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Is there a Wage Curve with Regional Real Wages?

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Abstract

Do wages react to regional unemployment, as proposed by the theory behind the regional wage curve, if regional price differences are taken into account? This paper applies regional price indexes to assess the wage curve, whereas in the literature only nominal wages are used for wage curve regressions. In order to test the impact of regional prices on the wage curve we apply a variety of methodological approaches. With individual data from the US Census and the Polish Labor Force Survey we find a wage curve. However, in both countries, the local unemployment elasticity and spatial spillovers decrease significantly once regional price deflators are applied.

Zusammenfassung

Reagieren die Löhne auf regionale Arbeitslosigkeit, wie es die Theorie hinter der regionalen Lohnkurve behauptet, wenn regionale Preisunterschiede berücksichtigt werden? In diesem Papier werden regionale Preisindizes zur Beurteilung der Lohnkurve verwendet, während in der Literatur nur Nominallöhne für Lohnkurvenregressionen verwendet werden. Mit Individualdaten aus der US-Volkszählung und der polnischen Arbeitskräfteerhebung finden wir eine Lohnkurve. In beiden Ländern nehmen jedoch der Lohneffekt der Arbeitslosigkeit und ihre räumlichen Auswirkungen erheblich ab, sobald regionale Preisdeflatoren angewendet werden.

JEL

C26, J30, J60

Keywords

Wage Curve; Spatial Spillovers; Regional Price Index; Regional Labor Markets

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1 Introduction

In the labor market literature, regional price differences are normally ignored, though theoretical arguments are derived on the basis of real wages. If, for example labor supply is analyzed, it is assumed that the price level is the same in the whole economy. It could be demonstrated, however, that larger countries, in particular, show significant regional price differentials. In the view of this finding, it may be that many of the empirical analyses in the labor market are mis-specified, because they omit an important variable. Sometimes, a justification for the use of nominal wages is the inclusion of regional fixed effects. However, they can take care of regional price differences only if these are sufficiently constant over time.

Regional fixed effects were used in the case of analyses on the wage curve, which is a non-linear decreasing function of wages on regional unemployment. Wage curve estimations in the style of Blanchflower and Oswald (1994, 2005) included fixed effects to control for regional heterogeneity, among others, for differing regional prices. However, due to a lack of data about regional prices, it is not clear, whether price differences between regions are stable or dynamic. Unemployment, wages and prices are typically relatively high in urban centres compared to the rural country. Due to this correlation there is even the possibility that the wage curve is only an illusion because it vanishes with the use of real regional wages. The many papers on the wage effects of regional unemployment, which are meanwhile available (including some by authors of this article), could be affected by a common artefact due to wrong specification! Therefore, we are interested to test the relation between regional unemployment and wages without and with regional price indexes.

We have data on two countries, on Poland and on the US. These countries are different in many respects. One is the major economic force in the world, the other one is a former transformation country. Therefore, we expect that the results we receive could give hints about the labor markets of other countries not covered by our study.

The remainder of the paper is organized as follows. The next section presents the challenge for moving from nominal to real prices. Section 3 reviews prior literature on regional price differentials, while in section 4 we discuss the research methodology and the data used in our analysis. In section 5, we present empirical results for both the US and Polish wage curve based on nominal and on real regional wages. Finally, section 6 offers some concluding remarks.

2 The Challenge

In this paper, we test whether the estimation of the wage curve is influenced by the inclusion of regional prices or not. Apart from the possibility that the wage curve vanishes with the introduction of regional price differences, there is the possibility, that the size of the coefficient in the wage curve equation is influenced. In the classical formulation of the “empirical law of economics” by Blanchflower and Oswald (1994), even the size of the coefficient was included. After analyzing the economies of 12 countries, they concluded that the coefficient is regularly close to -0.1. In the double logarithmic specification of the wage curve, this implies that a doubling of the unemployment rate would reduce wages by 10 percent. Later empirical studies found a greater variety of coefficients, because the size of the effect is related to the institutional structure of the respective economies, e.g. whether wage bargaining is centralized or not. This is one of the reasons why there are still new analyses using the wage curve in a variety of countries (see Baltagi et al., 2017; Blien and Phan, 2019; Johansen et al., 2019).

Yet, while the wage curve approach describes the relationship between the regional unemployment rates and real wages, existing studies assume the prices to be equal across regions. As a result, there are virtually no papers that effectively examine the relationship between unemployment rates and *real* wages, where the wages are adjusted by fully developed regional price deflators. Blanchflower and Oswald (1995) are aware of the potential criticism that can be associated with the omission of the regional price indices. Bear in mind that the negative relationship between wages and unemployment rates is stronger the lower the wages in regions with high unemployment and the higher the wages in regions with low unemployment. Hence, any positive correlation between regional unemployment rates and prices may lead to a bias in the wage curve estimation. Indeed, the unemployment rate is considered as one of the regional price determinants (e.g. Blien et al., 2009). So, lower unemployment rates lead to higher prices while higher unemployment is associated with lower price indices. As a result, real wages are likely to be higher, as compared to the nominal ones, in regions with higher unemployment rates. Exactly the opposite occurs with the real wages in regions with lower unemployment rates – on average, they should be lower than the nominal ones.

Blanchflower and Oswald (1994) claim that the above problem is not too serious since the wage curve remains intact once controlling for regional prices in Britain. Still, the data on regional prices they use in a robustness check comes in the form of a cost of living index provided by a commercial company and covers only a very short period of time and a limited number of regions. The authors apparently do not regard regional price differences as an important issue, because they neither provide the methodology of the price index calculation nor do they show the size of the regional price differentials. Therefore, it is not possible to assess the data reliability and its possible impact on the wage curve estimations. Hence, once we assume that the regional price differentials within particular countries are sizeable and dynamic it is more than likely that the existing estimates of the wage curve are significantly biased since they overestimate both the negative relationship between low wages and high unemployment and high wages and low unemployment. The question is though how large is this bias and whether it is statistically significant.

The present paper provides new evidence concerning the possible overestimation of the wage curve. We apply Regional Price Parities (RPP) for the US states and Polish NUTS2 level regions (NUTS - Nomenclature of Territorial Units for Statistics - is a geographical nomenclature subdividing the economic territory of the European Union into different levels of regions). Poland and the USA are two of the rare cases of countries for which regional price deflators are available. They are sufficiently different from each other to facilitate generalizations of the results.

We show whether there is a significant difference between the results of the wage curve analysis based on nominal and those of real (adjusted by RPPs) data. In both cases we analyze local and spatial approaches. The estimates we refer to as “local” are based on equations that include only the unemployment rate of the region in which a respective worker is located, whereas the spatial approach also includes the spillover effects of the unemployment rates of the surrounding regions.

We also assess whether the results hold not only for the whole sample but for subsamples too (e.g., males versus females). As a robustness check, we apply the two-step approach developed by Bell et al. (2002).

In the next section, a brief overview of some of the ways in which regional price data have been assembled and analyzed prior to the development of the formal testing in section 4.

3 Regional price differentials – literature review

For many years, the existence of regional price differentials has not garnered much interest in the economics literature. For instance, Deller et al. (1996) claim that “most of the discussion of regional income convergence in recent decades has operated under the assumption, either explicit or implicit, that spatial and temporal differences in regional prices (i.e., cost of living and inflation) are negligible.” The main reason is probably the problem with data availability. For many years, the estimation of reliable regional price indices was not possible.

In the case of the US, the first attempts to analyze regional price differences were made in the 1970s. Here, authors such as Haworth and Rasmussen (1973), Sherwood (1975) and McMahon and Melton (1978) investigated the sources of geographical differences in cost of living, relying on regression analysis. These early studies were followed by papers by Cebula (1980, 1989), Hogan (1984) or McMahon (1991). Among variables most commonly used as determinants of regional living-cost differentials, we can find per capita income, total population, population density, housing prices, geographic area, educational attainment of inhabitants and dummy variables for the coast locations or for the existence of the right-to-work legislation (e.g., Cebula, 1989). More recently, the Bureau of Economic Analysis released, as official statistics, Regional Price Parities for US states and Metropolitan areas (see Aten and Figueroa, 2014). These regional price indices are estimated using hedonic regression models (e.g., Aten and D’Souza, 2008) and are available for the 2008-2013 period.

Different econometric approaches towards regional price differentials have also been applied elsewhere. For instance, Roos (2006), Kosfeld et al. (2008) and Dreger and Kosfeld (2010) used regression analysis, while Blien et al. (2009) applied Multiple Imputation techniques, to estimate regional price indices for Germany at different levels of territorial aggregation. Among variables correlated with prices, we can find per capita GDP, average wages, total population and population density, size of regions, price of building land, unemployment rate as well as dummy variables for tourism and East Germany.

The main problem with regression-based regional price indices is their reliability. For example, Hogan (1984) criticizes the conclusions drawn by Cebula (1980) due to the fact that his regional cost-of-living indices were based on aggregate budget data. He claims that the regression model applied by Cebula (1980) was only able to “explain” more than half of the total variance in living costs for one out of nine different consumption categories. In the paper by Blien et al. (2009), the authors argue that the price index by Roos (2006) ignores the uncertainty of the estimation process, because it is based on the results of OLS regressions. Hence, several attempts have been made recently in order to calculate regional price deflators using raw regional price data. As a result, non-regression based regional price indices were estimated for China (e.g. Brandt and Holz, 2006), the Czech Republic (e.g. Čadil et al., 2014), Poland (e.g. Rokicki and Hewings, 2019) or the US (Beraja et al., 2019). In the last case, the regional price index is based primarily on food products; therefore, its representativeness is limited.

Are regional price differentials really sizable and can they significantly influence regional income measures such as per capita GDP or wages? In the case of the US, McMahon and Melton (1978) develop cost-of-living index for the US states (updated by McMahon 1991) and show that differences in living-cost are large – the index for 1973 varies between 127.8 in Connecticut and 90.6 in West Virginia (with the national average = 100). Official statistics provided by the Bureau of Economic Analysis confirm the above findings. Regional Price Parities at the state level vary in 2013 from 117.7 in the District of Columbia to 86.8 in Mississippi. The differences are slightly larger at the metropolitan areas level – the lowest price index is found in Beckley, WV (78.0), the highest in Urban Honolulu, HI (122.5). Several other studies reveal the existence of significant regional price differentials in Europe or China. Moreover, the differences in regional price indices seem to be persistent over time. Existing studies show either no convergence in regional prices (e.g. Dreger and Kosfeld, 2010, in the case of German districts; Nagayasu, 2011, in the case of Japanese regions) or very slow rates of convergence (e.g. Cecchetti et al., 2002, in the case of the US cities).

Several studies confirm that the application of regional price indices may significantly influence the results of analysis based on regional income measures. Deller et al. (1996) apply indices developed by McMahon and Melton (1978) and McMahon (1991) in analysis of regional income convergence across US states between 1969 and 1991. They show that regional price differentials can partly "explain" the absolute level of regional income inequality. Furthermore, they find the 1980s divergence pattern is not supported once the nominal data is adjusted with regional price deflators. Kosfeld et al. (2008) claim that regional income disparities at the NUTS3 level in Germany are significantly reduced once regional price differentials are taken into account. They also show that regional price deflators influence the convergence process - real (adjusted) per capita income converges faster to the unique steady state than nominal (unadjusted) per capita income. Rokicki (2015) confirms significant associations of regional price indices and wages. He finds that application of regional price deflators decreases the overall level of wage disparities across Polish NUTS2 regions although it does not significantly change the overall pattern of their evolution.

Given these findings, it seems reasonable to believe that the application of regional price indices may indeed significantly influence the results of any wage curve analysis. Note also that the results of regression based studies show that income variables (e.g. per capita GDP or wages) are positively correlated with the regional price level. This implies that better developed areas have, on average, higher levels of prices. The above suggests that we may face the omitted variable bias problem. Hence, as noted earlier, we can expect the existing estimates of the wage curve to overestimate both the negative relationship between low wages and high unemployment and high wages and low unemployment.

This paper adds to the existing literature by discussing the impact of regional price differentials on results of the wage curve analysis. In particular, it compares the results of wage curve analysis, in the case of the US and Poland, based on nominal wages (deflated by the average/national price deflators) and real wages adjusted to regional price differentials. We find that, in both countries, the local unemployment elasticity and spatial spillovers decrease significantly once regional price deflators are applied. In some cases the application of regional price deflators causes the wage curve to become statistically insignificant.

4 Research methodology and data

The existence of the wage curve is normally explained by two theoretical approaches (Blanchflower and Oswald 2005): By efficiency wages and by wage negotiation approaches. In the first case profit maximizing firms are interested to keep the efforts of their employees high. If (regional) unemployment rates are high, firms can expect high efforts because workers fear times without regular income in case they got dismissed. If unemployment is low firms motivate workers to put more effort into their work by paying relatively high wages. Also, wage negotiations can produce a wage curve, because workers try to increase wages in situations with low unemployment. If unemployment is high they are more reluctant in their demands. Finally, the wage curve can also be derived in a job search context (Blien, Messmann and Trappmann 2012 and Brown and Taylor 2015), because the regional reservation wage is also influenced by regional unemployment.

Since the pioneering study by Blanchflower and Oswald (1990), the negative relationship between wages and local unemployment rates has been a subject of many papers. Blanchflower and Oswald (2005) claim that wage curve studies cover over 40 countries and that in most of the cases, the estimates of unemployment elasticities show values around -0.1. However, this result on the size of the effect is questioned by Nijkamp and Poot (2005). After carrying out a meta-analysis they claim that due to publication bias, the average 'true' wage curve elasticity is no more than -0.07. Thus, the wage curve results and estimation methodology have not been exempt from controversy. For example, Card (1995) suggests the need to apply subsample specific unemployment rates, since results based on average unemployment rates can be biased (downward) for particular subsamples. Longhi et al. (2006) argue that the wage curve estimates should control for region heterogeneity as well as for spatial spillovers in order to avoid estimation bias and misleading inference.

While there have been several methodological improvements, none of the recent studies takes into account possible overestimation bias resulting from the omission of regional price deflators. The results confirming a significant bias could be particularly helpful in explaining high estimates of the spatial spillovers found in the studies by Fingleton and Palombi (2013) or Baltagi and Rokicki (2014). The former study reports the unemployment rate within commuting distance to exert the strongest influence on wages, while the local unemployment rate accounts only for a small fraction of the total impact. The latter paper shows that the spatial spillovers in unemployment rates more than double the local unemployment rate elasticity.

Recently, the Bureau of Economic Analysis released as official statistics Regional Price Parities for US states, covering the period between 2008 and 2015 (e.g., Aten and Figueroa, 2014). Hence, we focus on the US and use microdata from the US census to analyze the impact of regional price differentials on the results of wage curve analysis. In order to check for robustness of our findings, we also assess the impact of regional price deflators on wage curve estimation in Poland. To the best of our knowledge, this is the only European country where such a data are currently available for a number of years. For Germany a regional price index has been recently developed (Weinand and von Auer, 2019). However, because the data refer only to a cross-section, it cannot be used in a wage-curve analysis. Similar problem occurs with the data for the Czech Republic (Čadil et al., 2014) or the United Kingdom (ONS, 2018). Here, we apply regional PPP deflators developed for Polish NUTS2 level regions (see Rokicki and Hewings, 2019) and microdata from the Labor Force Survey over the 2000-2015 period.

According to Blanchflower and Oswald, the wage curve is a standard wage equation normally used to estimate the returns to education or the male–female wage gap but with the addition of the local unemployment variable to the set of regressors. A set of regional fixed effects is included to control for regional heterogeneity. In our case, we also include spatial spillovers of the regional unemployment rate so the equation to estimate takes the following form:

$$log\, W_{irt} = \alpha + \beta\, log\, U_{rt} + \chi(\textstyle\sum_s G_{rs}\, log\, U_{st}) + X_{irt}^{'}\gamma + \mu_r + \lambda_t + \nu_{irt} \qquad (4.1)$$

where W_{irt} is the real hourly wage rate of individual *i* observed in region *r* at time *t*. U_{rt} is the unemployment rate in region *r* at time *t*. μ_r is a region effect, λ_t is a time effect and ν_{irt} is the remaining error term. X_{irt} represents control variables that include the characteristics of individual *i* such as: gender, age, age squared, tenure, tenure squared, education, marital status, occupation, industry, sector, size of the employing firm, duration of the job and city size. The matrix *G* is a row-normalized spatial weights matrix (meaning that each row sums to one) that symbolizes the connections between regions *r* and *s* with typical element G_{rs} where *r, s* = 1, 2,..,*R*. *G* is of dimension *R*×*R* with diagonal elements equal to zero. The spatially weighted unemployment regressor

($\sum_s G_{rs} \log U_{st}$) allows the unemployment rates of the neighboring regions to influence local wages. Longhi (2012) shows that the unemployment rate could be substituted by a different measure of job competition. However, we stick to the original measure introduced by Blanchflower and Oswald.

As a robustness check, we also test the wage curve with regional prices in a framework using the two-step approach suggested by Card (1995) and applied by Bell et al. (2002), Baltagi et al. (2012) and others. The advantage of the two-step approach is that both crucial variables, i.e. wages and unemployment, are stated at the same level of aggregation. Therefore, the standard errors represent observations of regions and not observations of individuals. An instrumental variable approach for both the models (specified for individuals and for regions) is intended to exclude reverse causality. In 2SLS estimations, the temporally lagged unemployment rates are used as instruments.

In the two-step approach, first a region/time specific fixed effect α_{rt} is calculated in a sequence of cross-sections:

$$log\, W_{irt} = \alpha_t + \alpha_{rt} + X_{irt}^{'}\gamma + \nu_{irt} \qquad (4.2)$$

The fixed effect α_{rt} can be regarded as a regional wage which is stripped off from all the individual characteristics of the local labor force. In a second step, the real wage curve is calculated by using the composition corrected wage α_{rt} as the response variable:

$$\alpha_{rt} = \beta_0 + \beta' \log U_{rt} + \chi(\textstyle\sum_s G_{rs} \log U_{st}) + \mu'_r + \lambda'_t + \nu'_{irt} \quad (4.3)$$

Regional price parities (RPP) for the US states come from the Bureau of Economic Analysis, US Department of Commerce. Individual data on wages comes from the US census (see Ruggles et al. 2015) – our sample includes 7,245,942 observations at the state level. Due to the fact that we analyze both the standard and the spatial wage curve, we exclude Alaska and Hawaii. Aggregated data used in the two-step approach includes 392 observations. The data on unemployment comes from the Bureau of Labor Statistics, US Department of Labor while the data on regional population comes from the US Census Bureau. The housing price index is taken from the Federal Housing Finance Agency and the data on land area from the SAGE Stats. All data cover the 2008-2015 period. The data used to compute spatial weights matrices comes from the shapefile data for US regions.

Regional price deflators for Poland are estimated in accordance with the common Eurostat/OECD methodology (See European Communities/OECD (2006) and Rokicki and Hewings (2019) for more details). Almost all of the remaining data are provided by various publications of the Polish Central Statistical Office. In particular, the data on regional unemployment rates comes from the Local Data Bank while individual wage data is from the Polish Labor Force Survey. In the case of the latter, our sample includes 142,010 observations at the NUTS2 level regions. Aggregated data used in two-step approach includes 256 observations. All data cover the 2000-2015 period. The data used to compute spatial weights matrix comes from the ESRI shapefile data for Polish NUTS2 regions.

5 Empirical Results

All the results reported in this paper are based on an instrumental variables approach that deals with possible endogeneity of the unemployment rate. We use the lagged value of the unemployment rate as an instrument and present FE-2SLS estimates. We begin our analysis showing the existence of omitted variable bias. Table 1 compares the results of local wage curve estimations based on equation 1 without spatial spillovers for the US states and Polish NUTS2 regions. As expected, in both cases, we find the RPP variable to be positively and statistically significantly correlated with nominal wages. Moreover, the unemployment elasticity decreases once RPP are included (model 1 versus model 2). Note, that both model 1 and model 2 include regional fixed effects that are supposed to absorb regional price differences if these are constant over time. Actually, once we exclude regional fixed effects (model 3) the RPP coefficient increases. In the case of Polish NUTS2 regions it is very close to 1.

Next we turn to the estimation of the wage curve based on nominal and real wages. We start with the local wage curve; it is the wage curve without spatial spillovers. Table 2 shows estimation results of equation 1 for the US states based on the fixed effects approach, controlling for individual characteristics of workers. We test two specifications: in the first one, the wage variable does not take into account regional price differentials (“nominal”), while in the second one, wages are deflated using RPP (“real”). Hence, we compare the same model with two different dependent variables.

Table 1: Omitted variable bias verification – US states and Polish NUTS2 regions (Response variable - nominal hourly wages)

	US states			Polish NUTS2 regions		
	(1)	(2)	(3)	(1)	(2)	(3)
VARIABLES	Model	Model	Model	Model	Model	Model
Unemployment	-0.049***	-0.034***	0.006***	-0.067***	-0.059***	-0.083***
	(0.005)	(0.005)	(0.001)	(0.012)	(0.012)	(0.006)
RPP deflator		0.581***	0.644***		0.469***	1.063***
		(0.033)	(0.002)		(0.096)	(0.031)
Constant	1.741***	1.790***	1.723***	2.515***	2.488***	2.541***
	(0.010)	(0.011)	(0.004)	(0.068)	(0.068)	(0.061)
Regional dummies	Yes	Yes	No	Yes	Yes	No
Yearly dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	7,245,942	7,245,942	7,245,942	142,010	142,010	142,010
R-squared	0.38	0.38	0.38	0.47	0.47	0.47
Adj. R-squared	0.38	0.38	0.38	0.47	0.47	0.47

Notes:

a) Robust standard errors in parentheses; *, ** and *** represent significance at 10%, 5% and 1%, respectively.

b) FE-2SLS estimation, the logarithm of unemployment rate by region in the previous year has been used as an instrument for the logarithm of unemployment rate by region at time t.

Source: US Census; Polish Central Statistical Office; own calculations

Table 2: The US unemployment elasticity of real hourly wages – the impact of PPP deflators on local wage curve

	All workers		Men		Women	
	Nominal	Real	Nominal	Real	Nominal	Real
Unemployment	-0.049***	-0.023***	-0.062***	-0.036***	-0.039***	-0.014**
	(0.005)	(0.005)	(0.007)	(0.007)	(0.007)	(0.007)
Constant	1.741***	1.826***	1.533***	1.618***	1.631***	1.717***
	(0.010)	(0.010)	(0.013)	(0.013)	(0.014)	(0.014)
Regional dummies	Yes	Yes	Yes	Yes	Yes	Yes
Yearly dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	7,245,942	7,245,942	3,667,084	3,667,084	3,578,858	3,578,858
R-squared	0.38	0.38	0.39	0.39	0.38	0.37
Adj. R-squared	0.38	0.38	0.39	0.39	0.38	0.37

Notes:

a) Robust standard errors in parentheses; *, ** and *** represent significance at 10%, 5% and 1%, respectively.

b) FE-2SLS estimation, the logarithm of unemployment rate by region in the previous year has been used as an instrument for the logarithm of unemployment rate by region at time t.

Source: US Census; own calculations

The first two columns of the Table 2 reports the results for the whole sample. As expected, the unemployment elasticity seems to be significantly lower for the specification based on the real wages (-0.023) as compared to the usual specification that does not take into account differences in regional price indices (-0.049). The confidence bands of the coefficients do not overlap. Therefore, we can conclude that there is a significant difference between the two estimates. This means that the unemployment elasticity is in fact considerably lower when real regional wages replace the nominal ones.

It has been argued (e.g., Baltagi and Rokicki, 2014) that males and females in general compete for different jobs, hence their situation in the labor market is different. The same applies, for example, to workers with different levels of educational attainment. As a result, one may raise the question as to whether the magnitude of overestimation is similar across different groups on the labor market. If it is not, then local price levels must have different impacts on nominal wages of different groups of workers. Therefore, in columns 3-4 and 5-6, we report the results for the male and female subsamples. Here, although unemployment elasticities for men and women differ significantly (-0.062 vs. -0.039 in the case of nominal wage approach) the impact of regional price deflators appears to be rather similar. The application of the regional price deflators, based on the point estimates, results in the reduction of the unemployment elasticity by -0.026 in the case of males and -0.025 in the case of females. This implies the reduction of unemployment elasticity by around 40 percent in the case of men and more than 60 percent in the case of women. Still, the application of regional price deflators does not change the sign or statistical significance of the relationship between wages and local unemployment rate.

Table 3: The Polish unemployment elasticity of real hourly wages – the impact of PPP deflators on local wage curve

	All workers		Men		Women	
	Nominal	Real	Nominal	Real	Nominal	Real
Unemployment	-0.067***	-0.051***	-0.077***	-0.063**	-0.058***	-0.041**
	(0.012)	(0.012)	(0.017)	(0.017)	(0.016)	(0.016)
Constant	2.515***	2.456***	2.540***	2.485***	2.410***	2.347***
	(0.068)	(0.068)	(0.090)	(0.090)	(0.092)	(0.092)
Regional dummies	Yes	Yes	Yes	Yes	Yes	Yes
Yearly dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	142,010	142,010	73,936	73,936	68,074	68,074
R-squared	0.47	0.47	0.44	0.44	0.52	0.51
Adj. R-squared	0.47	0.47	0.44	0.44	0.51	0.51

Notes:

a) Robust standard errors in parentheses; *, ** and *** represent significance at 10%, 5% and 1%, respectively.

b) FE-2SLS estimation, the logarithm of unemployment rate by region in the previous year has been used as an instrument for the logarithm of unemployment rate by region at time t.

Source: Polish Central Statistical Office; own calculations

Table 3 shows the results of similar analysis performed for Polish NUTS2 level regions respectively. Here, we can observe similar patterns as in the case of the US states. However, the negative relationship between wages and unemployment is stronger – the unemployment elasticity for whole sample based on nominal wages is -0.067. However, the impact of regional price indices is smaller; the unemployment elasticity for the specification based on the real wages reaches -0.051, a reduction of less than 25 percent. Similar results can be found for the male and female subsamples. In the case of the former, the unemployment elasticity decreases from -0.077 to -0.063 that implies almost 20 percent reduction. In the case of the latter, the decline is larger and reaches almost 30 percent (from -0.058 to -0.041).

As a robustness check we apply the two-step approach by Bell et al. (2002), described by equations 2 and 3. Table 4 reveals the second step estimates for the US states. On average, the results are very similar to the ones based on the much used microeconometric approach. Unemployment elasticities are only slightly higher in the case of the entire sample and female subsample and slightly lower for the male subsample. Moreover, the impact of RPP on the value of unemployment elasticity is exactly the same as found in microeconomic specification – in each case, it leads to a significant decrease. The local unemployment elasticity drops more than 55 percent for the full sample (from -0.055 to -0.024), by more than 50 percent in the case of males (from -0.060 to -0.029) and over 60 percent in the case of females (from -0.050 to -0.019).

Table 4: The US unemployment elasticity of real hourly wages – traditional wage curve in the two-step approach

	All workers		Men		Women	
	Nominal	Real	Nominal	Real	Nominal	Real
Unemployment	-0.055***	-0.024*	-0.060***	-0.029*	-0.050***	-0.019
	(0.016)	(0.013)	(0.019)	(0.016)	(0.017)	(0.015)
Constant	1.633***	1.615***	1.496***	1.478***	1.715***	1.697***
	(0.028)	(0.022)	(0.032)	(0.026)	(0.029)	(0.025)
Regional dummies	Yes	Yes	Yes	Yes	Yes	Yes
Yearly dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	392	392	392	392	392	392
R-squared	0.97	0.95	0.96	0.95	0.98	0.95
Adj. R-squared	0.97	0.95	0.96	0.95	0.98	0.95

Notes:

a) Robust standard errors in parentheses; *, ** and *** represent significance at 10%, 5% and 1%, respectively.

b) FE-2SLS estimation, the logarithm of unemployment rate by region in the previous year has been used as an instrument for the logarithm of unemployment rate by region at time t.

c) Second step estimates.

Source: US Census; own calculations

Corresponding results of two-step approach for Polish NUTS2 regions can be found in Table 5. The application of RPP leads to a decrease in unemployment elasticity by more than 20% for the full sample (from -0.057 to -0.049), around 15 percent for males (from -0.084 to -0.071) and almost 30 percent for females (from -0.045 to -0.032). Note, that both in the case of the US states and Polish NUTS2 regions unemployment elasticity becomes statistically insignificant once real wages are used instead of nominal ones.

Table 5: The Polish unemployment elasticity of real hourly wages – local wage curve in the two-step approach

	All workers		Men		Women	
	Nominal	Real	Nominal	Real	Nominal	Real
Unemployment	-0.066***	-0.052***	-0.084***	-0.071***	-0.045**	-0.032
	(0.015)	(0.017)	(0.021)	(0.023)	(0.020)	(0.022)
Constant	2.825***	2.665***	2.841***	2.777***	2.510***	2.455***
	(0.045)	(0.051)	(0.063)	(0.067)	(0.059)	(0.064)
Regional dummies	Yes	Yes	Yes	Yes	Yes	Yes
Yearly dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	256	256	256	256	256	256
R-squared	0.99	0.99	0.99	0.99	0.99	0.99
Adj. R-squared	0.99	0.99	0.99	0.99	0.99	0.99

Notes:

a) Robust standard errors in parentheses; *, ** and *** represent significance at 10%, 5% and 1%, respectively.

b) FE-2SLS estimation, the logarithm of unemployment rate by region in the previous year has been used as an instrument for the logarithm of unemployment rate by region at time t.

c) Second step estimates.

Source: Polish Central Statistical Office; own calculations

These findings seem to confirm that the inclusion of regional price indices may indeed significantly influence the results of local wage curve analysis. As a matter of fact, unemployment elasticities estimated for real wages in all analyzed cases hardly exceed -0.05 and are significantly lower from the -0.1 value existing in the wage curve literature (Blanchflower and Oswald, 2005). Still, the wage curve relationship exists in all tested specifications (with the exception of female subsample in the two-step approach).

We now turn to the spatial wage curve in order to test the hypothesis concerning the possible significant overestimation of spatial spillovers. Table 6 shows the results of the analysis of the spatial wage curve for the US states. It is based on the contiguity weights matrix and the same estimation approach as in the case of the local wage curve. We also tested other weight matrices (inverse or inverse square distance). However, the results were very similar. In columns 1-2, we compare the results for the whole sample and confirm the validity of our research hypothesis. An application of regional price deflators leads to a reduction of the local unemployment elasticity by -0.023 (from -0.036 to -0.013) while the spatial spillover decreases by -0.012 (from -0.056 to -0.044). These results imply that the local unemployment elasticity decreases by more than 60 percent while the spatial spillovers decrease by more than 20 percent. The impact of regional price deflators on both the local unemployment elasticity and the spatial spillovers seems to be similar across subsamples. The local unemployment rate elasticity is reduced by -0.024 for males and -0.023 for females. The decrease in spatial spillover is -0.011 and -0.012 respectively. However, the relative magnitude of the impact is much larger in the case of females. Here, the local unemployment elasticity decreases by almost 80 percent (and becomes statistically insignificant) while the spatial spillover decreases by more than 25 percent. In the case of males, the reduction is over 50 percent and less than 20 percent respectively. In all of the above cases, the differences between elasticities are statistically significant.

Table 6: The US spatial unemployment elasticity of hourly wages by worker type – the impact of PPP deflators on spatial wage curve

	All workers		Men		Women	
	Nominal	Real	Nominal	Real	Nominal	Real
Unemployment	-0.036***	-0.013***	-0.047***	-0.023***	-0.029***	-0.006
	(0.005)	(0.005)	(0.007)	(0.007)	(0.007)	(0.007)
Spatial spillover	-0.056**	-0.044***	-0.065***	-0.054***	-0.045***	-0.033***
	(0.005)	(0.005)	(0.007)	(0.007)	(0.008)	(0.008)
Constant	1.817***	1.886***	1.621***	1.691***	1.693***	1.763***
	(0.013)	(0.013)	(0.018)	(0.018)	(0.019)	(0.019)
Regional dummies	Yes	Yes	Yes	Yes	Yes	Yes
Yearly dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	7,245,942	7,245,942	3,667,084	3,667,084	3,578,858	3,578,858
R-squared	0.38	0.38	0.39	0.39	0.38	0.37
Adj. R-squared	0.38	0.38	0.39	0.39	0.38	0.37

Notes:

a) Robust standard errors in parentheses; *, ** and *** represent significance at 10%, 5% and 1%, respectively.

b) FE-2SLS estimation, the logarithm of unemployment rate and spatial spillover by region in the previous year has been used as an instrument for the logarithm of unemployment rate and spatial spillover by region at time t.

c) Spatial spillover based on contiguity weights matrix.

Source: US Census; own calculations

In the case of Polish regions, the full sample local unemployment elasticity decreases by -0.003 while spatial spillovers by decline by -0.031 (see Table 7). This means a reduction of around 30 percent in the latter case. In the case of the male subsample, local unemployment rate falls by -0.002 and spatial spillover by -0.031. For the females, the reduction is by -0.004 and -0.030 respectively. Similarly to the US states, the value of spatial spillovers is always higher than local unemployment elasticity. However, in Polish case the local unemployment elasticity is no longer statistically significant. This may be due to the fact that the wage curve evolves over time in accordance to labor market conditions. Hence, the local unemployment elasticity may be higher once those conditions are not favorable and lower (or even not statistically significant) while they improve. The current situation in the Polish labor market is characterized by an historically low unemployment rate that decreased to less than 6 percent in 2019. Earlier work by Baltagi and Rokicki (2014) shows the existence of statistically significant spatial wage curve in Poland over the period 1999-2010.

Table 7: The Polish spatial unemployment elasticity of real hourly wages by worker type – the impact of PPP delators on spatial wage curve

	All workers		Men		Women	
	Nominal	Real	Nominal	Real	Nominal	Real
Unemployment	-0.027	-0.024	-0.036	-0.034	-0.022	-0.018
	(0.019)	(0.019)	(0.026)	(0.026)	(0.027)	(0.027)
Spatial spillover	-0.094***	-0.063**	-0.099**	-0.068*	-0.085**	-0.055
	(0.028)	(0.028)	(0.039)	(0.039)	(0.039)	(0.039)
Constant	2.658***	2.552***	2.690***	2.589***	2.541***	2.431***
	(0.075)	(0.075)	(0.101)	(0.101)	(0.103)	(0.103)
Regional dummies	Yes	Yes	Yes	Yes	Yes	Yes
Yearly dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	142,010	142,010	73,936	73,936	68,074	68,074
R-squared	0.47	0.47	0.44	0.44	0.52	0.51
Adj. R-squared	0.47	0.47	0.44	0.44	0.51	0.51

Notes:

a) Robust standard errors in parentheses; *, ** and *** represent significance at 10%, 5% and 1%, respectively.

b) FE-2SLS estimation, the logarithm of unemployment rate and spatial spillover by region in the previous year has been used as an instrument for the logarithm of unemployment rate and spatial spillover by region at time t.

c) Spatial spillover based on contiguity weights matrix.

Source: Polish Central Statistical Office; own calculations

Once again, we assess the robustness of our findings applying two-step approach. Table 8 reveals the results of second step estimates for the US states. This time we find that the impact of RPP on local unemployment rates is very similar both for the full sample and the subsamples. The reduction of unemployment elasticity is close to 50 percent in all of the cases. At the same time spatial spillover coefficient is very small and not statistically significant. In this sense, the results of two-step approach differ from the ones based on the Mincerian approach.

Table 8: The US unemployment elasticity of real hourly wages – spatial wage curve in the two-step approach

	All workers		Men		Women	
	Nominal	Real	Nominal	Real	Nominal	Real
Unemployment	-0.052***	-0.026**	-0.053***	-0.027*	-0.051***	-0.025*
	(0.016)	(0.013)	(0.019)	(0.015)	(0.017)	(0.015)
Spatial spillover	-0.006	0.005	-0.015	-0.004	0.003	0.014
	(0.010)	(0.008)	(0.012)	(0.010)	(0.011)	(0.009)
Constant	1.637***	1.611***	1.507***	1.481***	1.713***	1.687***
	(0.030)	(0.024)	(0.034)	(0.029)	(0.031)	(0.027)
Regional dummies	Yes	Yes	Yes	Yes	Yes	Yes
Yearly dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	392	392	392	392	392	392
R-squared	0.97	0.95	0.96	0.95	0.98	0.95
Adj. R-squared	0.97	0.95	0.96	0.95	0.98	0.95

Notes:

a) Robust standard errors in parentheses; *, ** and *** represent significance at 10%, 5% and 1%, respectively.

b) FE-2SLS estimation, the logarithm of unemployment rate by region in the previous year has been used as an instrument for the logarithm of unemployment rate by region at time t.

c) Second step estimates.

Source: US Census; own calculations

Table 9: The Polish unemployment elasticity of real hourly wages – spatial wage curve in the two-step approach

	All workers		Men		Women	
	Nominal	Real	Nominal	Real	Nominal	Real
Unemployment	-0.025	-0.026	-0.040	-0.041	-0.003	-0.004
	(0.024)	(0.026)	(0.033)	(0.035)	(0.030)	(0.033)
Spatial spillover	-0.095***	-0.062*	-0.102**	-0.068	-0.098**	-0.064
	(0.034)	(0.037)	(0.049)	(0.049)	(0.044)	(0.049)
Constant	2.966***	2.756***	2.991***	2.878***	2.664***	2.550***
	(0.059)	(0.069)	(0.083)	(0.088)	(0.081)	(0.092)
Regional dummies	Yes	Yes	Yes	Yes	Yes	Yes
Yearly dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	256	256	256	256	256	256
R-squared	0.99	0.99	0.99	0.99	0.99	0.99
Adj. R-squared	0.99	0.99	0.99	0.99	0.99	0.99

Notes:

a) Robust standard errors in parentheses; *, ** and *** represent significance at 10%, 5% and 1%, respectively.

b) FE-2SLS estimation, the logarithm of unemployment rate by region in the previous year has been used as an instrument for the logarithm of unemployment rate by region at time t.

c) Second step estimates.

Source: Polish Central Statistical Office; own calculations

In the case of Polish NUTS2 regions the results of two-step approach are almost identical to the results of one-step approach, both in terms of the size of coefficients as in terms of their statistical significance (see Table 9). The local unemployment rate is not statistically significant in any of the specifications. On the other hand, in the case of full sample, the spatial spillover is statistically significant and decrease with the application of RPP by slightly more than 30 percent. The reduction of spatial spillover in the case of subsamples is similar in terms of the size, however, we also observe the loss of statistical significance.

These results seem to confirm our hypothesis concerning possible overestimation of the wage curve. We show that both the local unemployment elasticity and the magnitude of the spatial spillovers decrease significantly once regional price differentials are taken into account; however, the magnitude of the impact may differ for both countries. This in turn depends on the strength of the relationship between regional price indices and wages and may be related to differences in the size of the corresponding regions. We also find that the impact may somehow differ between male and female subsamples.

6 Conclusions

This paper reconsiders the negative relationship between wages and the regional unemployment rate, commonly referred to as the wage curve. We apply regional price deflators in order to adjust regional wages and estimate the unemployment elasticity using microdata for the US states and Polish NUTS2 level regions. In order to test the impact of regional prices on the wage curve we apply a variety of methodological approaches, which includes a Mincerian, a spatial spillovers and the two-step approach by Bell et al. (2002). Our results indicate that previous results of wage curve studies overestimate the negative relationship between (real) wages and unemployment rates and may imply that the 'true' unemployment elasticity is significantly lower than the commonly adopted -0.1. Still, we confirm that the wage curve exists when real wages are considered instead of nominal ones.

We find that in the case of the local wage curve, the unemployment elasticity estimated for the full sample falls from -0.049 to -0.023 for the US states and from -0.067 to -0.051 for Polish NUTS2 regions. These results signify a reduction of more than 50 percent and less than 25 percent respectively. We find though that the impact may differ for male and female subsamples. For instance, in the case of the US regions, the reduction of unemployment elasticity is around 40 percent for men and 60 percent for women. In the case of Polish NUTS2 regions unemployment elasticity drops by 20 percent and 30 percent respectively. The results of the two-step approach are in line with the one-step approach based on the Mincerian framework. The impact of RPP on the unemployment elasticity is almost exactly the same in terms of its magnitude.

A sizeable impact of regional price deflators is also observed in the case of the spatial wage curve. Here, spatial spillovers decrease significantly in the case of the US states and Polish NUTS2 level regions, both for the full sample and the subsamples. The magnitude of the impact is very similar – results for the full sample indicate reduction of spatial spillovers by 20 percent and 30 percent respectively. Once again, the two-step approach estimates fully confirm our findings.

These results are important for the discussion of wage curves in general. From the analyses the expectation can be derived that also in countries, for which no regional price indexes are available, a wage curve might exist. However, the "true" coefficient of the unemployment rate is smaller in absolute terms than an estimate will show.

The analyses presented used data about two countries, about the labor markets of Poland and of the US, which differ in many respects. One country is the major economic force in the world, the other one is a former transformation country. Therefore, we think that our results support the view that the wage curve is also 'real' in other countries, though we cannot prove it due to a lack of data on regional price differences.

Due to the confirmed inverse relationship between wages and unemployment we can conclude that disadvantaged regions are hit twice. They show high rates of unemployment and additionally low wages.

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