Sticky wage Nash bargaing model with incomplete information

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Streszczenie

We develop an alternative novel method of introducing real wage rigidity into an otherwise standard search and matching model. Wages are constantly renegotiated through Nash wage bargaining, however negotiations are based on imperfect information regarding the productivity level and consequently marginal productivity. The imperfect information mechanism is modeled by means of a Kalman filter. As a consequence, after a positive technology shock some of the increase in productivity is attributed to information noise, resulting in a smaller rise in the real wage. This in turn prompts firms to post more vacancies and increase capital investment. Overall, we show that the real wage rigidity mechanism substantially amplifies the model's internal propagation mechanism.

JEL classification: C63, C78, E24; E32, J64
Keywords: DSGE, on-the-job search, endogenous destruction, labor market frictions, heterogenous macroeconomic models, perturbation method

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1 Introduction

In the standard, general equilibrium model of unemployment proposed by Mortensen and Pissarides (1994) one can not reflect properly the empirical properties of wage behavior. It is due to the fact that wages are determined within this framework in the Nash bargaining process between firms and workers that takes into account only mariginal productivity of new matches in a given period and induces too much volatility into the wages. In consequence also the incentives to hire in the boomtime are lower as wages are too much procyclical. Hall (2005) tried to introduced ad-hoc wage stickiness into the model in order to fix this problem showing that wage rigidites can be a source of employment volatility. His solution was however non microeconomically founded and the sources of possible wage stickiness remained hidden.

One possible solution to this problem is to apply the price contracts similar to those proposed by Calvo (1989) for goods prices. This approach has been explored by Gertler and Trigari (2009). They show that wage rigidities can successefully lead to lagged reaction of the wages to macroeconomic shocks, but is not capable to do the same with marginal cost. This is due to the fact that the marginal cost is determined by new workers that set their wages optimally. In effect staggered wage mechanism of the Calvo type is not capable to impact the overall model dynamics. This could be very unfortunate from the perspective of monetary economics as it is widely assumed that wage rigidities are responsible for the lagged response of the inflation to macroeconomic shocks. In fact this is exactly the case of the monetary models with Walrasian labor market. Those models however do not allow for co-existence of unemployment and opened vacancies. Therefore the successful introduction of all of the labor market variables into the monetary models can not be done without the solution to the "marginal cost problem" of the Gertler and Trigari (2009) model.

We propose the numerical framework to do this. In our model the wage rigidities are generated by the non complete information about the financial situation of the firm. This mechanism impacts the marginal costs of the enterprise and transmits to the rests of the economy. Our method can be therefore successfully applied in the monetary models with search and match mechanism on the labor market. It is also relatively simple to implement and solve especially if we compare this to the Calvo type of wage contracts within the Nash bargaining mechanisms. An equally attractive feature of the proposed method is low numerical costs that in our opinion makes it universal.

Paper is organized as follows. In section 2 we describe the model structure. In section 3 detailes o numerical procedure are revealed. Section 4 presents the details of model calibration whereas the section 5 shows its properties. Final section concludes.

2 Model

2.1 Household

The representative household seeks to maximize the expected value of lifetime utility U_t at time zero, which is a function of consumption $\tilde{C}_t$ given by:

$$U_t = \frac{\tilde{C}_t^{1-\sigma} - 1}{1-\sigma} + \beta E_t\{U_{t+1}\},$$

where β is the time preference parameter, and σ is the elasticity of intertemporal substitution of consumption. We assume that the household is populated by a countinuum of members defined on the unit interval and that they perfectly insure each other from variations in income resulting from spells of employment and unemployment. In each time period each household member inelastically offers a unit of labour, and variable N_t defines how many members of the household are employed in period t. For their work in period t employed members receive wage W_t, therefore the total labour income of the household is $W_t N_t$. The household is also the owner of firms, which make investment decisions. The household maximizes utility subject to the following budget constraint:

$$C_t = W_t N_t + \Pi_t,$$

where Π_t is the profit of the firm in period t, and C_t is the consumption of market goods. Total consumption of goods $\tilde{C}_t$ is defined as the consumption of market goods and home production goods produced by unemployed members of the household. We assume that market goods and home production goods are perfect substitutes, therefore:

$$\tilde{C}_t = C_t + b \times (1 - N_t),$$

where parameter b defines the effectiveness of home production.

2.2 Firms

The firm maximizes the expected value of time zero discounted profits $\tilde{\Pi}_t$ which are measured in terms of the households utility given by:

$$\tilde{\Pi}_t = \lambda_t \Pi_t + \beta E_t\{\tilde{\Pi}_{t+1}\},$$

where λ_t is the marginal utility of consumption of the household and Π_t is the current profit of the firm. The firms production Y_t depends on the input of capital and labour. The capital is in possession of the firm, therefore the firm needs to make capital investment decisions I_t. In order to recruit new employees, the firm must post job vacancies V_t and incurs unit vacancy costs equal to c. The firms current profit is given by:

$$\Pi_t = Y_t - W_t N_t - I_t - cV_t,$$

and it is fully transferred to the household. The law of motion of capital if the following:

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

The production technology is the standard Cobb-Douglas production function with two inputs: labour and the level of capital installed in period t:

$$Y_t = A_t K_{t-1}^{\alpha} N_t^{1-\alpha},$$

where A_t is the exogenous level of technology in period t

2.3 Labour market

The labour market is characterized by a standard search and matching mechanism. Let us denote the number of employed workers at time t by N_t and the number of unemployed by U_t. The number of new job matches is given by the Cobb-Douglas production function and is dependent on the number of unemployed U_t and the number of vacancies posted by firms:

$$M_t = \Upsilon \times V_t^{1-\psi} U_t^{\psi},$$

where Υ is the matching effectiveness parameter. New job matches become productive in the following period. The probability of filing a job vacancy and Ψ_t and the probability of transition from unemployment to employment Φ_t for a worker are given by:

$$\Psi_t = \frac{M_t}{V_t}, \qquad \Phi_t = \frac{M_t}{U_t}.$$

Both these probabilities are taken as exogenous by the firm and unemployed job searcher. The law of motion for employment is the following:

$$N_t = (1 - s) \times N_{t-1} + M_{t-1}, \tag{1}$$

where s is the exogenous job-separation rate.

2.4 Wage negotiations

Let us denote by V_t^E, V_t^U, V_t^F respectively the value of a job for a worker in period t, the value of unemployment and the value of a job match for a firm. All of the above values are measured in terms of the utility of the household. Given the structure of the model, the values are the following:

$$\begin{aligned} V_t^E &= \lambda_t W_t + (1-s)\beta E_t\{V_{t+1}^E\} + s\beta E_t\{V_{t+1}^U\}, \\ V_t^U &= \lambda_t b + \beta \Psi_t E_t\{V_{t+1}^E\} + \beta E_t\{(1-\Psi_t)V_{t+1}^U\}, \\ V_t^F &= \lambda_t (X_t - W_t) + (1-s)\beta E_t\{V_{t+1}^F\}. \end{aligned}$$

The variable X_t denotes the marginal productivity of an additional worker and is treated by both the firm and worker as exogenous:

$$X_t = (1-\alpha)\frac{Y_t}{N_t}.$$

The wage is the result of individual Nash bargaining negotiations between the firm and the worker, where ξ denotes the workers' bargaining strength. The negotiations are based on incomplete information I_t, which is a subset of the complete information set in period t.

$$W_t = \arg\max_{W_t} \; E\{V_t^E - V_t^U | I_t\}^{\xi} \times E\{V_t^F | I_t\}^{1-\xi},$$

under the following feasibility condition: $E\{V_t^E - V_t^U | I_t\} \geq 0$, $E\{V_t^F | I_t\} \geq 0$. This implies that

$$E\{V_t^F | I_t\} = \frac{1-\xi}{\xi} \times E\{V_t^E - V_t^U | I_t\}, \tag{2}$$

therefore $E\{V_t^F | I_t\} < 0 \Leftrightarrow E\{V_t^E - V_t^U | I_t\} < 0$ and the feasibility condition is satisfied whenever $E\{V_t^F | I_t\} \geq 0$. We also have that

$$0 = E\Big\{\xi\lambda_t X_t + (1-\xi)\lambda_t b + \beta\xi\Psi_t E_t\{V_{t+1}^F\} - \lambda_t W_t \Big| I_t\Big\}. \tag{3}$$

It remains to define the value of an open vacancy for a firm V_t^V, also measured in terms of utility of the household:

$$V_t^V = -\lambda_t c + \beta\Phi_t E_t\{V_{t+1}^F\}.$$

Firms will continue to post new vacancies as long as the value is greater than zero. It follows that the optimal number of open vacancies requires that the value of an open vacancy be equal to zero:

$$V_t^V = 0.$$

From this, we have that:

$$\frac{\lambda_t c}{\Phi_t} = \beta E_t\{V_{t+1}^F\}.$$

Based on the above and using the fact, that $W_t = E\{W_t | I_t\}$, the wage equation (3) can be written in the following way:

$$W_t = E\{\lambda_t | I_t\}^{-1} \times E\Big\{\xi\lambda_t X_t + (1-\xi)\lambda_t b + \xi\lambda_t c\frac{\Psi_t}{\Phi_t}\Big| I_t\Big\}. \tag{4}$$

We assume, that during wage negotiations, both firms and employees observe the technology level A_t in an imperfect manner, that is the information set I_t is given by $I_t = \{I_{t-1}, h_t\}$, where

$$h_t = A_t + \mu_t,$$

where μ_t is a normally distributed random variable with mean zero.

3 Numerical algorithm

Optimization problem under consideration can be expressed in the following general form

$$0 = \sum_j A_j \times E_t^j y_t + \sum_j B_j \times E_t^j y_{t+1} + C \times y_{t+1} + \sum_j V_j \times E_t^j \epsilon_t$$

where $j \in \{1, \ldots, N\}$ and $E_t^j x = E\{x | I_t^j\}$ for a given information set I_t^j and $\epsilon_t \perp I_{t-1}^j$ for every j. Let $J_t = \bigcap_j I_t^j$ and $E_t^J x = E_t\{x | J_t\}$. We look for the solution in the form

$$x_t = Px_{t-1} + Q \times E_t^J\{\epsilon_t\} \qquad E_t^J y_t = Rx_{t-1} + S \times E_t^J\{\epsilon_t\}$$

with $x_{t-1} \in J_{t-1}$. Substituting we get the set of matrix equations allowing us to determine numerically the matrixes P, Q, R, S.

$$0 = \sum_j A_j \times R + \big(\sum_j B_j + C\big) \times RP$$
$$0 = \sum_j A_j \times S + \big(\sum_j B_j + C\big) \times RQ + \sum_j V_j$$

Those four matrixes constitute the final solution. If we assume that information sets I_t^j are sequentially nested one in another e.g. for $j < k$, $I_t^j \subset I_t^k$, we can express the model solution in the form

$$y_t = E_t^J y_t + \sum_{k>1} M_k \times (E_t^k \epsilon_t - E_t^J \epsilon_t)$$

where matrixes M_j for $j > 1$ must solve equation

$$0 = V_j + A_j \sum_{k>1}^{k<j} M_k + \Big(\sum_{k \leq j} A_k\Big) \times M_j \qquad\qquad 0 = CM_j$$

with $0 = CS$.

Let us assume that $N = 2$ and I_t^2 includes all modeled variables up to the period t. Than $I_t^1 = \{I_{t-1}^1, h_t\}$ with $h_t = K_1 y_t + K_2 \epsilon_t$. Using this notation we should note that $E_t^2 \epsilon_t = \epsilon_t$ and $E_t^1 \epsilon_t = \Omega \times (h_t - E_{t-1}^1 h_t)$ with

$$\Omega = cov_{t-1}(\epsilon_t, h_t) \times var_{t-1}(h_t)^{-1}$$

where $cov_{t-1}(x_t, y_t)$ and $var_{t-1}(x_t)$ denote respectively the covariance and variance in the steady state with the information set I_{t-1}^1. With this notation we can express the matrix Q indirectly through equations

$$\Sigma = (K_1 M_2 + K_2) \times \Upsilon \times (K_1 M_2 + K_2)'$$
$$\Omega = \Big(I + \Upsilon \times (K_1 M_2 + K_2)' \times \Sigma^{-1} \times K_1(S - M_2)\Big)^{-1}$$
$$\times \Upsilon \times (K_1 M_2 + K_2)' \times \Sigma^{-1}$$

where $\Upsilon = var(\epsilon_t)$. We have also $E_{t-1}^1 h_t = K_1 R \times x_{t-1}$. This completes the solution and allows us to apply standard perturbation algorithm of model solving. Note that Matrixes M_k are given by linear equations and therefore easy to solve numerically. Moreover, if the information set is entirely composed of exogenous variables than we can directly solve for $E_t^k \epsilon_t$. In non generic case matrix Q is therefore given explicite what makes the numerical cost of solving the model with imperfect information very limited.

4 Empirical Data and Calibration

4.1 Data description

We calibrate our model using quarterly macroeconomics time series for EU-15 countries. All time series have been taken from Eurostat, with the exception of data concerning wages and capital, which are from the OECD and European Commission KLEMS database respectively. Most time series cover a time span from the mid 90' until the end of 2010, however for some countries the data goes back as far as the 50'.

The only exception are time series concerning vacancies, for which data is available only for the last decade. Altogether, most time series cover at least one recession and one expansion, allowing us to calculate and extract a cyclical component.

In order to calculate sample statistics for EU-15 countries we first take the logarithm of all variables and then decompose them into a trend and a cyclical component using the Hodrick-Prescott filter. The sample statistics that we calculate are the standard deviations, relative standard deviations with respect to gdp and correlations at various leads and lags between variables of interest. We also calculate a steady-state, that is an average for the last 40 quarterly observations, for variables which are stationary such as employment rate, ratio of investment to gdp. In order to derive sample statistics for the whole EU, we simply calculate a mean for the relevant statistics for EU-15 countries. These values are used for calibration of our model.

4.2 Calibration summary

We now proceed to choosing parameter values of the model. The basic parameters of the model are set in a standard way based on the literature. The parameter describing time preferences β is set to 0.99, elasticity of output with respect to capital α is set to 0.36, the intertemporal elasticity of substitution in consumption parameter σ is assumed to be 1.5, whereas the depreciation rate is set so that steady-state investment share in GDP equals to 0.25, which results in the value for δ equal to 0.023.

The calibration of labour market parameters is also fairly standard. Using the home production parameter b we set the steady-state employment rate to 0.65, which is approximately the value for EU-15. The elasticity of the matching function with respect to unemployment ψ, and the workers bargaining power ξ are both set to 0.6, and the exogenous job-separation rate is set to 0.1, a value in line with the literature. The effectiveness of the matching function Υ is set, so that the steady-state probability of filling a job vacancy Ψ is equal to 0.9. The unit vacancy cost c is computed so that total recruiting costs for firms equal 1% of GDP.

We assume that the technology level evolves according to the following equation: $A_t = \rho_A A_{t-1} + \epsilon_t$, where ϵ_t is an i.i.d. normal random variable with standard deviation σ_ϵ. The parameter ρ_A is set to 0.95 and the standard deviation of ϵ_t is set to match the standard deviation of output with its empirical counterpart, resulting in a value of 0.008.

The final parameter to be set is the standard deviation σ_μ of μ_t, which is the observation noise. In order to fully assess the effect the noise has on wage determination and other properties of the model we will simulate the model for three different values of σ_μ. The first chosen value is 0, which is equivalent to a standard labour market search model with perfect information - the benchmark model. The two other chosen values are 0.008 and 0.02, which is respectively 100% and 250% of the standard deviation of ϵ_t. In what follows we will refer to the three models as M1, M2 and M3. Table (1) summarizes the calibration.

5 Simulation results

We now proceed to assessing the models ability to replicate the basic empirical properties EU-15 economies. We will be especially interested if and in what way the sticky-wage mechanism helps the standard search and matching model account

Tablica 1: Calibration

Parameter name	Parameter Value	Calibrated Variable	Parameter Interpretation
		Steady state	
μ_A	-0.56	$Y_{ss} = 1.000$	mean value of technology shock
δ	0.023	$(\frac{I}{Y})_{ss} = 0.25$	capital depreciation rate
c	0.16	$c(\frac{V}{Y})_{ss} = 0.01$	vacancy cost
β	0.99	-	discount factor
b	0.95	$N_{ss} = 0.65$	home production
s	0.10	-	job destruction rate
Υ	0.37	$\Phi_{ss} = 0.900$	matching technology effect.
		Elasticities	
α	0.36	-	output elasticity w.r.t. capital
ξ	0.60	-	workers' bargaining power
ψ	0.60	-	match elasticity w.r.t. unemp.
σ	1.50	-	intertemp. elast. of substitution
		Technology process	
ρ_A	0.95	-	autocorr. of technology process
σ_ϵ	0.008	-	std dev of technology shock
		Remaining parameters	
σ_μ	0; 0.008; 0.02	-	std dev of observation noise

for the stylized facts of real economies. The assessment will be based on the models ability to generate variations of main macro variables and correlations between variables that match the empirical data. The analysis will be supplemented by comparing Impulse Response Functions for the benchmark model and the two sticky wage models.

5.1 Variability of main macro variables

Table (2) summarizes the main cyclical properties of the 3 versions of the model and the economies of the European Union. These statistics are supplemented by impulse response functions which are presented in Figure 1 and Figire 2. Overall the model does well in replicating the dynamics of the whole economy, with the wage stickiness mechanism providing strong amplification of shocks. We show that wage setting under imperfect information improves the general properties of the baseline model, but it also fails in some dimensions.

The first main observation is that the higher the degree of wage-stickiness the stronger the response of most macroeconomic variables to a one percent technology shock. Also, stronger stickiness increases the time needed for macroeconomic variable to return to the path of the baseline model. The explanation for this is quite simple. Since wages do not respond to an increase in productivity as strongly as in the baseline model, firms have a greater incentive to post more vacancies, which results in a significantly sharper rise in employment, and consequently a larger drop in unemployment. On the other hand, smaller wages, combined with an increase in expected future employment induce a rise in investment and accumulated capital. Regarding relative standard deviations, the results of the models with different degrees of wage stickiness are varied. While the response of most variables to a technology shock are stronger, the impact on relative standard deviations with re-

Tablica 2: Empirical and model volatility of main macro variables

Variable		**EU-15**		Std dev			Rel std dev		
		Std	Rel std	M1	M2	M3	M1	M2	M3
Product	Y_t	0.012	1.00	0.013	0.014	0.016	1.00	1.00	1.00
Wage	W_t	0.005	0.59	0.006	0.004	0.002	0.45	0.29	0.12
Consumption	C_t	0.008	0.63	0.007	0.008	0.01	0.55	0.55	0.61
Employment	N_t	0.008	0.62	0.008	0.009	0.013	0.61	0.65	0.79
Unemployment	U_t	0.077	6.68	0.015	0.017	0.024	1.14	1.21	1.47
Vacancies	V_t	0.129	11.77	0.072	0.086	0.124	5.48	6.09	7.52
Investment	I_t	0.047	4.00	0.036	0.037	0.04	2.73	2.63	2.40
Capital	K_t	0.004	0.49	0.003	0.004	0.004	0.26	0.25	0.23
Labor share	LP_t	0.009	0.77	0.007	0.007	0.006	0.56	0.49	0.37
Productivity	LS_t	0.009	0.77	0.002	0.004	0.006	0.11	0.30	0.34

gard to GDP are not obvious because of the fact, that the standard deviation of GDP increases from 0.013 for $\mu = 0$ to 0.016 for $\mu = 0.02$. While the impact on the relative standard deviation of consumption, investment and capital is not significant, the impact on wages, employment, unemployment and vacancies is strong. The relative standard deviation of wages drops from an acceptable level of 0.32 to 0.08 for the model with the highest degree of stickiness. The reason for this drop is the following: a positive technology shock raises marginal productivity, however a large part of this increase is attributed to the imperfection of the information set. Therefore the level of marginal productivity which is used by the household during wage negotiations is lower than its actual level, resulting in a smaller wage increase. Over time, the observed level of marginal productivity rises and becomes closer to its actual level, bringing the wage to the level for the baseline model.

The relative standard deviation of vacancies is increased from 5.8 to 6.87, while the standard deviation of unemployment is increased from 1.3 to 1.46, bringing the model closer to the data. While the empirical value for this statistic is much larger, it has to be noted that this model does not separately treat unemployment and nonparticipation. Like most basic labour market models, the one presented here pools the unemployed and nonparticipants into one group of non-employed. The relative standard deviation of non-employed for the US and EU are 0.83 and 1.55 respectively, which is closer to the values generated by the model. The model can also account for the well-known empirical fact known as the Beveridge curve, that is the negative contemporaneous correlation of vacancies and unemployment. The correlation coefficient varies from -0.33 to -0.29 for the three presented models. This is much less than what is actually observed in the data, however one needs to keep in mind the argument raised earlier when discussing the volatility of unemployment. The contemporaneous correlation between non-employed and vacancies is equal to -0.44 for the EU, which is also a value much closer to the model.

The model can also account for the well known empirical fact, that over the business cycle, wages fluctuate much less than labor productivity. This observation is valid for all three model specifications. The explanation for this risk-sharing phenomenon is provided in Danthine and Donaldson (1989). Labour share is countercyclical and exhibits relatively weak volatility, which is also in line with empirical observations.

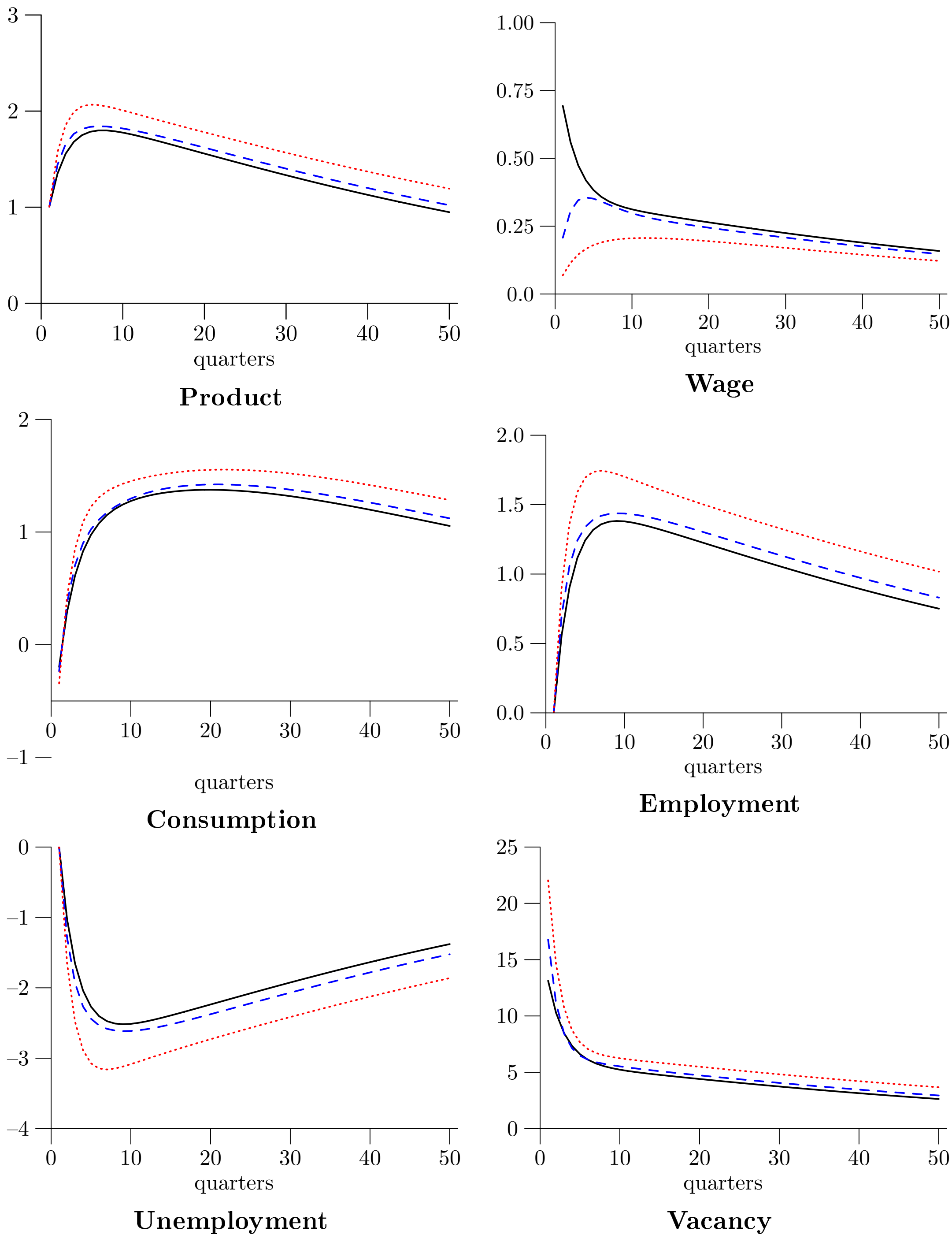
As we can see from table (3), the model does not suffer from an insufficient degree of persistence of main macro variables. All three models show a higher degree of

Tablica 3: Model and empirical dynamic correlations with output Y and vacancies V.

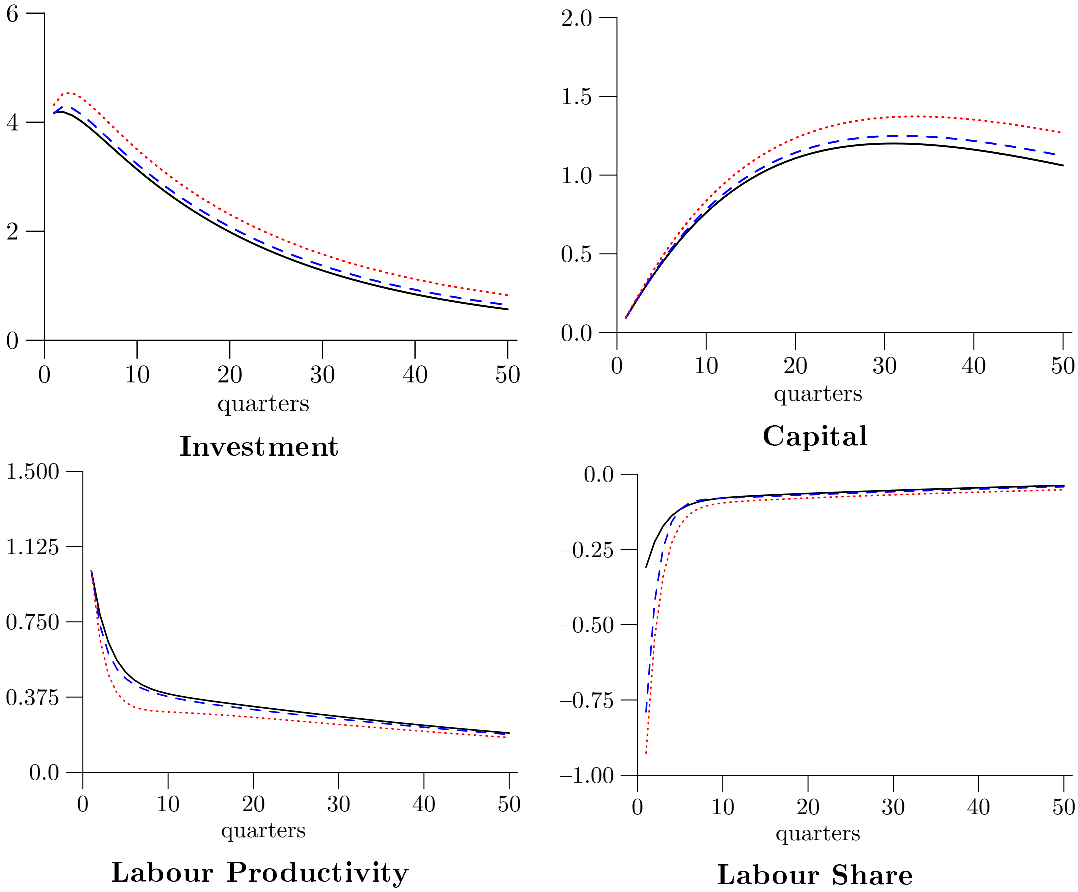
Variable			(τ)						
			-3	-2	-1	0	+1	+2	+3
Dynamic correlations with product.									
Product	Y_t	M1	0.56	0.78	0.94	1.00	0.94	0.78	0.56
		M3	0.55	0.77	0.94	1.00	0.94	0.77	0.55
		EU-15	*0.43*	*0.70*	*0.92*	*1.00*	*0.92*	*0.70*	*0.43*
Wage	W_t	M1	0.74	0.90	0.95	0.86	0.63	0.34	0.07
		M3	0.30	0.54	0.76	0.91	0.97	0.93	0.81
		EU-15	*0.05*	*-0.13*	*-0.22*	*-0.06*	*0.06*	*0.11*	*0.11*
Consumption	C_t	M1	0.08	0.31	0.55	0.77	0.93	0.98	0.94
		M3	0.13	0.37	0.62	0.84	0.97	0.98	0.88
		EU-15	*0.34*	*0.51*	*0.63*	*0.68*	*0.63*	*0.52*	*0.36*
Employment	N_t	M1	0.22	0.45	0.67	0.87	0.98	0.99	0.89
		M3	0.33	0.56	0.78	0.94	1.00	0.93	0.76
		EU-15	*0.02*	*0.19*	*0.36*	*0.49*	*0.57*	*0.58*	*0.52*
Unemployment	U_t	M1	-0.22	-0.45	-0.67	-0.87	-0.98	-0.99	-0.89
		M3	-0.33	-0.56	-0.78	-0.94	-1.00	-0.93	-0.76
Nonemployment		*EU-15*	*-0.02*	*-0.20*	*-0.37*	*-0.51*	*-0.59*	*-0.60*	*-0.53*
Unemployment		*EU-15*	*-0.09*	*-0.34*	*-0.56*	*-0.71*	*-0.77*	*-0.73*	*-0.61*
Vacancies	V_t	M1	0.75	0.89	0.94	0.83	0.60	0.30	0.02
		M3	0.80	0.90	0.86	0.68	0.38	0.07	-0.18
		EU-15	*0.39*	*0.55*	*0.65*	*0.64*	*0.55*	*0.40*	*0.22*
Investment	I_t	M1	0.71	0.88	0.98	0.94	0.78	0.53	0.26
		M3	0.71	0.90	0.99	0.95	0.78	0.54	0.28
		EU-15	*0.35*	*0.56*	*0.74*	*0.83*	*0.79*	*0.62*	*0.38*
Capital	K_t	M1	-0.16	0.06	0.29	0.51	0.68	0.79	0.84
		M3	-0.19	0.02	0.26	0.48	0.65	0.76	0.81
		EU-15	*-0.47*	*-0.48*	*-0.11*	*0.41*	*0.63*	*0.38*	*0.00*
Productivity	LP_t	M1	0.75	0.90	0.94	0.84	0.60	0.31	0.03
		M3	0.79	0.90	0.87	0.69	0.40	0.09	-0.15
		EU-15	-	-	-	-	-	-	-
Labor Share	LS_t	M1	-0.76	-0.88	-0.89	-0.75	-0.48	-0.16	0.12
		M3	-0.76	-0.80	-0.69	-0.44	-0.10	0.22	0.44
		EU-15	*-0.35*	*-0.47*	*-0.54*	*-0.51*	*-0.36*	*-0.12*	*0.12*
Dynamic correlations with vacancies.									
Unemployment	U_t	M1	0.26	0.09	-0.16	-0.44	-0.71	-0.88	-0.92
		M3	0.33	0.17	-0.08	-0.39	-0.69	-0.87	-0.90
Nonemployment		*EU-15*	*-0.01*	*-0.14*	*-0.27*	*-0.38*	*-0.47*	*-0.50*	*-0.46*
Unemployment		*EU-15*	*-0.02*	*-0.19*	*-0.35*	*-0.48*	*-0.56*	*-0.57*	*-0.50*

persistence than can be seen in the data for both the US and the EU.

Rysunek 1: Impulse response functions



Rysunek 2: Impulse response functions countinued



6 Concluding remarks

We have constructed the RBC model with Mortensen Pissarides (1994) type of labor market module with Nash wage bargaing and wage rigidities. We show that if wages are staggered due to incomplete information on the technology level in a given period they can result in real effects on the entire economy. This contrasts our model with that of Gertler and Trigari (2009) that adapted Calvo price contracts into the Nash wage negotiations process. In our model the producer surplus perceived by the workers is smaller than in reality what limits the wage growth during the boomtime. Firms anticipate this mechanism and respond in more vigorous vacancy posting. This results in the larger employment, production, consumption and investment as well as smaller unemployment. We show that wage rigidities increase the deviation between the negotiated wage and the marginal productivity of worker what impacts negatively the labor share in the economy. On the other hand we show that although wage rigidities can affect the entire economy through mentioned transmission mechanism their real role as the source of acyclical behavior of wages is probably limited. This is due to the impact of staggered wages on labor market variables - employment and unemployment - goes in the undesirable direction. Model with not-negligible rigidities fits the cyclical properties of the labor market data (apart from wages) more poorly than model without wage stickiness. On the other hand if wages are rigid to the limited extend one can utilize proposed model as a building block for new Keynesian models in order to reflect the empirical dynamics of inflation.

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