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Are Firing Costs Important for Business Cycles? Lessons from Bulgaria (1999-2018)

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Abstract

We introduce firing costs into a real-business-cycle setup augmented with a detailed government sector. We calibrate the model to Bulgarian data for the period following the introduction of the currency board arrangement (1999-2018). We investigate the importance of such labor market frictions for cyclical fluctuations in Bulgaria. Firing costs decrease employment volatility and pro-cyclicality, where both effects come at odds with data. Besides those, we do not find other important effects of firing costs for business cycle fluctuations in Bulgaria.

Keywords: business cycle fluctuations, labor markets, firing costs, Bulgaria

JEL Classification Codes: E24, E32

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1 Introduction and Motivation

As pointed out in Vasilev (2016, 2017b,c), the standard Dynamic Stochastic General Equilibrium (DSGE) setupls, equipped with the perfectly-competitive labor markets assumption, e.g. Vasilev (2009), are not able to capture well the dynamics exhibited by the major labor market variables - namely wages, employment and unemployment - in Bulgaria. The shortcoming of the neoclassical framework might be driven by the assumption that hours are being rented for any number of hours at no additional cost for the firm besides the going wage rate. In reality, the employer-employee relationship in Bulgaria is much more complicated than that, especially in the post-recruitment stage. More specifically, a labor contract has a social dimension, and the job security aspect takes the form of a so-called "permanent contract." In other words, most labor arrangements are long-term ones, and often done collectively by organizations such as labor unions on the worker's behalf. Vasilev (2019) documents the importance of organized labor for aggregate economic outcomes in Bulgaria.[1]

The facts presented above should motivate researchers who are interested in studying economic issues of relevance to Bulgaria to adapt the benchmark DSGE model, and more specifically, to augment it with a more realistic labor market mechanism, which has to deviate substantially from spot wage contracting. After all, the employer-employee relationship is a multi-period contract problem. Terminating a relationship, especially when done unilaterally by the employer, is costly in terms of time and resources. In addition, the laid-off personnel would then need to be replaced by new hires, i.e., there are so called "turnover costs." Lastly, there are costs associated with recruiting, training, and retaining new workers. Dunne *et al.* (1989), Lazear (1990), Bentolia and Bertola (1990), Hopenhayn and Rogerson (1993), among many others, argue that the presence of firing costs is important for the structure of industry, as well as firm dynamics.

We take the presence of such labor cost frictions seriously. The novelty relative to earlier studies is that in this paper we will focus on the effect of firing cost on business cycle fluctuations in Bulgaria. We will introduce such costs into the firm problem as a convex

[1] On a different note, Paskaleva (2016), shows that real wages in Bulgaria are indeed downward rigid exactly due to collective agreements in place, which prohibit cuts in base wages.

function of past employment. Our *ad hoc* approach is thus going to be utilized as a diagnostic tool, aiming to assess the quantitative importance of labor market imperfections.[2] What is more important is that those real rigidities in the labor markets, and the way they are modelled in this paper, introduce persistence in employment, unemployment, and indirectly in output. Such labor market imperfections could be thus regarded as potentially important propagation mechanism to replicate data behavior, especially along the labor market dimension.

We proceesd to incorporate firing costs in a standard real-business-cycle (RBC) model with a government sector. We think that the analysis of labor markets should be always performed within a general equilibrium setup. We calibrate the model for Bulgaria in the period 1999-2018, and then proceed to quantitatively evaluate the effect of such labor market frictions. To the best of our knowledge, this is the first study on the issue using modern macroeconomic modelling techniques, and thus an important contribution to the field.

The rest of the paper is organized as follows: Section 2 describes the model framework and describes the decentralized competitive equilibrium system, Section 3 discusses the calibration procedure, and Section 4 presents the steady-state model solution. Sections 5 proceeds with the out-of-steady-state dynamics of model variables, and compared the simulated second moments of theoretical variables against their empirical counterparts. Section 6 concludes the paper.

2 Model Description

There is a representative households which derives utility out of consumption and leisure. The time available to households can be spent in productive use or as leisure. The government

[2]Extending the current work to a more detailed setup, e.g. along the lines of Vasilev (2019), is left for future work. After all, there are several candidates justifying the presence of firing costs, e.g., irreversible human capital investment in the form of specific training, which is lost when a worker takes leaves the firm; other examples could be the too generous unemployment benefits, which are also non-taxable, a relatively high minimum wage rate, among many others. Union premium in the wage rate, the skill premium, which also represent increase the labor costs from the perspective of the firm are other directions for research.

taxes consumption spending, and levies a common proportional ("flat") tax on labor and capital income in order to finance wasteful purchases of government consumption goods, and government transfers. On the production side, there is a representative firm, which hires labor and capital to produce a homogenous final good, which could be used for consumption, investment, or government purchases.

2.1 Households

There is a representative household, which maximizes its expected utility function

$$\max E_0 \sum_{t=0}^{\infty} \beta^t \Big\{ \ln c_t + \gamma \ln(1 - h_t) \Big\} \tag{2.1}$$

where E_0 denotes household's expectations as of period 0, c_t denotes household's private consumption in period t, h_t are hours worked in period t, $0 < \beta < 1$ is the discount factor, $0 < \gamma < 1$ is the relative weight that the household attaches to leisure.

The household starts with an initial stock of physical capital $k_0 > 0$, and has to decide how much to add to it in the form of new investment. The law of motion for physical capital is

$$k_{t+1} = i_t + (1 - \delta)k_t \tag{2.2}$$

and $0 < \delta < 1$ is the depreciation rate. Next, the real interest rate is r_t, hence the before-tax capital income of the household in period t equals $r_t k_t$. In addition to capital income, the household can generate labor income. Hours supplied to the representative firm are rewarded at the hourly wage rate of w_t, so pre-tax labor income equals $w_t h_t$. Lastly, the household owns the firm in the economy and has a legal claim on all the firm's profit, π_t.

Next, the household's problem can be now simplified to

$$\max E_0 \sum_{t=0}^{\infty} \beta^t \Big\{ \ln c_t + \gamma \ln(1 - h_t) \Big\} \tag{2.3}$$

s.t.

$$(1 + \tau^c)c_t + k_{t+1} - (1 - \delta)k_t = (1 - \tau^y)[r_t k_t + \pi_t + w_t h_t] + g_t^t \tag{2.4}$$

where where τ^c is the tax on consumption, τ^y is the proportional income tax rate on labor and capital income ($0 < \tau^c, \tau^y < 1$), and g_t^t denotes government transfers. The household takes the tax rates $\{\tau^c, \tau^y\}$, government spending categories, $\{g_t^c, g_t^t\}_{t=0}^{\infty}$, profit $\{\pi_t\}_{t=0}^{\infty}$, the realized technology process $\{A_t\}_{t=0}^{\infty}$, prices $\{w_t, r_t\}_{t=0}^{\infty}$, and chooses $\{c_t, h_t, k_{t+1}\}_{t=0}^{\infty}$ to maximize its utility subject to the budget constraint.[3]

The first-order optimality conditions as as follows:

$$c_t \quad : \quad \frac{1}{c_t} = \lambda_t(1+\tau^c) \tag{2.5}$$

$$h_t \quad : \quad \frac{\gamma}{1-h_t} = \lambda_t(1-\tau^y)w_t \tag{2.6}$$

$$k_{t+1} \quad : \quad \lambda_t = \beta E_t \lambda_{t+1}\Big[1+(1-\tau^y)r_{t+1}-\delta\Big] \tag{2.7}$$

$$TVC \quad : \quad \lim_{t\to\infty} \beta^t \lambda_t k_{t+1} = 0 \tag{2.8}$$

where λ_t is the Lagrangean multiplier attached to household's budget constraint in period t. The interpretation of the first-order conditions above is as follows: the first one states that for each household, the marginal utility of consumption equals the marginal utility of wealth, corrected for the consumption tax rate. The second equation states that when choosing labor supply optimally, at the margin, each hour spent by the household working for the firm should balance the benefit from doing so in terms of additional income generates, and the cost measured in terms of lower utility of leisure. The third equation is the so-called "Euler condition," which describes how the household chooses to allocate physical capital over time. The last condition is called the "transversality condition" (TVC): it states that at the end of the horizon, the value of physical capital should be zero.

2.2 Firm problem

There is a representative firm in the economy, which produces a homogeneous product. The price of output is normalized to unity. The production technology is Cobb-Douglas and uses both physical capital, k_t, and labor hours, h_t, to maximize the present value of profit

$$\Pi = \sum_{t=0}^{\infty} \beta_t \Big\{ A_t k_t^{\alpha} h_t^{1-\alpha} - r_t k_t - w_t h_t - \frac{\phi}{2} h_{t-1}^2 \Big\}, \tag{2.9}$$

[3] Note that by choosing k_{t+1} the household is implicitly setting investment i_t optimally.

where $\beta_t = \beta c_{t-1}/c_t$ is the firm's stochastic discount factor, and A_t denotes the level of technology in period t. Note that in addition to the direct payment to labor, the firm also faces quadratic firing costs, $\frac{\phi}{2}h_{t-1}^2$, where $\phi > 0$ is the scale parameter. The firing costs are introduced as a function of past employment, as firing costs are usually associated with hiring decisions made in the past.[4] In addition, the presence of such convex adjustment costs make the firm problem dynamic. Firm's optimal rental of capital and labor services is determined by the following conditions:

$$k_t \quad : \quad \alpha\frac{y_t}{k_t} = r_t, \tag{2.10}$$

$$h_t \quad : \quad (1-\alpha)\frac{y_t}{h_t} - \beta\frac{c_t}{c_{t+1}}\phi h_t = w_t. \tag{2.11}$$

In equilibrium, capital is paid its marginal product. However, the presence of firing costs works like a negative externality in the model, and effectively decreases the return to labor. In this setup labor is an asset: once hired, it generates a return, but there is an intertemporal tradeoff, which says that there might be an additional cost in case the labor relation, which initiated yesterday, is terminated today.[5] Such costs decrease the benefit from working. The firm then builds those costs into today's wage offer, lowering the hourly pay rate, and realizes a certain rent. Thus, in equilibrium with fixed costs, labor is paid less than its marginal products, and there are economic profits, or in period terms, $\pi_t > 0$, $\forall t$.

2.3 Government

In the model setup, the government is levying taxes on labor and capital income, as well as consumption, in order to finance spending on wasteful government purchases, and government transfers. The government budget constraint is as follows:

$$g_t^c + g_t^t = \tau^c c_t + \tau^y[w_t h_t + r_t k_t + \pi_t] \tag{2.12}$$

consumption tax, income tax rate and government consumption-to-output ratio would be chosen to match the average share in data. Finally, government transfers would be determined residually in each period so that the government budget is always balanced.

[4]This is in line with Hopenhayn and Rogerson's (1993) modelling approach.

[5]This equation is similar to the job creation condition (JCC) in search and matching models, e.g. Vasilev (2016).

2.4 Dynamic Competitive Equilibrium (DCE)

For a given process followed by technology $\{A_t\}_{t=0}^{\infty}$ tax schedules $\{\tau^c, \tau^y\}$, lagged employment $\{h_{-1}\}$ and initial capital stock $\{k_0\}$, the decentralized dynamic competitive equilibrium is a list of sequences $\{c_t, i_t, k_t, h_t\}_{t=0}^{\infty}$ for the household, a sequence of government purchases and transfers $\{g_t^c, g_t^t\}_{t=0}^{\infty}$, and input prices $\{w_t, r_t\}_{t=0}^{\infty}$ such that (i) the household maximizes its utility function subject to its budget constraint; (ii) the representative firm maximizes profit; (iii) government budget is balanced in each period; (iv) all markets clear.

3 Data and Model Calibration

To characterize business cycle fluctuations in Bulgaria, we will focus on the period following the introduction of the currency board (1999-2018). Quarterly data on output, consumption and investment was collected from National Statistical Institute (2019), while the real interest rate is taken from Bulgarian National Bank Statistical Database (2019). The calibration strategy described in this section follows a long-established tradition in modern macroeconomics: first, as in Vasilev (2016), the discount factor, $\beta = 0.982$, is set to match the steady-state capital-to-output ratio in Bulgaria, $k/y = 13.964$, in the steady-state Euler equation. The labor share parameter, $1 - \alpha = 0.571$, is obtained as in Vasilev (2017d), and equals the average value of labor income in aggregate output over the period 1999-2018. This value is slightly higher as compared to other studies on developed economies, due to the overaccumulation of physical capital, which was part of the ideology of the totalitarian regime, which was in place until 1989. Next, the average labor and capital income tax rate was set to $\tau^y = 0.1$. Similarly, the average tax rate on consumption is set to its value over the period, $\tau^c = 0.2$. We calibrate the firing cost parameter ϕ so that in steady state those costs are 5% of GDP.[6]

Next, the relative weight attached to the utility out of leisure in the household's utility function, γ, is calibrated to match that in steady-state consumers would supply one-third of their time endowment to working. This is in line with the estimates for Bulgaria (Vasilev

[6] We performed robustness checks, but it turned out that this parameter does not affect the results quantitatively in any major way.

2017a) as well over the period studied. Net, the steady-state depreciation rate of physical capital in Bulgaria, $\delta = 0.013$, was taken from Vasilev (2016). It was estimated as the average quarterly depreciation rate over the period 1999-2014. Finally, the process followed by the TFP process is estimated from the detrended series by running an AR(1) regression and saving the residuals. Table 1 below summarizes the values of all model parameters used in the paper.

Table 1: Model Parameters

Parameter	Value	Description	Method
β	0.982	Discount factor	Calibrated
α	0.429	Capital Share	Data average
γ	0.873	Relative weight attached to leisure	Calibrated
δ	0.013	Depreciation rate on physical capital	Data average
τ^y	0.100	Average tax rate on income	Data average
τ^c	0.200	VAT/consumption tax rate	Data average
ϕ	0.900	Scale parameter, firing costs	Calibrated
ρ_a	0.701	AR(1) persistence coefficient, TFP process	Estimated
σ_a	0.044	st. error, TFP process	Estimated

4 Steady-State

Once the values of model parameters were obtained, the steady-state equilibrium system solved, the "big ratios" can be compared to their averages in Bulgarian data. The results are reported in Table 2 on the next page. The steady-state level of output was normalized to unity (hence the level of technology A differs from one, which is usually the normalization done in other studies), which greatly simplified the computations. Next, the model matches consumption-to-output and government purchases ratios by construction; The investment ratios are also closely approximated, despite the closed-economy assumption and the absence of foreign trade sector. The capital share of income is also identical to those in data, which is an artifact of the assumptions imposed on functional form of the aggregate production function. The labor share is lower than that in data by the amount of the firing costs. The after-tax return, where $\bar{r} = (1-\tau^y)r - \delta$ is also relatively well-captured by the model. Lastly, given the absence of debt, and the fact that transfers were chosen residually to balance the government budget constraint, the result along this dimension is understandably not so close to the average ratio in data.

Table 2: Data Averages and Long-run Solution

Variable	Description	Data	Model
y	Steady-state output	N/A	1.000
c/y	Consumption-to-output ratio	0.648	0.674
i/y	Investment-to-output ratio	0.201	0.175
k/y	Capital-to-output ratio	13.96	13.96
g^c/y	Government consumption-to-output ratio	0.151	0.151
wh/y	Labor income-to-output ratio	0.571	0.521
rk/y	Capital income-to-output ratio	0.429	0.429
$\phi h^2/2y$	Firing costs-to-output ratio	0.050	0.050
h	Share of time spent working	0.333	0.333
$\bar{r}$	After-tax net return on capital	0.014	0.016

5 Out of steady-state model dynamics

Since the model does not have an analytical solution for the equilibrium behavior of variables outside their steady-state values, we need to solve the model numerically. This is done by log-linearizing the original equilibrium (non-linear) system of equations around the steady-state. This transformation produces a first-order system of stochastic difference equations. First, we study the dynamic behavior of model variables to an isolated shock to the total factor productivity process, and then we fully simulate the model to compare how the second moments of the model perform when compared against their empirical counterparts.

5.1 Impulse Response Analysis

This subsection documents the impulse responses of model variables to a 1% surprise innovation to technology. The impulse response functions (IRFs) are presented in Fig. 1. As a result of the one-time unexpected positive shock to total factor productivity, output increases upon impact. This expands the availability of resources in the economy, so used of output - consumption, investment, and government consumption also increase contemporaneously.

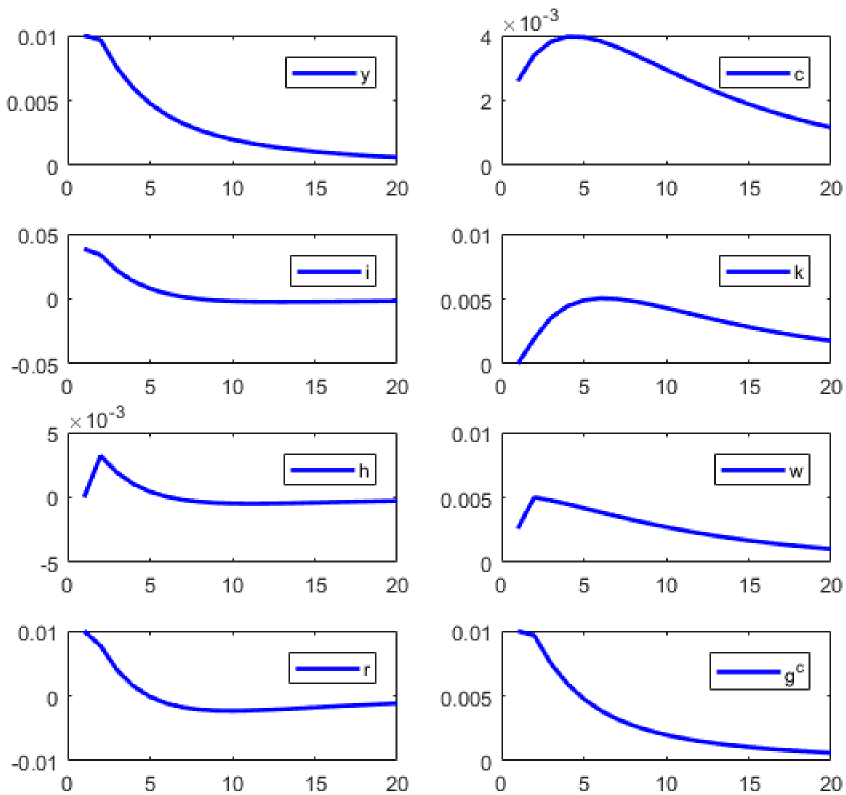

Figure 1: Impulse Responses to a 1% surprise innovation in technology

At the same time, the increase in productivity increases the after-tax return on the two factors of production, labor and capital. The representative households then respond to the incentives contained in prices and start accumulating capital, and supplies more hours worked. In turn, the increase in capital input feeds back in output through the production function and that further adds to the positive effect of the technology shock. In the labor market, the wage rate increases, and the household increases its hours worked. However, due to the presence of firing costs in the framework, hours are predetermined, so the increase in hours happens with a delay, and is dampened, as compared to the case without firing costs. All in all, the increase in total hours further increases output, indirectly and with a delay.

Over time, as capital is being accumulated, its after-tax marginal product starts to decrease, which lowers the households' incentives to save. As a result, physical capital stock eventually returns to its steady-state, and exhibits a hump-shaped dynamics over its transition path. The rest of the model variables return to their old steady-states in a monotone fashion as the effect of the one-time surprise innovation in technology dies out.

5.2 Simulation and moment-matching

As in Vasilev (2017b), we will now simulate the model 10,000 times for the length of the data horizon. Both empirical and model simulated data is detrended using the Hodrick-Prescott (1980) filter. Table 3 on the next page summarizes the second moments of data (relative volatilities to output, and contemporaneous correlations with output) versus the same moments computed from the model-simulated data at quarterly frequency. The "Model" is the case with firing costs, while the "Benchmark RBC" is a setup without such frictions. In addition, to minimize the sample error, the simulated moments are averaged out over the computer-generated draws. As in Vasilev (2016, 2017b, 2017c), both models match quite well the absolute volatility of output. By construction, government consumption in the model varies as much as output. In addition, the predicted consumption and investment volatilies in both models are too high. Still, the models are qualitatively consistent with the stylized fact that consumption generally varies less than output, while investment is more volatile than output. The model with firing costs produces smoother investment series, but the quantitative effect is quite small. Overall, the two models are almost indistinguishable from one another.

With respect to the labor market variables, the variability of employment predicted by both model is lower than that in data, and much lower in the case of fixed costs; the variability of wages in the model is very close to that in data. This is yet another confirmation that the

Table 3: Business Cycle Moments

	Data	Model	Benchmark RBC
σ_y	0.05	0.05	0.05
σ_c/σ_y	0.55	0.82	0.82
σ_i/σ_y	1.77	2.31	2.35
σ_g/σ_y	1.21	1.00	1.00
σ_h/σ_y	0.63	0.17	0.28
σ_w/σ_y	0.83	0.83	0.86
$\sigma_{y/h}/\sigma_y$	0.86	0.83	0.86
$corr(c, y)$	0.85	0.91	0.90
$corr(i, y)$	0.61	0.83	0.83
$corr(g, y)$	0.31	1.00	1.00
$corr(h, y)$	0.49	0.43	0.59
$corr(w, y)$	-0.01	0.95	0.96

perfectly-competitive assumption, even when we allow for quadratic firing costs, does not describe very well the dynamics of labor market variables. Next, in terms of contemporaneous correlations, both models systematically over-predicts the pro-cyclicality of the main aggregate variables - consumption, investment, and government consumption. This, however, is a common limitation of this class of models. Along the labor market dimension, the contemporaneous correlation of employment with output is a bit lower than that in data, as the lagged term in the firing cost function makes hours less procyclical. With respect to wages, both models predicts strong cyclicality, while wages in data are acyclical. This shortcoming is well-known in the literature and the presence of firing costs does not affect that results in any major way.

In the next subsection, as in Vasilev (2015c), we investigate the dynamic correlation between labor market variables at different leads and lags, thus evaluating how well the model matches the phase dynamics among variables. In addition, the autocorrelation functions (ACFs) of empirical data, obtained from an unrestricted VAR(1) are put under scrutiny and compared and contrasted to the simulated counterparts generated from the model.

5.3 Auto- and cross-correlation

This subsection discusses the auto-(ACFs) and cross-correlation functions (CCFs) of the major model variables. The coefficients empirical ACFs and CCFs at different leads and lags are presented in Table 4 below against the averaged simulated AFCs and CCFs. For the sake of economizing space, we only provide results for the setup with firing costs.

As seen from Table 4 above, the model compares relatively well vis-a-vis data. Empirical ACFs for output and investment are slightly outside the confidence band predicted by the model, while the ACFs for total factor productivity and household consumption are well-approximated by the model. The persistence of labor market variables are also relatively well-described by the model dynamics. Overall, the model with firing costs generates too much persistence in output and both employment and unemployment, and is subject to the criticism in Nelson and Plosser (1992), Cogley and Nason (1995) and Rotemberg and Woodford (1996b), who argue that the RBC class of models do not have a strong internal propagation mechanism besides the strong persistence in the TFP process. In those models, e.g. Vasilev (2009), and in the current one with firing costs, a technology shock can be regarded as a factor shifting the labor demand curve, while holding the labor supply curve constant. Therefore, the effect between employment and labor productivity is only a contemporaneous one. As a result, output and unemployment persistence is low. However, as seen from Table 5 below, over the business cycle, in data labor productivity leads employment. The model, however, cannot account for this fact.

Table 4: Autocorrelations for Bulgarian data and the model economy

		k			
Method	Statistic	0	1	2	3
Data	$corr(u_t, u_{t-k})$	1.000	0.765	0.552	0.553
Model	$corr(u_t, u_{t-k})$	1.000	0.952	0.893	0.823
	(s.e.)	(0.000)	(0.029)	(0.056)	(0.081)
Data	$corr(n_t, n_{t-k})$	1.000	0.484	0.009	0.352
Model	$corr(n_t, n_{t-k})$	1.000	0.952	0.893	0.823
	(s.e.)	(0.000)	(0.029)	(0.056)	(0.081)
Data	$corr(y_t, y_{t-k})$	1.000	0.810	0.663	0.479
Model	$corr(y_t, y_{t-k})$	1.000	0.957	0.905	0.846
	(s.e.)	(0.000)	(0.026)	(0.050)	(0.073)
Data	$corr(a_t, a_{t-k})$	1.000	0.702	0.449	0.277
Model	$corr(a_t, a_{t-k})$	1.000	0.955	0.901	0.837
	(s.e.)	(0.000)	(0.027)	(0.051)	(0.075)
Data	$corr(c_t, c_{t-k})$	1.000	0.971	0.952	0.913
Model	$corr(c_t, c_{t-k})$	1.000	0.958	0.910	0.854
	(s.e.)	(0.000)	(0.025)	(0.048)	(0.070)
Data	$corr(i_t, i_{t-k})$	1.000	0.810	0.722	0.594
Model	$corr(i_t, i_{t-k})$	1.000	0.954	0.896	0.829
	(s.e.)	(0.000)	(0.028)	(0.053)	(0.077)
Data	$corr(w_t, w_{t-k})$	1.000	0.760	0.783	0.554
Model	$corr(w_t, w_{t-k})$	1.000	0.958	0.909	0.853
	(s.e.)	(0.000)	(0.025)	(0.049)	(0.071)

6 Conclusions

We introduce firing costs into a real-business-cycle setup augmented with a detailed government sector. We calibrate the model to Bulgarian data for the period following the introduction of the currency board arrangement (1999-2018). We investigate the importance of such labor market frictions for cyclical fluctuations in Bulgaria. Firing costs decrease employment

Table 5: Dynamic correlations for Bulgarian data and the model economy

		k						
Method	Statistic	-3	-2	-1	0	1	2	3
Data	$corr(h_t, (y/h)_{t-k})$	-0.342	-0.363	-0.187	-0.144	0.475	0.470	0.346
Model	$corr(h_t, (y/h)_{t-k})$	0.014	0.020	0.024	0.362	0.030	-0.029	-0.069
	(s.e.)	(0.328)	(0.287)	(0.237)	(0.289)	(0.212)	(0.246)	(0.280)
Data	$corr(h_t, w_{t-k})$	0.355	0.452	0.447	0.328	-0.040	-0.390	-0.57
Model	$corr(h_t, w_{t-k})$	0.017	0.017	0.016	0.153	-0.032	-0.066	-0.087
	(s.e.)	(0.340)	(0.296)	(0.242)	(0.334)	(0.218)	(0.254)	(0.289)

volatility and pro-cyclicality, where both effects come at odds with data. Besides those, we do not find other important effects of firing costs for business cycle fluctuations in Bulgaria.

Declarations

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