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The Eurasian Customs Union and the Economic Geography of Belarus: A panel convergence approach*

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Abstract

This study presents novel research on the economic geography of Belarus. The 118 regions of Belarus are examined in relation to the Eurasian Customs Union (EACU) through the period 2005-2014. Spatial clusters and outliers are identified and compared across the periods prior and after the establishment of the EACU. We observe that EACU membership corresponds to a slowdown in the process of regional economic convergence in Belarus, and intensified economic competition with a geographical dimension among regions. We also observe that urban regions have benefited more from the EACU than less urbanised areas.

Key words: Eurasian Customs Union, Belarus, convergence, spatial analysis, economic integration.
JEL Classifications: F15, F55, O47, R11, R12, R58.

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1 Introduction

When several countries in Central and Eastern Europe joined the European Union (EU), many people in those countries expected that the integration would allow their nations to leap the development gap and catch-up with their western neighbours. This expectation lead to a prevailing question: does regional integration reduce economic disparities? The answer to the question is complex. For instance, the evidence found by Armstrong (1995) suggested that there was convergence in the EU, albeit a slow one. On the other hand, numerous studies have shown that the process of convergence varies by a considerable degree within the EU. Whereas convergence occurred primarily in Western Europe, other regions have experienced divergence (Dunford and Smith, 2000; Giannetti, 2002). A study by Puga (2002) finds that although income differences across countries have decreased, disparities across regions persist. Even further complexity was earlier introduced by Quah (1996) who observed that the evolution of the distribution of income in the EU differs also across time.

Most of the existing studies, however, use countries, or regions from multiple countries pooled together, as their units of analysis. As a result, these studies inform us only about the *between effect* of integration. But a policymaker from a national government may be interested in the *within effect* induced by integration as well. To illustrate, results from the previous analyses can tell a government official in Poland whether further integration would allow the country (or individual regions within Poland) to catch-up with Germany (or regions in Germany), but the official still would not know how much further integration may affect income disparities within Poland. This study addresses this knowledge gap and examines the distributional impacts of the Eurasian Customs Union (EACU) on regional disparities within Belarus.

The case of Belarus is particularly relevant. Unlike Russia and Kazakhstan which are major oil exporters in the region, Belarus is a small open economy. As a neighbour of the EU, about 50 percent of its exports and over half of its imports are with Russia (UN Comtrade, 2018). This makes Belarus an ideal case to study the effect of the EACU as it affects Belarus the most among the other member countries. To be more specific, the present study concentrates on the EACU and Belarus for two reasons. Firstly, existing discussion on the EACU mainly surrounds Russia's statecraft and potential political consequences such as authoritarian persistence of the region (Alimbekov et al., 2017; Cadier, 2014; Kaczmarski, 2017; Kirkham, 2016; Roberts, 2017). Research on the economic impacts of the institution is scant and, if exists, is confined to the effect of the EACU on trade diversion (Isakova et al., 2016; Tarr, 2016), on competitiveness (Falkowski, 2017; Hartwell, 2016), on economic stability (Vinokurov et al., 2017) and on welfare (Gnutzmann and Arevik). Moreover, the discussion also disproportionally falls to Russia. As a consequence, little has been known about the impacts of the Eurasian integration project on regional disparities at the sub-national level in Belarus. That being so, our study presents a novel examination of the distributional effect of the EACU on the regional economies of Belarus, and a unique inspection of the regional economic geography of the country through the use of spatial analysis methods.[1] The second reason behind

[1] Regarding socioeconomic topics other than per capita income distribution, important region-level evidence is presented by Nefedova et al. (2016) on migration for the period 1990-2013, Karachurina and Mkrtchyan (2015) on population distribution through 1989 to 2009, and Fateyev (2000) on employment and privatization for Belarus in the 1990s.

our focus on Belarus and the EACU is based on the fact that the customs union was agreed on 27 November 2009 and launched on 1 January 2010. As Isakova et al. (2016) points out, the short policy window of about one month renders the case of the EACU a unique opportunity for studying the effects of integration, because it circumvents the identification problem related to the endogenous nature of the tariff, an empirical issue difficult to tackle and often ignored when studying the impacts of regional integration.

Does the EACU increase or reduce economic disparities in Belarus? To answer the question, we compiled an original data set by collecting data from official statistical reports for all 118 "raions" of Belarus (henceforth referred to as regions) for the period 2005-2014. We find that the process of regional economic convergence in Belarus has slowed down as a response to EACU membership. We also observe some evidence of economic competition with a geographical dimension between Belarusian regions. Alongside with the new economic geography literature, our research suggests that the distributional impacts of regional integration depends on the trade and production structure of a country. In the case of Belarus, oil and food productions are the main tradables of the country. And similar to other post-Soviet economies, production process is relatively simple and the production chains are relatively short and fragmented. Although some sectors of the Belarusian economy benefit from the reduction of trade barriers (i.e. petroleum products and foods), the gains unevenly fall into a few sectors. The simple production structure substantially limits the benefits which could spill over to the upstream or downstream industries in other geographical areas. Consequently, instead of creating positive network externalities which could lead to a big push (Murphy et al., 1989), regional integration produces clear winners and losers in Belarus, such that development happens only in some regions. Production activities flourish only in some regions, and regions become spatial substitutes as highlighted by the negative spatial effect found from our econometric results which we discuss in Section 5.

In short, this study contributes to the literature in several ways. Firstly, existing regional integration literature on convergence tends to concentrate on the between country variation – either in national or regional level. In contrast, we focus on the within-country effect of regional integration, and thus provide groundwork for distinct policy implications. Furthermore, differing from most studies which only look at income convergence after integration, our analysis includes the pre-integration years as well. In this way, we are able to capture the distributional impact of integration. Secondly, our study is the first in specifically documenting the effects of EACU on economic convergence in Belarus. Thirdly, following Barro et al. (1991), many studies consider macroeconomic fundamentals such as physical capital, human capital and infrastructure key factors that explain economic variations and convergence (Mankiw et al., 1992; Button, 1998; Ding et al., 2008). But as Quah (1996) points out, neighbourhood effect is potentially a stronger driving force behind economic convergence (or divergence) than many macroeconomic factors. Our approach particularly takes spatial interrelatedness across regions into account while examining per capita income convergence. Finally, our study suggests a new way of looking at mechanisms that explains convergence. Economic convergence can take place through different channels; for instance, factor mobility (Barro and Sala-i Martin, 1992), technological spillovers (Ertur and Koch, 2007), institutions such as the EU and trade agreements (Armstrong, 1995; Chiquiar, 2005), policies (Cappelen et al., 2003; Hansen and Teuber, 2011) and agglomeration (Marquez and Hewings, 2003; Geppert and Stephan, 2008). Findings from this study suggest that economies with relatively simple production structures and short production chains are more likely to suffer negative distributional effects from regional integration. These negative effects may cause divergence or a slowdown in convergence in the short run, as we observe in our results.

The subsequent sections will introduce the background of the EACU and the Belarusian economy, followed by a review of the literature on the economic impacts of free trade agreements. Next, we explain our empirical approach, the data, and elaborate on our empirical results. Finally, the conclusion section discusses the policy implications of our findings.

2 Theoretical Background and Empirical Approach

2.1 Spatial effects of customs unions

After the dissolution of the Soviet Union in 1991, the economic power of Russia and former Soviet countries have declined. To reverse the trend, numerous attempts were made to reintegrate the region: the Ruble zone currency union, the Commonwealth of Independent States (CIS) and the Eurasian Economic Community (Libman and Vinokurov, 2012). In common, these attempts tried to limit disintegration by strengthening regional trade within the Eurasian region. The Eurasian Customs Union (EACU), launched in 2010, is one of the recent examples of the Eurasian reintegration attempts. The EACU aims to eliminate non-tariff barriers among the three member states: Belarus, Kazakhstan and Russia. It essentially adopted a common external tariff towards non-member economies. The EACU was succeeded by the formation of the Common Economic Space in 2012, enabling the free movement of services, capital, labour and a greater variety of goods, due to the removal of non-tariff barriers. The next step of the Eurasian integration was the creation of the Eurasian Economic Union (EEU) and the joining of Armenia and Kyrgyzstan to the EACU in 2015.

Generally, a free trade agreement applies the same to all regions of an economy. However, its impact on the economic activity in each location is shown to vary.[2] Solidifying this argument, Krugman and Livas Elizondo (1996) theoretically established the effects of nation-wide trade policies – within the New Economic Geography (NEG) framework – on the formation of large metropolises in the developing world. Theory and empirics have identified inter-regional labor mobility and trade costs as factors affecting the firm incentives for spatial concentration (Krugman, 1991; Monfort and Nicolini, 2000; Paluzie, 2001; Behrens et al., 2007), together with the role of proximity of national economic cores to supra-national economic centers (Paelinck and Polèse, 1999).

From an empirical point of view, the influence of an external political agreement on the internal spatial economic structure of a country has been documented by several authors. The commonly examined cases are the North American Free Trade Agreement (NAFTA) and the European Union (EU). For instance, Paelinck and Polèse (1999) compare how NAFTA has affected the sub-regional economic activity in Mexico and Canada. Their results imply that the spatial effects of trade-based economic integration depends on the relative locations of the economic cores of the member countries and the general core of the union. In another study that looks at the effects of NAFTA, Baylis et al. (2012) observe that rich border regions in Mexico have benefited from trade integration

[2] See for instance Hanson (1998) and Behrens et al. (2007).

unlike the more densely populated areas. For the case of the EU on the other hand, studies mostly focus on the convergence among the regions within the union as a whole, probably thanks to the availability of standardized regional data across nations. As a result, there is a plethora of studies on EU regional convergence. However, unlike the research on the NAFTA countries, studies focusing exclusively on the effect of the EU on convergence within a single country are scarce. Nevertheless, several EU-wide studies that also elaborate on within-country trends can be singled out; such as Martin (2001) who observe divergence in regional employment growth in the EU countries during the period 1975-1998, and Armstrong (1995) who finds that the within-country convergence speeds in the EU decreased after the 1960s (the study covers the period 1950-1999), a result supported by the findings of Cuadrado-Roura (2001).

Focusing on the economic effect of customs unions, Venables (2003) theorises that the effect of a customs union on regional disparities will depend on the comparative advantage of its members with the rest of the world (Venables, 2003). The key insight from the theory is that if the members have to divert their trade from a more productive-efficient non-member to a less productive-efficient member, this trade diversion effect will harm the members of the customs union. Furthermore, if comparative advantage is associated with income, the membership is likely to lead to divergence of income within the customs union composed of low-income countries because of the trade diversion effect (Venables, 2003, 748). The theory, however, mainly concerns convergence among member states and does not predict the distributional effect within a country.

Given that the EACU primarily lifted the trade barriers between the member countries and imposed a single external tariff to non-members, the EACU is expected to affect economic convergence or divergence directly through trade. Because internal and external tariff rates have been reduced (Isakova et al., 2016), consumers and downstream industries can obtain consumption goods and intermediate inputs from other countries with lower prices. The people of Belarus may also gain from a boost in exports, because the import prices of intermediate inputs are lower. Nevertheless, these economic benefits distribute unequally over space, depending on the comparative advantage of the Belarusian economy and the industrial structure of a region. A region will benefit more from the EACU if it was importing high-tariff inputs for production before joining the EACU. On the other hand, a region may not gain much when it does not rely on imported products, although its demand may shift to the lower price products or inputs. In contrast, a region may lose because of trade diversion; that is, it shifts its demand from a more efficient supplier to a less efficient one because of the tariffs. The tariff rate of some products and inputs can also become higher if the external common tariff rate was higher than the ones prevailed.

Most industries in Belarus are legacies of the Soviet era. They are outdated, inefficient and internationally uncompetitive, except for the CIS (Savchenko, 2009). Economic activities too are distributed unequally over space, and regional disparities remain a perpetual economic feature of the country. In Belarus the formation of production patterns in regions and the clustering of firms gravitate towards more industrialized areas, in particular to cities and capital regions of oblasts such as Minsk, Gomel and Vitebsk. [3] Since most economic activities of the country are concentrated in the major cities, it is expected that these economic centres would become the winners

[3] Minsk, Gomel and Vitebsk oblasts in total account for about half of the industrial output of the country (National Statistical Committee of the Republic of Belarus, a). In contrast, a large portion of agricultural production clusters exist in the Brest and Grodno oblasts in the west of the country.

of the EACU, thereby contributing to agglomeration processes and divergence among Belarusian regions.

Certainly, the Eurasian integration may offer significant trade privileges for peripheral regions and prompt the centrifugal effect of resource distribution. However, in order to maximise this effect, certain conditions have to be met. Firstly, the resources of the economy should be mobile in order to utilise emerging opportunities in the border regions, and secondly, the border regions should establish business networks with the agglomerating centres to support forward and backward linkages (Niebuhr and Stiller, 2002). The latter condition highlights the need of linkage maintenance for expanding and efficient production, which is especially important in industrially-oriented regional economies. Moreover, it also implies that the benefits of positive externalities from economic centres are more likely to fall into the areas located closer to the capital regions, which means that these areas gain more benefits from regional integration. Thus, the gains in the border zone are expected to be less, even if all other factors would be the same.

Despite the existence of studies on the cases of the NAFTA and the EU, there is no previous research available on the effects of the EACU on any type of convergence, regional or countrywide. Little subnational level research exist on Belarusian regions either, despite the country being located in a critical location between the EU and Russia. Our research therefore addresses the aforementioned theoretical argument regarding free trade agreements – or economic integration in general – through a never researched but highly relevant case.

2.2 Regional β-convergence, technological spill-overs, and spatial effects

Our empirical analysis is rooted in the theoretical foundation of the β-convergence approach established by Barro and Sala-i Martin (Barro et al., 1991; Barro and Sala-i Martin, 1992; Sala-i Martin, 1996b), and its panel application substantiated by Islam (1995). β-convergence equations lead to empirical results that answer whether (and how fast) per capita income differentials across regions diminish over time. This type of convergence analysis is based on the Solow (1956) and Swan (1956) neo-classical growth model which is about a single economy converging to a steady-state level of output growth that can be equal to zero. This growth rate can be positive if there is exogenous technological progress that is labor-augmenting. Such convergence is anticipated by (albeit for a single economy) the neo-classical framework due to the assumption of diminishing marginal products of capital investments.

β-convergence of economies may only happen under certain conditions such as similar technology and common structural characteristics (Mankiw et al., 1992). To test whether such conditions play a role, growth-convergence equations are generally augmented through the addition of theoretically supported variables. In a sub-national regional context, where the relative locations of economies are obvious factors that influence their economic outcomes, a further augmentation to the model is through the consideration of spatial effects. Formally referred to as spatial dependence, these effects are caused by various types of spill-overs in a geographical framework (Anselin, 1988a). A comprehensive formalization of these spill-overs is rigorously presented by Ertur and Koch (2007) who formulate the occurrence of technological spill-overs through spatial connections. An older, less rigorous argument underlining spill-overs among regions resulting from technological progress is given by Armstrong and Taylor (2000). Regarding the study of regional income convergence in particular, as earlier mentioned, Quah (1996) has shown that space-related spill-over effects play a more important role in regional income distribution dynamics compared to macroeconomic factors.

Aside of actual spatial spill-over effects caused by real socioeconomic phenomena such as the diffusion of technology and knowledge, trade, and migration, spatial dependence can also be a by-product of data if the correspondence between the market processes over space and the spatial units such as administrative regions is imperfect (Anselin and Rey, 1991; Rey, 2001). It is therefore imperative to include spatial effects in regional convergence analyses, as shown by Rey and Montouri (1999) and Rey and Dev (2006), among others. We therefore estimate conditional convergence model parameters where convergence is conditioned on a set of regional socioeconomic variables – discussed in Section 3 – together with region-specific and time-specific unobserved effects. We then include spatial effects on top of the aforementioned factors for the purpose of incorporating the geographic dimension as an additional feature of conditional convergence.

2.3 Estimation

The analysis is in the form of a panel data model with annual observations on all the 118 regions of Belarus over the period 2005-2014 (the details of our data are presented in Section 3). The sample ends in 2014 because a more extensive reintegration project, the Eurasian Economic Union, was established in 2015. Our approach involves dividing the data into two parts: before (2005-2009) and after (2010-2014) the joining of Belarus into the EACU, and comparing the parameter estimates and the speeds of conditional convergence between the two periods. Based on the foundation outlined in Section 2.2, we present the following baseline panel β-convergence model – which we apply on the pre-accession and post-accession periods.

$$ln(y_{it}) = \theta + \ (1+\beta)ln(y_{i,t-1}) + \sum_{k=1}^{m} \gamma_k x_{k,it} + \mu_i + \eta_t + \xi_{it} \quad (1)$$

In Equation 1, y_{it} denotes the per capita income in region i at time t. θ is a constant term, and β is the convergence parameter (it is summed with 1 as a result of expressing the left-hand-side as a level rather than a growth rate). The coefficient $1+\beta$ equals e^{-bT} where b is known as the speed of convergence, the key parameter that we estimate, and T is the number of years between two observations and equals to one in our panel setting (Sala-i Martin, 1996a). The speed of convergence is related to the half-life of convergence which is the time it would take for half of the current per capita income gaps to be eliminated and is equal to $\frac{ln(2)}{b}$ (Barro et al., 1991; Arestis et al., 2007). x_k denotes the k explanatory variables that are used to augment the model into a conditional convergence specification, where the effect of each x_k is measured through its parameter γ_k and $k = 1, ..., m$. Convergence is further conditioned on the unobserved region-specific effects absorbed by the fixed effects term μ_i, and on the year-specific effects η_t. Finally, the idiosyncratic error term of the model is denoted as ξ_{it}.

The aforesaid spatial effects enter our estimation in five alternative ways. The per capita income level of a given region may depend on the economic activity that takes place in all other regions j, and their effects can depend on how far they are from region i (Elhorst et al., 2010). The Spatial Autoregressive Model (SAR; Anselin, 1988b) takes this possibility into account by including the per capita income levels of all other regions – weighed by distance. This possible spatial dependence in the dependent variable would be captured by the coefficient ρ in the term $\rho \sum_{j=1}^{N} w_{ij} ln(y_{jt})$ in the below SAR specification (Equation 2). The term w_{ij} is the row-normalized inverse Euclidean distance between the regional capitals of regions i and j, and is an element of the spatial weight matrix W. Each diagonal element (where $i = j$) of W is equal to zero as there is no distance from a given region to itself. W is an $N \times N$ matrix where N is the number of regions (118; $i = 1, ..., N$, $j = 1, ...N$). In order to ensure conformability in a panel setting, W is expanded such that in our estimations the weight matrix is $I_T \otimes W$ where I_T is an identity matrix of length T as $t = 1, ..., T$ (Millo et al., 2012).

$$ln(y_{it}) = \theta + \rho \sum_{j=1}^{N} w_{ij} ln(y_{jt}) + (1 + \beta) ln(y_{i,t-1}) + \sum_{k=1}^{m} \gamma_k x_{k,it} + \mu_i + \eta_t + \xi_{it} \quad (2)$$

The Spatial Error Model (SEM; LeSage and Pace, 2009) tests whether there is spatial dependence among the errors which would imply the existence of spatially clustered omitted variables (Ward and Gleditsch, 2008). The disturbances ξ_{it} are now defined as in the SEM specification in Equation 3. Spatial dependence in this error term is observed by the parameter λ. The remaining i.i.d. error term is $\vartheta_{it} \sim N(0, \sigma_{\vartheta}^2)$.

$$\begin{aligned} ln(y_{it}) &= \theta + (1 + \beta) ln(y_{i,t-1}) + \sum_{k=1}^{m} \gamma_k x_{k,it} + \mu_i + \eta_t + \xi_{it} \\ \xi_{it} &= \lambda \sum_{j=1}^{N} w_{ij} \xi_{jt} + \vartheta_{it} \end{aligned} \quad (3)$$

The Spatial Autoregressive Combined model (SAC; Kelejian and Prucha, 1998) brings together the two preceding models such that both the SAR and SEM specifications are nested within the SAC as shown in Equation 4. The SAC model would reduce to the SAR equation if $\lambda = 0$, to the SEM specification if $\rho = 0$, and to the non-spatial base model (Equation 1) if $\rho = \lambda = 0$.

$$\begin{aligned} ln(y_{it}) &= \theta + \rho \sum_{j=1}^{N} w_{ij} ln(y_{jt}) + (1 + \beta) ln(y_{i,t-1}) + \eta_t + \xi_{it} \\ \xi_{it} &= \lambda \sum_{j=1}^{N} w_{ij} \xi_{jt} + \vartheta_{it} \end{aligned} \quad (4)$$

Furthermore, spatial dependence may exist through the explanatory variables. This type of spatiality is initially explored in a Spatial Durbin Model (SDM; Anselin, 1988b) where the spatially lagged counterparts of all explanatory variables are added into the specification such that:

$$ln(y_{it}) = \theta + \rho \sum_{j=1}^{N} w_{ij} ln(y_{jt}) + (1+\beta) ln(y_{i,t-1}) + \sum_{k=1}^{m} \gamma_k x_{k,it} + \sum_{k=1}^{m} \delta_k \sum_{j=1}^{N} w_{ij} x_{k,jt} + \mu_i + \eta_t + \xi_{it} \tag{5}$$

Finally, the SDM can be augmented so that it nests the SAC model (LeSage and Pace, 2009). Halleck Vega and Elhorst (2015) label this specification which comprises all types of spatial effects as the General Nesting Spatial model (GNS; Equation 6):

$$\begin{aligned} ln(y_{it}) &= \theta + \rho \sum_{j=1}^{N} w_{ij} ln(y_{jt}) + (1+\beta) ln(y_{i,t-1}) + \sum_{k=1}^{m} \gamma_k x_{k,it} + \sum_{k=1}^{m} \delta_k \sum_{j=1}^{N} w_{ij} x_{k,jt} + \mu_i + \eta_t + \xi_{it} \\ \xi_{it} &= \lambda \sum_{j=1}^{N} w_{ij} \xi_{jt} + \vartheta_{it} \end{aligned} \tag{6}$$

The above models incorporate regional fixed effects and therefore are prone to the Nickell (1981) bias. This would result in an underestimation of the coefficient $1 + \beta$, because it is greater than zero as we shall see in our estimation results. Therefore, an upward bias in the estimate of the convergence speed would be present, leading to the estimation of shorter half-lives. As a consequence, our estimates of the convergence parameter may be subject to a distortion which is of order $1/T$ – i.e decreasing in the length of the time period in our panel (Nickell, 1981). In a non-spatial setting, variants of the Generalized Method of Moments (GMM) estimation are used to deal with this type of bias (Arellano and Bond, 1991; Arellano and Bover, 1995; Blundell and Bond, 1998). Furthermore, an additional type of bias would be present in the estimation of the spatial parameter (ρ) if the estimation method of the spatial models is Ordinary Least Squares (OLS). On this point, Maximum likelihood estimation (MLE) stands out as a frequently used approach for thwarting the expected inconsistency and bias while providing asymptotic efficiency (Elhorst, 2003).[4] Elhorst et al. (2010) show that even though GMM is effective in reducing this bias, the resulting bias in the estimated spatial term would be large; that is to say, relative to an estimate resulting from an MLE approach. Turning back to the Nickell bias, it is possible to argue that this issue is likely to apply to our estimates of the convergence speeds for the pre-accession and post-accession periods. This would alleviate the possible consequences of the Nickell bias on the interpretation of our findings as our interest lies mainly in the comparison of the two periods. And since our analysis has a strong geographical emphasis, we use MLE in the estimation of all our models.

[4] The usage of MLE is common in the estimation of spatial panel models despite not being robust to assumptions regarding the distribution of the data. This method has been used, among others, by Pfaffermayr (2012), Ertur and Musolesi (2012), Baltagi and Bresson (2011), Lee and Yu (2010a), Lee and Yu (2010b), Debarsy and Ertur (2010), and Elhorst and Freret (2009).

A final point that requires consideration in the estimation of spatial models is the existence of direct and indirect effects. LeSage and Pace (2009) first indicated that in spatial models, explanatory variables exhibit a direct effect, as well as an indirect effect. Continuing on this line, Elhorst (2010) demonstrates that it is imperative to differentiate between the indirect and direct effects in models with spatial terms. In a spatial model where observed units are regions, the observed direct effect of a variable belonging to specific region is the change it causes in the dependent variable for the same region, and the indirect effect is the change it causes on the dependent variable in the other regions (Elhorst, 2014). More specifically, Elhorst (2014) shows how these effects are contained in a matrix of partial derivatives of which the average of the diagonal elements summarizes the direct effect, and the average of the row or column sums of the off-diagonal elements summarize the indirect effect. For the GNS and SDM estimations in particular, the indirect and direct impacts of explanatory variables are contingent upon the coefficients of the covariates with spatial lags, namely, the estimates of the δ_k's (Elhorst, 2014; Golgher and Voss, 2016). In line with this account, we have calculated the speeds of convergence based on the direct effect of $y_{i,t-1}$ for all our models, rather than using the point estimates reported in the output tables.

3 The Dataset and the Choice of Model Variables

The fundamental theoretical setting of conditional convergence analysis suggests conditioning the model on: the share of capital, the rate of productivity growth, depreciation rate, and population growth (Sala-i Martin, 1996a). Empirical convergence studies build upon these theoretical suggestions by altering or enhancing this set of economic characteristics. The diversity in the choice of variables is attributable to the contextual focus of the research, the availability of data, and often depends on whether the observations are nations or regions. The variable selection in our study is also subject to the same considerations. For regional per capita income (y), we use the regional revenue per capita, and condition convergence on several regional characteristics. As regional capital stock figures are unavailable in a regional level, we use fixed capital investments and denote it as K. Mankiw et al. (1992) have shown that human capital can play a significant role in explaining the differences in productivity levels between economies. In line with their approach, we use the percentage of students (H) as an indicator of the level of human capital in a region.

As earlier discussed, technological progress is an integral part of the theoretical convergence framework. There is no clear-cut measure available for the technological differences across Belarusian regions. We propose that the industrialization level in a region may provide information regarding its relative technological sophistication, and include the share of industrial production in a region (I) to account for this regional characteristic. The agglomeration of manufacturing labor is a central theme in the new economic geography literature (Krugman, 1991; Krugman and Livas Elizondo, 1996; Fujita and Krugman, 2004). When a region becomes more urbanized, agricultural activity is replaced – to some extent – by manufacturing and the services industry. With respect to economic convergence, DiCecio and Gascon (2010) empirically show that the level of urbanization has been an important determinant of regional disparities in the US. Alongside the theoretical and empirical suggestions, and subject to the availability of data for the Belarusian regions, we account for manufacturing agglomeration through the use of the share of the urban population (U) in our analysis. Finally, we also consider the relative weights of public and private economic activity in a region.

Beugelsdijk and Eijffinger (2005) argue (and support with empirical findings) that an increase in the productivity of a region may attract private investment which in turn increases income per capita. In our models, we represent private economic activity in each region with the share of private firms (P).

The above presented indicators constitute the set of k explanatory variables in the term $x_{k,it}$ which appears in Equations 5 and 6. As discussed in Section 2.3, it is highly likely that variables observed in individual regions will affect each other across space. Therefore, they all enter the estimation also in the form of spatial lags, through the term $\sum_{j=1}^{N} w_{ij} x_{k,it}$. The variable definitions are summarized in Table 1, and their descriptive statistics are presented in Table 2. All variables vary across regions and years. All data has been obtained from the statistical yearbooks of the National Statistical Committee of Belarus (issued in 2014 and 2015).

Table 1.
Variable Definitions

Variable	Definition
y	Revenues from sales of products, goods, works and services, divided by population in constant 2004 prices (millions of BYR).
K	Investments in fixed capital in constant 2004 prices (billions of BYR).
I	Volume of industrial production divided by regional revenue (both variables in constant 2004 prices, billions of BYR).
P	Share of private companies.
H	Percentage of students.
U	Share of urban population.

Source: National Statistical Committee of Belarus (2014 and 2015).

Table 2.
Descriptive Statistics

Variable	Mean	St. Dev.	Min	Max
y_{it}	8.22	6.69	1.73	60.75
K_{it}	105.01	147.75	5.13	1,501.52
I_{it}	0.40	0.20	0.07	2.01
P_{it}	0.42	0.15	0.10	1.00
H_{it}	4.99	3.74	0.90	22.80
U_{it}	0.48	0.18	0.00	1.00
		$N = 118$, $T = 10$		

Source: National Statistical Committee of Belarus (2014 and 2015).

4 A descriptive look to the Belarusian economic geography

In order to elucidate the regional economic outcomes in Belarus with respect to the EACU, we begin by discovering the spatial patterns in the country. For this aim, we present descriptive illustrations depicting the distribution of income, alongside the identification of spatial clusters and spatial outliers as formalized by Anselin (1995). For the purpose of observing the variation through time, we examine the Local Indicators of Spatial Association (LISA; Anselin, 1995) for three snapshots in time: the first year in our data, the year of establishment of the EACU, and the final year in our data.[5,6]

The geographical distribution of income per capita (in millions of BYR) is presented in the maps in the upper row of Figure 1 where darker shades of blue represent higher per capita income levels. For all the three years, we observe that regions with high per capita income levels are located mostly in the central parts of Belarus; around the capital Minsk, and several southern regions. These regions, among others, are exclusively identified in the LISA cluster maps presented in the bottom row. The LISA cluster maps identify four types of spatial clusters partly based on the categorization made by the Moran Scatterplots in Figure 2. The Moran Scatterplots (Anselin, 1995) for the three years plot $ln(y_i)$ against its own spatial lag (denoted by $Wlny$ in the graphs) and include a fitted regression line representing the Global Moran's I statistic (Moran, 1950; Cliff and Ord, 1972) for the corresponding year. The associated p-values for the Global Moran's I statistics for the years 2005, 2010, and 2014 are all significant in the 0.01 level (reported under the figures), indicating the existence of global spatial dependence across regions in terms of their per capita incomes. These significant Moran's I results reinforce the necessity for the usage of spatial estimation models for accurately assessing the convergence process in Belarus.

The LISA cluster maps depend on the significance of the spatial association of each region with its surroundings such that only regions with Local Moran's I p-values less than 0.05 are colored.[7] Each category, shown in yellow, blue, green, and red, highlight the cores of spatial clusters based on the type of spatial association they have with their surrounding regions (Anselin et al., 2006). The HH category marks the core of the spatial cluster where regions with higher-than-average per capita income are significantly clustered with other regions which also have an average per capita income that is higher than the country average. The HL category includes regions that have high income despite being surrounded by low income regions. In contrast, LH clusters are those where poor regions are surrounded by richer ones. Finally, LL regions mark the cluster cores where poor

[5] The descriptive and empirical analyses in this study have been applied using the `R` software. For calculating the direct effects we used the equations presented in Table 2.1 in Elhorst (2014) which yielded the same result – for the SAR model – when the effects are calculated based on the routine presented by Piras (2014) who uses the `impacts` function in of the `spdep` package developed by Bivand et al. (2011). The following `R` packages and functions were also used for the various steps of our study: `plm` by Croissant et al. (2008), `splm` by Millo et al. (2012), `ggmap` by Kahle and Wickham (2013), the `Moran.I` function by Paradis et al. (2004), the `localmoran` function by Bivand et al. (2011), and the `spDists` function described in Bivand et al. (2008). All statistical maps have been overlaid on the base map obtained from Google Maps. Our `R` scripts can be made available to reviewers if requested.

[6] Belarus is a founding member of the EACU. Therefore, its membership year is the year of establishment of the EACU (2010).

[7] The Global Moran's I statistic is $I = \left(\frac{n}{\sum_i \sum_j w_{ij}}\right) \sum_i \sum_j w_{ij} z_i z_j / \sum_i z_i^2$ where w_{ij} are the spatial connectivity terms discussed in Section 5 and the z_i are deviations from the mean per capita income. The local Moran's I statistic for each region i is calculated as $I_i = z_i \sum_j w_{ij} z_j$.

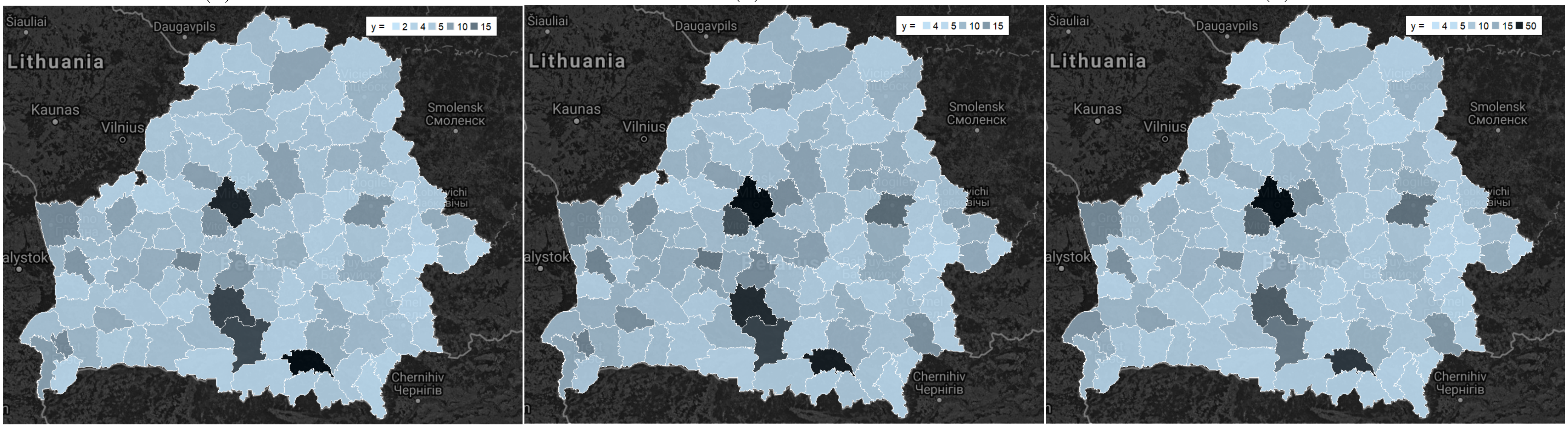
regions are grouped together. We therefore identify the areas with significant spatial association (i.e. spatial cluster cores) in Belarus, and designate these clusters in the Moran scatterplots where the grey dots are regions with no significant Local Moran's I statistics (denoted as "N" in the graphs).

The spatial cores of the Belarusian economy have been subject to some changes, especially after 2010, the EACU membership year. The LH cluster in the south (shown in green) has ceased to exhibit a highly significant spatial correlation as of 2014. However, the HH clusters around and in the south of Minsk, and the cluster around Hrodna were persistent. Similarly, the LL category cluster cores close to the borders with Russia and Ukraine are identified, though with decreasing significance, particularly in 2014. We then observe regions with significant negative spatial association with their surrounding economies, HL type regions and LH type regions. Svislach, which is located at the border with the EU (Poland), has been remaining in the latter category throughout our sample period. Mahilyow and Homyel stand out as regions falling into the former category, and are high-income cores surrounded by poorer regions.

As a final descriptive look, we follow the trajectories of the spatial cluster cores and spatial outliers (i.e. regions with significant Local Moran's I p-values) in Figure 3. Each line graph displays (in natural logarithms) how the income per capita of the regions in the cores of these clusters have evolved over time. In the period before the EACU membership, the LH and LL clusters (green and red) seem to have had similar directions to those of the high income clusters. However, they become flatter after 2010, which may imply divergence, or a slowdown in convergence. The trend in regional inequalities is represented specifically in the overlaid coefficient of variation (CV) line, which uses the information not only from the clusters and outliers, but from all other regions as well. As an indicator of what is referred to as σ-convergence in the convergence literature (Sala-i Martin, 1996a,b), the trend in the CV further implies that EACU membership may have hindered regional convergence in Belarus; a steady decline in the variation of regional per capita income over years is no longer visible after 2010. This visual hint implies that EACU membership may have affected poorer Belarusian regions differently, relative to the richer ones. We therefore elaborate particularly on the difference in the speeds of convergence in the pre-EACU and EACU periods that result from our empirical analysis in Section 5.

Figure 1.
Income per capita and the Spatial Clusters in Belarus

Income per capita (a) 2005 (b) 2010 (c) 2014



LISA Cluster map

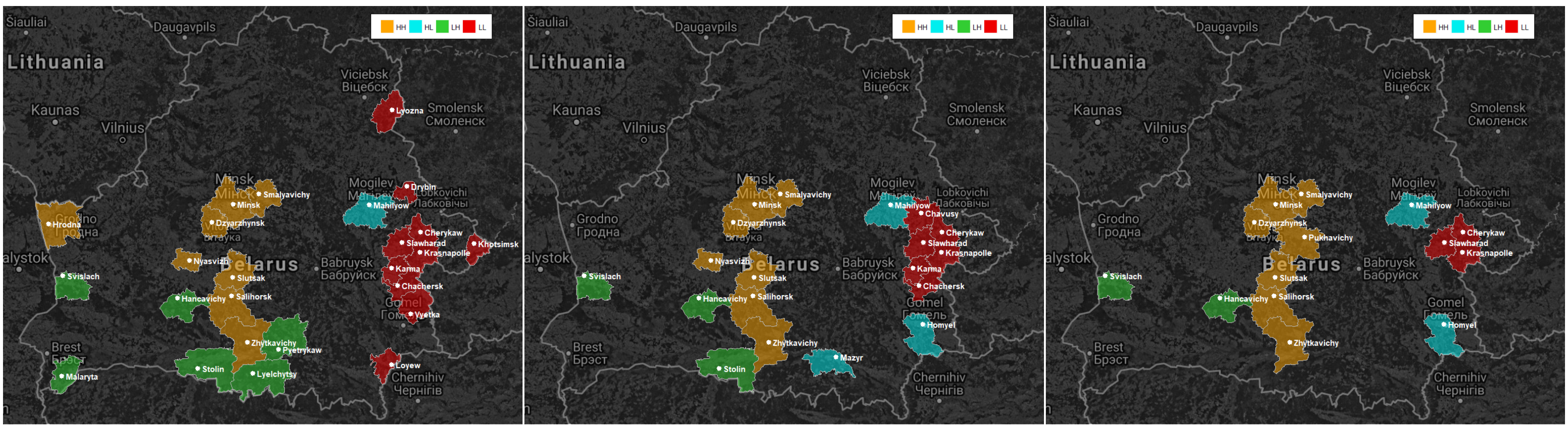
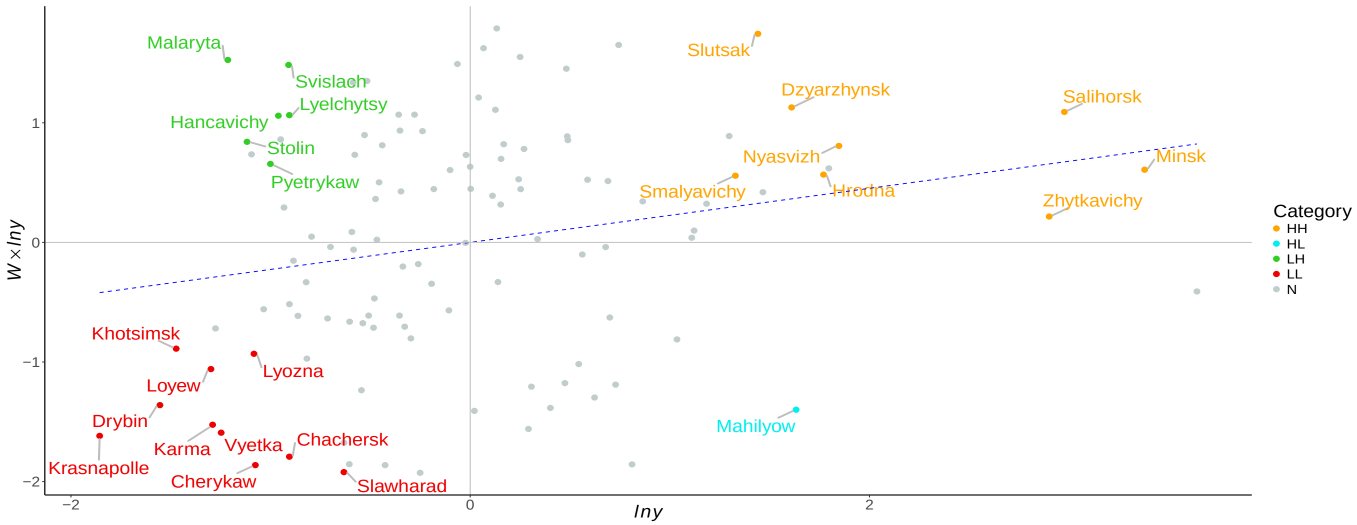


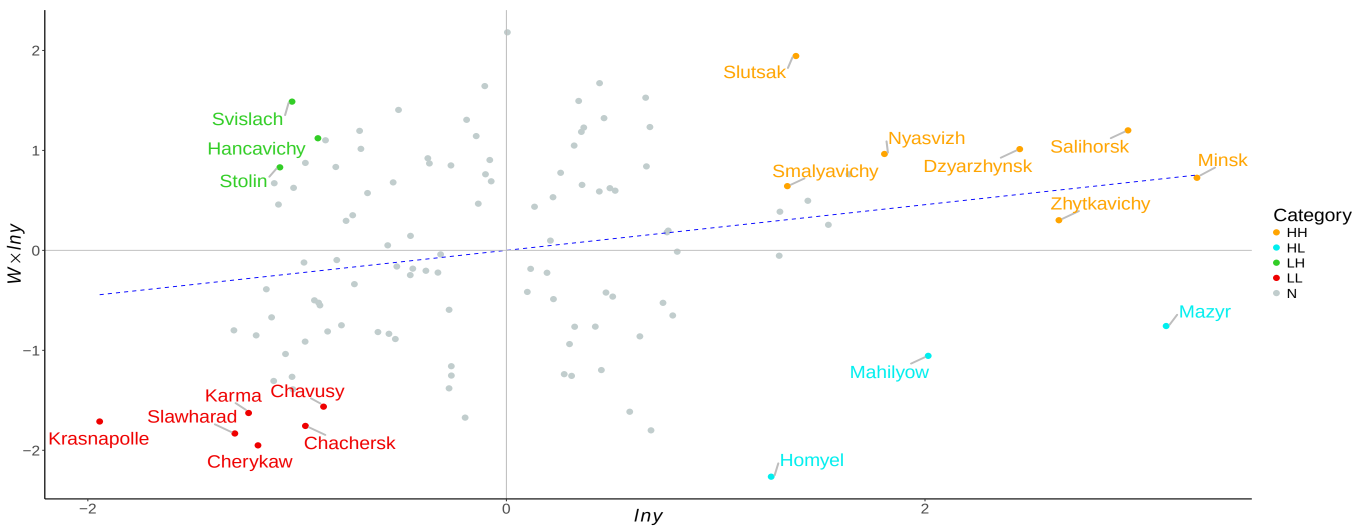
Figure 2.
Moran Scatterplots

(a) 2005



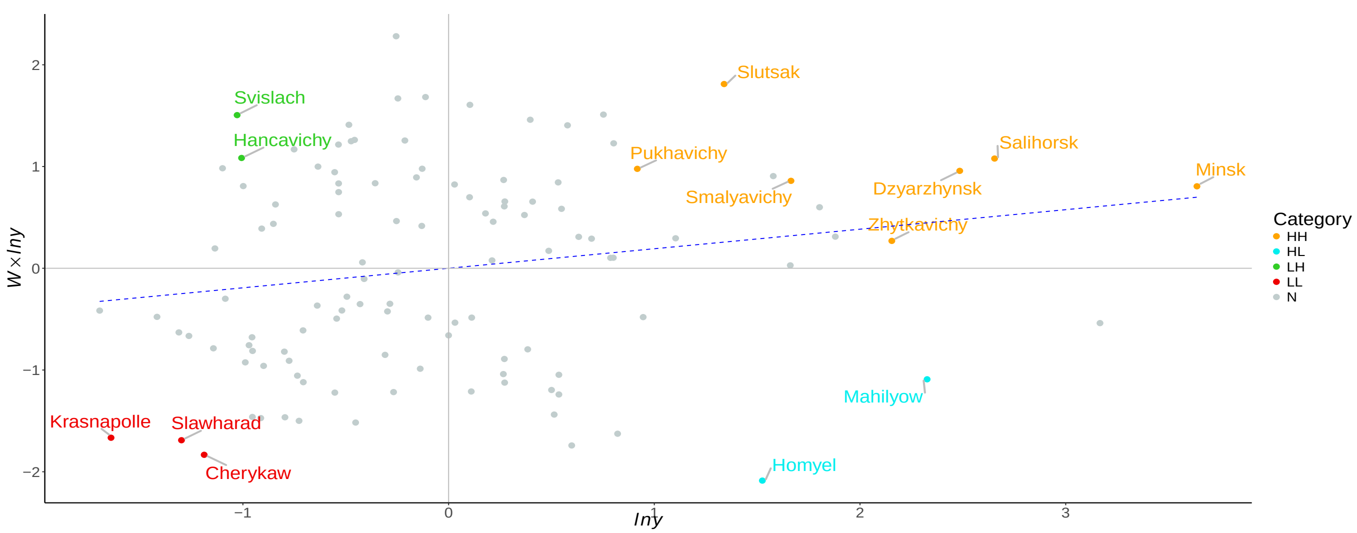
Global Moran's I p-value for year 2005: 0.000086.

(b) 2010



Global Moran's I p-value for year 2010: 0.000184.

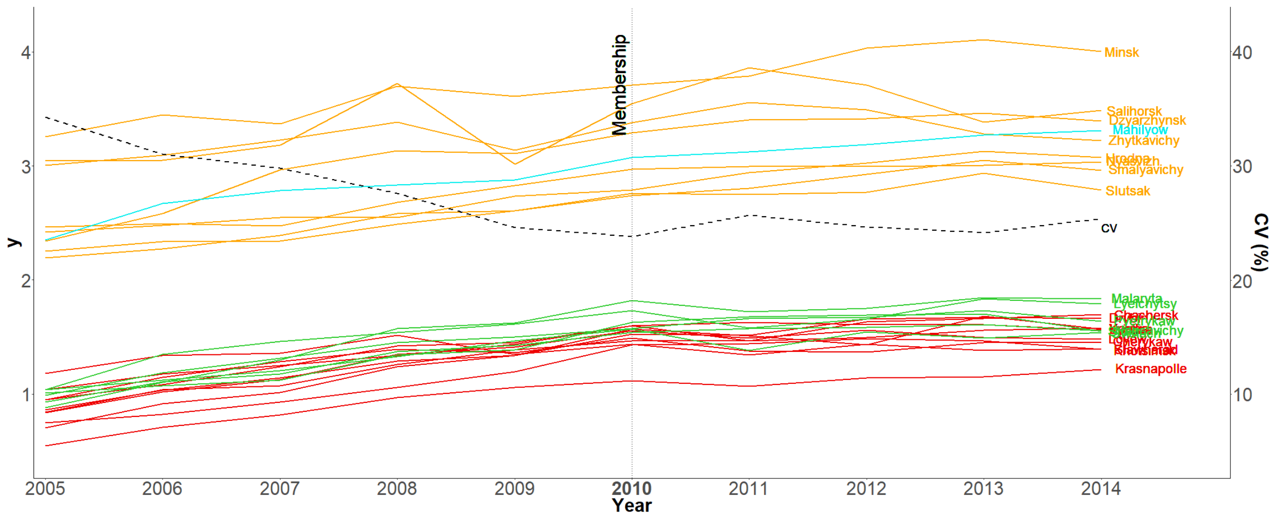
(c) 2014



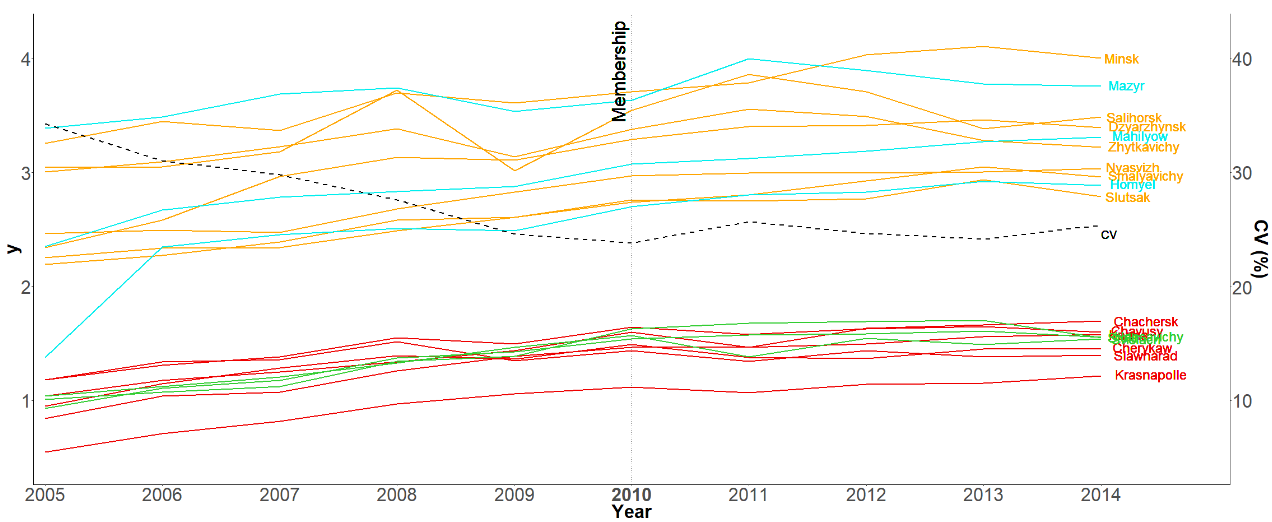
Global Moran's I p-value for year 2014: 0.002718.

Figure 3.
Trajectories of Spatial Clusters

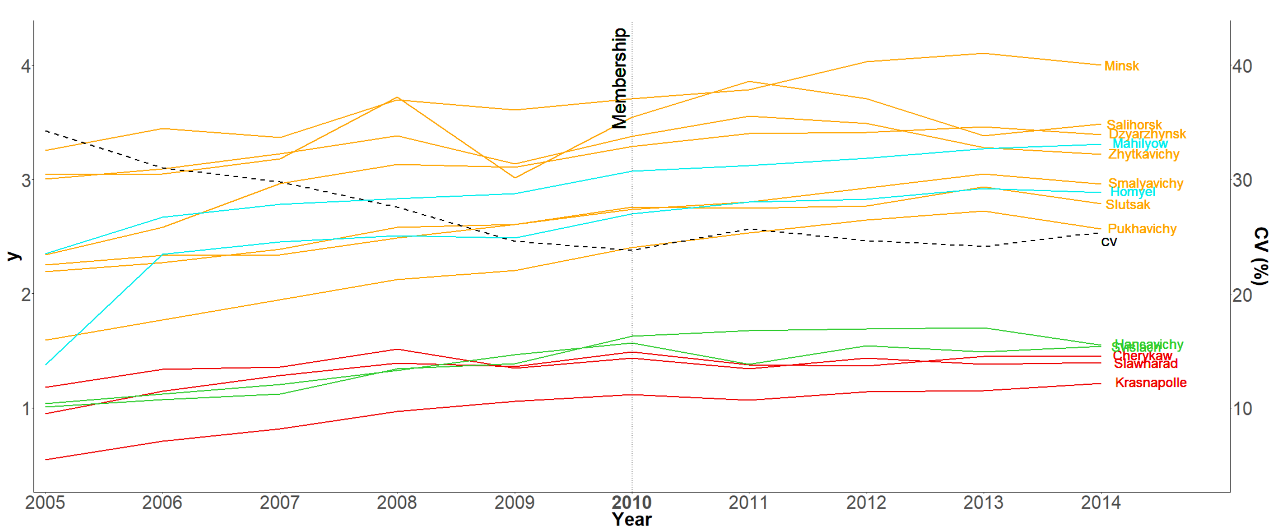
(a) Based on the clusters as of 2005



(b) Based on the clusters as of 2010



(c) Based on the clusters as of 2014



5 Empirical results

The empirical results of the models discussed in Section 2.3 are presented in Tables 3 and 4, where the former reports the findings for the pre-EACU period, and the latter for the EACU period. The six columns of each table report the non-spatial (base), SAR, SEM, SAC, SDM, and the GNS models respectively.

First and foremost, we observe that there has been regional β-convergence in Belarus during both periods, as can be concluded from the estimates of $(1+\beta)$ in all results. The speeds of convergence associated with the coefficient estimates of $ln(y_{i,t-1})$ are reported in the lower part of each table. Regardless of the model specification, all estimations for the pre-EACU period yield very similar convergence speeds and half lives – calculated using the earlier discussed direct effects of $ln(y_{i,t-1})$ – on average of 1.66 and 0.42 respectively. Our primary result is that the half-lives estimated for the pre-EACU period are all lower than those presented in Table 4, which are for the EACU period. The convergence speed and half life averages for the EACU period estimations are 0.71 and 0.98 respectively, with insubstantial differences across models. This result is consistent with our earlier descriptive observations regarding the σ-convergence process and the per capita income trends of the spatial clusters and outliers.[8,9]

Our second empirical observation is from the most comprehensive model in Table 4 (GNS): spatially lagged previous per capita income has been negatively impacting regional income since the entry of Belarus to the EACU. In other words, since EACU membership, if a region is located close to regions that had above average per capita income levels in the previous period, it is expected to have lower per capita income. This result implies regional competition with a spatial dimension; richer regions in the surroundings may absorb a region's economic activity. This result sheds further light on the slowdown of regional convergence in Belarus that took place after its EACU membership. The main implication is that economic activity has been shifting from poorer areas to surrounding richer regions after 2010, hence a spatial mechanism is attested.

Another effect of EACU membership seems to occur in relation to fixed capital investments ($ln\ K_{i,t}$). We observe positive effects of this variable on regional per capita income – with slight and varying significance across the models – during the pre-EACU period. This effect persists and becomes somewhat more noticeable after the EACU establishment year, although with smaller elasticity. We also observe a slightly significant spatially lagged coefficient estimate for fixed capital investments. This may be due to the spatial continuity and impact of certain infrastructure investments.

The share of industrial production had a negative and significant coefficient estimate before 2010, implying that less industrial regions had higher per capita incomes. The effect has become weaker while remaining significant after 2010. This being the case, the share of private companies in a region (P_{it}) is positive but insignificant in all models. However, the spatial lag of this variable is

[8] Our key empirical result regarding the slowdown in regional per capita income convergence in Belarus that is observed upon its entry into the EACU is robust across models. Therefore, we do not offer a model selection procedure.

[9] While the differences between the periods in terms of the convergence speeds and half lives are evident, we estimate high speeds of convergence in general. This may be due to the afore mentioned overestimation that can be caused by the Nickell bias which would apply with a similar degree to all results from both sample periods.

significant in the most comprehensive specification (GNS) for the period following EACU membership. Thus, own private sector activity is less important for a region than being a part of a general cluster of private sector activity, given EACU membership. This result suggests that the effects of economic integration favors spatial clusters in Belarus when it comes to business activity. All in all, EACU membership has made the spatial dimension more prominent, both through the promotion of clustering and the emergence of a geographic competition effect.

Finally, we observe an intriguing result regarding the effect of the share of students (H_{it}). While a positive and significant effect is observed in all models for the pre-EACU period, there is no evidence of an impact following EACU membership. In other words, the positive effect of student share on regional income per capita is no longer present after international economic integration. Conversely, stronger evidence for the effect of agglomeration, represented by the urbanization level, is observed for the EACU period compared to the pre-EACU years. Therefore, the relatively more urbanized regions of Belarus have benefited more from economic integration.

Table 3.
Estimation Results for the pre-EACU period

	Base	SAR	SEM	SAC	SDM	GNS
$lny_{i,t-1}$	0.193***	0.191***	0.19***	0.191***	0.186**	0.186***
	(0.073)	(0.074)	(0.037)	(0.048)	(0.075)	(0.051)
lnK_{it}	0.042*	0.043	0.042**	0.043*	0.047	0.045
	(0.023)	(0.039)	(0.02)	(0.026)	(0.04)	(0.028)
I_{it}	-0.374***	-0.369***	-0.374***	-0.37***	-0.348**	-0.349***
	(0.14)	(0.136)	(0.068)	(0.089)	(0.14)	(0.092)
P_{it}	0.114	0.118	0.122	0.118	0.093	0.092
	(0.115)	(0.164)	(0.081)	(0.106)	(0.175)	(0.114)
H_{it}	0.062***	0.06**	0.06***	0.06***	0.057*	0.057***
	(0.018)	(0.029)	(0.015)	(0.019)	(0.03)	(0.021)
U_{it}	0.828	0.834	0.808	0.834	0.879	0.87
	(0.542)	(0.988)	(0.496)	(0.64)	(1.029)	(0.662)
$\sum_{j=1}^{N} w_{ij} lny_{j,t-1}$					-0.455	-0.499
					(0.936)	(0.649)
$\sum_{j=1}^{N} w_{ij} lnK_{jt}$					0.222	0.218
					(0.352)	(0.392)
$\sum_{j=1}^{N} w_{ij} I_{jt}$					0.592	0.764
					(1.763)	(1.429)
$\sum_{j=1}^{N} w_{ij} P_{jt}$					0.016	0.02
					(1.148)	(0.83)
$\sum_{j=1}^{N} w_{ij} H_{jt}$					-0.281	-0.284
					(0.339)	(0.205)
$\sum_{j=1}^{N} w_{ij} U_{jt}$					2.171	2.354
					(12.351)	(7.895)

Table 3.
Estimation Results for the pre-EACU period (cont'd)

	Base	SAR	SEM	SAC	SDM	GNS
ρ		-0.422		-0.411	-0.507	-0.227
		(0.353)		(1.287)	(0.368)	(3.179)
λ			-0.325	-0.011		-0.369
			(0.345)	(1.095)		(3.39)
Convergence Speed	1.645	1.654	1.663	1.654	1.68	1.68
Half-life (years)	0.421	0.419	0.417	0.419	0.413	0.413
Observations	472	472	472	472	472	472
Obs. per Region	4	4	4	4	4	4

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 4.
Estimation Results for the EACU Period

	Base	SAR	SEM	SAC	SDM	GNS
$lny_{i,t-1}$	0.495***	0.495***	0.497***	0.498***	0.481***	0.486***
	(0.076)	(0.083)	(0.037)	(0.045)	(0.083)	(0.046)
lnK_{it}	0.024**	0.024	0.024***	0.024**	0.027	0.027**
	(0.012)	(0.02)	(0.009)	(0.011)	(0.02)	(0.011)
I_{it}	-0.113**	-0.113*	-0.113***	-0.113***	-0.092	-0.091***
	(0.056)	(0.06)	(0.027)	(0.033)	(0.061)	(0.033)
P_{it}	0.102	0.101	0.094	0.094	0.067	0.058
	(0.125)	(0.203)	(0.091)	(0.112)	(0.204)	(0.114)
H_{it}	0.024	0.024	0.024	0.024	0.023	0.025
	(0.028)	(0.044)	(0.02)	(0.024)	(0.045)	(0.025)
U_{it}	0.648**	0.647	0.642**	0.641*	0.571	0.561*
	(0.291)	(0.623)	(0.278)	(0.341)	(0.621)	(0.34)
$\sum_{j=1}^{N} w_{ij} lny_{j,t-1}$					-1.051	-1.248**
					(0.912)	(0.521)
$\sum_{j=1}^{N} w_{ij} lnK_{jt}$					0.232	0.227*
					(0.227)	(0.121)
$\sum_{j=1}^{N} w_{ij} I_{jt}$					0.264	0.333
					(0.673)	(0.344)
$\sum_{j=1}^{N} w_{ij} P_{jt}$					3.012	2.902***
					(1.869)	(1.1)
$\sum_{j=1}^{N} w_{ij} H_{jt}$					0.139	0.083
					(0.405)	(0.204)
$\sum_{j=1}^{N} w_{ij} U_{jt}$					2.694	2.755
					(6.106)	(3.112)

Table 4.
Estimation Results for the EACU period (cont'd)

	Base	SAR	SEM	SAC	SDM	GNS
ρ		0.036		-0.117	-0.129	0.194
		(0.244)		(0.802)	(0.272)	(0.786)
λ			0.123	0.2		-0.475
			(0.233)	(0.679)		(1.138)
Convergence Speed	0.703	0.703	0.699	0.698	0.732	0.721
Half-life (years)	0.986	0.986	0.992	0.993	0.947	0.961
Observations	590	590	590	590	590	590
Obs. per Region	5	5	5	5	5	5

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

6 Conclusion

Regional economic integration has become a central feature of the global economy. However, research on the impacts of economic integration on the economic geography of countries is limited, particularly apart from the cases of EU and NAFTA countries. This article examined the impact of the Eurasian Customs Union on regional economic convergence in Belarus. We observed that economic convergence in Belarus has slowed down after the country's entrance to the EACU. Similar to the previous studies, we found evidence of spatial dependence in the convergence process. More specifically, we observed evidence of competition among regions – characterized by their relative locations over space – that became prominent after EACU membership. Our analysis also showed that the economic geography of Belarus is highlighted by a significant core-periphery structure, and that urban regions have benefited more from the EACU relative to less urbanized areas. This may be due to the relatively simple economic structure of the economy. Low production complementarity between sectors benefited only a few regions. Without making the pie larger, EACU created both winners and losers and hence reduced the speed of convergence.

Our study has a significant implication to economic geography research. As Martin and Ottaviano (2001) show, agglomeration and growth are mutually self-reinforcing processes. Agglomeration stimulates growth as it reduces the cost of innovation through externalities. Growth also fosters agglomeration as it benefits new firms by reducing transportation costs. An empirical study by Braunerhjelm and Borgman (2004) on Sweden shows that regions with a higher degree of concentration in the production of goods and services experience stronger regional growth. Results in the present study highlight agglomeration as a driving force for growth, which leads industries and economic activities to grow but disperse. On the one hand, reduced agglomeration may harm economic growth and damage the overall competitiveness of an economy in the long run. On the other hand, the lack of dispersion deepens regional disparities which is socially undesirable. Future research that identifies the conditions under which equitable growth can be achieved would help policy makers to enhance the benefits of regional integration.

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