United in Diversity. Labor Markets in the CEE Countries[1]

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Abstract

We study supply side factors of the labor market in the Czech Republic, Hungary, Poland and Slovakia. The common economic history of these Central European economies suggests that long-run relationships should have similar patterns. While we find that for the Czech Republic and Hungary there exists a long-run relation of equilibrium unemployment rate to real wages, capital stock and terms of trade, such relationship does not hold for Poland and Slovakia. Instead, labor market trends are better described by the relationship of equilibrium real wages. This finding uncovers structural differences within the Visegrad countries. These differences relate to the extent to which labor supply can adapt to shocks. In practice this would suggest that it was more efficient for Slovakia to conduct supply-oriented policies to stabilize labor market conditions. On the contrary, the more efficient tools for the Czech Republic are wage-oriented policies, connected to the demand side.

Introduction

Each national labor market has a specific structure and therefore is driven by its own set of relationships. Relationships can be formed by various responses to specific labor market characteristics. We aim to address these differences by capturing them in a simple equilibrium modelling framework for the Central European economies (CEEs) and offer a narrative for why these differences have emerged.

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The unemployment rate can be driven by the business cycle, or by reservation wages, or eventually responding to imbalances in a system with other elements, such as real wages or capital stock. The long-run properties of the unemployment rate relationship are usually derived from a model specification of an equilibrium unemployment rate. There are three main approaches to determining the equilibrium unemployment rate, depending on the underlying theoretical hypothesis.

The first concept refers to the gap between the actual and equilibrium unemployment rate, which is linked to the business cycle and inflationary pressures via the Phillips curve.[2] The second concept understands the equilibrium unemployment as a function of the wedge (ratio of producer and consumer wages), the replacement rate, the minimum wage rate and relative capital costs.[3] The third concept describes the search for work by unemployed agents. There are search models, defining equilibrium unemployment by comparing wages offered with the actual and implicit pay-out in unemployment (value of free time),[4] constructing probability distributions of an unemployed person accepting a job offer[5] or studying the interplay between the number of unemployed persons and the number of vacancies (Beveridge curve).[6] The fourth approach is to model the unemployment from flows (from employment to unemployment and vice versa; the possibility of becoming inactive must be taken in account as well).[7] We, however, follow the fifth concept that embeds the rate of unemployment within a system containing also the real wages, terms of trade and the capital stock. The latter variables are linked to the supply side of the economy.

[2] This hypothesis is usually implemented with the Kalman filter. For example, in Boone et al. (2002) for OECD countries, in Varga (2013) for CEEs and in Gylánik and Huček (2009) and Šrámková (2010) specifically for Slovakia. This approach can also be applied by using time series methods, as in Blanchard and Quah (1989), a vector error correction model containing the link between business cycle and unemployment as in Stark (1998) and Zagler (2003) or two stage least squares as in Gabrisch and Buscher (2006) who study the link between unemployment and output for the transition countries.

[3] Van der Horst (2003) investigates the wedge function in six OECD countries and provides one of the few applications of this kind (mainly due to short data history). Karasová et al. (2019) use disaggregated data to study the efficiency of labor market policy in Slovakia, so that the economic hypothesis of their work is somewhat similar to this approach. Karšay (2020) combines elements of the first and second approaches. A newer application of this approach is in Fredriksson and Söderström (2020), who use instrumental variables estimation to quantify the impact of unemployment benefits. This approach can be combined with the approach using output gap as in Chélini and Prat (2018).

[4] Ciocchini (2006) determines equilibrium unemployment in a search model, while Ljungqvist and Sargent (2012) deals more with wages. DellaVigna et al. (2016) construct a search model for Hungary that reflects references. For a survey of search models see Rogerson et al. (2006)

[5] See Matějka and McKay (2015) or Scharfenaker and Foley (2021).

[6] See for example Sheldon (2020). Empirical Beveridge curves for V4 countries are presented and discussed in Gertler (2022).

[7] See Kołodziejczak (2018) for a model for Poland. A similar approach can be used to model wages, combined with the search model approach, as in Broersma et al. (2004).

The approach is based on a vector error correction (VEC) model, which determines the long-run relationship and the rate of adjustment to disequilibrium (deviation from the long-run relationship). The starting point of the analysis in this paper is the work by Mayes and Vilmunen (1999), who apply this approach to Finland and New Zealand.[8] The appealing feature of this concept is that it is well suited to studying long-run relationships, as it does not require stationarity or differenced variables. Differencing is a sort of filter that leaves out long-run information from the time series. The interpretation of approaches using it (as in VARs[9]) should take into account that the long run properties of the studied system are altered by it. Instead, we focus on I(1) variables in levels and their long-run relationships. This way, we make use of a significant amount of long-run information in the data, that would otherwise (in a VAR) be omitted.

The Visegrád countries began their transformation with low and obsolete capital stock and there was a deep recession in the 1990s caused by profound institutional changes. Around the beginning of the new millennium, the relations in the economy started to resemble those in standard capitalistic economies. The capital stock and sophistication of production, however, was still lower than in the original EU countries. In these circumstances it is important to know how the rising capital stock and evolving terms of trade impact the labor market. Capital stock can be both a substitute for and complement to labor. Unlike the approach with output gap, a method capable of capturing the long-run (non-cyclical) evolution of unemployment rate, real wage and supply side variables is needed. We aren't interested in labor market fluctuations in the business cycle, we want to study it from the point of view of long-term economic development. The approach of Mayes and Vilmunen (1999) is suitable for this task and allows us to implement identifying restrictions to determine prevailing relationships between variables. Thus we replicate the estimation of the vector error correction model of Mayes and Vilmunen (1999), discuss the specific features of V4 countries that alter the values of estimated parameters and identify whether labor supply or labor demand is more stable in every country (this implies the type of prevailing shocks). We also present descriptive statistics about population and labor markets that provide underpinning for the values of estimated parameters.

We find that it should not be taken for granted that an equilibrium unemployment rate can be explained by supply side factors as in the case of Finland. In some countries, the long-run relationship between variables determines wages. Two types of long-run relationships (for unemployment rate and for wages)

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[8] Arestis et al. (2007) use a similar hypothesis for the equilibrium unemployment, but more general, with elements of the second concept.

[9] See for instance Jakab and Kaponya (2010) or Balcerzak and Żurek (2011) for the use of VARs in the CEE countries, where the long-run information is practically omitted.

correspond to the labor supply curve and labor demand curve (in inverted form, as a wage curve). In the paper we show that where the labor supply curve was identified, prevailing shocks come from the demand side and vice versa.

The decline in working age population after 2010 can be observed in all countries of the V4 and, due to its nature, can be interpreted as a permanent population shock. In the Czech Republic and Hungary labor supply is identified, thus the prevailing shocks come from the demand side and these countries coped better with the decline of the working age population. In Poland and Slovakia, on the other hand, the labor demand curve was identified, therefore labor markets were subject to supply shocks. Thus these countries were less successful in countering adverse demography.

The paper is organized as follows. Section 1 summarizes the theoretical model. Section 2 presents the characteristic features of the labor markets in Visegrad countries and their consequences. Section 3 deals with the technical details of testing and estimation, section 4 presents the estimation results, and the last section concludes.

1. The Model

The models we estimate follow the model of Mayes and Vilmunen (1999) closely. For brevity, we will not repeat the derivation of the equations of the model here. We just summarize the main economic assumptions here and direct readers' attention where the underlying parameters differ from the Finnish case.

In the model, the long-run relationship of the error correction is linked to the labor supply. More specifically, as in a standard Cobb-Douglas production function, it combines labor and capital to obtain the volume of output. Mayes and Vilmunen (1999) derive the Cobb-Douglas function to arrive at an equilibrium unemployment and investigate to what extent unemployment has been the result of slow adjustment to large external shocks. We proceed in a similar manner.

In line with Mayes and Vilmunen (1999), we invert and extend the function so that demand for labor in the corporate sector increases with the amount of output and decreases with PPI deflated real wages. Similarly, the demand for capital is higher with more labor and lower with a rising rental price of capital. The labor supply is then motivated by higher CPI deflated real wages. The wage setting then defines the real wage as a decreasing function of unemployment and terms of trade.[10] Finally, terms of trade scale down with both labor and capital.

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[10] The sign of the terms of trade is ambiguous. It is positive, when terms of trade reflect rising productivity, or negative, when terms of trade decline and inflation pressures from import prices prevail.

Figure 1

Linkages between Endogenous Variables
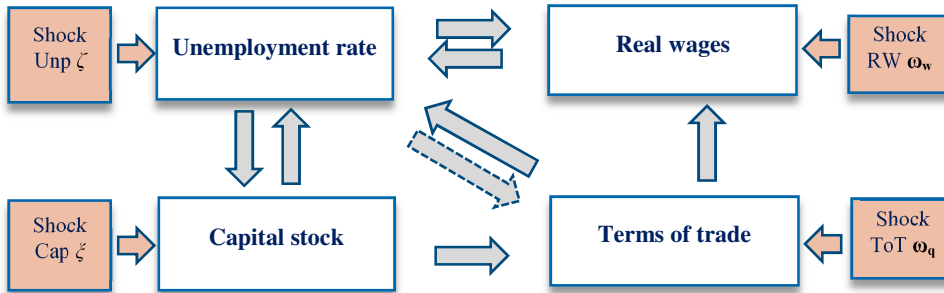
Source: Author.

All the above relationships contain stochastic shocks, too. These relationships are then transformed into a vector autoregression. A function of the unemployment rate is defined by the means of labor supply and labor demand. The derived equation takes the following form:

$$u_t = (\theta + \gamma_2) w_t - \gamma_2 (1 - \phi) q_t - \gamma_1 k_t + \xi_t - \zeta_t \tag{1}$$

Under a set of technical assumptions, the shocks ζ_t and ξ_t combine to a stationary shock, such that there exists a stationary combination of unemployment rate u_t, real wages w_t, terms of trade q_t and capital stock k_t that can be interpreted as a deviation from equilibrium unemployment. The models in the baseline specification are empirical applications of this long-run relationship between the four latter variables.

The parameter values θ and γ_2 determine the character of a labor market and lead to preferred specification of the model for every country. Parameter θ represents the positive elasticity of labor supply to real wages and parameter γ_2 is a transformed parameter α associated with labor in a Cobb-Douglas production function[11], so that it assumes positive values only.

$$\gamma_2 = \frac{1}{1 - \alpha} \tag{2}$$

Combining (1) and (2) implies that parameter α strengthens the impact of labor supply component in the long run relationship. In contrast to the case of Finland, the estimated value of parameter associated with wages is much lower in the case of the CEEs.

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[11] The Cobb-Douglas production function can be defined in many ways. Here we have in mind the equation $y_t = \beta k_t + \alpha l_t + \mu_t$ according to Meyes and Vilmunen, where y_t is log output, k_t is log capital stock, l_t is log labor and μ_t is time-specific technology shock.

2. Effects of Population Shocks and Labor Market Efficiency

Apparently, CEE labor markets experienced specific developments. Some of them are observable directly in the statistics published in the Labor Force Survey (LFS) by Eurostat. Two long-term trends stand out.

The first trend portrays a structural break around 2010 in productive age population (15 – 64 years of age). While productive cohorts were growing in the Czech Republic and Slovakia (approximately by 0.5% per year) initially, they began shrinking in size at about the same pace after 2010. Hungary and Poland also experienced the change at about the same time, but their working age population had been relatively flat before 2010 and falling faster in the last decade (Figure 2). This latter decline amounts to permanent, cumulative negative shock and naturally constrains the labor supply.

F i g u r e 2
Population 15 – 64 Years (2001Q1 = 100)
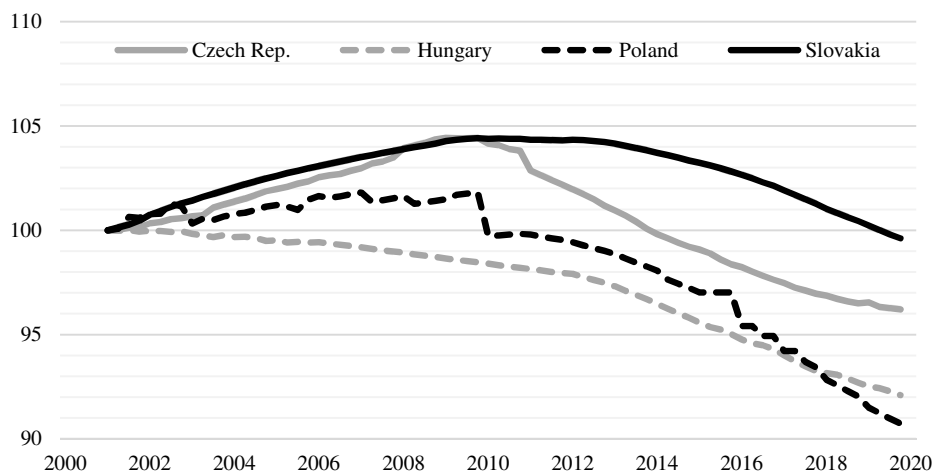
Note: Data for Poland contain a break in 2010.
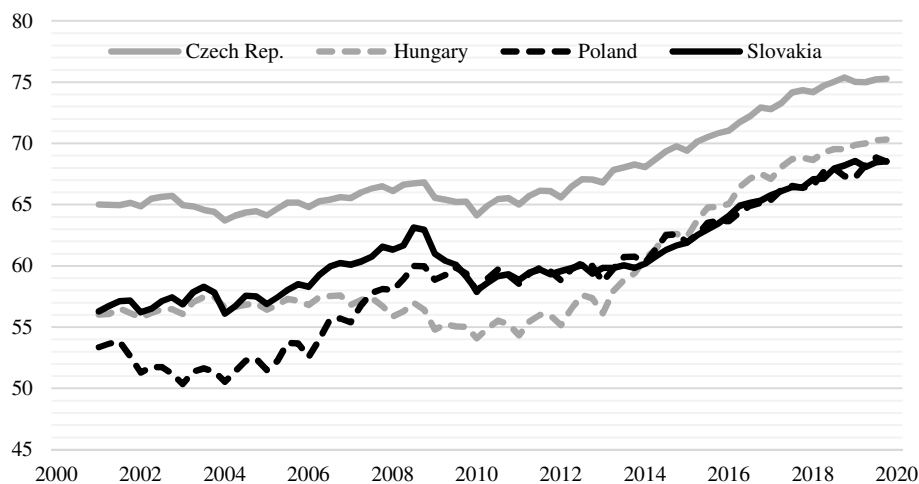*Source:* Own computations from Eurostat and NBS data.

Since the decline in the recent decade has been in general steeper and more consistent than its prior growth, we can expect that the elasticity of labor supply to wage growth (parameter θ) for the four (CEE) countries turns negative. We can confirm this assumption also by doing a simple calculation. The share of employee compensations to GDP (a proxy for labor share parameter α) is close to 0.4 in all four countries, which implies a value of 1.7 for the parameter γ_2 (eq. 2). Since our estimate of wage elasticity $(\theta + \gamma_2)$ is significantly below this value, parameter θ turns negative.

We therefore reformulate the hypothesis in a way that the absolute value of the parameter θ depends on the efficiency of the labor market in a corresponding country. Hence, we assume that a more efficient labor market can better counter negative shocks originating from population decline.

Figure 3 addresses this point. A low employment ratio implies that a significant share of the eligible population does not work. Some agents choose not to search for work (inactive) and some do actively seek work but fail to find it (unemployed). The reason for labor supply not meeting labor demand, apart from short-term fluctuations, can be a mismatch in required skills or geographic location. Additionally, for low skilled individuals, who can earn only low wages, the motivation for entering the job market can be lacking, especially if they can obtain income not related to work. Since the labor market is not homogenous, both the excess supply (unemployment) and excess demand (vacancies) can and do exist at the same time. A higher degree of mismatch makes the labor market function less efficiently. We see a general increase in the ratios of employed persons to population in productive age, likely also helped by increasing involvement of the foreign labor force in the local labor markets.

F i g u r e 3

Share of Employed Persons to Population (15 – 64 years old)

Source: Own computations from Eurostat data.

Cross checking figures 2 and 3, we can observe declines in working age population across the board, but the Czech Republic and Hungary were apparently able to counter this adverse shock more efficiently. On the other hand, Poland and Slovakia enjoyed only a moderate growth in the employment share. That

means adverse shocks were countered to a lesser extent, although coming from much higher levels of unemployment rate. Our country-specific estimates of θ confirm these observations, finding mildly positive parameters for Czech Republic and Hungary ($|\theta| < |\gamma_2|$) and clearly negative for Poland and Slovakia ($|\theta| > |\gamma_2|$). The character of prevailing shocks may determine whether the observed data points follow a supply or demand schedule.

F i g u r e 4a

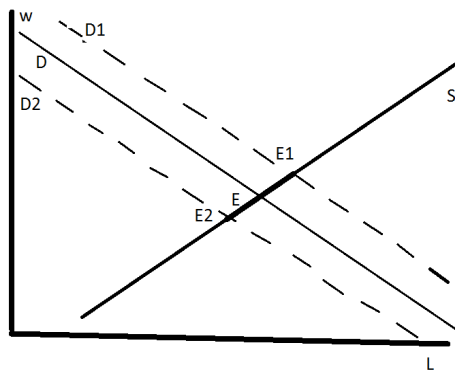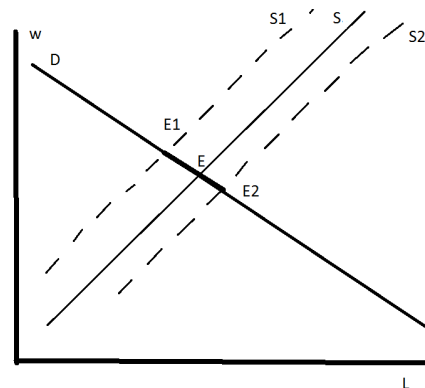**Identification of the Supply Curve in Presence of Demand Shocks** (left)

F i g u r e 4b

Identification of the Demand Curve in Presence of Supply Shocks (right)

Source: Own drawings.

Consider a simple demand and supply system. Figures 4a and 4b show two border case situations of pure demand and supply shocks. Demand shocks shift the demand schedule away from D (to D1 or D2) and consequently the equilibrium away from E (to E1 or E2). The highlighted part of the supply function represents the observed equilibria (Figure 4a). Similarly, supply shock shifts the supply function away from S (to S1 or S2). The highlighted part of the demand function represents the observed equilibria shifted away from E (to E1 or E2).

In practice, we will observe a combination of shocks both on the supply and demand side. The relationship between equilibrium wages and labor quantities is driven by the prevailing type of shock. We have seen above that labor markets in the Czech Republic and Hungary can better offset the unfavorable shocks from a decline in productive population. Thus the demand shocks in these countries should prevail. On the other hand, if supply shocks are offset in a less efficient manner (as in Poland and Slovakia) supply shocks will prevail.

We aligned the modelling approach with the above narrative for the CEE countries. We identified a labor supply relationship for the former and (inverse) labor demand relationship for the latter two countries. The labor supply model setting is analogous to that for Finland in Mayes and Vilmunen (1999) (i.e. as

outlined in eq. 1). The labor demand model is an augmented version of wage equation, which explains real wages as a function of the unemployment rate, terms of trade and capital stock.[12]

3. Tests and Estimation Settings

We used quarterly series of unemployment rates, real wages, terms of trade and capital between 1999 and 2019.[13] Wage series were converted to quarterly as period averages, imputed where necessary, and deflated by HICP to obtain real wages. We have calculated and seasonally adjusted terms of trade.[14] Our estimation and testing follow Harris (1995). We have tested the series for unit root (see Appendix 1) and identified long-run relationships among the endogenous variables in all the cases but the Czech Republic, where terms of trade could not be included (due to its stationarity).

Next, we conducted country-specific Johansen tests (see Appendix 2) to determine the rank of the matrix of long-run multipliers. We found one cointegrating vector for each country model.

Our baseline specification of the vector error correction is defined as

$$\Delta X = \Pi\left(X_{t-1},\ 1\right) + \sum_{i=1}^{4}\Gamma_i\Delta X_{t-i} + c + \varepsilon_t \tag{3}$$

where X is a (column) vector of endogenous variables[15] containing the unemployment rate, log of real wages, terms of trade (except for the Czech Republic) and log of capital stock. In an alternative specification, real wages and the unemployment rate swap positions. Matrix Π contains 5x4 long-run multipliers,

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[12] Microeconomic theory stipulates that wages should be linked to marginal labor productivity and that depends on capital stock per capita. Since the variance of capital stock is greater than the variance of employment, movements of capital stock per capita are predominantly caused by changes in aggregate capital stock. Thus, we include capital stock (that is the part of the endogenous vector already) as a proxy for non-cyclical increases in labor productivity.

[13] We used the Macrobond database and its feature searching for analog series in other countries. Despite this, the form of data varied greatly among countries (different periodicity, seasonally adjusted or not, in one case real wages were directly available. In the case of Poland, the observations from wage series had to be discarded, because they were not comparable with the rest. Due to this heterogeneity, we omit the detailed description of data preparation for reasons of brevity. Capital stock series were sourced from the AMECO database.

[14] We have defined the terms of trade as a ratio of export deflator and import deflator (these were computed from national accounts). The real wages were seasonally adjusted by X12 ARIMA with additional seasonal factors. We have applied HP filter in the case of Poland, where terms of trade exhibited pronounced irregular short-term swings.

[15] There is a separate model for every country, but we omit the country subscripts for simplicity. Four lags are included in every model.

Γ_i are 4x4 matrices of short-run parameters, c is a column vector of constants and ε_t is the error term. Inclusion of the constant term in the cointegrating space (indicated by 1 in the long run term in eq.1) is due to differing means and drift in some variables.

The matrix of long run multipliers can be expressed as a product of factor loadings α and matrix of cointegrating vectors β (including constant),[16] i.e. $\Pi = \alpha\beta'$. Since we have one cointegrating vector for each country, α and β reduce to row vectors. After normalizing β and shifting other variables to the right side, we end up with a long-run relationship for the unemployment rate in the baseline specification and for the real wages in the alternative one.[17]

Thus, we have reached the baseline and alternative specification for every country, reflecting the sign of parameters in the cointegrating vector. This means that if the unemployment rate was increasing along with growing real wages, labor supply prevails, and baseline specification featuring the unemployment rate as a dependent variable of a long-run relationship was preferred. Vice versa, if the unemployment rate was falling along with growing real wages, the model was reparametrized in a way to reflect the labor demand function, and an alternative specification featuring the real wages as a dependent variable of a long-run relationship was preferred. This set up was used to disentangle the two estimating strategies, the baseline used for the Czech Republic and Hungary and the alternative for Poland and Slovakia.

4. Results

We only report the long run parameters of the preferred model (cointegrating vector β and factor loadings α) in Table 1. The cross product of cointegrating vectors and the vectors of corresponding dependent variables shall be interpreted as a short-run deviation from the long-run relationship.

Variables that do not respond to disequilibrium are perceived to be exogenous. The factor loadings show that wages are flexible and do react to the disequilibrium in the labor market. This is made possible by inflation, which is higher

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[16] The factorization of Π is not unique. It can be shown that there are many pairs of cointegration vectors and corresponding factor loadings that lead to the same matrix Π. The researcher can thus choose the factorization that corresponds most closely to economic theory. Mayes and Vilmunen (1999) do it as well, their cointegration vector for New Zeeland is normalized and interpreted differently than that for Finland. It should be added that if there is more than one cointegration vector, identifying restrictions for its values are necessary. However, in our case Johansen tests indicate that there is only one in all countries, so that they are not needed.

[17] The matrices Π in the baseline and alternative specification differ only in order or rows and columns. They are, however, normalized in different ways.

than in advanced EU member countries and provides a cushion allowing the real wages to drop when nominal wages remain unchanged.

T a b l e 1

Parameters of the VEC Models for the CEE Countries

	Cointegrating vectors		Factor loadings	
	CZ	**HU**	**CZ**	**HU**
Unemployment rate	1.000	1.000	−0.066***	−0.02*
			−3.3	−1.5
Terms of trade		1.56**		−0.001
		2.7		0
Real wages	−0.180*	−1.11***	−0.334***	0.125**
	−1.8	−5.5	−3.3	2.4
Capital	0.440***	1.3***	0	−0.002***
	3.0	5.50	−0.2	−4.1
Constant	−12.42	−37.17		
	Cointegrating vectors		Factor loadings	
	PL	**SK**	**PL**	**SK**
Real wages	1.000	1.000	−0.258***	−0.337***
			−4.0	−4.0
Unemployment rate	2.86***	1.12***	−0.049***	0.058*
	7.8	6.5	−2.9	1.7
Terms of trade	1.56***	0.53*	0	−0.185**
	3.3	1.4	0	−2.1
Capital	−0.35***	−0.63***	0.001	0.003*
	−9.8	−4.7	1.1	1.5
Constant	−0.02	8.58		

Note: t-values are displayed in italics below parameters.

Source: Own computations.

The cointegrating relationships for Poland and Slovakia lead to wage equations, indicating that the real wage is a decreasing function of the unemployment rate and terms of trade and an increasing function of capital stock. The capital stock causes productivity to grow, which supports wages. More generally, capital and labor are complements in those countries, rather than substitutes. This is to be expected in countries that are catching up.

The sign of the terms of trade reflects inflationary pressures, since the terms of trade include an import deflator in denominator and a relatively greater share of consumption goods is imported in the CEE small open economies. The character of the cointegrating relationships allows us to make a statement about the shocks driving the system. The prevalence of labor supply shocks (originating in the demography and sluggish labor market efficiency) leads to the identification of the long-run relationships in Poland and Slovakia as an inverse labor demand function.

On the contrary, the cointegrating relationships for the equilibrium unemployment as proposed by Mayes and Vilmunen (1999) hold for the Czech Republic

and Hungary. The labor markets in these countries were able to offset the decline in population of productive age and identify the labor supply relationship.

If the Figure 4a and 4b describe the workings of labor markets correctly, we can deduct the degree of resilience to population shocks presented in Part 3 (as an important class of labor supply shocks), based on the prevailing type of shocks in every country. First, we have shown that labor markets in the Czech Republic and Hungary face predominantly demand shocks and are thus capable of accommodating the medium and long-term population shocks illustrated in Figure 2 and 3. The equilibrium unemployment rate is explained by capital and real wages in the long run. More specifically, additional capital tends to attract new employment and reduce the unemployment rate. This is a phenomenon often observed in labor markets with a higher level of skills. However, higher real wages then suppress employment and therefore make the unemployment rate rise.

The case is largely different in Poland and Slovakia where the labor supply is rigid and less able to adjust to population shocks. It is also for this reason that estimating an equilibrium unemployment rate for these economies is quite a challenge.[18]

From these findings, we can draw two policy implications. The labor markets converge to equilibrium if economic policy is able to smooth out prevailing shocks and let the market evolve along the stable relationship (labor supply or labor demand curve). Following the above findings, the focus of economic policy in the Czech Republic and Hungary should be on the demand side (steering wages to a sustainable level). The market will respond by reaching a sustainable level of unemployment rate. On the other hand, economic policy in Poland and Slovakia should focus on counteracting the labor supply shocks first. The real wages will then adjust until the labor market converges to the equilibrium.

Conclusion

All four CEE countries have experienced a brisk transition to market economies in the 1990s, but the lengthy transformation of their economies was exposed to many shocks on the way. We find that despite the cultural and structural proximity of these countries, there is a clear split in their ability to adjust to labor market shocks.

We used an error correction setup to assess if country-specific labor market trends are predominantly driven by supply or demand factors. First, we have identified a structural break in productive age population in all four countries and

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[18] Gylánik and Huček (2009) also struggle with structural mismatches and their estimated NAIRU for Slovakia is unusually volatile.

found that labor markets in the Czech Republic and Hungary could offset these shocks more efficiently than the labor markets in Slovakia and Poland.

Based on economic theory and estimated parameter values, we distinguish two separate settings of long-run relationships among endogenous variables. We derive a long-run relationship for equilibrium unemployment rate, explained by real wages, capital stock and terms of trade in the case of Hungary and the Czech Republic. The estimates of long run relationships imply that demand shocks prevail in this pair of countries. Thus, we find that these two countries are more capable of accommodating medium and long-term population shocks (as a special class of supply shocks) rather efficiently. This finding is supported by population survey data.

We found that this is not the case for Poland and Slovakia. Labor markets in these countries are described instead by a long-run relationship of equilibrium real wages explained by unemployment, capital stock and terms of trade. We have found that real wages are flexible in all countries, most likely owing to higher inflation relative to the original EU member countries. The prevalence of supply shocks implies that the labor supply is more rigid here and less able to adjust to population shocks. This makes estimating equilibrium unemployment rate a challenging task.

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A p p e n d i x 1

Unit Root Tests

Variable	Country	ADF test	p-value	KPSS test	p-value	PP test	p-value	KPSS 2	p-value
Terms of trade	Czech R.	–3.482464	0.0106	0.147976	p>0.1	–3.39688	0.0136		
	Hungary	–2.094843	0.2473	0.992243	p<0.01	–1.88052	0.3401		
	Poland	–1.385060	0.5862	0.627944	0.01<p<0.05	–5.77221	0		
	Slovakia	–1.547455	0.5052	1.205070	p<0.01	–1.08539	0.7188		
Unemployment rate	Czech R.	–1.513360	0.5224	0.698260	0.01<p<0.05	–0.991884	0.7534		
	Hungary	–1.402482	0.5773	0.171578	p>0.1 **	–1.036610	0.7369	7.181815	<0.01
	Poland	–1.809618	0.3737	0.584877	0.01<p<0.05	–0.590685	0.8665	13.96989	<0.01
	Slovakia	–0.868229	0.7940	0.664133	0.01<p<0.05	–0.591679	0.8663	45.67742	<0.01
Real wages	Czech R.	–0.099147	0.9456	1.176689	p<0.01	–0.180731	0.9361		
	Hungary	–0.566612	0.8715	1.047672	p<0.01	–0.371309	0.9086		
	Poland	–1.781414	0.3875	1.202406	p<0.01	–1.754122	0.4009		
	Slovakia	1.099715	0.9973	1.185269	p<0.01	0.733736	0.9923		
Real wages with trend	Czech R.	–1.117283	0.9200	0.226374	p<0.01	–1.351517	0.8684		
	Hungary	–2.682903	0.2463	0.168497	0.01<p<0.05	–1.224404	0.8991		
	Poland	–3.078849	0.1176	0.120934	0.05<p<0.1	–3.137332	0.1041	3.637906	<0.01
	Slovakia	–2.635622	0.2660	0.103053	p>0.1	–2.039374	0.5719	3.110544	<0.01
Capital stock with trend	Czech R.	–2.062451	0.5583	0.267140	p<0.01	–0.667066	0.9721		
	Hungary	–4.608211	0.0019	0.250823	p<0.01	–1.332483	0.8734		
	Poland	–3.143942	0.1032	0.222668	p<0.01	–1.399759	0.8547		
	Slovakia	–4.241837	0.0062	0.192816	0.01<p<0.05	–1.554903	0.8029		

Notes:
1. ADF – Augmented Dickey Fuller test, number of lags based on AIC, KPSS - Kwiatkowski-Phillips-Schmidt-Shin test, Newey-West automatic) using Bartlett kernel, KPSS2 – same with Spectral OLS AR based on SIC, PP – Phillips-Perron test, Newey-West automatic) using Bartlett kernel. Unless stated otherwise, the tests are without trend.
2. The ADF and PP tests have the null hypothesis that the series is non-stationary. The KPSS test has the null hypothesis that the series is stationary. Thus, in order to use the series in cointegreation analysis, the ADF and PP tests shall not reject the null hypothesis, but KPSS test shall. The complete distribution for KPSS test is not available, thus the interval, where p-value lies, is indicated.
3. The KPSS2 test was computed only in cases where we suspected that the default option does not fit the data well.

Source: Own computations.

A p p e n d i x 2

Johansen Tests

Test	Trace test			Maximum eigenvalue test		
Country \ H0	r = 0	r < =1	r < =2	r = 0	r < =1	r < =2
Czech Republic	34.74*	11.09	1.535	23.652*	9.551	1.535
Hungary	62.69*	28.80	8.163	33.890*	20.63	7.180
Poland	63.50*	27.42	9.669	36.077*	17.75	9.598
Slovakia	53.64*	21.30	8.321	32.339*	12.98	7.194

Notes: All tests are done for models with four lags, a constant in cointegrating space and linear trends in the data. Tests for r < =3 are not shown for space reasons, null hypothesis is never rejected. Asterisks mean rejection or the null hypothesis of the test at 5% significance level.

Source: Own computations.