What drives the labour wedge?
A comparison between CEE countries and the Euro Area

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Abstract

We use a structural macroeconomic model with search and matching frictions on the labour market to analyse the differences in the business cycle fluctuations of the labour wedge between two CEE countries and the Euro Area. Our results indicate that the observed higher volatility of this wedge in the CEE region reflects mainly different characteristics of stochastic disturbances rather than country-specific features of the labour market. We also find significant differences in the sources of labour wedge fluctuations across the considered economies. While the labour wedge dynamics in Poland is to large extent explained by shocks originating in the labour market, most of its variations in the Czech Republic and in the Eurozone are attributable to changes in households' preferences. Overall, our results suggest that labour market frictions in Poland are relatively more severe and generate fluctuations that are more harmful for social welfare.

JEL: E32, J64
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1 Introduction

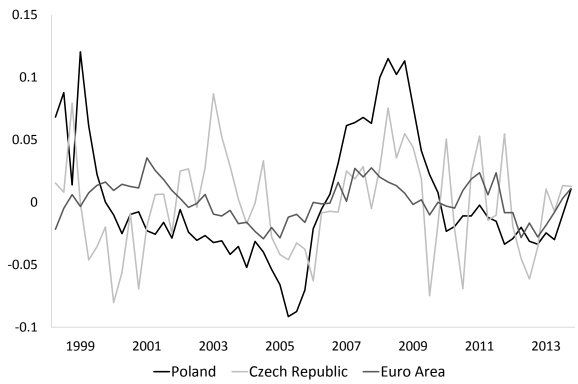
This paper investigates the differences in the labour wedge fluctuations in two Central and Eastern European (CEE) countries and the Euro Area (EA). We look at the labour wedge through the lens of a small open economy real business cycle (RBC) model with search and matching frictions on the labour market (see Pissarides 1985 and Mortensen and Pissarides 1994). We next use the constructed framework to evaluate the cyclical properties of the wedge and identify the stochastic disturbances affecting its volatility. The standard frictionless real business cycle model assumes that the wage should be equal to the firms' marginal product of labour (MPL) and the households' marginal rate of substitution (MRS). However, the data indicates that this relationship does not hold and that the labour wedge, defined as a gap between these two objects, is characterized by large cyclical variations.

The business cycle accounting framework proposed by Chari et al. (2007) clearly demonstrated that, along with the efficiency wedge, the labour wedge accounts for most of the variation in U.S. output. No wonder, then, that a lot of attention in the literature has been devoted to its behaviour. For example, Hall (1997) demonstrated that procyclical fluctuations in the gap between the observed components of MRS and MPL are crucial for employment dynamics. Sala et al. (2010) found close correspondence between the output gap and the labour wedge. Galí et al. (2007) decomposed the labour wedge into price and wage mark-ups and used it to measure the welfare costs of business cycles in the U.S.

More recently, Shimer (2009) and Pescatori and Tasci (2011) showed that search and matching frictions do not help to explain fluctuations in the labour wedge per se. However, as Shimer pointed out, subsidiary assumptions in the search models, especially alternative concepts of the wage setting, may help to solve this problem. Karabarbounis (2014) argued that the labour wedge dynamics reflects predominantly fluctuations in the gap between the real wage and the households' marginal rate of substitution, rather than between the wage and the firms' marginal product of labour. Cheremukhin and Restrepo-Echavarria (2014) used an RBC model with search and matching frictions to decompose the wedge into exogenous separation, bargaining and matching shocks and found that wedge variations are to large extent attributable to changes in the matching efficiency.

It has been empirically proved that the labour wedge in CEE countries is characterized by higher variability than in the EA (see Gradzewicz et al. 2012 for evidence for Poland). Figure 1 presenting the series of the labour wedge in Poland, the Czech Republic and the EA confirms that this wedge in CEE economies is much more volatile. The importance of the MRS-MPL gap for output fluctuations in the Euro Area and, even more notably, in the CEE countries was reported by Kolasa (2013). However, it is still unclear what the source of the difference in the labour wedge volatilities in these economies is. This paper aims to clarify this issue by estimating a macroeconomic model for the Eurozone, Poland and the Czech Republic and using it to identify the main driving forces of the labour wedge variations. We choose Poland and the Czech Republic as the representatives of the CEE region as these economies seem to be respectively the least and the most similar to the Euro Area in terms of the importance of the labour wedge fluctuations for output evolution (see Kolasa 2013).

Figure 1: Cyclical component of the labor wedge



Notes: The labour wedge is calculated according to formula (52) defined in section 2.7 with the parameters set at their posterior means (see section 3.3). The series used are HP-filtered.

The model economy used in our analysis consists of households, two firm sectors, the government and the exogenous foreign economy. The real wage setting mechanism is based on the standard Nash bargaining between the worker and the firm. Additionally, in order to improve model's data fit, our framework includes real wage rigidity and habit persistence in consumption[1].

By employing Bayesian methods, the constructed model is estimated separately for Poland, the Czech Republic and the Euro Area on seven macroeconomic variables, including real GDP for home and foreign economies, households' and government consumption, the unemployment rate, real wages and the number of vacancies. Conformable with the number of variables, the model includes seven structural shocks. The set of stochastic disturbances contains three labour market shocks affecting the job destruction rate, the cost of hiring and workers' bargaining power, as well as four standard shocks used in small open economy frameworks (one supply shock affecting productivity, two

[1]The labour wedge fluctuations may be affected not only by labour market frictions, but also by other types of market imperfections, in particular product market imperfections. However, estimation of a model with sticky prices and mark-up shocks has demonstrated that the role of such product market frictions for the labour wedge dynamics in the analysed economies is negligible.

demand shocks to households' preferences and to government spending, and a shock to foreign output).

We first analyse the variance decomposition of the labour wedge and show that the forces driving its volatility differ across the analysed economies. While the dynamics of the gap between MRS and MPL in Poland can be attributed mainly to labour market disturbances, the consumption preference shock is the main force behind the wedge variability in the Euro Area and the Czech Republic. The bigger role of the labour market disturbances in Poland may suggest that the labour market in this country functions less smoothly, with negative consequences for welfare.

In the second step we perform some counterfactual simulations which indicate that the differences in volatilities of the labour wedge in the analysed economies result primarily from the distinct characteristics of stochastic disturbances. However, in Poland the labour market structure also plays some role in explaining the differences vis-à-vis the EA. More precisely, the elasticity of the matching process with respect to unemployment and workers' bargaining power contribute to higher variability of the wedge in this country. The impact of heterogeneity in these parameters between the EA and the Czech Republic is rather marginal.

Overall, we find heterogeneity in term of the labour wedge fluctuations within the CEE region. The Czech Republic stands out as more similar to the EA, not only in the wedge volatility, but also in its driving forces. Poland appears to be structurally different and the frictions in this country may be more costly for welfare.

The rest of this paper is organized as follows. The next section lays out the model setup. Section 3 presents the calibration and estimation procedures. Section 4 discusses the results. The last section concludes.

2 Model economy

2.1 Households

The economy is populated by a number of infinitely-lived households with the continuum of members of measure unity. The fraction of currently employed family members is N_t, whereas the number of unemployed household members is $U_t = 1 - N_t$. The family provides a perfect consumption insurance for its members, implying that consumption is the same for both employed and unemployed workers (Merz 1995). An instantaneous utility is a function of consumption basket C_t, to be defined below, and the labour effort N_t. A typical household maximizes the lifetime utility (1) subject to the sequence of the budget constraints (2) and the physical capital accumulation equations (3)

$$\max_{C_t,K_{t+1},I_t,D_{t+1}} E_0 \sum_{t=0}^{\infty} \beta^t \varepsilon_{\beta,t} \left(\frac{\left(C_t - h\tilde{C}_{t-1}\right)^{1-\zeta}}{1-\zeta} - \kappa^L \frac{N_t^{1+\phi}}{1+\phi} \right) \tag{1}$$

$$P_t C_t + P_t^I I_t + T_t + E_t[Q_{t,t+1} D_{t+1}] = P_t b U_t + W_t N_t + R_t K_t + \Pi_t + D_t \tag{2}$$

$$K_{t+1} = K_t(1-\delta) + I_t \tag{3}$$

where E_t denotes the expectation operator taken at time t, β is the discount factor, h is the external habit motive, $\tilde{C}_t$ denotes the average consumption, κ^L is the parameter scaling the disutility of work, ζ is the inverse of intertemporal substitution elasticity, ϕ stands for the inverse of the Frisch elasticity of labour supply, P_t is the price for the consumption bundle C_t, P_t^I denotes the price for the investment bundle I_t, T_t stands for the nominal government taxes, D_t is the portfolio of Arrow-Debreu securities, $Q_{t,t+1}$ is the stochastic discount factor, b refers to the real unemployment benefits, R_t is the nominal rental rate of capital K_t, δ is the depreciation rate, and $\varepsilon_{\beta,t}$ denotes the preference shock that obeys

$$ln\left(\varepsilon_{\beta,t}\right) = \rho_\beta ln\left(\varepsilon_{\beta,t-1}\right) + \epsilon_{\beta,t} \tag{4}$$

and where all innovations, including $\epsilon_{\beta,t}$ are zero-mean i.i.d. random variables.
The consumption bundle C_t consists of home-made goods $C_{H,t}$ and foreign-made goods $C_{F,t}$ aggregated according to

$$C_t = \left(\alpha'^{\frac{1}{\omega'}} \left(C_{H,t}\right)^{\frac{\omega'-1}{\omega'}} + \left(1-\alpha'\right) \left(C_{F,t}\right)^{\frac{\omega'-1}{\omega'}} \right)^{\frac{\omega'}{\omega'-1}} \tag{5}$$

The optimal allocation of the expenditures between the domestic and imported goods is given by

$$C_{H,t} = \alpha' \left(\frac{P_t}{P_{H,t}}\right)^{-\omega'} C_t \qquad C_{F,t} = \left(1-\alpha'\right) \left(\frac{P_t}{P_{F,t}}\right)^{-\omega'} C_t \tag{6}$$

where $P_{H,t}$ denotes the price of domestic goods, $P_{F,t}$ stands for the price of imported goods and the aggregate price P_t is given by

$$P_t = \left(\alpha' \left(P_{H,t}\right)^{1-\omega'} + \left(1-\alpha'\right)\left(P_{F,t}\right)^{1-\omega'}\right)^{\frac{1}{1-\omega'}} \tag{7}$$

The investment bundle I_t is aggregated in the similar fashion as the consumption good, which implies the following definitions

$$I_t = \left(\alpha''^{\frac{1}{\omega''}} \left(I_{H,t}\right)^{\frac{\omega''-1}{\omega''}} + \left(1-\alpha''\right)\left(I_{F,t}\right)^{\frac{\omega''-1}{\omega''}}\right)^{\frac{\omega''}{\omega''-1}} \tag{8}$$

$$I_{H,t} = \alpha' \left(\frac{P_t^I}{P_{H,t}}\right)^{-\omega''} I_t \qquad I_{F,t} = \left(1-\alpha''\right)\left(\frac{P_t^I}{P_{F,t}}\right)^{-\omega''} I_t \tag{9}$$

$$P_t^I = \left(\alpha'' \left(P_{H,t}\right)^{1-\omega''} + \left(1-\alpha''\right)\left(P_{F,t}\right)^{1-\omega''}\right)^{\frac{1}{1-\omega''}} \tag{10}$$

2.2 Labour market

Household members are employed by intermediate firms indexed by i on the unit interval. In order to attract and employ new workers, the intermediate producers need to post vacancies. The matching process which describes how the vacancies and the unemployed workers get together is given by the standard Cobb-Douglas matching technology

$$M_t = \sigma^m U_t^{\sigma} V_t^{1-\sigma} \tag{11}$$

where M_t is the number of new matches, σ^m is the parameter describing the matching efficiency and V_t is the number of vacant jobs. The aggregate labour market tightness is defined as

$$\theta_t = \frac{V_t}{U_t} \tag{12}$$

An average probability that a searching worker finds a job is given by

$$s_t = \frac{M_t}{U_t} = \sigma^m \theta_t^{1-\sigma} \tag{13}$$

Similarly, an average probability that the firm fills the vacancy is given by

$$q_t = \frac{M_t}{V_t} = \sigma^m \theta_t^{-\sigma} \tag{14}$$

Each period the exogenous fraction ϱ_t of employed workers is separated from their jobs. Additionally, the total workforce is enlarged by the flows from unemployment to employment from the previous period (Gertler and Trigari 2009; Moyen and Sahuc 2005). The employment law of motion is thus given by

$$N_t = (1-\varrho_t)N_{t-1} + M_{t-1} \tag{15}$$

where ϱ_t is assumed to follow AR(1) process

$$ln(\varrho_t) = (1 - \rho_\varrho)ln(\varrho) + \rho_\varrho ln(\varrho_{t-1}) + \epsilon_{\varrho,t} \tag{16}$$

and where ϱ represents the steady state job destruction rate.

2.3 Firms

In our economy there are two sectors of production. Firms in the first sector produce the differentiated goods using the labour and capital rented from households. The firms in the second sector aggregate the differentiated intermediate goods into a homogeneous final good Y_t and sell it at price $P_{H,t}$.

2.3.1 Final good producers

The final good producers operate in the perfectly competitive environment. They take the differentiated intermediate goods indexed by i on the unit interval and bundle them according to Dixit-Stiglitz technology (18). In order to maximize their profits, they solve the following problem

$$\max_{Y_t(i),Y_t} P_{H,t}Y_t - \int_0^1 P_{H,t}(i)Y_t(i)di \tag{17}$$

subject to

$$Y_t = \left(\int_0^1 Y_t(i)^{\frac{1}{\mu}} di\right)^{\mu} \tag{18}$$

where μ denotes the intermediate producers' gross price mark-up. The price level satisfying the zero-profit condition is defined by

$$P_{H,t} = \left(\int_0^1 P_{H,t}(i)^{\frac{1}{1-\mu}} di\right)^{1-\mu} \tag{19}$$

2.3.2 Intermediate goods producers

Intermediate firms use the capital and labour as the input in their production process. They also have to pay the real cost κ_t^v for posting vacant jobs. Their aim is to maximize profits (20) facing the demand of the final producers (21), constant return to scale Cobb-Douglas production technology (22) and the law of motion for employment (23)

$$\max_{\substack{Y_t(i),K_t(i),N_t(i),\\ P_{H,t}(i),V_t(i)}} \sum_{t=0}^{\infty} \beta_{0,t} \left[P_{H,t}(i)Y_t(i) - W_t(i)N_t(i) - P_{H,t}\kappa_t^v V_t(i) - R_t K_t(i)\right] \tag{20}$$

subject to

$$Y_t(i) = \left(\frac{P_{H,t}(i)}{P_{H,t}}\right)^{-\frac{\mu}{\mu-1}} Y_t \tag{21}$$

$$Y_t(i) = Z_t K_t(i)^{\alpha} N_t(i)^{1-\alpha} \tag{22}$$

$$N_t(i) = (1 - \varrho_t) N_{t-1}(i) + q_{t-1} V_{t-1}(i) \tag{23}$$

where $\beta_{0,t}$ is the equilibrium stochastic discount factor consistent with households' preferences and is given by

$$\beta_{t,t+s} = \beta^s E_t \left[\frac{\lambda_{t+s}}{\lambda_t} \right] = \beta^s E_t \left[\frac{\epsilon_{\beta,t+s} u_C(C_{t+s}, N_{t+s})}{\epsilon_{\beta,t} u_C(C_t, N_t)} \right] \tag{24}$$

and where the productivity Z_t and the real hiring cost κ_t^v are given by exogenous AR(1) processes

$$ln(Z_t) = \rho_z ln(Z_{t-1}) + \epsilon_{z,t} \tag{25}$$

$$ln\left(\kappa_t^v\right) = (1 - \rho_v)\, ln\left(\kappa^v\right) + \rho_v ln\left(\kappa_{t-1}^v\right) + \epsilon_{v,t} \tag{26}$$

2.3.3 Wage setting

Forming the match entails economic rents which have to be shared between two parties of the matching process i.e. a worker and a firm. We assume that the way in which the overall surplus from the match is divided is determined in the standard generalized Nash bargaining. Taking into account that problems of all agents in the model are symmetric, we can omit the i indices in all the equations below.
The value for the household of having employed worker earning the real wage w_t is given by the combination of the wage income, the utility loss from working and the continuation value. With probability $1 - \varrho_{t+1}$ the worker will stay employed for the next period and with probability ϱ_{t+1} he will lose his job. The value of the worker when employed is thus given by

$$\mathcal{V}_t^W = w_t - \kappa^L \frac{N_t^{\phi}}{(C_t - h\tilde{C}_{t-1})^{-\zeta}} + E_t \beta_{t,t+1} \left[(1 - \varrho_{t+1}) \mathcal{V}_{t+1}^W + \varrho_{t+1} \mathcal{V}_{t+1}^U \right] \tag{27}$$

The value of the unemployed worker is defined by

$$\mathcal{V}_t^U = b + E_t \beta_{t,t+1} \left[s_t \mathcal{V}_{t+1}^W + (1 - s_t) \mathcal{V}_{t+1}^U \right] \tag{28}$$

In the current period, an unemployed receives an unemployment benefit b and has a chance equal to s_t of finding a job in the next period. With probability equal to $1 - s_t$, the worker stays unemployed.

The household's surplus from having employed rather than unemployed member is given by

$$S_t^W = w_t - \kappa^L \frac{N_t^\phi}{(C_t - h\tilde{C}_{t-1})^{-\varsigma}} - b + E_t\beta_{t,t+1}(1 - \varrho_{t+1} - s_t)S_t^W \tag{29}$$

The firm's value of the job matched to the worker who receives the real wage w_t is given by

$$\mathcal{V}_t^J = mc_t f_{N,t} - w_t + E_t\beta_{t,t+1}\left[(1 - \varrho_{t+1})\mathcal{V}_{t+1}^J + \varrho_{t+1}\mathcal{V}_{t+1}^V\right] \tag{30}$$

Here mc_t denotes the real marginal cost of the i-th intermediate producer, which, multiplied by the marginal product of labour $f_{N,t}$ gives the workers contribution to the firm's profits. In the next period, with probability $1 - \varrho_{t+1}$ the job will be still matched with the worker and with probability ϱ_{t+1} the match will be separated. The value of an open vacancy for the firm is given by

$$\mathcal{V}_t^V = -\frac{P_{H,t}}{P_t}\kappa_t^v + E_t\beta_{t,t+1}\left[q_t\mathcal{V}_{t+1}^J + (1 - q_t)\mathcal{V}_{t+1}^V\right] \tag{31}$$

Due to the free entry into vacancy posting, having vacant jobs by the firm is economically worthless, i.e. $\mathcal{V}_t^V = 0$ at any time t. Thus, the total firm's surplus from the match is given by

$$S_t^F = mc_t f_{N,t} - w_t + E_t\beta_{t,t+1}(1 - \varrho_{t+1})S_{t+1}^F \tag{32}$$

The negotiated wage depends on the relative bargaining strength of both match participants and satisfies

$$w_t^N = argmax\ (S_t^W)^{\eta_t}(S_t^F)^{1-\eta_t} \tag{33}$$

The workers' bargaining power η_t is assumed to evolve according to

$$ln\,(\eta_t) = (1 - \rho_\eta)\,ln\,(\eta) + \rho_\eta ln\,(\eta_{t-1}) + \epsilon_{\eta,t} \tag{34}$$

where η is the steady state workers' bargaining power. Solving the problem above and using the definitions of firm's and worker's surpluses gives the equation for the negotiated wage level w_t^N

$$w_t^N = (1 - \eta_t)\left[b + \kappa^L \frac{N_t^\phi}{(C_t - h\tilde{C}_{t-1})^{-\varsigma}}\right] + \eta_t\left[mc_t f_{N,t} + \frac{P_{H,t}}{P_t}\kappa_t^v\theta_t\right] \tag{35}$$

It is empirically proven that the models with fully flexible wages fail in reflecting the dynamics of the labour market variables (Blanchard and Galí 2010, Shimer 2005). As a result, many forms of wage rigidities were proposed in the literature. In our model we use the adaptive wage introduced by Hall (2005), according to which the current level of wage is set as the weighted average of the wage from the previous period and the Nash bargaining solution. Thus, the average real wage level is given by

$$w_t = \alpha_w w_t^N + (1 - \alpha_w) w_{t-1} \tag{36}$$

where $1 - \alpha_w$ describes the degree of wage rigidity.

2.4 Government

The government levies lump-sum taxes T_t on households and spends them on government consumption g_t and unemployment benefits b. We assume that the government consumes only domestic goods implying that the price of government consumption is $P_{H,t}$. The government budget constraint satisfies

$$P_{H,t} g_t + P_t b U_t = T_t. \tag{37}$$

where government consumption g_t is given by exogenous AR(1) process

$$ln(g_t) = (1 - \rho_g) ln(g) + \rho_g ln(g_{t-1}) + \epsilon_{g,t} \tag{38}$$

and where g is the steady state level of government spending.

2.5 Foreign economy, exchange rate and exports

We assume that the domestic economy is "small" compared to the foreign one. Thus, anything that happens abroad is completely unaffected by what happens in the domestic economy. Therefore, foreign output is exogenous and follows the AR(1) process

$$ln\left(\frac{Y_t^*}{Y^*}\right) = \rho_y ln\left(\frac{Y_{t-1}^*}{Y^*}\right) + \epsilon_{y,t} \tag{39}$$

where Y^* is the steady state value of foreign GDP.
Moreover, we assume that the law of one price holds at all times, which, given that the problems of all agents are symmetric and all firms choose the same price, implies that

$$P_{F,t} = e_t P_t^* \tag{40}$$

where e_t is the nominal exchange rate and P_t^* denotes foreign goods price measured in foreign currency. Following Galí and Monacelli (2005), we also define the bilateral real exchange rate Q_t as the ratio of foreign and domestic Consumer Price Indices, both measured in domestic currency

$$Q_t = \frac{e_t P_t^*}{P_t} \tag{41}$$

Since international markets are complete, the real exchange rate can also be expressed as follows (Chari et al. 2002)

$$\frac{\lambda_t^*}{\lambda_t} = \frac{1}{\varepsilon_{\beta,t}} \left(\frac{C_t^* - h\tilde{C}_{t-1}^*}{C_t - h\tilde{C}_{t-1}} \right)^{-\zeta} = Q_t \tag{42}$$

where C_t^* is foreign consumption. In the equation above we assume that the world economy is characterized by the same households' preferences as the domestic one and there are no preference shocks abroad.
Finally, we define the total demand for domestically produced goods by foreigners as (Christiano et al. 2011)

$$X_t = \psi \left(\frac{P_{H,t}}{e_t P_t^*} \right)^{-\omega} Y_t^* \tag{43}$$

where X_t denotes exports, ψ is the exports scaling parameter and ω represents the relative price elasticity of demand for exports.

2.6 Market clearing

Several market clearing conditions must hold in the equilibrium. Firstly, the total demand for capital by all intermediate producers has to be equal to its supply offered by households

$$K_t = \int_0^1 K_t(i)di \tag{44}$$

Similarly, the aggregate numbers of employed workers and vacancies have to satisfy

$$N_t = \int_0^1 N_t(i)di \tag{45}$$

$$V_t = \int_0^1 V_t(i)di \tag{46}$$

Moreover, net foreign assets in the equilibrium are given by

$$E_t \left[Q_{t,t+1} D_{t+1} \right] = D_t + NX_t \tag{47}$$

where NX_t denotes net exports and is defined by

$$NX_t = P_{H,t} X_t - P_{F,t}(C_{F,t} + I_{F,t}) \tag{48}$$

Using the equations above and combining the budget constraints of all agents of the model yields the standard resource constraint in the final goods market, which is given by

$$Y_t = C_{H,t} + I_{H,t} + g_t + \kappa_t^v V_t + X_t \tag{49}$$

Finally, we have to ensure that the market of final foreign goods clears. Assuming that there is no distinction between the investment and consumption goods abroad, the world market clearing condition can be stated as follows

$$C_t^* = Y_t^* \tag{50}$$

2.7 Labour wedge

Following Chari et al. (2007), we define the labour wedge as a difference between households' (log) marginal rate of substitution and firm's (log) marginal product of labour

$$wedge_t = mrs_t - mpl_t \tag{51}$$

Using the functional forms of the production technology and the utility function, we get that the labour wedge is, up to an additive constant, given by the following formula

$$wedge_t = \left(\phi \hat{N}_t + \zeta \frac{\hat{C}_t - h\hat{C}_{t-1}}{1-h}\right) - \left(\hat{Y}_t - \hat{N}_t\right) \tag{52}$$

where the variables with hats denote the log deviations from the deterministic steady state.

3 Calibration and estimation

3.1 Data

We estimate the log-linearized version of the model separately for Poland, the Czech Republic and the Eurozone (comprising 18 member countries). Consistently with the number of structural shocks in the model, for the estimation we employ seven observable macroeconomic variables: output (measured as real GDP), consumption (measured as the final consumption expenditure of households for the CEE countries and, due to the lack of relevant data, as the final consumption expenditure of households and non-profit institutions serving households for the EA), government consumption (the final consumption expenditure of general government), unemployment (the unemployment rate), vacancies (total unfilled job vacancies), wages (real wage per employee in Poland and in the Eurozone and real compensation per employee in the Czech Republic) and foreign output (real GDP of the Euro Area (18 countries) in the model for the CEE economies and real GDP of the U.S. in the model for the EA).

Most of the time series are taken from the Eurostat. However, due to the lack of several variables in this database, we also use other data sources. Thus, the time series of wage per employee in Poland comes from the Polish Central Statistical Office (GUS). The data on wage per employee and the unemployment rate in the Euro Area is taken from the Area-Wide-Model database. The measure of vacancies for all three considered economies is taken from the OECD statistics. As the number of vacancies in the Euro Area is not readily available, we construct the measure of vacancies by calculating the population-weighted average from the individual data from six EA member countries[2]. The sample starts from 1997q1 and ends in 2013q4, except for the Czech time series that are available from 1998q1. All data used in the estimation of the model is expressed in quarterly frequency, seasonally adjusted and expressed in constant prices from the year 2005. Since in the theoretical model the size of the labour force is normalized to unity, all variables used in estimation are expressed in per labour force terms. As the model is stationary, we detrend the logs of all data using the Hodrick-Prescott filter ($\lambda = 1600$).

In order to fit the model to the data, we apply the mixture of calibration and estimation. First, we calibrate the important steady state ratios and the parameters for which there is not enough information in the data. Then, we perform the Bayesian estimation for the rest of the parameters.

[2]For constructing the EA vacancy index we use data from Austria, Finland, Germany, Luxembourg, Portugal and Holland. Data from the entire analysed sample for the rest of EA member is not available.

3.2 Calibration

Table 1 presents the important calibrated parameters and steady state ratios. Most of the parameters are consistent with the standard DSGE models (see Smets and Wouters 2003 and Gomes et al. 2012).

The steady state government spending g is calibrated in order to satisfy the government spending to output ratios of 0.177 for the Polish economy, 0.211 for the Czech Republic and 0.207 for the EA. The output elasticity for capital α is set to meet investment to output ratios equal to 0.205 for Poland, 0.260 for the Czech Republic and 0.201 for the EA. The scaling parameter in the households' utility function κ^L targets the steady state unemployment rates of 0.132 for Poland, 0.072 for the Czech Republic and 0.095 for the Eurozone. All the above steady state ratios are computed as the averages over the collected data sample.

Table 1: Important calibrated parameters and steady state ratios

Parameter/steady state ratio	Value		
	PL	CZ	EA
β	0.990	0.990	0.990
δ	0.025	0.025	0.025
μ	1.100	1.100	1.100
α	0.316	0.401	0.310
α'	0.751	0.614	0.859
α''	0.521	0.479	0.608
κ^L	1.150	0.864	1.355
ϱ	0.029	0.029	0.035
σ^m	0.346	0.456	0.414
$\frac{\kappa^v V}{Y}$	0.005	0.005	0.005
$\frac{b}{w}$	0.480	0.565	0.557
$\frac{g}{Y}$	0.177	0.211	0.207

The import content of households' consumption $1-\alpha'$ and the import content of total investment $1-\alpha''$ are set to respectively 0.249 and 0.479 for Poland, 0.386 and 0.521 for the Czech Republic (Bussière et al. 2013) and 0.141 and 0.393 for the Eurozone (Brzoza-Brzezina et al. 2014). The steady state job destruction rate ϱ for both Polish and Czech economies is calibrated to 0.029 (Hobijn and Sahin 2007). The steady state separation rate in the Euro Area is set to 0.035 which is the population-weighted average of separation rates from eleven EA member states documented by Hobijn and Sahin (2007)[3].

[3]Hobijn and Sahin (2007) documented the job destruction rates for the following EA members: Belgium, Finland. France, Germany, Greece, Ireland, Italy, Luxembourg, Holland, Portugal and Spain.

Similarly, the steady state replacement rate $\frac{b}{w}$ in the EA is set as the population-weighted average over the replacement rates from seventeen EA member states (except Cyprus) available in the OECD's Benefits and Wages statistics. In order to calculate the replacement rates for the individual countries, we use data from 2012, which is the last vintage available, and take the simple average over the replacement rates for the initial phase of unemployment and long-term unemployment, different family types and earnings levels[4]. The replacement rate computed in such way is equal to 0.480 for Poland, 0.565 for the Czech Republic and 0.557 for the EA.

The discount factor β in all three economies is set to 0.99, which is common in the models estimated on quarterly data. The capital depreciation rate δ is set at 0.025, in line with the DSGE literature. The gross price mark-up μ is calibrated to the standard value of 1.1. Lacking any direct evidence about the steady state vacancy filling probabilities q, we set the efficiency of the matching process σ^m in order to meet $q = 0.7$. This value is commonly used in the models for the U.S. (Trigari 2006) and the EA (Christoffel et al. 2009). The real vacancy posing cost κ^v is calibrated to meet the steady state hiring costs to output ratio of 0.5%, which is somewhere in between the values used in the search literature (see e.g. Christoffel et al. 2009 and Blanchard and Galí 2010).

3.3 Estimation results

For estimation purposes, we employ the Bayesian approach. The posterior distribution is explored by generating draws with the use of Markov-Chain Monte-Carlo algorithm, Metropolis-Hastings implementation. In order to estimate the model, we use the Dynare package. We use the Metropolis-Hastings algorithm with 700 000 draws in two independent chains (first 350 000 draws are dropped) and an acceptance rate equal to about 24%. The convergence of Markov Chains is evaluated using the Brooks and Gelman diagnostics charts (1998).

The choice of prior distributions for the estimated parameters is based mainly on Smets and Wouters (2003), Christoffel et al. (2009), Adolfson et al. (2007) and, to some extent, preliminary experimentation with the model. Generally, the prior distributions for structural parameters and shock properties do not differ across the three economies. The only exceptions here are autoregressive coefficients in the government spending and the foreign output equations which are determined on the basis of the estimation of AR(1) processes outside the model. The prior distributions together with the estimation results are reported in Table 2 (structural parameters), Table 3 (shocks' persistence) and

[4]The OECD reports net replacement rates for six family categories: single person, one-earner married couple, two-earner married couple, lone parent with 2 children, one-earner married couple with 2 children and two-earner married couple with 2 children. We consider the replacement rates when the pre-unemployment income is 67% and 100% of the income of an average production worker.

Table 4 (shocks' standard deviations). The graphical representation of the estimation results is presented in the Appendix.

Table 2: Estimation results - structural parameters

	Prior distribution			Posterior distribution		
	Type	Mean	SD	5%	Mean	95%
Poland						
ζ	gamma	2.00	0.25	1.327	1.668	1.988
ϕ	gamma	2.00	0.25	1.516	1.924	2.311
h	beta	0.70	0.10	0.273	0.391	0.512
σ	beta	0.60	0.10	0.441	0.549	0.657
η	beta	0.50	0.10	0.493	0.620	0.745
α_w	beta	0.50	0.10	0.393	0.498	0.604
ω	gamma	1.50	0.30	1.050	1.534	2.024
ω'	gamma	1.50	0.30	1.083	1.513	1.993
ω''	gamma	1.50	0.30	1.011	1.501	1.970
Czech Republic						
ζ	gamma	2.00	0.25	1.383	1.712	2.039
ϕ	gamma	2.00	0.25	1.540	1.938	2.325
h	beta	0.70	0.10	0.453	0.564	0.671
σ	beta	0.60	0.10	0.631	0.703	0.774
η	beta	0.50	0.10	0.393	0.505	0.623
α_w	beta	0.50	0.10	0.457	0.567	0.678
ω	gamma	1.50	0.30	1.186	1.695	2.201
ω'	gamma	1.50	0.30	1.063	1.567	2.066
ω''	gamma	1.50	0.30	1.039	1.536	2.032
Euro Area						
ζ	gamma	2.00	0.25	1.403	1.733	2.060
ϕ	gamma	2.00	0.25	1.535	1.930	2.321
h	beta	0.70	0.10	0.336	0.486	0.645
σ	beta	0.60	0.10	0.636	0.714	0.792
η	beta	0.50	0.10	0.293	0.433	0.578
α_w	beta	0.50	0.10	0.144	0.220	0.290
ω	gamma	1.50	0.30	1.126	1.781	2.306
ω'	gamma	1.50	0.30	1.094	1.613	2.134
ω''	gamma	1.50	0.30	1.063	1.574	2.072

Although the model structure and the prior distributions of parameters are basically the same for all considered economies, there are some important differences in the posterior point estimates of the labour market parameters. The degree of wage rigidity in both CEE countries is rather comparable, but lower than in the EA, which seems to be quite reasonable (see Kolasa 2009 and Gradzewicz and Makarski 2013). The estimate of parameters describing the elasticity of the matching process with respect to unemployment in the Czech Republic resemble more the one observed in the EA. While in the Polish economy the share of the unemployed in the matching technology is relatively low, the opposite is true for the Czech Republic and the Eurozone. Moreover, the point estimates indicate that the employees in Poland have higher bargaining power than in the Czech Republic and the EA.

Table 3: Estimation results - shocks' persistence

	Prior distribution			Posterior distribution		
	Type	Mean	SD	5%	Mean	95%
Poland						
ρ_β	beta	0.50	0.20	0.105	0.288	0.459
ρ_z	beta	0.50	0.20	0.656	0.778	0.904
ρ_g	beta	0.58	0.01	0.563	0.580	0.596
ρ_y	beta	0.90	0.01	0.889	0.904	0.920
ρ_ϱ	beta	0.50	0.20	0.288	0.449	0.614
ρ_v	beta	0.50	0.20	0.801	0.865	0.932
ρ_η	beta	0.50	0.20	0.032	0.148	0.256
Czech Republic						
ρ_β	beta	0.50	0.20	0.122	0.297	0.468
ρ_z	beta	0.50	0.20	0.743	0.835	0.925
ρ_g	beta	0.55	0.01	0.534	0.550	0.566
ρ_y	beta	0.90	0.01	0.888	0.903	0.919
ρ_ϱ	beta	0.50	0.20	0.476	0.620	0.760
ρ_v	beta	0.50	0.20	0.825	0.887	0.950
ρ_η	beta	0.50	0.20	0.028	0.133	0.232
Euro Area						
ρ_β	beta	0.50	0.20	0.477	0.644	0.814
ρ_z	beta	0.50	0.20	0.713	0.786	0.860
ρ_g	beta	0.88	0.01	0.863	0.880	0.896
ρ_y	beta	0.86	0.01	0.847	0.863	0.876
ρ_ϱ	beta	0.50	0.20	0.594	0.721	0.853
ρ_v	beta	0.50	0.20	0.837	0.894	0.950
ρ_η	beta	0.50	0.20	0.084	0.236	0.384

The estimate of the relative risk aversion coefficient and the Frisch elasticity of the labour supply are similar in each considered economy. The dataset is rather uninformative on the elasticities of substitution in the consumption, investment and exports functions and the posterior distributions of these parameters are very similar to their prior equivalents. Generally, the magnitude of the shocks hitting Polish and Czech economies is substantially larger than the size of shocks identified for the EA. The shocks in the Eurozone are, however, more persistent.

Table 4: Estimation results - shocks' standard deviations

	Prior distribution			Posterior distribution		
	Type	Mean	SD	5%	Mean	95%
Poland						
ϵ_β	inv. gamma	0.01	inf	0.013	0.020	0.025
ϵ_z	inv. gamma	0.01	inf	0.005	0.006	0.007
ϵ_g	inv. gamma	0.01	inf	0.009	0.011	0.012
ϵ_y	inv. gamma	0.01	inf	0.005	0.006	0.006
ϵ_ϱ	inv. gamma	0.10	inf	0.090	0.107	0.123
ϵ_v	inv. gamma	0.10	inf	0.090	0.117	0.143
ϵ_η	inv. gamma	0.10	inf	0.093	0.190	0.283
Czech Republic						
ϵ_β	inv. gamma	0.01	inf	0.023	0.033	0.043
ϵ_z	inv. gamma	0.01	inf	0.006	0.007	0.008
ϵ_g	inv. gamma	0.01	inf	0.016	0.018	0.021
ϵ_y	inv. gamma	0.01	inf	0.005	0.006	0.006
ϵ_ϱ	inv. gamma	0.10	inf	0.066	0.078	0.089
ϵ_v	inv. gamma	0.10	inf	0.119	0.142	0.163
ϵ_η	inv. gamma	0.10	inf	0.093	0.165	0.235
Euro Area						
ϵ_β	inv. gamma	0.01	inf	0.008	0.014	0.020
ϵ_z	inv. gamma	0.01	inf	0.004	0.005	0.005
ϵ_g	inv. gamma	0.01	inf	0.003	0.003	0.003
ϵ_y	inv. gamma	0.01	inf	0.005	0.006	0.007
ϵ_ϱ	inv. gamma	0.10	inf	0.030	0.035	0.040
ϵ_v	inv. gamma	0.10	inf	0.050	0.061	0.071
ϵ_η	inv. gamma	0.10	inf	0.094	0.196	0.295

4 Results

4.1 Model's data fit

In order to assess the ability of the model to reflect the data dynamics, we compare the theoretical moments generated by the model with those observed in the data, see Table 5. The time series of the labour wedge is calculated using the data on consumption, employment and output and the posterior means of parameters from the utility function.

Table 5: Comparison of theoretical moments and moments from the data

	Standard deviation		Correlation wih GDP		Autocorrelation	
	Model	Data	Model	Data	Model	Data
Poland						
Y	0.018	0.014	1.000	1.000	0.922	0.883
C	0.014	0.011	0.592	0.798	0.829	0.746
U	0.010	0.013	-0.559	-0.729	0.942	0.945
V	0.209	0.177	0.071	0.492	0.697	0.881
w	0.016	0.013	0.484	0.488	0.770	0.739
g	0.013	0.014	-0.009	0.308	0.580	0.585
Y^*	0.013	0.012	0.396	0.705	0.904	0.896
wedge	0.037	0.049	0.415	0.668	0.746	0.869
Czech Republic						
Y	0.022	0.019	1.000	1.000	0.936	0.891
C	0.017	0.011	0.557	0.462	0.853	0.652
U	0.007	0.008	-0.349	-0.630	0.930	0.915
V	0.272	0.289	0.202	0.806	0.789	0.926
w	0.020	0.017	0.638	0.699	0.742	0.692
g	0.022	0.022	-0.014	-0.463	0.550	0.550
Y^*	0.013	0.013	0.472	0.879	0.903	0.898
wedge	0.041	0.039	0.072	0.192	0.478	0.423
Euro Area						
Y	0.012	0.012	1.000	1.000	0.912	0.896
C	0.011	0.006	0.545	0.785	0.910	0.852
U	0.004	0.005	-0.435	-0.852	0.936	0.935
V	0.134	0.149	0.168	0.822	0.760	0.957
w	0.008	0.003	0.688	0.248	0.935	0.804
g	0.006	0.006	-0.013	-0.378	0.880	0.877
Y^*	0.012	0.012	0.347	0.605	0.863	0.861
wedge	0.022	0.016	0.245	0.610	0.700	0.730

Given the purpose of this study, we focus mainly on the model's ability to match the moments of the labour market variables, i.e. the unemployment rate, the number of vacancies, real wages and the labour wedge. All in all, we can state that although the data fit is not ideal, the general patterns observed in the data are well reflected by our model.

The model performs relatively well in capturing the volatilities of the unemployment rate, vacancies and wage per employee for all three economies. The only exception here is the standard deviation of the real wage in the Euro Area, which is overestimated by the model. The model does a good job in capturing the sign of the correlation between output and the labour market variables. However, it is fair to remark that the model has some problems with reflecting the strength of these relationships. The persistence of these variables is roughly captured.

Although the model somewhat underestimates the volatility of the labour wedge in Poland and overestimates it in the Euro Area and, to lesser extent, in the Czech Republic, the volatility implied by the model is still lower in the Eurozone than in the CEE countries, as in the data. The model also manages to generate procyclicality in the labour wedge in both the EA and the CEE region. The strength of implied correlation between GDP and the wedge is, however, too small in all economies. Nevertheless, consistently with the data, the model implies the highest wedge procyclicality in Poland and the lowest in the Czech Republic. The persistence of the labour wedge is well reflected in all three models.

4.2 Shocks driving the labour wedge

In order to identify the forces driving the fluctuations of the labour wedge, we look at its variance decomposition for four different horizons. The contributions of each of the structural shocks to the forecast error variance are reported in Table 6. The parameters of the simulated model correspond to their posterior means.

Roughly speaking, the labour wedge variability both in the CEE region and in the Euro Area is explained by the consumption preference shock and two labour market disturbances affecting vacancy posting cost and job destruction rate. However, the contributions of these shocks differ across three countries.

Taking a closer look at the results for the Euro Area, it is apparent that the main factor responsible for the volatility of the gap between MRS and MPL is the consumption preference shock. Although its role decreases with the forecast horizon, it still accounts for more than 53% forecast error in the long run, which is much higher than the joint impact of both labour market shocks. In the shorter horizon, the role of the separation shock appears to be greater than the role of the hiring cost shock, but in the long run, the importance of these two labour market disturbances seems to be comparable.

The variance decomposition of the labour wedge differs significantly across the CEE economies. In the Czech Republic, the preference shock is the most important determinant to the labour wedge fluctuations over all considered forecast horizons and the role of the labour market disturbances is even less important than in the Eurozone. In the long run, vacancy posting cost and separation rate disturbances account together for only 24% of the wedge volatility.

Table 6: Variance decomposition of the labour wedge (in%)

	2q	4q	10q	40q
Poland				
Productivity shock	5.8	5.0	3.4	3.0
Consumption preference shock	65.9	47.5	31.4	27.8
Government spending shock	0.0	0.0	0.0	0.0
Foreign output shock	1.5	2.5	3.6	4.2
Separation rate shock	22.7	27.6	22.1	19.6
Bargaining power shock	0.6	1.5	1.5	1.4
Hiring cost shock	3.6	15.9	38.0	43.9
Czech Republic				
Productivity shock	3.9	4.7	4.8	4.7
Consumption preference shock	88.6	80.1	71.1	68.4
Government spending shock	0.1	0.1	0.0	0.0
Foreign output shock	0.3	1.0	2.1	2.8
Separation rate shock	6.0	9.4	9.8	9.5
Bargaining power shock	0.1	0.1	0.2	0.1
Hiring cost shock	1.0	4.7	12.0	14.5
Euro Area				
Productivity shock	4.1	3.4	2.8	2.8
Consumption preference shock	79.2	70.1	58.0	53.5
Government spending shock	0.2	0.2	0.1	0.1
Foreign output shock	5.9	5.9	8.6	11.7
Separation rate shock	9.2	14.6	16.7	15.7
Bargaining power shock	0.4	1.4	2.1	2.0
Hiring cost shock	1.2	4.6	11.5	14.2

In contrast to the Czech Republic, the labour market shocks play a crucial role for the MRS-MPL gap fluctuations in Poland. They are still less important than the preference shock in the short run, but in the long run they are the main driving force behind the labour wedge and account for more than 64% of its volatility.

Overall, we can state that while the sources of the labour wedge fluctuations in Poland and the Euro Area differ significantly, the Czech Republic stands out as more similar to the EA in terms of the sources of MRS-MPL gap fluctuations. The bigger role of labour market disturbances in Poland might indicate that the labour market in this country is less efficient. The distinct sources of the fluctuations in the labour wedge might have some effects on welfare (Galí et al. 2007). While in the standard DSGE literature preference shocks are considered to be in some sense efficient as they reflect changes in households' utility, labour market disturbances can be treated as a manifestation of some inefficiencies. In this context, different sources of the labour wedge fluctuations in Poland suggest that its fluctuations in this country may be more costly than in the Euro Area or the Czech Republic.

4.3 Structural vs. stochastic heterogeneity

In this subsection we investigate to what extent higher volatility of the labour wedge in the CEE countries results from the country-specific shocks (the persistence and the magnitude of shocks), and to what extent from the structure of their economies (captured by the structural parameters). For this purpose, we check what the hypothetical volatility of the labour wedge in the CEE countries would be if these economies were hit by the EA-specific shocks. The results of simulations summarized in Table 7 are based on the posterior means of estimated parameters.

Table 7: Labour wedge volatility, counterfactual simulation (shocks structure as in the EA)

	PL	CZ
Country model	0.0371	0.0405
Productivity shock as in the EA	0.0369	0.0399
Consumption preference shock as in the EA	0.0356	0.0286
Government spending shock as in the EA	0.0371	0.0405
Foreign output shock as in the EA	0.0367	0.0402
Separation rate shock as in the EA	0.0343	0.0392
Bargaining power shock as in the EA	0.0373	0.0406
Hiring cost shock as in the EA	0.0312	0.0381
Labour market shocks as in the EA	0.0280	0.0367
Euro Area shocks (all)	0.0250	0.0211

The results presented in Table 7 confirm relatively bigger role of the labour market disturbances for the labour wedge dynamics in Poland. Moreover, we can see that the CEE countries would experience much lower labour wedge volatility if all shocks in this region had the same characteristics as in the Eurozone. Therefore, we can state that the characteristics of stochastic disturbances contribute strongly to the relatively high variability of the labour wedge in Poland and the Czech Republic.

Interestingly, if shocks are the same, the labour wedge variability in the Czech Republic is even lower than in the EA, while in Poland the wedge is still more volatile. Thus, it might be noteworthy to identify the sources of these differences.

While it seems to be obvious that a part of this heterogeneity might result from different households' preferences, our focus is on the role of the labour market characteristics, such as the elasticity of matches to unemployment σ, workers' bargaining power η and the degree of real wage rigidity α_w. In order to clarify this issue, we check what the model-implied volatility of the labour wedge would be if these parameters were set at the levels identified for the Eurozone, leaving everything else, including the stochastic characteristics, as in the country-specific model, see Table 8. Similarly as before, the parameters of the simulated models correspond to their posterior means.

Table 8: Labour wedge volatility, counterfactual simulation (labour market parameters as in the EA)

	Parameters			Labour wedge volatility
Poland				
Country model	$\sigma = 0.55$	$\eta = 0.62$	$\alpha_w = 0.50$	0.0371
σ as in the EA	$\sigma = 0.71$	$\eta = 0.62$	$\alpha_w = 0.50$	0.0327
η as in the EA	$\sigma = 0.55$	$\eta = 0.43$	$\alpha_w = 0.50$	0.0327
α_w as in the EA	$\sigma = 0.55$	$\eta = 0.62$	$\alpha_w = 0.22$	0.0376
σ, η, α_w as in the EA	$\sigma = 0.71$	$\eta = 0.43$	$\alpha_w = 0.22$	0.0308
Czech Republic				
Country model	$\sigma = 0.70$	$\eta = 0.51$	$\alpha_w = 0.57$	0.0405
σ as in the EA	$\sigma = 0.71$	$\eta = 0.51$	$\alpha_w = 0.57$	0.0403
η as in the EA	$\sigma = 0.70$	$\eta = 0.43$	$\alpha_w = 0.57$	0.0403
α_w as in the EA	$\sigma = 0.70$	$\eta = 0.51$	$\alpha_w = 0.22$	0.0406
σ, η, α_w as in the EA	$\sigma = 0.71$	$\eta = 0.43$	$\alpha_w = 0.23$	0.0401

The results presented in Table 8 suggest that the elasticity of the matching function with respect to unemployment and workers' bargaining power contribute to differences between behaviour of the labour wedge in Poland and the Czech Republic. Lower, as compared to the Eurozone, unemployment share in the matching technology and higher workers' bargaining power raise the volatility of the labour wedge in Poland. Their impact in the Czech economy is, however, rather negligible. More flexible wages in the CEE region (higher α_w) seem to play a minor role for the wedge volatility. Setting all three considered labour market parameters at the levels identified for the Eurozone lowers the variability of the labour wedge in Poland significantly, but it basically does not affect its dynamics in the Czech Republic. Thus, while the characteristics of the stochastic disturbances contribute to relatively high volatility of the labour wedge in both analysed CEE economies, structural labour market features matter only in Poland.

5 Conclusions

This paper aims to shed more light on the differences between the labour wedge fluctuations in the CEE countries and the Euro Area. To this end, we construct a simple DSGE model of a small open economy with search and matching frictions on the labour market and estimate it separately for two CEE representatives, namely Poland and the Czech Republic, and the Eurozone. The estimated models succeed in replicating the general pattern of the labour wedge behaviour, including its procyclicality and higher volatility in the CEE region than in the EA.

Our results indicate significant differences in the sources of the labour wedge fluctuations in the CEE countries and the Eurozone. While the gap between MRS and MPL in Poland is driven largely by the labour market disturbances, the consumption preference shock appears to be the main driving force of its fluctuations in the EA and the Czech Republic.

Furthermore, we find that the distinct characteristics of stochastic disturbances are the main source of higher volatilities of the labour wedge in the CEE countries. However, in Poland the country-specific structural features of the labour market also play a role for its fluctuations. More specifically, the values of the elasticity of the matching process with respect to unemployment and workers' bargaining power enlarge the differences between the wedge variability in Poland and the EA. The impact of these parameters in the Czech Republic is rather marginal.

All in all, we find heterogeneity in the labour wedge fluctuations within the CEE region. The Czech Republic seems to resemble more the EA in terms of both wedge volatility and its driving forces. Our results suggest that the labour market frictions in Poland are relatively more severe and generate fluctuations that are more harmful for social welfare.

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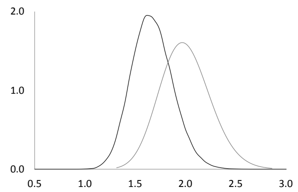
Appendix

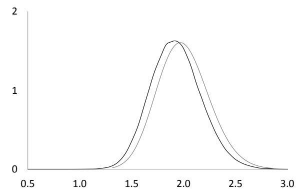
Prior and posterior distributions

Poland

ζ



ϕ



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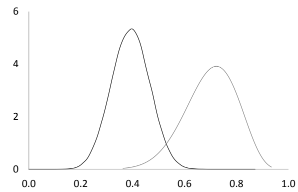
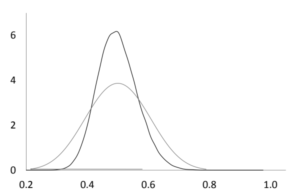
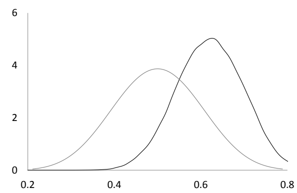


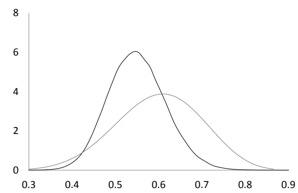
α_w



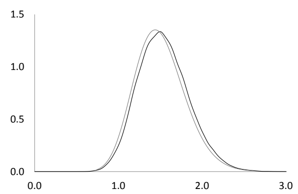
η



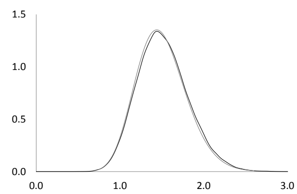
σ



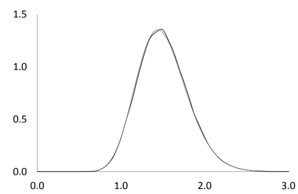
ω



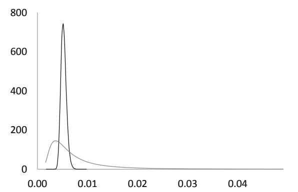
ω'



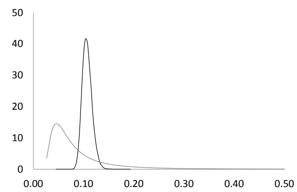
ω''



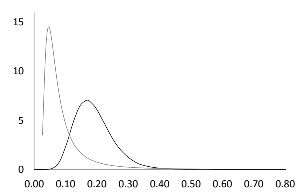
σ_z

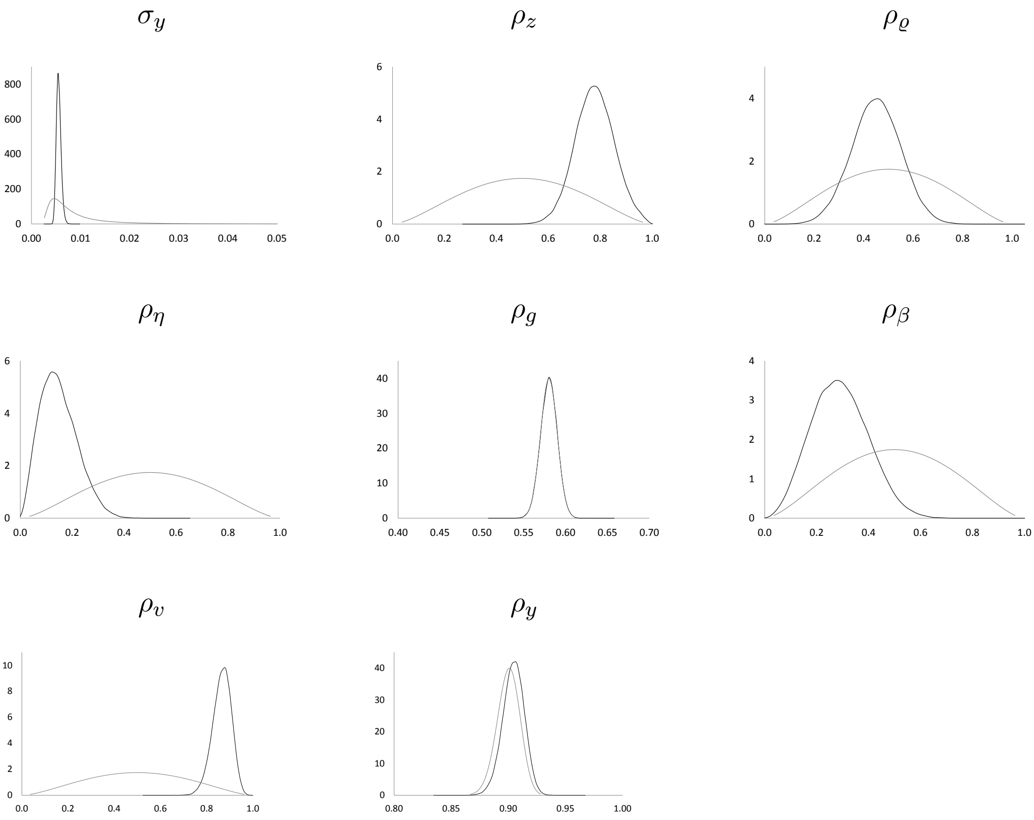


σ_ϱ



σ_η

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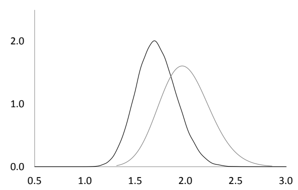
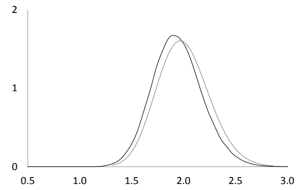
0.00 0.01 0.02 0.03 0.04 0.05
ρ_z
0 2 4 6
0.0 0.2 0.4 0.6 0.8 1.0
ρ_ϱ
0 2 4
0.0 0.2 0.4 0.6 0.8 1.0
ρ_η
0 2 4 6
0.0 0.2 0.4 0.6 0.8 1.0
ρ_g
0 10 20 30 40
0.40 0.45 0.50 0.55 0.60 0.65 0.70
ρ_β
0 1 2 3 4
0.0 0.2 0.4 0.6 0.8 1.0
ρ_v
0 2 4 6 8 10
0.0 0.2 0.4 0.6 0.8 1.0
ρ_y
0 10 20 30 40
0.80 0.85 0.90 0.95 1.00

Czech Republic

ζ



ϕ



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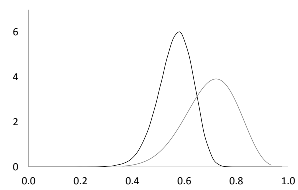
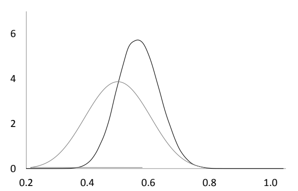


α_w



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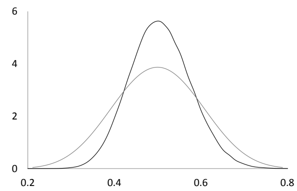
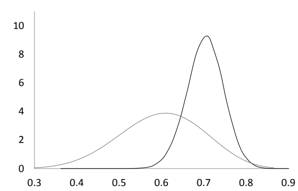
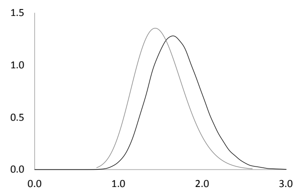


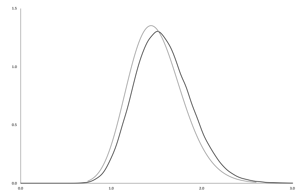
σ



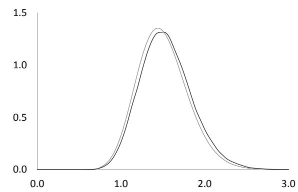
ω



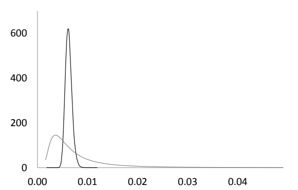
ω'



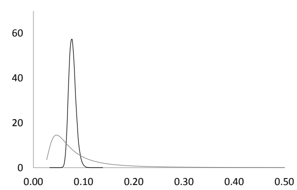
ω''



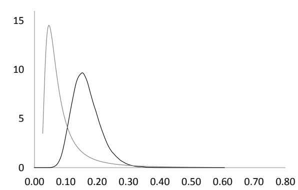
σ_z



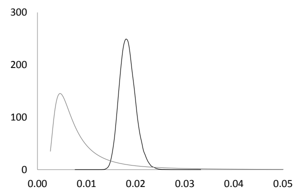
σ_ϱ



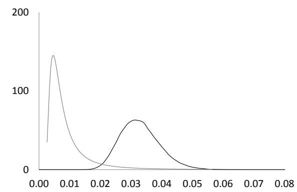
σ_η



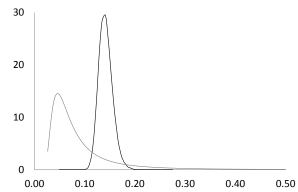
σ_g

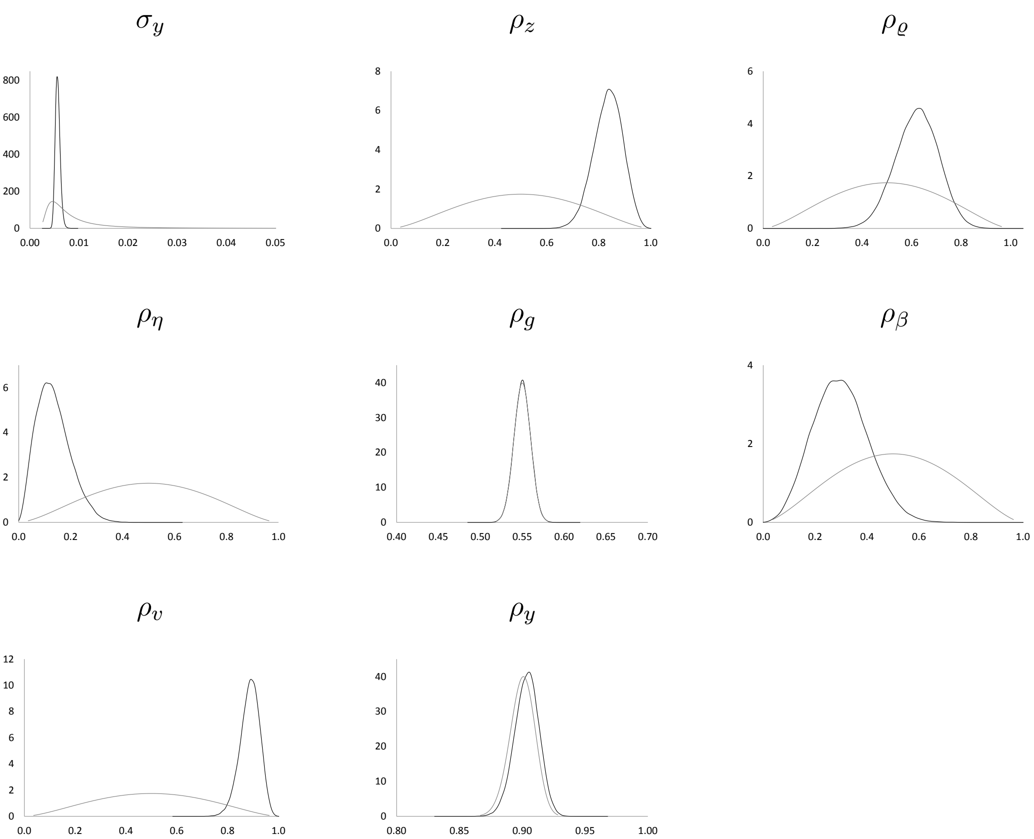


σ_β

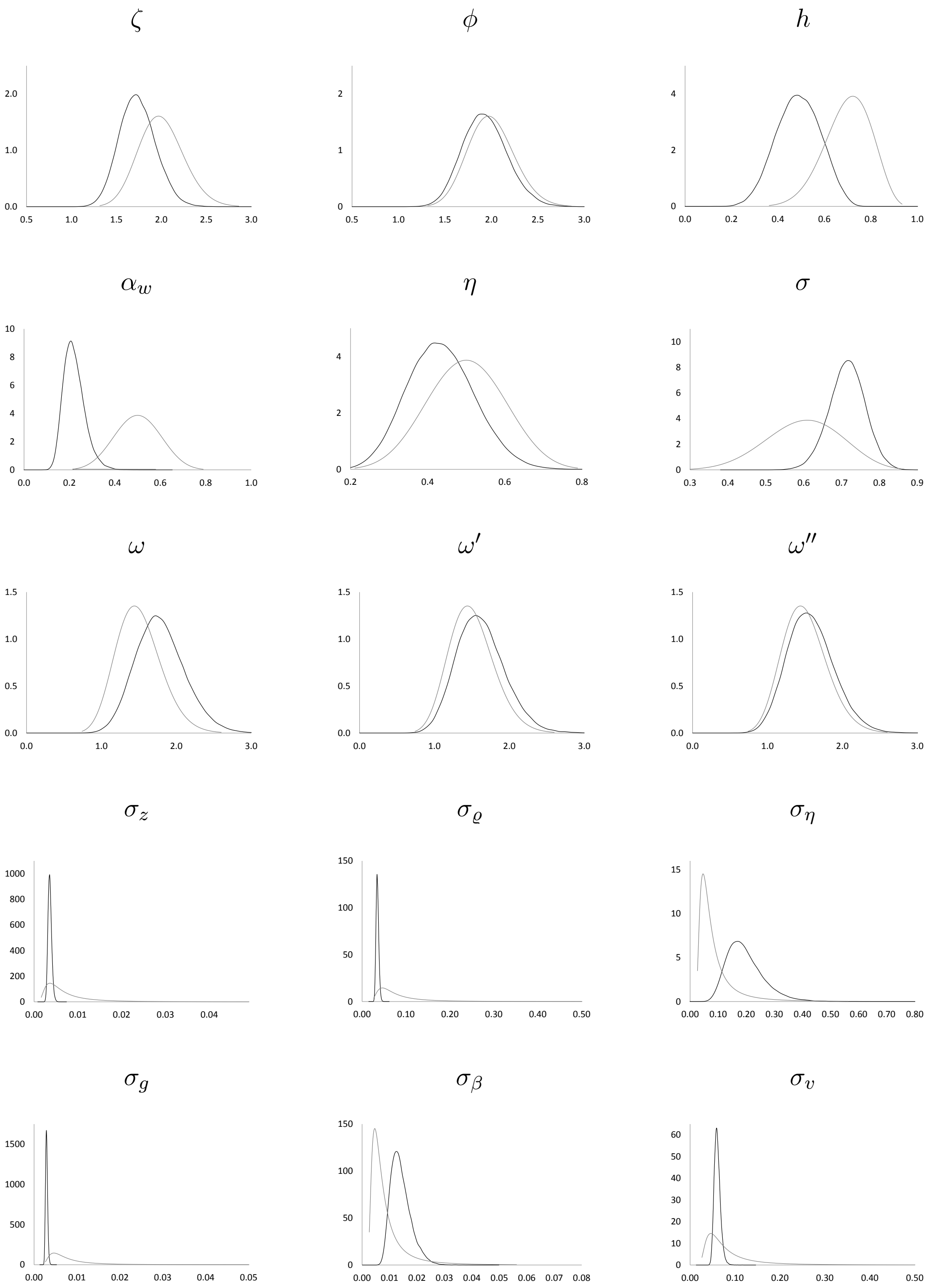


σ_v




σ_y
ρ_z
ρ_ϱ
ρ_η
ρ_g
ρ_β
ρ_v
ρ_y

Euro Area


ζ
ϕ
h
α_w
η
σ
ω
ω'
ω''
σ_z
σ_ϱ
σ_η
σ_g
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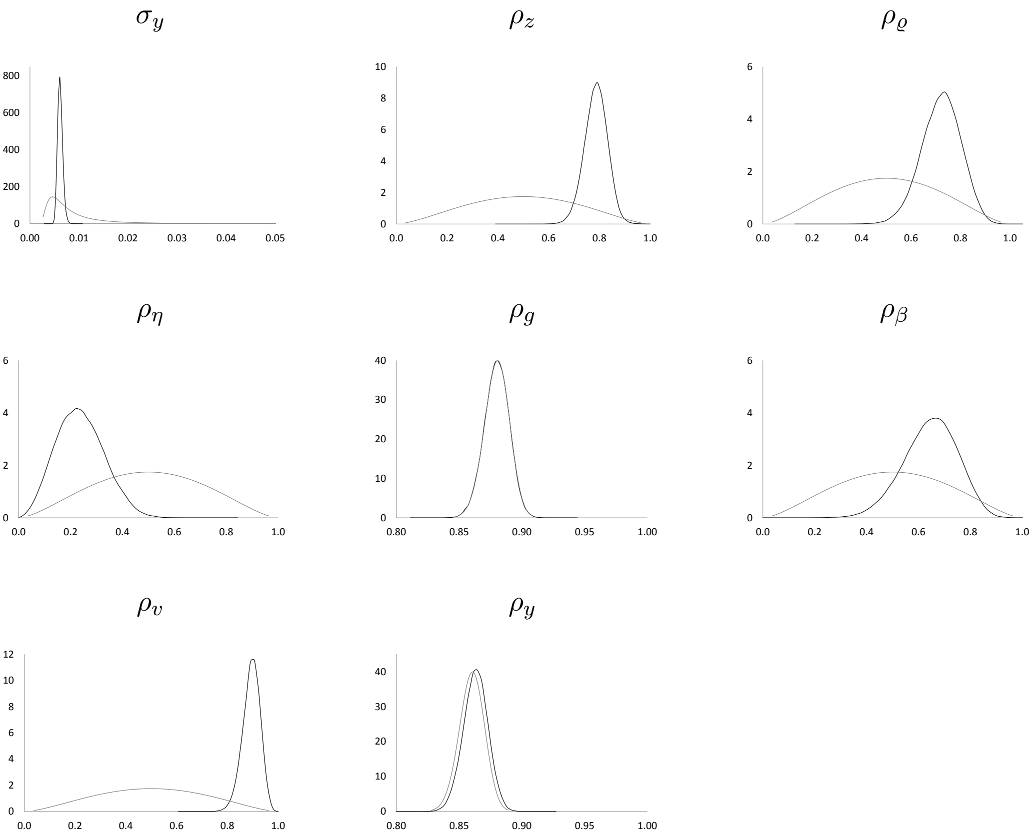
σ_v



Note: Grey line - prior distribution, black line - posterior distribution