133* (0.071)			0.175** (0.087)	0.113 (0.072)
Distance from Novorossiysk	-0.020 (0.155)	0.034 (0.119)	0.094 (0.108)	0.110 (0.079)	-0.016 (0.152)	0.073 (0.107)	0.091 (0.103)	0.125 (0.077)
Distance from Primorsk	0.028 (0.072)	0.035 (0.056)	-0.003 (0.083)	0.034 (0.054)	0.028 (0.070)	0.020 (0.053)	-0.000 (0.078)	0.025 (0.057)
Distance from Saint-Petersburg	-0.043* (0.032)	-0.026 (0.114)	-0.004 (0.019)	0.108 (0.091)	-0.054** (0.023)	0.031 (0.110)	-0.015 (0.022)	0.125 (0.097)
Population density	0.008*** (0.002)	0.006** (0.003)	0.004** (0.002)	0.004 (0.003)	0.008*** (0.002)	0.007*** (0.002)	0.004** (0.002)	0.005* (0.003)
Number of students per 10,000 Population	0.032 (0.025)	0.019 (0.024)	-0.003 (0.011)	-0.007 (0.012)	0.033 (0.024)	0.017 (0.020)	0.006 (0.010)	0.000 (0.012)
Cons	-6.760 (5.073)	-3.807 (4.164)	-0.274 (2.063)	-0.658 (2.027)	-3.837 (4.592)	-2.403 (3.697)	0.227 (2.383)	-0.837 (2.310)
Obs	72	67	72	67	72	67	72	67
Durbin-Wu-Hausman test (prob)	0.018	0.090	0.020	0.019	0.032	0.139	0.027	0.027
Weak instrument tests:								
Robust F	3.273	2.359	37.816	60.372	2.849	2.588	39.726	64.402
Min Eigenvalue Statistics	2.447	2.257	39.438	45.8079	2.803	3.077	41.852	49.488
2SLS size of nominal 5% Wald test	19.93	19.93	19.93	19.93	19.93	19.93	19.93	19.93

Durbin-Wu-Hausman test (prob): Null hypothesis of exogenous variables
Hansen's J (prob): Null hypothesis of valid instruments
Robust F = Null hypothesis (coefficients for instruments are jointly equal to zero)
MinEigenvalue Statistics (Stock, Yogo, 2005) Null hypothesis of weak Instruments
Tests for weak Instruments are the same for 2SLS and GMM in each model
Instruments: product density for products without RCA, latitude of the capital city in a region
*, **, and *** indicate significance at 10%, 5%, and 1%, respectively

The results indicate that Russian regions that export products that are exported by rich Russian regions do not grow with higher rates. This fact allows us to state that the narrow version of the H-H-R-K-H approach fails in the case of the Russian regions and, accordingly, diverges with the results obtained by Hausmann, Hwang, and Rodrik (Hausmann et al., 2007). At the same time, related variety in a region has a positive impact on growth in terms of value added per capita labor productivity. This can be interpreted as confirmation of the wide version of the H-H-R-K-H approach, represented, for example, by Hausmann and Klinger (Hausmann, Klinger, 2006; 2007).

Our findings can be explained by the idea of an optimal level of cognitive distance in social learning (De Groot et al., 2009). Indeed, regional knowledge spillovers cannot occur between two any industries because industries can "learn" from each other only in cases in which they are technologically connected. Therefore, a set of technology-related industries in a region may be more beneficial to economic growth than a diversified set of unrelated industries because the former combines the positive effects of diversity between industries and relatedness within industries.

A recent paper suggested the name "regional branching" for the process of the emergence of new related industries (Boschma, Frenken, 2011b). At the core of the process is the idea that the product space of regions may evolve as new industries join existing industries through knowledge transfer mechanisms, leading to economic growth. In this regard, several distinct mechanisms can be distinguished: (1) firm diversification, (2) spin-off activity, (3) labor mobility, and (4) networking (Boschma, Frenken, 2011b). Because these mechanisms operate mainly at the regional level (i.e., at the sub-national level within the regions), the process of branching can be applied to the regions within the country.

4. Conclusion

In this study, we investigate the impact of export diversification on economic growth in Russian regions. This study is built on the approach to the analysis of the relationship between industry variety and economic development proposed in recent papers by Hausmann, Hwang, Rodrik, Klinger, and Hidalgo. It examines the performance of the ideas proposed for the economic growth of the Russian regions in 2003-2008. In line with recent empirical studies on economic growth and income levels we emphasize the need for further investigation on the possible endogeneity and the use of weak instruments, which lack most of empirical papers.

We show that the economic development of the Russian regions is largely influenced by a related variety of industries in the export basket, which satisfies the wide version of the approach, rather than by the diversity of unrelated industries in the export basket, which satisfies the narrow version. The results indicate that Russian regions that have diversified export baskets and that have a related variety of export industries (or, in other words, that export similar products in terms of necessary production knowledge and skills) have higher economic growth rates.

The results show that the current structure of exports in Russian regions has a significant effect on the subsequent rate of economic growth, predetermining the emergence of new export industries. The concern is that the emergence of new industries is largely determined by the availability of the necessary assets at the regional level; these assets are redistributed from other industries within the region. Based on these findings, we hypothesize that the assets can be reallocated relatively more efficiently and at lower costs only within related industries. Consequently, regional branching or the emergence of new industries can be expected in those regions in which there is a variety of related industries.

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