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PAPER

Economic Transition and Regional Wages: The Evidence from Poland

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Abstract The paper studies regional wage differences across 16 NUTS-2 regions in Poland during 1994-2007. The analysis is based on data of individual workers from the Polish Labor Force Survey, which includes about 8,000-15,000 full-time workers each year. In the first part of the analysis, the microdata are used to estimate regional wage measures while controlling for differences in observed worker characteristics across regions. Although adjusting for worker heterogeneity reduces regional wage differences, regional disparities still exist. In the second part of the analysis, the relative regional wage measures (in both nominal and real terms) are regressed on a set of regional macro variables.

The results show that regional differentials are correlated with historical patterns of agglomeration, market access, regional amenities as well as internal and external migration. Furthermore, higher regional wage differentials are, in part, compensation for a higher regional cost of living.

Keywords Regional labor markets - wage differentials - economic transition

JEL classification J31 - P23 - R23

1. Introduction

Regional disparities have been a major concern for European policy-makers since the inception of the European Union (EU) in the 1950s. Attention to this issue intensified after the latest enlargements when several new member countries with relatively low levels of economic development joined the Union. Financial resources for Cohesion Policy increased significantly and now constitute the second largest outlay in the EU budget after the Common Agricultural Policy. However, research suggests that, while this policy focus may have narrowed disparities between the EU countries, regional differences within member countries – particularly the new ones – have remained stable or even widened. Growing spatial inequalities pose a key challenge for EU regional Cohesion Policy. Therefore, it is important for scientists, politicians and society as a whole to understand the determinants of regional disparities and potential reinforcement mechanisms. In Poland, regional development was an integral part of the broad process of political and economic transformation.

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However, the effects of the systemic changes were not evenly distributed across the Polish regions. The spatial differentiation was caused by a historical east-west divide rooted in the eighteenth-century partitions, a legacy of socialist economic policies, and an asymmetric impact of transition shocks on the regions (Czyż and Hauke, 2011). This study focuses on one aspect of spatial pattern and provides a comprehensive examination of regional wage differentials in Poland over the period from 1994, when the country was recovering from its initial transition shock, to 2007 when Poland was a full member of the EU in the mature phase of its transition to a market economy.1 We treat the transition-specific shocks in Poland as a source of exogenous variation that identifies how structural changes affected the spatial distribution of wages. The objective of the exploratory analysis is to find a correlation between the demand and supply shocks during transition (such as, massive inward FDI, trade liberalization and openness, emigration, and the accession to the EU) on the one hand, and regional relative wages on the other, given the regional characteristics. On the theoretical front, our analysis draws on a broad framework of labor economics and spatial economics (which currently includes two main strands – the new neoclassical urban/regional economics and the New Economic Geography (NEG) – along with their numerous refinements and extensions).

Empirical studies on regional differences in earnings within transition economies, and particularly Poland, are rather scant.2 While the empirical evidence is far from conclusive (estimates of regional wage differentials vary considerably because of variations in methodologies used as well as data sources), the majority of studies find that significant inter-regional pay differentials do exist. However, disentangling the sources of differentials in order to explain their persistence and stability over time has proven difficult. Furthermore, while spatial disparities in nominal earnings are reasonably well documented, there is still a shortage of studies about regional real wages due to the fact that data on regional costs of living are typically not collected by government agencies and, hence, unavailable.

Our research innovates on previous work in several ways. The first is the estimation of determinants of both nominal and real3 regional wage differentials using composition corrected4 data, and a model that captures demand shocks from historical patterns of agglomeration and market access and the role of amenities and local housing supply on inter-regional migration. The second contribution is an

1 We end our examination of regional wages at 2007 for three reasons. First, we consider the early and mature transition periods in Poland up to the start of the global financial crisis. Second, there seems to be a consensus among transition economists that now, 20 years after the start of economic transformation, transition is over, and "all former socialist countries are market economies at the middle stage of economic development" Sonin (2013, p. 1). Third, for several years after 2007 the Polish Labor Force Surveys (that constitute the major data source in our study) stopped reporting individual actual earnings, but instead reported individual wage data only for relatively wide predefined wage ranges. Furthermore, the Central Statistical Office allowed respondents to opt not to answer this question, and the non-response rate was high in some surveys.

2 Those available generally focus on the distribution of output, income, employment and unemployment. Only a small number of researchers consider price effects, in terms of regional wages. The analysis of inter-regional disparities in wages have been typically in conjunction with the distribution of other macroeconomic indicators, but rarely as the main subject of research. We found only a few papers for Poland: Góra and Sztanderska (1998), Duffy and Walsh (2000, 2002), Sibley and Walsh (2002), Egger *et al.* (2005), Rogut (2007), Adamczyk *et al*. (2009), Bogumil (2009), Rokicki (2007, 2015), and Cieślik and Rokicki (2015, 2016).

3 A severe problem for inter-regional comparisons on a regional level is the lack of regional price indices. Such data are not available in Poland. In this study, we construct a measure of regional cost-of-living conditions (Relative Regional Price Indices). We also try to account for regional housing costs.

4 The predominant majority of previous studies on regional wages in Poland employed regional data publicly available on the Polish Central Statistical Office website. Due to a high degree of aggregation, such data may not adequately reflect regional differences. In this study, we use microdata on individual workers from Polish Labor Force Surveys in order to estimate annual regional wage differentials. Using micro data allows us to reduce worker heterogeneity that remains unobserved at a more aggregate (regional) level.

examination of the unique Polish situation of very high rates of emigration throughout the transition period but especially post-2004 and the effects of this type of supply shock on the regional structure of wages. Further, as compared to many other studies for Poland, we consider a long time span – from 1994 to 2007. Such a long time span allows us to extend our gaze over the early and mature phases of transition in Poland as well as the country's early membership in the European Union.

Our study suggests that economic transformation in Poland was associated with increased regional disparities. We find evidence of pronounced and persistent nominal and real wage differentials even when controlling for a large number of personal characteristics. These differentials are broadly consistent with the theoretical predictions and reflect regional differences in the historical pattern of agglomeration, geographical proximity to external and internal markets and potential for internal and external migration. Our study may provide an important contribution to the current debate on efficiency and effectiveness of EU regional policy. The evolution of regional earnings is an interesting topic in its own right because the average pay is an indicator of regional well-being along with the commonly used per capita GDP and disposable income. Furthermore, if the wage curve holds for Poland, persistent regional wage differentials may further exacerbate existing unemployment disparities.

The paper is organized as follows. Section 2 describes our empirical strategy, data sources and choice of territorial units. In Section 3 we explain our estimation techniques and present the estimated inter-regional wage differentials from the cross-sectional Mincerian wage equations. Section 4 attempts to disentangle the macroeconomic forces causing persistent regional wage disparity in Poland. The final section summarizes our findings and concludes.

2. Empirical strategy, data, and choice of territorial units

In the analytical part of this study, we proceed in two stages. Our two-stage empirical strategy is close to that of Combes et al. (2008), Fally et al. (2010), and Groot et al. (2014). In the first stage (Section 3), we first describe the magnitude and dynamics of "raw" regional wage differences using rich micro data from the Polish Labor Force Surveys in 1994-2007. We then apply the Mincerian (Mincer, 1974) wage equation in order to control for observed worker heterogeneity and to subsequently derive the relative regional wage differentials that cannot be attributed to individual characteristics. A Markov transition probability matrix is used to study the development in the estimated relative regional wage differentials over time. An advantage of the Markov analysis in this study is that it is based on estimated regional wage differences (corrected for worker heterogeneity) rather than raw wage differences.

In the second stage (Section 4), we regress the estimated relative regional wage differentials on the set of regional macro variables. The choice of independent variables is justified by theoretical framework of urban/regional economics and the NEG. Both approaches are general equilibrium, and assume maximizing agents, but differ in their view on what factors underlie the uneven distribution of economic activity across space. Urban/regional economics stresses 'first-nature geography' (i.e., local factor endowments and amenities), while the NEG instead emphasizes 'second nature geography.' by explicitly considering the territorial dimension. It is worth noting that, unlike many empirical studies, our goal is not to determine which of these two theories more accurately describes inter-regional wage differentials in Poland. We believe that notwithstanding the epistemological differences between the two approaches, empirical economics would benefit from an interchange of the models' ideas. Though urban/regional economics and the NEG differ in some keyways, they also have many similarities, and hence may be viewed as complements, and not competitors (Glaeser and Gottlieb, 2009, p.1002; Brakman et al., 2009, p 780.) Labor Force Surveys (LFS) conducted by the Polish Central Statistical Office in May of 1994-2007 constitute

the data source for the estimation of regional wage differentials. We restrict our attention to full-time hired employees because only this category reported their earnings in the survey. We further narrowed our sample of full-time hired workers by deleting those individuals who did not report their earnings, who were full-time students, or handicapped, or younger than 18, or older than 60 (the retirement age for women) or 65 (the retirement age for men). Furthermore, for consistency we controlled if an employee worked 40 and more hours per week on a regular basis. After all these adjustments, we had samples of about 8,000-15,000 full-time hired employees for each year in 1994-2007.5

Data for the independent macro variables mainly come from the Polish Central Statistical Office (Główny Urząd Statystyczny) website (http://stat.gov.pl/). The climate data are from the official website of the Polish National Meteorological Service (Państwowa Służba Hydrologiczno-Meteorologiczna) which is found at http://www.pogodynka.pl/polska/daneklimatyczne/.

In our analysis, we use 16 NUTS-2 (voivodships6) administrative territorial units in Poland. Although the number of voivodships in Poland changed from 49 to 16 in 1999, the Polish Central Statistical Office provided us with the 1994-1999 Labor Force Survey data adjusted for the new territorial classification. One may argue that these territorial units are too large and the unobserved heterogeneity may lead to the ecological fallacy problem or the Modifiable Areal Unit Problem, so that it would be more relevant to use NUTS-3 (sub-regions) or NUTS-4 (poviats) territorial units. The regional breakdown adopted in this study is constrained by data availability. The Polish Central Statistical Office makes every effort to protect the identity of the LFS participants and releases the location variable only at the NUTS-2 level. Another justification is that NUTS-2 regions are the main focus of the EU Cohesion Policy, and thus it would make sense to examine the relative position of the Polish voivodships in relation to one another for policy implications. Furthermore, in their study of the effect of local density on wages, Briant et al. (2010) show that the 'shape and size' effects are of secondary importance and the biases are of a significantly smaller magnitude as compared to the model mis-specification. Combes and Gobillon (2015, p. 294) thus conclude that "choosing the right specification when measuring the impact of local characteristics appears to be more important than choosing the right spatial units." Nevertheless, we are aware of all the shortcomings of our choice of territorial units, and that our empirical findings may be affected by it. Hence, the results should be interpreted with caution.

3. Estimation of regional wage differentials

We use two different measures to assess the overall dispersion of regional wages – the weighted average absolute regional wage differential, AVG|delta|, and the standard deviation of regional wage differentials, SD(delta). We first calculate the overall "raw" regional wage differentials (deltas) using current wages in Zlotys (see Table 1 and the notes under it). As expected, the Mazowieckie voivodship (with the capital city of Warsaw) exhibits the largest positive deviations

5 Table 1 shows the number of observations in our data sets for each year. A noticeable reduction in the number of observations after 1999 is caused by a significant decrease in the total number of people surveyed in the LFS's. If in 1994-1999 the total number of the surveyed individuals were 65,000-75,000, then in 2000-2007 the total number of the surveyed individuals were 55,000-60,000.

6 Since the 14th century, a 'voivodship' ('województwo' in Polish) has been the major territorial division in Poland. At the outset of the transition, in the early 1990s there were 49 small and economically weak voivodships. The 1999 Polish local government reform reduced the number of territorial units to 16 sizeable administrative regions, 9-35 thousand km2 each. The aim of the reform was to create fewer but stronger regions, capable of implementing their local independent policies according to their own needs and priorities. Polish voivodships are equivalent to provinces and correspond to the NUTS 2 level according to the EU Nomenclature of Territorial Units for Statistics.

from the national average: 11% in 1994 and 18% in 2007. As expected, the regions in the Eastern part of Poland typically exhibit the largest negative deviations from the national average wage: Podkarpackie (-13%) and Podlaskie (-15%) in 1994, and Podkarpackie (-13%) and Świętokrzyskie (-15%) in 2007. Over all 16 regions, the AVG|delta| measure was about 7% and the SD(delta) measure was about 9% in both 1994 and 2007 (see Columns (c) and (f) in Table 1). The dynamic pattern of these two measures, however, suggests a decline in regional wage dispersion in 1994-1999, a subsequent increase in 2000-2001, another decline in 2002-2004, and another increase in 2005-2007. Of course, these statistics do not control for differences across regions in the characteristics of workers.

To control for observed heterogeneity of workers, we use the Mincerian 'human capital earnings function' (Mincer, 1974) and apply the restricted least squares (RLS) estimation procedure developed by Haisken-DeNew and Schmidt (1997). The advantage of the RLS procedure is that the results are independent of the choice of the reference group, and all dummy coefficients and standard errors are estimated. In our regression, we include 16 regional dummy variables, that is, one dummy variable for each of the 16 Polish regions. Hence, there is no reference group for this category; and the estimated regional coefficients are interpreted as percentage-point deviations from the country's average wage (i.e., the regions' weighted average wage). The Mincerian earnings function is in its traditional semi-log form:

$$\ln W_i = \alpha + X_i\beta + \sum_{r=1}^{R}\delta_r D_{ri} + \varepsilon_i \qquad (1)$$

subject to restriction , $\sum_{r=1}^{R}\delta_r \frac{n_r}{N} = 0,$

where lnW_i is the natural logarithm of monthly earnings of a full-time hired employee i ; X_i is a vector of observed characteristics other than the region of residence; D_{ri} is a regional dummy which assumes the value of *1* if worker i resides in region r and *0* otherwise, $r = 1,...,R$, $R = 16$; n_r is the number of workers residing in region r ; N is the total number of workers in the sample; α, β, δ_r are the coefficients to be estimated; and ε_i is an error term assumed to be $N(0, \sigma_\varepsilon)$. Equation (1) assumes that β's do not vary by region. While not beyond reproach, this assumption is quite common in empirical regional studies (see, for example, Maier and Weiss, 1986; Azzoni and Servo, 2002; Combes *et al*., 2008; Beenstock and Felsenstein, 2008; Fally et al., 2010; Groot *et al*., 2014.)

Compared to other papers on the Polish wage structure, the specification of the earnings equation in our study is one of the most comprehensive with 65 individual socio-economic characteristics. In addition to the 16 regional dummies, we include: 5 city/town/rural dummies, 5 educational dummies, marital status (married or divorced/separated/widowed vs single as a reference group), whether the worker heads a household, private sector (vs public sector as a reference group), 13 industry dummies, potential experience and potential experience squared, tenure at the current workplace and tenure squared, 8 occupational dummies, permanent job (vs temporary job as a reference group), recent (within the past 12 months) graduate, whether the worker holds a second job, whether the worker is looking for another job in accordance with his/her qualifications, and whether the worker has an additional non-wage source of income.

An important caveat should be stressed at this point. Endogeneity concerns may arise at the individual level when regional dummies D_{ri} are correlated with the individual error ε_i . Endogeneity may arise due to the omission of explanatory variables (when workers sort across regions according to their unobserved characteristics such as abilities, ambition, motivation or dedication to work) or due to reverse causality when workers' location choices depend upon their wages if they receive

job offers with known wages. To remedy for this endogeneity issue, researchers typically resort to using panel data or structural models. Unfortunately, none of these strategies can be implemented in this study. We hope to reduce concerns about endogeneity by including a large number of observed control variables.[7] For instance, the argument could be that higher ability workers tend to choose high-end occupations in high-productivity large firms in high-tech industries located in dense areas. If so, controlling for occupation, firm and industry types, the size of city/town, the level of education and job experience might help reduce the upward bias caused by spatial sorting to a negligible level.8 Furthermore, we believe that spatial sorting should not significantly impact our estimates due to a very low inter-regional mobility of Polish workers.

The wage regression (1) was estimated for each of the 14 years within the 1994-2007 period. The estimated coefficients on the regional dummy variables ($\hat{\delta}_r$) are interpreted as the regional differences in wages that still exist after controlling for the compositional mix of the work force as well as different socio-economic characteristics. Figure 1 depicts the estimated RLS regional wage coefficients for the entire period of 1994-2007.9 We next compute the summary measures of regional wage dispersion using the estimated coefficients on the regional dummy variables from the RLS regressions. The results are summarized in Columns (d) and (g) in Table 1. Looking at the time series of data on AVG|delta| we see that there was a downward trend in measured regional dispersion from 1994 to 1997 followed by a sharp increase in 1998-2001, a sharp decrease in 2002-2005, and a sharp increase in the last two years (2006-2007). The dynamics of SD(delta) shows a similar pattern. When we compare 1994 and 2007, we see that AVG|delta| increased from 4.1% to 5.2%, and SD(delta) increased from 4.9% to 6.2%. The T2 statistic proposed by Carree and Klomp (1997) rejected equality of the variances in 1994 and 2007.

Columns (e) and (h) of Table 1 indicate that controlling for observed worker heterogeneity reduced measured inter-regional wage disparity by 25-50%. For instance, in the Mazowieckie voivodship (with the capital city of Warsaw) in 2007 deltas reduce from 18% (using actual wages) to 12% (using RLS coefficients). Our further comparison of the two approaches to measuring regional wage disparity, i.e., actual wages vs RLS coefficients, produces an interesting result. Regional wage dispersion as measured by AVG|delta| slightly decreased by 3.3% (from 7.5% in 1994 to 7.2% in 2007) when using actual wages, but increased by 25.3% (from 4.1% to 5.2%) when using RLS coefficients. The pattern is similar for SD(delta): a decrease by 2.1% (from 8.9% to 8.7%) when using actual wages, but an increase by 26.2% (from 4.9% to 6.2%) when using RLS coefficients. We conclude that controlling for observed worker heterogeneity does reduce regional wage disparity in Poland, but wage differentials still exist, albeit smaller. Moreover, not only do these remaining wage differentials persist, but they seem to intensify over time.

4. The impact of region-specific factors on regional wage differentials

In this section, we turn to an examination of the cross-region correlates of the wage differentials identified in the previous section. Our initial focus (Section 4.1) is on the determinants of the relative nominal wage differentials. Available data allow us to consider variation across the 16

7 Our approach is similar to Groot *et al*. (2014) who prefer a large number of relevant control variables over a fixed effects strategy in order to control for worker heterogeneity (see pp. 504, 513-514).

8 For instance, to control for spatial sorting, Eeckhout *et al*. (2014) use educational attainment and occupation as direct measures of skills, and control for industry selection and large versus small cities. Bacolod *et al*. (2009) show that city size is positively correlated with cognitive and people skills but negatively correlated with physical strength and motor skills. Bartel and Sicherman (1999) show that more able workers sort themselves into high-tech industries.

9 The detailed annual results for 1994-2007 are available from the authors upon request.

voivodships over the period from 1995 to 2007. In Section 4.2 we focus on regional differences in real wages and use available data to introduce controls for regional differences in the relative cost of living over time and in relative apartment rents at the beginning of the period for the years from 1999 to 2007. We do not present any formal model. Our empirical framework is "sufficiently general to capture a wide variety of business environment and quality-of-life factors" (Partridge et al., 2010, p. 441) and we "motivate our reduced-form approach on the basis of the informal reasoning and the intuitive predictions" (Overman and Winters, 2011, p. 999).

4.1. Nominal wage differentials

In the spirit of Storper and Scott (2009, p. 164), we consider the historical, geographical and economic specificities of regional development in Poland during the period under consideration. The discussion below provides a broad, albeit somewhat simplified, conceptual model for the empirical analysis of relative regional wage differentials in this analysis.

FDI, trade openness and agglomeration. One aspect of the remarkable transformation from controlled central planning to relatively free markets in Poland was the considerable concentration of economic activity through inward FDI. The stock of FDI in Poland expanded from $3.8 billion in 1994 to $56.1 billion in 2003 (pre-accession) and $172.1 billion in 2007 (http://unctadstat.unctad.org/). Poland was (and still is) the biggest recipient of FDI in the Central and Eastern European region, accounting for about one-third of total FDI inflows. The share of FDI positions in GDP increased from 3.5% in 1994 to 40.1% in 2007, indicating a growing significance of firms with foreign capital in the Polish economy. Empirical research shows that inward FDI in Poland was very uneven and gravitated toward the existing geographic agglomerations of economic activity, the size of the local market and proximity to surrounding markets (see Domański, 2003; Ablov, 2015 and references therein). FDI seems to raise labor demand, employment, productivity and wages in the local labor markets (Bedi and Cieślik, 2002; Kolasa, 2008; Hagemejer and Kolasa, 2008; Onaran and Stockhammer, 2008); however, FDI also appears to be associated with an increase in wage differentials due to the concentration of foreign capital in certain voivodships as well as weak labor mobility (Skuratowicz, 2005).

The process of trade liberalization and re-orientation started in Poland as early as in 1990 when the EU granted Poland the Generalized Systems of Preferences status, and completed in 2004 with Poland's accession to the EU. Inward FDI also contributed positively to the development of international trade.10 Similar to FDI, Polish exports were characterized by large regional concentration and disparities (Ciżkowicz et al., 2013). In his extensive survey on the spatial effects of trade openness, Brülhart (2011, p. 59) concludes that, ceteris paribus, "regions with inherently less costly access to foreign markets, such as border or port regions, stand to reap the largest gains from trade liberalization" such as employment and higher wages. Indeed, increased trade with the EU appears to have enhanced labor demand in CEE regions near the EU border (Egger and Egger, 2002; Egger et al., 2005; Niebuhr, 2008). And wages seem to rise smoothly in market access (López-Rodríguez and Runiewicz-Wardyn, 2014; Oshchepkov, 2015; Cieślik and Rokicki, 2015, 2016). However, whether trade liberalization and market access raise or lower regional inequality depends upon each country's specific geography (Brülhart, 2011). For instance, for CEE Egger et al. (2005) associate trade openness with spatial divergence in wages, while Damijan and Kostevc (2011) find a U-shaped pattern, that is, first divergence and then convergence in wages.

Overall, due to the uneven spatial distribution of FDI and trade during the transition period in Poland, economic activity became more concentrated in the voivodships along the Western

10 In 2007 two-thirds of total Polish exports originated in the firms with foreign capital (OECD, 2010, p. 107).

borders and in more urbanized regions. As postulated by the NEG, higher productivity in denser areas translates into higher nominal wages in those areas. Hence, the uneven spatial agglomeration pattern in Poland may, in part, explain the observed relative regional wage differentials.

In the subsequent analysis, we measure regional agglomeration and market potential with five variables. We measure regional agglomeration by the number of individuals per unit of land (i.e., density)[11]. Following Ciccone and Hall (1996), we instrument for current density in order to mitigate endogeneity, and measure agglomeration by the logarithm of population density in each region at the beginning of the transition in 1990 ($lnDen1990_r$)[12]. We also capture the effects of market access by including several other variables, as market access is one of the main agglomeration forces driving differences in local outcomes at a larger scale, typically the region (Combes and Gobillon, 2015, p. 294). The concept of wage-augmenting agglomeration economies and Hanson's (2005) derivation of an equilibrium wage relationship guide our approach. In his formulation, the nominal wage level in region r depends on its market potential, measured by economic activity in neighboring regions weighted by their distance from r, the size of the local housing stock, which captures the ability of region r to accommodate in-migration, and wages in other regions. Our two measures of proximity to regions with market potential are the logarithm of travel distance in kilometers from the principal city in each region to the center of the Polish economy in Warsaw ($lnDisW_r$)[13] and to the center of the EU in Brussels ($lnDisB_r$). We also measure access to external markets with dummy variables indicating whether the region was located on the Baltic Sea coast ($Coast_r$) or the border with EU member states ($EUbor_{rt}$). Two voivodships are located on the coast. Prior to EU accession, two voivodships shared a border with Germany; after expansion of the EU in 2004 eight voivodships are located on the border of Germany or the former CEE countries joining the union (the Czech Republic, Slovakia and Lithuania).

Labor migration. During the transition period, the labor market in Poland was plagued by excess labor supply and persistent high unemployment. However, internal rates of migration in Poland were very low and did not work as an equilibrium adjustment mechanism in reducing interregional unemployment and wage differentials.[14] An inefficient housing market along with credit market imperfections were a possible impediment to internal mobility. On the other hand, Poland had a pronounced international out-migration and low immigration.[15] A standard

11 In practice, production can also be used to measure agglomeration; however, production is more subject to endogeneity issues than population (Combes and Gobillon, 2015). Furthermore, Ciccone and Hall (1996) and Briant et al. (2010) argue that using density should reduce the Modifiable Areal Unit Problem caused by the fact that territorial units are based on arbitrary administrative boundaries.

12 Puga (2010, p. 207) explains, "Since there is substantial persistence in the spatial distribution of population but the drivers of high productivity today differ from those in the distant past, the usual instruments are historical data for size/density as well as characteristics that are thought to have affected the location of population in the past but that are mostly unrelated to productivity today. Ciccone and Hall (1996) find that reverse causality on this matter is only a minor issue. This conclusion has been confirmed by much of the subsequent literature."

13 Distance to Warsaw for the Mazowieckie region was approximated as $0.333\sqrt{area/\pi}$, that is, one third of the radius of a circle with the same area as the Mazowieckie region.

14 The nationwide unemployment rate was 13% in 1995, then decreased slightly to 11% in 1998, but rose to 20% in 2002-2003, that is, just before the accession to the EU. Dustmann *et al*. (2015, p. 538) report that not only was internal mobility across regions low but it also decreased over time: "in 2001, 0.24 percent of the population reported living in a different region than in the previous year, and this share decreased to 0.12 percent in 2007." Also, see Fidrmuc (2004), Ghatak *et al*. (2008), Bogumił (2009), Jurajda and Terrell (2009), Dustmann and Görlach (2015).

15 International emigration from Poland was high even before joining the EU (Okólski, 2006). Temporary

neoclassical framework predicts that the labor-supply effect of out-migration will lead to reducing spatial wage differentials; however, whether the emigration shocks had significant effects on regional wages in Poland is unclear. Some studies find a weak overall impact of emigration on wages in Poland (Budnik, 2007; Kaczmarczyk, 2012; Dustmann et al., 2015), while others report that the effect was stronger in voivodships with high emigration rates (Anacka et al., 2014). Dustmann et al. (2015) present evidence for a positive correlation between regional differences in Polish emigration rates and average wages for lower skilled workers remaining in the home region.[16] In line with Hanson's (2005) model, studies of inter-regional migration find that the very low rate of inter-regional migration seen within Poland largely reflects the availability of housing, with in-migration rates highly correlated with the housing stock in destination regions. Our regressions thus include two variables designed to control for the potential effect of labor supply changes through internal and external migration on regional relative wages. The first is the logarithm of the region's stock of dwelling units relative to the resident population at mid-year ($lnHouse_{rt}$). The second is the regional net emigration rate (emigration for permanent residence in a foreign country minus immigration from foreign countries for permanent residence in each region) per 10,000 people in the resident population ($NetEmigr_{rt}$).

Physical geography. As agglomeration of economic activity may also be explained by the presence of natural advantages, that is, within the framework of urban/regional economics (see Roos, 2005 and references therein), we tried to take into account the possibility that the physical geography may also have a bearing on regional wages. We experimented with a large number of climate variables, such as, temperature, elevation, precipitation, sunshine, etc. However, these variables were typically highly correlated, and we ended up with including only two of them: a dummy variable when a voivodship borders the sea ($Coast_r$) and the average relative temperature. The latter is the logarithm of the ratio of average Centigrade temperature in each region over the period from 1981 to 2010 to the temperature range over the same period ($lnClimate_r$).

Other estimation issues: a pooled regression model and endogeneity. The RLS coefficients for each region and each year ($\hat{\delta}_{rt}$) yield a panel of estimated regional wage measures which identify the positive or negative percentage difference between the regional wage and the average wage across all regions, controlling for a large number of individual and regional characteristics. We transform those coefficients in two ways. First by adding one to each of the coefficient estimates, we convert them into relative nominal wage ratios. We then take the logarithm of the relative nominal wage ratio and use this variable, $\ln(\hat{\delta}_{rt}+1)$, as the dependent variable in regressions focused on determinants of nominal wage differentials across Polish regions:

$$\ln(\hat{\delta}_{rt}+1) = \theta + Z_r\gamma + V_{rt}\phi + u_{rt} \quad (2)$$

and permanent emigration intensified significantly after Poland's accession to the EU in 2004, such that the stock of Poles abroad numbered 1.45 million in 2005, 2 million in 2006, and 2.3 million (6.6% of the total population) at the end of 2007 (Kaczmarczyk and Okólski, 2008; Fihel and Kaczmarczyk, 2013; Zaiceva, 2014). Emigration was particularly marked in rural areas of the south-eastern part of Poland where 20-35% of the working-age population left between 2004 and 2007 (Kaczmarczyk, 2012). Emigration became more evenly distributed across voivodships and included more urban dwellers after 2004 (Kaczmarczyk and Okólski, 2008). Despite a recent increase, immigration to Poland remains low: the immigrant share in employment was the lowest among all OECD countries at 0.3% compared to 12.0% on average in the OECD in 2007 (OECD, 2010, p. 108).

16 Ozgen *et al*. (2010) in their meta-study conclude that empirical analyses in general find a positive but small effect of migration. According to Shioji (2001), this may be due to the two countervailing effects of migration – the scale and composition of migrant flows – which affect both convergence and divergence.

where Z_r is a vector of the time-constant regional explanatory variables, V_{rt} is a vector of the time-varying regional explanatory variables , and u_{rt} is an error term.

The fact that we include time-constant explanatory variables into our model along with the relatively small number of regions and years precludes us from using panel data estimators, making the pooled regression our only choice. As shown in many standard econometrics textbooks, if the pooled model is correctly specified and regressors are uncorrelated with the error term, then it can be consistently estimated using pooled OLS. The error term is likely to be correlated over time for a given region, hence, panel-corrected standard errors must be used for statistical inference. There could be a potential endogeneity issue at the local level if the explanatory variables are correlated with the local random component. This can occur because of some missing (unobserved) regional variables or reverse causality. To remedy the endogeneity issue, we instrument the regional determinants using local geographical and historical variables. Furthermore, the explanatory variables were lagged, if necessary, in order to avoid potential simultaneity problems (see Section 5.4 "Estimation strategy" in Combes and Gobillon, 2015, pp. 282-297 for an excellent discussion of these issues). We assume that our geographical variables are exogenous since climate is independent of regional labor market developments. We also assume that the five variables reflecting agglomeration and market potential are exogenous determinants of regional relative wages since they are geographic characteristics or, in the case of density, predetermined by policies and developments during the Communist era (Korcelli, 2005). The housing stock is also treated as exogenous since it evolves slowly over time and factors external to the country and region are the most important drivers of net emigration from Poland (Zaiceva, 2014). While initially we assume that the net emigration rate is an exogenous variable, we later release this assumption and treat the net emigration rate as an endogenous regressor.

Table 2 presents regression estimates of the determinants of nominal regional relative wages in Poland along with descriptive statistics for all of the variables. Regional data on the number of dwellings and emigrants for each region are available only from 1995 so the results in Table 2 cover the period from 1995 to 2007. The first regression presents OLS estimates while the second presents weighted least squares results, using the inverse squared standard errors of the region coefficients from the RLS regressions as analytic weights. This regression gives greater weight to region by year observations with more precise estimates of the regional wage coefficient.

The coefficient and robust standard error estimates in both regressions are very similar. The five variables measuring aspects of market potential are all statistically significant at the one percent level and have impacts on nominal regional relative wages that are consistent with the hypotheses in Hanson (2005). Regional relative wages are higher in areas with greater population density at the start of the transition to the market economy. A ten percent higher initial density level is associated with a four percent higher relative wage, ceteris paribus. The nominal regional relative wage falls with distance from both Warsaw and Brussels. This is in line with Brülhart and Koenig (2006). Unlike the studies by Cieślik and Rokicki (2015, 2016) we find evidence that proximity to the EU is considerably more important for regional wages than proximity to the domestic economy. The estimate of the coefficient on distance from Brussels is more than three times the estimated effect of distance from Warsaw. Regions on the Baltic coast with enhanced proximity to the Nordic countries and, indeed, the world have nominal relative wages six to seven percent higher than the other regions. In addition, relative wages are two to three percent higher for regions directly on the border with the EU.

Alternative estimates that split the EU border effect into a pre-2004 and post-2004 estimate find no statistical difference between the two periods despite the big difference in the number of regions with this characteristic in the two periods. We also tested for pre- and post-accession differences in

the coefficient estimates for the other market access variables but none was statistically significant. These results are available from the authors upon request. Poland pursued an asymmetric trade liberalization policy with Germany and the EU right from the beginning of the transition in 1990 so that the process of economic integration with the EU began well before 2004. Looking at the effects of EU accession from the other side, Braakman and Vogel (2011) also find minor post-accession effects on small to medium size German firms located close to the Polish and Czech borders.

The estimated coefficients on the three migration related variables present interesting results. As suggested by the Hanson (2005) model, nominal regional relative wages are lower in regions with more abundant dwelling units relative to the resident population, since these regions can more readily accommodate the in-migration of workers attracted by higher labor demand. Relative wages are also lower in regions with warmer and less variable average temperatures although $lnClimate_r$ is statistically significant at just the 0.10 level in the weighted least squares regression.

Finally, the rate of net emigration from a region has a statistically significant positive effect on nominal regional relative wages, suggesting that a reduction in local labor supply from outmigration raises relative wages for workers who remained at home. However, our estimates are that this effect is quite small. A one standard deviation increase in the net regional emigration rate would raise the regional relative wage by less than one percent. Dustmann et al. (2015) report a higher elasticity of regional wage levels to emigration from Poland, and Mishra (2006) and Hanson (2007) both report substantially higher home wage effects related to emigration from Mexican regions. This may be because our emigration variable captures only the number of people registered as leaving a region for permanent residence abroad. It does not capture temporary emigration nor does it measure emigrants who fail to register their change in residence, both of which have been important components of emigration from Poland (Bijak and Koryś, 2006; Dustmann and Görlach, 2015).

4.2. Controlling for the cost of living

To analyze how real regional wages react to changes in economic activity, we augment our model with additional variables that measure regional costs of living and housing costs. Following the amenities-based theory of equilibrium regional wage differences by Rosen (1979) and Roback (1982, 1988), Winters (2009) develops a model that guides our analysis of regional wage differentials controlling for differences in the cost of living across Polish voivodships. His model is based on two points of empirical methodology. First, that a partial adjustment model, with the cost of living as an independent variable, is more appropriate than deflating wages and thereby assuming that there is full adjustment of wages to prices (see also Dumond et al., 1999). In addition, rents are the best measure of the cost of housing (as compared to house prices). Assuming that utility can be described by a Cobb-Douglas utility function and that total spending equals disposable wage income, Winters' (2009) model leads to two hypotheses. The first is that the elasticity of wages with respect to local prices should be equal to unity to maintain equal utility across regions. And the second is that the elasticity of wages with respect to the price of a given category of goods will equal the expenditure share on that category of goods in household income. His cross-section analysis of the effect of city amenities, including cost of living indexes, on individual wages for US workers in 2006 finds support for both hypotheses and the methodological assertions.

We take advantage of available annual regional and national price data for more than 130 goods and services to construct relative regional price indices (RRPI) for each voivodship for the period from 1999 to 2007. The Polish Central Statistical Office reports prices in eight major categories: food and non-alcoholic beverages; alcoholic beverages and tobacco products; apparel and shoes;

housing, utilities, and household equipment and furnishings; health; transportation; recreation and entertainment; and other. That said, however, it is important to emphasize that the price data in the housing category covers the cost of utilities and some housing maintenance activities but does not provide information on the cost of housing services, i.e., actual rent expenditures.

An example in the Appendix explains in detail how we calculated the RRPI for the Mazowieckie region in 2007. We computed the RRPI indices for all other years and regions in a similar fashion. The relative regional price index for each region shows the difference in living costs between a particular region and the national average level. If the RRPI is equal to 1, it implies that the price level in this region equals the average price level in Poland; if the RRPI is greater (less) than 1, the price level in this region is higher (lower) than the average price level in Poland. We use the logarithm of the constructed RRPI ($lnRRPI_{rt}$) as one control variable for the cost of living in regressions explaining regional nominal wage differentials. Oshchepkov (2015) argues that this type of local price index for non-housing products could be considered exogenous to relative wages since many of the products included are tradable goods that vary across regions mainly due to transportation costs and many non-traded goods are provided by public utilities and government agencies.

We also have limited information on regional housing cost differentials. The Polish Statistical Office web site provides data on apartment rents per square meter in buildings owned by cooperatives and for company-owned and communal dwellings by region, but only for 1999 and 2000. We construct the weighted average rental rate for 1999-2000 in each region for these two types of apartments using usable floor space of apartments by type of ownership in 2002 for the weights. The variable $lnRent_r$, the logarithm of regional average rent in 1999-2000 relative to national average rent in 1999-2000, is used to control for cross-region housing cost differentials. The best that we can do is to estimate the effect of higher relative housing costs at the beginning of the period on annual relative wages over the period.

To provide a comparison for the other regressions, Column (c) in Table 3 focuses on nominal wage differences without controlling for annual differences in the regional cost of living index and in relative rents for 1999-2000. These results are very similar to those reported in Table 2 over a slightly longer sample period with the exception that we now cannot reject the null hypothesis of zero effect of the climate variable on relative wage levels. Columns (d) and (e) in Table 3 present OLS and WLS estimates for regressions that include the price index and rent variables. These variables both have statistically significant positive coefficients indicating that wage differentials across Polish regions are compensating for the negative amenity of a higher cost of living. The quantitative estimates seem to be consistent with Winters' hypotheses. The sum of coefficients on $lnRRPI_{rt}$ and $lnRent_r$ is not significantly different from unity, and the coefficient on $lnRent_r$ at 0.17 is close to the true share of apartment rents in household income. The Polish Central Statistical Office data base includes a measure of the "share of rent related to occupied dwelling in disposable household income." On average for Poland, this share was 18.4% in 1999, 17.9% in 2000, and 19.3% over 1999-2007.

Including the price and rent controls in the regression has significant effects on the estimated coefficients of the other determinants of regional relative wages. The density of population in 1990 is no longer statistically significant indicating that denser communities have both higher nominal wages and a higher cost of living. The estimated coefficients on the external market variables, distance to Brussels and location on the Baltic or the EU border, are lower by a half or more but remain statistically significant and positive. Regions with a favorable geographic location relative to Europe have higher relative wages even after controlling for the cost of living and housing costs. The estimated relative wage advantage of proximity to Warsaw and the negative effect of housing

supply on relative wages are also slightly lower in the regressions controlling for price and rent differentials while the positive effect of net emigration on local relative wages remains unchanged. These results lead to the conclusion that demand and supply factors associated with the increased integration with the EU and housing constraints on internal migration had a significant effect on relative real wages in Polish regions during this period.

Our findings are in contrast to those of Egger et al. (2005), who analyzed regional disparities within eight Central and East European countries in the early transition period from 1991 to 1998 and found significant convergence of real wages in Poland.[17] However, our findings are in line with a methodologically similar and more recent study for Poland by Rokicki (2015). Like us, Rokicki adopts a more nuanced approach and constructs regional PPP deflators for the 16 Polish voivodships in 2000-2011.[18] He reports: "the application of regional PPP deflators significantly decreases the overall level of wage disparities across Polish regions (as compared to nominal wages). Nevertheless, it does not significantly change the overall pattern of their evolution. Hence, there is a tendency toward regional real wage divergence rather than equalization" (p. 353). Our results point to increased European integration during the mature phase of Poland's transition as the source of real wage divergence across voivodships.

Thus far the regressions reported in Table 2 and columns (c)-(e) in Table 3 assume that the net emigration rate is an exogenous variable. This is because the main drivers of emigration from Poland appear to be network connections with previous migrants and the substantially higher wages relative to all Polish regions in destination countries and because immigration to Poland has been relatively limited (Kaczmarczyk and Okólski, 2008). As a robustness check, the regression reported in column (f) of Table 3 treats $NetEmigr_{rt}$ as endogenous and presents two-stage least squares (2SLS) estimates of our model. As instrumental variables we use four lags on the regional net emigration rate to account for network influences on emigration decisions, and a one year lag of the logarithm of employment in the main European destinations for Polish emigrants, to proxy for job opportunities abroad for Polish workers. The destination countries are Germany and Italy for the years prior to 2004 and, after accession, Germany, Italy, the UK, Ireland and Sweden. There is no noticeable difference in the coefficient or robust standard error estimates in the 2SLS regression when compared to those obtained from OLS or WLS. The robust score of the $\chi^2(1)$ test, with a value of 1.86 and a significance level of 0.17, cannot reject the null hypothesis that the variables are exogenous. And the $\chi^2(4)$ test, with a value of 2.21 and a probability level of 0.69, supports the over identifying restrictions on the model.

As another robustness check, we estimate the model with the dependent variable fully adjusted for non-housing prices. While Winters (2009) makes a strong case for the partial adjustment model, empirical work often uses "real" wage levels that deflate nominal values by the local price index. So we do the same using the annual regional index for relative non-housing costs as the deflator for our regional relative nominal wage variable. The logarithm of $\frac{\hat{\delta}_{rt}+1}{RRPI_{rt}}$ is the dependent variable in the regressions reported in columns (g)-(i) of Table 3. Similar to the discussion above, OLS, WLS and 2SLS (again treating $NetEmigr_{rt}$ as endogenous) estimates

17 It is worth to note that the authors found regional convergence in real wages only for Poland and Bulgaria. For Romania wage convergence was insignificant, and in all other countries (Czech Republic, Estonia, Hungary, Slovakia, and Slovenia) evidence suggested divergence. The shortcoming of this study was that the authors used the national (*i.e.*, not regional) consumer price indices to convert nominal wages into real wages.

18 Rokicki uses the Éltetö-Köves-Szulc method to calculate regional PPP deflators. Despite a more sophisticated methodology, the values of his regional price indices are very close to ours (see the Appendix), suggesting that our indices provide accurate and reliable estimates of the regional cost of living.

are provided. There are very few differences between the coefficient and robust standard error estimates reported in columns (d)-(f) and columns (g)-(i) in Table 3. Proximity to Brussels and Warsaw and a location on the Baltic or EU borders have positive effects on regional relative wages fully adjusted for non-housing costs. In addition the availability of housing and the net emigration rate have almost identical effects on the dependent variable. Perhaps the one noticeable difference between the two specifications is in the estimated coefficient for $lnRent_r$. The coefficient is about 0.15 for regional relative wages adjusted for non-housing prices, two points below the estimates for regional nominal relative wages. This likely reflects the fact that the construction of the dependent variable in these regressions increases the weight of non-housing costs in determining relative wages from around 0.82 to 1.0. The estimates of the regression coefficients are quite robust to changes in the method of estimation and the specification of the dependent variable.

6. Conclusion

The spatial disparities in Poland and in the EU as a whole are in striking contrast to the influential view (e.g., Caimcross, 1997; Friedman, 2005) that in the twenty-first century geography will not matter. In this view, location will become irrelevant in the globalized world, and regional differences will dissipate because of decreasing transport costs and disappearing communication barriers. However, we observe exactly the opposite trend: regional divergence within countries increases, regions become more polarized, and location still matters.

Our analysis of Polish Labor Force Survey data from 1994 to 2007 indicates the presence of significant wage differentials across the 16 NUTS 2 regions (voivodships) in Poland that have persisted over time. Controlling for a large number of individual wage determinants in annual cross-section Mincerian regressions serves to reduce but not eliminate the disparity in wages across regions. While it appears that some convergence occurred during the 1990s, this was offset by developments during the period from 2000 to 2007. In the end, after controlling for detailed worker characteristics, our summary measures of regional wage dispersion in Poland were fully 25% higher in 2007 than in 1994.

Using our annual estimates of regional wage differentials as dependent variables in regressions across regions over time, we find evidence that is in line with the hypotheses drawn from NEG models. Regional nominal relative wage differentials are positively correlated with historical patterns of agglomeration, as measured by population density in 1990 at the beginning of the economic transition in Poland, and with market access, measured by proximity to Warsaw and Brussels and location on the Baltic coast and the EU border. There is also evidence that regional wage differentials responded to the potential for internal and external migration. Differentials were lower in regions with more housing and a warmer climate and higher in regions that experienced larger outflows of people to other countries.

We were able to take advantage of available data to construct indices of cross-region differences in the annual non-housing cost of living and average apartment rents in 1999-2000. Higher regional wage differentials are, in part, compensation for a higher regional cost of living. The elasticity of regional relative wages to non-housing costs plus rent is equal to unity and the elasticity of regional relative wages with respect to rent is close to estimates of rent as a share of household income in Poland. While controlling for non-housing prices and rent reduces the magnitude of most of the other coefficients in the regressions, regional relative wages are still positively correlated with proximity to EU and internal markets and with the rate of net emigration and the level of housing supply. Growing integration with the EU during the mature phase of the transition period appears to have reinforced the historical pattern of more favorable labor market outcomes in western Poland.

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Appendix Calculation of the Regional Relative Price Index (RRPI)

The Polish Central Statistical Office reports prices in eight major categories: food and non-alcoholic beverages; alcoholic beverages and tobacco products; apparel and shoes; housing, utilities, and household equipment and furnishings; health; transportation; recreation and entertainment; and other.

For each voivodship, we first computed a relative regional price ratio for each major category as the arithmetic mean of the price ratios (price in the region / price in Poland) for all goods and services listed in this category. The "food and non-alcoholic beverages" category includes 48 products. In 2007, the price of 1 kg of rice was 2.89 Zlotys nationally and 3.25 Zlotys in the Mazowieckie region, implying the price ratio of 1.125. The price of a wheat roll (50 g) was 0.35 Zlotys nationally and 0.32 Zlotys in the Mazowieckie region, implying

the price ratio of 0.914. The price of a loaf of rye bread (0.5 kg) was 2.04 Zlotys nationally and 2.04 Zlotys, in the Mazowieckie region, implying the price ratio of 1.000. We computed the price ratios for the Mazowieckie voivodship for the remaining 45 products in the "food and non-alcoholic beverages" category and then computed the arithmetic mean of these 48 price ratios. The calculated average ratio was 1.033 meaning that, on average, prices of food and non-alcoholic beverages in the Mazowieckie region in 2007 were 3.3% higher than the national average.

The "apparel and shoes" category includes 17 products. In 2007, the price of a wool coat for women was 598.53 Zlotys nationally and 689.79 Zlotys in the Mazowieckie region, implying the price ratio of 1.152. The price of a pair of leather shoes for men was 149.85 Zlotys nationally and 158.58 Zlotys in the Mazowieckie region, implying the price ratio of 1.058. The price of a winter jacket for children 2-6 years of age was 95.74 Zlotys nationally and 104.96 Zlotys in the Mazowieckie region, implying the price ratio of 1.096. The calculated average ratio for all 17 products in this category was 1.042 meaning that, on average, prices of apparel and shoes in the Mazowieckie region in 2007 were 4.2% higher than the national average.

We then calculated the overall RRPI as the weighted average of a region's relative price ratios, multiplying the relative regional price ratio for each major category by its relative weight in the consumer basket. The relative weights were those used by the Polish Central Statistical Office to calculate the CPI. In 2007, the weight of food and non-alcoholic beverages in the consumer basket was 26.20%, the weight of apparel and shoes was 5.38%, etc. Therefore, the overall RRPI for the Mazowiecki region in 2007 = 1.033*0.2620 + 1.042*0.0538 + etc. for all other major categories = 1.024, meaning that the price level (for a particular bundle of goods and services) in this region was 2.4% higher than the price level (for the same bundle of goods in services) in Poland as a whole.

`Below, we compare our Relative Regional Price Indices (RRPI) used in this analysis and regional PPP deflators (in parentheses) reported in Rokicki (2015): Dolnośląskie 1.000 (1.009), Kujawsko-Pomorskie 0.972 (0.984), Lubelskie 0.969 (0.973), Lubuskie 1.042 (1.036), Łódzkie 0.986 (0.991), Małopolskie 1.014 (1.016), Mazowieckie 1.024 (1.030), Opolskie 0.985 (0.989), Podkarpackie 0.971 (0.974), Podlaskie 0.973 (0.971), Pomorskie 1.038 (1.043), Śląskie 1.007 (1.010), Świętokrzyskie 0.985 (0.985), Warmińsko-Mazurskie 0.981 (0.979), Wielkopolskie 0.981 (0.984), Zachodniopomorskie 1.033 (1.029), Poland 1.000 (1.000).

Table 1 Summary measures of the overall dispersion of regional wages: AVG|delta| and SD(delta)

Year	N obs	AVG|delta|			SD(delta)		
		using actual wages	using RLS coefficients	reduction in dispersion, % (d/c-1)*100%	using actual wages	using RLS	reduction in
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)
1994	14941	0.0746	0.0411	-45.0	0.0886	0.0487	-45.0
1995	15245	0.0668	0.0347	-48.1	0.0768	0.0434	-43.5
1996	14708	0.0588	0.0317	-46.0	0.0682	0.0379	-44.4
1997	14566	0.0537	0.0262	-51.2	0.0634	0.0331	-47.8

Year	N obs	AVG|delta|			SD(delta)		
		using actual wages	using RLS coefficients	reduction in dispersion, % (d/c-1)*100%	using actual wages	using RLS	reduction in
1999	13312	0.0488	0.0354	-27.6	0.0592	0.0440	-25.7
2000	9599	0.0641	0.0375	-41.4	0.0897	0.0488	-45.6
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)
2003	8040	0.0509	0.0411	-19.3	0.0619	0.0495	-20.1
2004	8116	0.0455	0.0306	-32.9	0.0601	0.0378	-37.2
2005	7924	0.0559	0.0271	-51.6	0.0670	0.0352	-47.5
2006	8147	0.0683	0.0400	-41.5	0.0846	0.0508	-39.9
2007	8391	0.0721	0.0515	-28.6	0.0867	0.0615	-29.0

Notes: The table shows the weighted average absolute regional wage differential, $AVG\,|\,\delta\,|$, and the standard deviation of regional wage differentials, $SD(\delta)$, where deltas are regional wage differentials measured as deviations from the average wage in the national economy:

$AVG\,|\,\delta\,| = \sum_r |\,\omega_r \delta_r\,|$,

$SD(\delta) = \sqrt{\sum_r \omega_r \delta_r^2}$ using actual wages and $SD(\delta) = \sqrt{\sum_r \omega_r \hat{\delta}_r - \sum_r \omega_r \sigma_r^2}$ using RLS coefficients,

$\delta_r = \dfrac{\sum_{i=1}^{n_r} \dfrac{w_{ir}}{\overline{w}}}{n_r} - 1$,

where $r = 1,...,R$; R is the number of regions (i.e., 16 voivodships); $i=1,...n_r$; n_r is the number of workers in region r; w_{ir} is the wage of worker i in region r; $\omega_r = \dfrac{n_r}{N}$ is the share of each region in the total number of workers (N); $\overline{w}$ is the average wage in the national economy, $\hat{\delta}_r$ are the estimated coefficients on the regional dummy variables in the Mincerian wage equation, and σ_r^2 is the variance of $\hat{\delta}_r$.

Table 2 Determinants of nominal relative wages across regions, 1995-2007

Variable	Notation	Mean, std. deviation	OLS	WLS
Log population density (people/ km2) in the region at the beginning of the transition in 1990	$lnDen1990_r$	4.74, 0.46	0.0429 (0.0057)*	0.0435 (0.0050)*

Log travel distance in kilometers from the principal city in the region to Warsaw	$lnDisW_r$	5.47, 0.61	-0.0636 (0.0065)*	-0.0647 (0.0047)*
Log travel distance in kilometers from the principal city in the region to Brussels	$Coast_r$	7.10, 0.15	-0.2056 (0.0248)*	-0.2038 (0.0216)*
The region is located on the Baltic Sea coast (Yes = 1, No = 0)	$EUbor_{rt}$	0.19, 0.39	0.0632 (0.0062)*	0.0646 (0.0056)*
The region is located on the border with EU member states (Yes = 1, No = 0)	$lnHouse_{rt}$	0.28, 0.45	0.0324 (0.0069)*	0.0288 (0.0068)*
Log dwelling units in the region divided by the resident population at mid-year	$lnClimate_r$	-1.16, 0.08	-0.1713 (0.0410)*	-0.2017 (0.0419)*
Log ratio of average Centigrade temperature in the region over the period from 1981 to 2010 to the temperature range over the same period	$NetEmigr_{rt}$	0.97, 0.10	-0.0871 (0.0418)*	-0.0684 (0.0411)
Net international emigration from the region per 10,000 people in the resident population		4.73, 7.62	0.0008 (0.0002)*	0.0009 (0.0003)*
Constant			1.4600 (0.1925)*	1.4002 (0.1636)*
R^2			0.54	0.54
N obs.			208	208

Notes: The dependent variable is $\ln(\hat{\delta}_{rt}+1)$. Its mean is -0.0010 with a standard deviation of 0.0460. The WLS regression weights observations by the inverse squared standard error of the region coefficient in the cross-section Mincer regressions discussed in Section 3. Robust standard errors are in parentheses. *Coefficient is significant at the 0.05 level or better.

Table 3 Determinants of nominal relative wage across regions, controlling for regional price and rent differences (columns c-f) and determinants of regional relative wages adjusted for non-housing prices (columns g-i), 1999-2007

Variables	Mean, std. deviation	Regional nominal relative wages[a]				Regional relative wages adjusted for non-housing prices[b]		
		OLS	OLS	WLS	2SLS	OLS	WLS	2SLS
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)
$lnDen1900_r$	4.74, 0.47	0.04632 (0.0078)*	0.0120 (0.0091)	0.0071 (0.0087)	0.0122 (0.0088)	0.0122 (0.0093)	0.0064 (0.0089)	0.0124 (0.0090)

Variables	Mean, std. deviation	Regional nominal relative wages[a]				Regional relative wages adjusted for non-housing prices[b]		
		OLS	OLS	WLS	2SLS	OLS	WLS	2SLS
$lnDisB_r$	7.10, 0.15	-0.2038 (0.0216)*	-0.0922 (0.0427)*	-0.0932 (0.0402)*	-0.0951 (0.0414)*	-0.0981 (0.0418)*	-0.0965 (0.0404)*	-0.1006 (0.0405)*
$Coast_r$	0.19, 0.39	0.0646 (0.0056)*	0.0251 (0.0086)*	0.0236 (0.0092)*	0.0255 (0.0082)*	0.0224 (0.0088)*	0.0206 (0.0092)*	0.0229 (0.0086)*
$EUbor_{rt}$	0.32, 0.47	0.0376 (0.0082)*	0.0257 (0.0076)*	0.0226 (0.0075)*	0.0257 (0.0073)*	0.0229 (0.0071)*	0.0196 (0.0072)*	0.0230 (0.0069)*
$lnHouse_{rt}$	-1.14, 0.07	-0.2241 (0.0587)*	-0.1854 (0.0454)*	-0.1774 (0.0454)*	-0.1879 (0.0434)*	-0.1883 (0.0446)*	-0.1758 (0.0455)*	-0.1905 (0.0428)*
$lnClimate_r$	0.97, 0.10	-0.0786 (0.0535)	-0.0494 (0.0456)	-0.0494 (0.0448)	-0.0514 (0.0441)	-0.0581 (0.0442)	-0.0366 (0.0423)	-0.0596 (0.0429)
$NetEmigr_{rt}$	5.21, 8.11	0.0007 (0.0002)*	0.0008 (0.0002)*	0.0007 (0.0002)*	0.0008 (0.0002)*	0.0008 (0.0002)*	0.0008 (0.0002)*	0.0009 (0.0002)*
$lnRRPI_{rt}$	-0.002, 0.02		0.8184 (0.1272)*	0.8370 (0.12267)*	0.8271 (0.1253)*			
$lnRent_r$	-0.02, 0.10		0.1748 (0.0481)*	0.1725 (0.0462)*	0.1707 (0.0475)*	0.1548 (0.0462)*	0.1567 (0.0462)*	0.1517 (0.0449)*
Constant		1.6768 (0.2519)*	0.7306 (0.3011)*	0.7436 (0.2817)*	0.7522 (0.2922)*	0.7720 (0.2942)*	0.7695 (0.2804)*	0.7906 (0.2866)*
R^2		0.60	0.74	0.76	0.74	0.57	0.60	0.57
N obs.		144	144	144	144	144	144	144

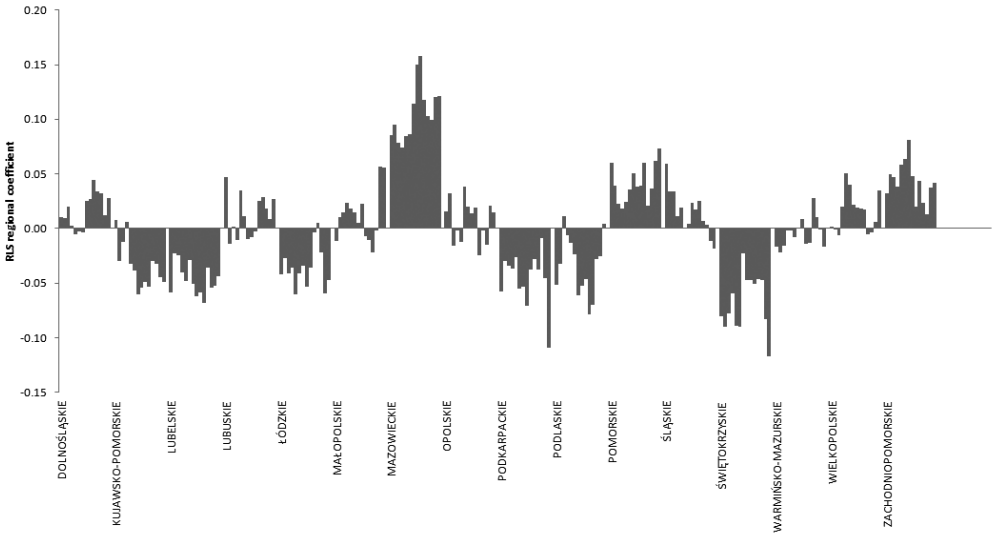
Notes:

[a] The dependent variable is $\ln(\hat{\delta}_r + 1)$ with the mean of -0.0012 and the standard deviation of 0.0489.

[b] The dependent variable is $\ln(\frac{\hat{\delta}_{rt} + 1}{RRPI_{rt}})$ with the mean of 0.0014 and the standard deviation of 0.0378.

See Table 2 for description of variables. In addition, $lnRRPI_{rt}$ is log of Relative Regional Price Index (not including housing rent) and $lnRent_r$ is log of actual rental prices (Zlotys per sq meter). Refer to Section 4 and the Appendix for more explanations. The WLS regression weights observations by the inverse squared standard error of the region coefficient in the cross-section Mincer regressions discussed in Section 3. The 2SLS regression treats $NetEmigr_{rt}$ as endogenous with the lagged level of employment in European destination countries for Polish emigrants and four lags of $NetEmigr_{r,t-1}$ $i = 1, , 4$ as instruments. Robust standard errors are in parentheses. *Coefficient is significant at the 0.05 level or better.

Figure 1 RLS regional wage coefficients, 1994-2007



For each region (voivodship), the graph shows the estimated RLS wage coeffcients for 1994-2007 (from left to right). The 0.0 line represents a benchmark (i.e., the average wage in the national economy).