

**Center for
Economic Theories and Policies**
Sofia University St. Kliment Ohridski
Faculty of Economics and Business Administration

ISSN: 2367-7082



Business Cycle Accounting: Bulgaria after the Introduction of the Currency Board Arrangement

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**BEP 11-2016
Publication: November 2016**

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November 24, 2016

Abstract

This paper focuses on explaining the economic fluctuations in Bulgaria after the introduction of the currency board arrangement in 1997, the period of macroeconomic stability that ensued, the EU accession, and the episode of the recent global financial crisis. This paper follows Chari et al. (2002) and performs business cycle accounting (BCA) for Bulgaria during the period 1999-2014. As in Cavalcanti (2007), who studies the Portuguese business cycles, most of the volatility in output per capita in Bulgaria over the period is due to variations in the efficiency and labor wedges.

JEL classification: E32, E37, O47

Keywords: Business Cycle accounting; Bulgarian economy; efficiency and labor wedges

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1 Introduction

This paper focuses on explaining the economic fluctuations in Bulgaria after the introduction of the currency board arrangement in 1997, the period of macroeconomic stability that ensued, the EU accession, and the episode of the recent global financial crisis. One objective of the study is to show that Bulgaria's transition and EU accession experience, as well as the slump during the financial crisis are comparable in magnitude to what other old and new EU member states experienced.¹ Therefore, it will be shown that modern business cycle accounting methodology, when applied to Bulgaria can produce results which are comparable with findings in other countries.²

Over the period studied (1999-2014), Bulgaria implemented a lot of structural reforms that achieved macroeconomic stability, fulfilled all the accession criteria and joined the EU as a new member state.³ In 1997, Bulgaria fixed its currency, Bulgarian lev (BGN), initially at par to the German mark, and from 2001 on - to the Euro (1 Euro =1.95583 BGN) and liberalized most of its markets, and continued privatizing state assets. Public finances were put in order, and the economy started reorienting its exports to Western European countries, increasing trade with the other EU member states at the expense of former markets in the East, such as Russia. The EU structural and accession funds also helped Bulgaria develop its infrastructure, which decreased transportation costs, attracted foreign investors and increased inter-city labor mobility. The EU accession process and the change in trade partners is easy to be incorporated within the neoclassical paradigm - trade shocks are equivalent to productivity shocks when one regards trade as a technology that allows countries to convert inputs into outputs at a lower opportunity cost.

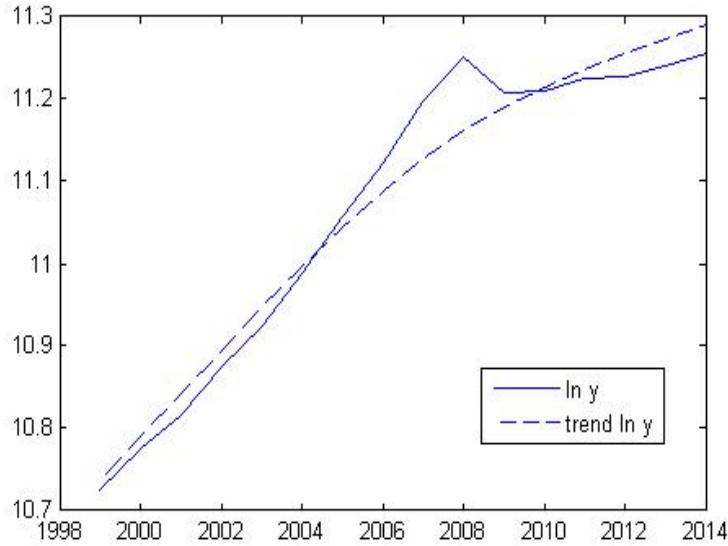
¹For a recent study on Central European countries (Hungary, Poland and Czech Republic), see Konya (2013).

²A non-exhaustive list of studies is the January 2002 issue of *The Review of Economic Dynamics*, the May 2002 issue of the *The American Economic Review*, Kehoe and Prescott (2007), and the references therein.

³Earlier years were excluded due to the (i) lack of sensible data during the initial years of transition; (ii) the very high volatility during most of the decade and the slowdown in the reform process; (iii) the financial and banking crisis during the 1996-97 period, which represented a significant structural break in the economy.

As seen in Figure 1 below, the period studied exhibits a typical business cycle pattern: until 2004 Bulgarian output per capita is below trend, then between 2004-08 the economy is above trend.⁴ The global financial crisis hits Bulgaria in 2009, and as of 2014, the economy still has not fully recovered from the negative shocks.

Figure 1: Log of output per worker in Bulgaria, 1999-2014.



Next, following Prescott (2002) and Cavalcanti (2007), if we define the aggregate production function as a Cobb-Douglas one with a time-varying trend, *i.e.* $Y_t = (A_t \gamma^t) K_t^\alpha (N_t h_t)^{1-\alpha}$, where Y_t is aggregate output, A_t denotes the level of Total Factor Productivity (TFP), γ is one plus the average growth rate, K_t is aggregate physical capital stock, N_t is population, and h_t are per person hours. We can take natural logs from both sides and thus decompose the log output into the following factors:

$$\ln y_t = t \ln \gamma + \ln A_t + \frac{\alpha}{1-\alpha} \ln \frac{k_t}{y_t} + \ln h_t, \quad (1)$$

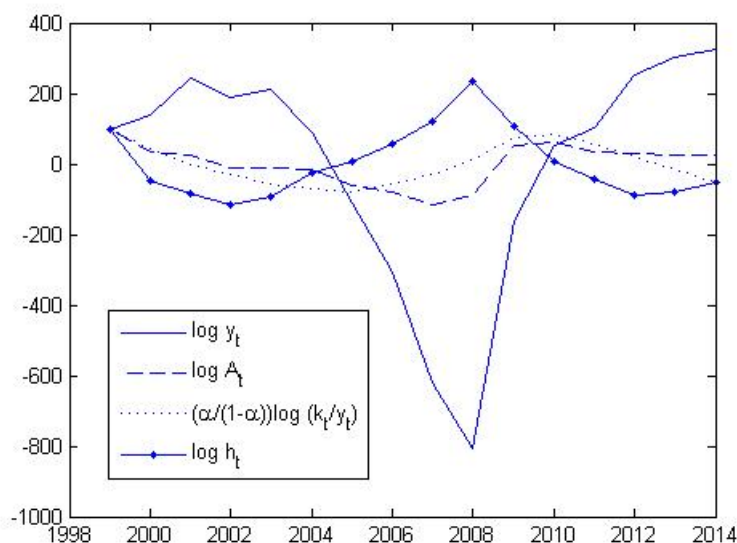
where the small-case letters denote per capita variables. The first factor driving output per capita growth is the trend, the second is the technology (productivity) factor, the third is the capital-to-output ratio (the capital factor), and the fourth one is the labor factor.⁵ Those

⁴The trend is the smooth non-linear trend extracted from the original series using the Hodrick-Prescott filter.

⁵There has not been much growth over the 1999-2014 period, so the gross growth γ term is not quantitatively significant.

are plotted in Figure 2, where the index value for all variables is normalized to 100.

Figure 2: Growth Accounting for Bulgaria (Index 1999=100)



As seen from Fig. 2 above, the weighted capital-to-output ratio is not varying much, thus leaving productivity changes and increases in the labor input as the major drivers of growth in output.⁶ The same pattern is observed in Table 1 on the next page, yet another argument that the investment wedge not being an important factor. During the period 2000-2007 there is a lot of disinvestment, and after the EU accession mechanizing production happens at the expense of laying off redundant labor. The effect of the financial crisis that hit Bulgaria in 2009, and the output plunge is seen in the drop in productivity. From 2012 onward, there has been some recovery, but without growth in the labor input. The accounting exercise in Table 1 on the next page suggests that, as in Cavalcanti (2007) for the case of Portugal, Bulgarian economy could benefit greatly from labor market reforms as a way to improve output per worker. Policy measures could include (i) increasing in labor efficiency, (ii) decreasing the distortions resulting from labor market policies already in place, and (iii) introduce more flexibility in labor contracting, especially when it comes to the process of collective bargaining over wages and employment. The other set of reforms should be aimed at increasing overall productivity, which is broadly connected to the level of competition in major industries, the level of barriers to entry and exit, the rate of innovations and technology adoption, and

⁶This finding is in line with Prescott (2002) for other European countries as well.

Table 1: Growth Accounting for Bulgaria (2000-2014)

	GDP	Productivity	Capital	Labor
Year	Factor	Factor	Factor	
2000	5%	8%	-1%	-3%
2001	4%	6%	-2%	0%
2002	6%	6%	-1%	1%
2003	5%	4%	-2%	3%
2004	6%	4%	-3%	4%
2005	6%	4%	-1%	3%
2006	6%	3%	-1%	4%
2007	6%	3%	-1%	3%
2008	5%	0%	1%	4%
2009	-4%	-5%	4%	-5%
2010	0%	0%	4%	-4%
2011	2%	2%	2%	-2%
2012	0%	1%	2%	-3%
2013	1%	1%	1%	-1%
2014	2%	1%	1%	0%

institutional quality.⁷

Next, we will implement business cycle accounting for Bulgaria, as pioneered in Chari *et al.* (2002). The method consists of two major components: The first component is an equivalence result, which states that that a large class of dynamic general equilibrium setups are equivalent to the stochastic optimal growth model with a representative agent and time-varying "wedges," which could be regarded as representing certain distortions and frictions that have an impact on overall economic efficiency and the allocations of the two major factors of production, capital stock and labor hours. Besides its tractability, the usefulness of the simple representative agent model is that it can be regarded as being an isomorphic

⁷Section 7 discusses in more depth certain policies that could improve efficiency and affect the level of the labor input.

representation to a much larger class of economic models, including but not limited to, much more sophisticated models with heterogeneous entrepreneurs engaging in investment project while facing credit constraints, as well as other setups with asymmetric information in financial markets and other credit frictions. All those frameworks are shown by Chari et al. (2002) to be equivalent to the baseline optimal growth model with "wedges", or distortions, that are allowed to vary over time.⁸ Those wedges enter the production function, the inter-temporal ("the consumption-Euler"), and the intra-temporal optimality conditions of the household ("consumption-vs-labor"), and look like fluctuating productivity processes, and time-varying taxes on labor and capital. In light of this model correspondence, the wedges are denoted as the efficiency, labor, and capital/investment wedge. Given the theoretical stochastic optimal growth model, we can derive the optimality conditions describing the choices that are made by the rational agents in the framework, and then use empirical data on those equations to construct all the wedges.

Furthermore, the methodology pioneered by Chari *et al.* (2002) is also very much in the spirit of Lucas (1980), who argues that theoretical models are to be interpreted as laboratories within which controlled computational experiments can be performed. More specifically, once we have estimated the series for the wedges in the stochastic optimal growth model, we can assess the quantitative impact of each individual wedge on output per person in Bulgaria during the period 1999-2014, as well as the combined effect of different wedges. This is the second important component of Chari *et al.* (2002)'s methodology, the accounting part. The procedure is conducted through a counterfactual experiment: the realized values of the wedges will be inserted in the model one at a time, and the other wedges would be held fixed at their steady-state level. In other words, the model economy would be subjected to the observed (sub)set of shocks. As pointed out in Kehoe and Prescott (2007), total factor productivity is taken as "external to the micro decision makers but not as invariant to policy" (p.3).⁹ This *ceteris paribus* logic would allow us to quantitatively evaluate, or to account for,

⁸This is because financial shocks can be viewed as a technology shocks, since banks use a process that takes deposits as inputs in the production function of loanable funds. For similar reasons, the recent financial crisis can be also viewed as a negative technology shock.

⁹Other interpretations of productivity shocks are weather and natural disasters, wars, trade sanctions, institutional (connected to the political/legal process and/or reforms) shocks, etc.

the relative importance of each wedge, as well as the role of a certain combination of wedges. In this way the general-equilibrium model is used as a diagnostic tool to guide researchers to the factors that need to be studied in more detail. For example, changes in institutional quality can affect not only the productivity wedge, but also labor and capital accumulation, and thus the labor and capital wedge as well.

The rest of the paper is organized as follows: Section 2 describes the model and the equilibrium concept to be utilized in the paper. Section 3 discusses the data to be used and describes the model calibration procedure. Section 4 solves for the steady-state. Section 5 computes the wedges using both the model and data. Section 6 conducts the counterfactual analysis. Section 7 provides some policy recommendations, and conclusions.

2 Model Description

This is a relative standard representative-agent model. The agent works and accumulates capital in order to maximize utility, which is a function of consumption and time off work. The representative firm uses both capital and labor as inputs to produce output, which can be used for consumption and investment. There is also a government sector, which taxes labor and capital income in order to finance wasteful government consumption, as well as some lump-sum transfers to the agent.

2.1 Household

There is a representative agent ("one-member household"), who is infinitely-lived, and there is no population growth. The household maximizes the following expected utility function

$$E_t \sum_{t=0}^{\infty} \beta^t [\ln c_t + \psi \ln(1 - h_t)], \quad (2)$$

where E_0 is the expectations operator in period 0, c_t is consumption at time t , and h_t denotes hours worked at time t .¹⁰ The parameter β is the discount factor, with $0 < \beta < 1$, and $\psi > 0$

¹⁰Note that with logarithmic specification of utility, the Frisch elasticity of labor supply equals $\frac{1}{\psi} - 1 = 2$ in our specification, which is higher than the estimate obtained from micro-studies. However, since we do not investigate what is behind the labor wedge but rather estimate the wedge from data, that aspect is not

denotes the relative weight attached to the utility of leisure. Household's time endowment has been normalized to unity, with total time being split between work and leisure, l_t . The hourly wage rate is w_t , so total pre-tax labor income generates equals $w_t h_t$.

In addition to the labor income generated, the household saves by investing i_t in physical capital. As an owner of capital, the household receives gross interest income $r_t k_t$ from renting the capital to the firms; r_t is the before-tax return to private capital, and k_t denotes physical capital stock in the beginning of period t . Each household's physical capital evolves according to the following law of motion:

$$k_{t+1} = i_t + (1 - \delta)k_t, \quad (3)$$

where $0 < \delta < 1$ is the depreciation rate on capital.

Finally, the households owns all firms in the economy, and receive an equal share of total profit (π_t) in the form of dividends. The household's budget constraint is

$$c_t + k_{t+1} - (1 - \delta)k_t = (1 - \tau_t^k)r_t k_t + (1 - \tau_t^h)w_t h_t + T_t + \pi_t, \quad (4)$$

where $\{\tau_t^h, \tau_t^k\}_{t=0}^\infty$ denote the time-varying tax rates on labor and capital, respectively, and T_t are government transfers.¹¹ The households acts competitively by taking prices $\{w_t, r_t\}_{t=0}^\infty$, the time-varying income tax rates $\{\tau_t^h, \tau_t^k\}_{t=0}^\infty$, and government transfers $\{T_t\}_{t=0}^\infty$ as given, and chooses allocations $\{c_t, i_t, k_{t+1}, h_t\}_{t=0}^\infty$ to maximize Eq. (2) s.t Eqs. (3)-(4), and initial conditions for physical capital stock $\{k_0\}$.

The optimality conditions from the household's problem, together with the transversality condition (TVC) for physical capital are as follows:

$$c_t : c_t^{-1} = \lambda_t \quad (5)$$

$$k_{t+1} : \lambda_t = \beta \lambda_{t+1} \left[(1 - \delta) + \left(1 - \tau_{t+1}^k \right) r_{t+1} \right] \quad (6)$$

$$h_t : \alpha(1 - h_t)^{-1} = \lambda_t(1 - \tau_t^h)w_t \quad (7)$$

$$TVC : \lim_{t \rightarrow \infty} \beta^t c_t^{-1} k_{t+1} = 0, \quad (8)$$

that relevant in this paper.

¹¹For the case when $T_t < 0$ for some t , transfers would represent a lump-sum tax.

where λ_t is the Lagrangian multiplier on the household's budget constraint. The household equates marginal utility from consumption with the marginal cost imposed on its budget. Next, the Euler equation describes the optimal capital accumulation rule, and implicitly characterizes the optimal consumption allocations chosen in any two contiguous periods. Hours worked are chosen so that the disutility of an hour work at the margin equals the return to labor. The last expression is the TVC, imposed to ensure that the value of the physical capital that remains at the end of the optimization horizon is zero.¹²

2.2 Stand-in Firm

There is also a representative private firm in the model economy. It produces a homogeneous final product using a production function that requires physical capital and labor. The production function is as follows

$$y_t = A_t k_t^\alpha h_t^{1-\alpha}, \quad (9)$$

where A_t measures the level of total factor productivity in period t , and $0 < \alpha < 1$ denote the productivity of physical capital and $1 - \alpha$ captures the productivity of labor.

The representative firm acts competitively by taking prices $\{w_t, r_t\}_{t=0}^\infty$, and chooses $k_t, h_t, \forall t$ to maximize firm's static profit:

$$\pi_t = A k_t^\alpha h_t^{1-\alpha} - r_t k_t - w_t h_t. \quad (10)$$

In equilibrium profit is zero. In addition, efficiency labor and capital receive their marginal products, *i.e.*

$$r_t = \alpha \frac{y_t}{k_t}, \quad (11)$$

$$w_t = (1 - \alpha) \frac{y_t}{h_t}. \quad (12)$$

2.3 Government sector

The government collects tax revenue from labor and capital income to finance wasteful government consumption $\{g_t\}_{t=0}^\infty$ and transfers $\{T_t\}_{t=0}^\infty$, which are returned lump-sum to the

¹²This boundary condition guarantees that the model equilibrium is well-defined by ruling out explosive solution paths.

household. The government budget constraint is then

$$\tau_t^k r_t k_t + \tau_t^h w_t h_t = g_t + T_t. \quad (13)$$

Government takes prices $\{w_t, r_t\}_{t=0}^\infty$ and allocations $\{k_t, h_t\}_{t=0}^\infty$ as given. The income tax rates are set to their average values in data. Government consumption share $\{g_t/y_t\}_{t=0}^\infty$ will be set equal to its average value in data, and lump-sum transfers will be residually determined: it will adjust to ensure the government budget constraint is balanced in every time period.

2.4 Decentralized Competitive Equilibrium

Given the initial conditions for the state variable k_0 , a Decentralized Competitive Equilibrium (DCE) is defined to be a sequence of prices $\{r_t, w_t\}_{t=0}^\infty$, allocations $\{c_t, i_t, k_t, h_t, g_t, T_t\}_{t=0}^\infty$, the processes followed by the income tax rates $\{\tau_t^k, \tau_t^h\}_{t=0}^\infty$ such that (i) expected utility is maximized; (ii) the stand-in firm maximizes profit every period; (iii) government budget is balanced in each time period; (iv) all markets clear.

3 Data and model calibration

The model is calibrated to Bulgarian data at annual frequency. The period under investigation is 1999-2014. Annual data on the output, household consumption, private fixed investment shares in output, and hours was obtained from the National Statistical Institute (NSI). Following Vasilev (2015a), capital income share is set to its average value $\alpha = 0.429$, and the labor income share is $1 - \alpha = 0.561$. Next, using Vasilev's (2015a) estimate that the annual depreciation rate on physical capital $\delta = 0.05$, we calibrate the discount factor from the steady-state Euler equation. The relative weight on leisure in the household's utility function, parameter $\psi = 1.658$, was set to match the household's steady-state labor supply, $\bar{h} = 1/3$. The average effective tax rates on both labor and capital income over the period are set $\tau^k = \tau^h = 0.11$. Steady-state output was normalized to unity, thus $A = 1.09$. Table 2 on the next page summarizes the values of all model parameters, and the next section provides the computed values of the model variables in the steady-state.

Table 2: Model Parameters

Param.	Value	Definition	Source
β	0.968	Discount factor	Calibrated
α	0.429	Capital income share	Data average
δ	0.050	Depreciation rate of physical capital	Data average
ψ	1.658	Relative weight on leisure in utility function	Calibrated
τ	0.110	Average effective income tax rate	Data average
A	1.090	Steady-state level of total factor productivity	Calibrated

4 Steady-State

Once model parameters were obtained, the steady-state ratios for the model calibrated to Bulgarian data were obtained and documented in Table 3 below.

Table 3: Data Averages and Long-run solution

	Description	BG Data	Model
c/y	Consumption-to-output ratio	0.633	0.659
i/y	Fixed investment-to-output ratio	0.200	0.174
g/y	Gov't consumption-to-output ratio	0.167	0.167
k/y	Physical capital-to-output ratio	3.491	3.491
$w\bar{h}/y$	Labor share in output	0.571	0.571
rk/y	Capital share in output	0.429	0.429
\bar{h}	Share of time spent working	0.333	0.333

Overall, the model captures quite well the average behavior in data. In the next section, we will use Bulgarian data for the period 1999-2014 and together with the equilibrium system of equations to compute the time-varying efficiency, labor and investment wedges.

5 Constructing the Wedges

After some simplifications, the model can be collapsed to the following four equations

$$A_t = \frac{y_t}{k_t^\alpha h_t^{1-\alpha}} \quad (14)$$

$$\frac{\psi c_t}{1 - h_t} = (1 - \tau_t^h)(1 - \alpha)A_t k_t^\alpha h_t^{-\alpha} \quad (15)$$

$$\frac{1}{c_t} = \beta E_t \left\{ \frac{1}{c_{t+1}} \left[(1 - \tau_{t+1}^k) \alpha A_{t+1} k_{t+1}^{\alpha-1} h_{t+1}^\alpha + (1 - \delta) \right] \right\} \quad (16)$$

$$y_t = c_t + k_{t+1} - (1 - \delta)k_t + g_t, \quad (17)$$

where $\{A_t\}$ is the efficiency wedge series, $\{(1 - \tau_t^h)\}$ is the labor wedge series, and $\{(1 - \tau_{t+1}^k)\}$ is the investment wedge series.¹³ Starting with the Cobb-Douglas production function, we compute the series of the efficiency wedge as a Solow residual from the detrended output series, and using data on physical capital and hours, as well as the calibrated values for capital and labor shares, which were set equal to their average values in data. The obtained $\{A_t\}$ process is the realized detrended total factor productivity sequence during the period 1999-2014.

Next, using the estimated $\{A_t\}$ sequence from the production function, as well as the marginal rate of substitution condition (which equated the ratio of the marginal utilities of consumption and labor to their relative after-tax prices), we can compute the series for the labor wedge, using the calibrated model parameters, and the detrended series for hours, consumption, and capital. The obtained labor wedge process $\{(1 - \tau_t^h)\}$ measures the distortion between the marginal rate of substitution and the marginal rate of transformation. This wedge captures the friction in the intra-temporal substitution between consumption and hours.

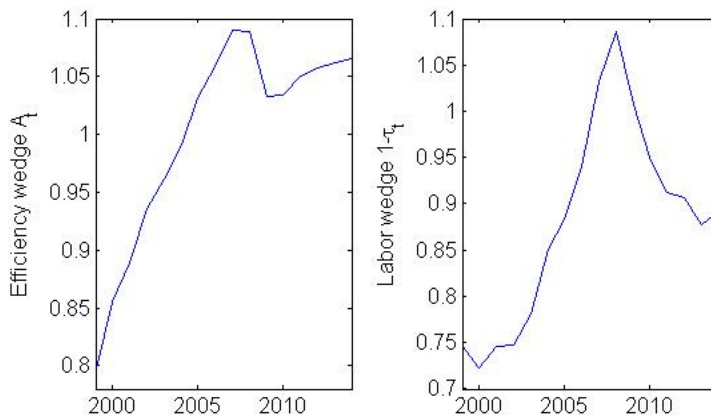
Lastly, from the consumption-Euler equation, we can compute the investment wedge. This wedge introduces a distortion in the household's inter-temporal optimality condition and represents a friction to the accumulation of physical capital as a mechanism to smooth consumption over time. This friction is typically associated with the tax on capital, but it

¹³In the equivalence part, we interpreted the latter two as being functions of taxes.

can be much broader, reflecting institutional deficiencies such as corruption, imperfect enforcement of property rights, liquidity constraints (which could be important for small-scale businesses), etc.¹⁴

The estimated series of the efficiency and labor wedges are shown in Fig. 3 below. The investment wedge is practically not varying (not plotted). This is consistent with Christiano et al. (2002), which finds that the investment wedge is not a major quantitative factor explaining the fluctuation in output in other developed and developing countries. Thus, as in Cavalcanti (2007), we will focus on the efficiency and labor wedge, while keeping investment wedge set to its steady-state value $1 - \tau^k = 0.89$.

Figure 3: Efficiency and labor wedges.



We can see that the efficiency wedge has been increasing from 1999 until 2008, which was due to the introduction of the currency board arrangement in 1997, the structural reforms in the public sector, the banking system, and the continued privatization of state assets. More specifically, in order to strengthen the credibility of the exchange rate regime (and to avoid disasters, such as the one that happened in Argentina), public finances had to be put in order, and the government started running budget surpluses. During same time period, Bulgaria's foreign debt was also restructured, and together with the growth in output, the debt-to-output ratio fell substantially below the 60% threshold suggested by the Maastricht criteria.

¹⁴In our simple setup, since firm profit is zero, corporate taxes would not play any role in the model. Thus the tax on capital has to do with capital earnings of households and family businesses.

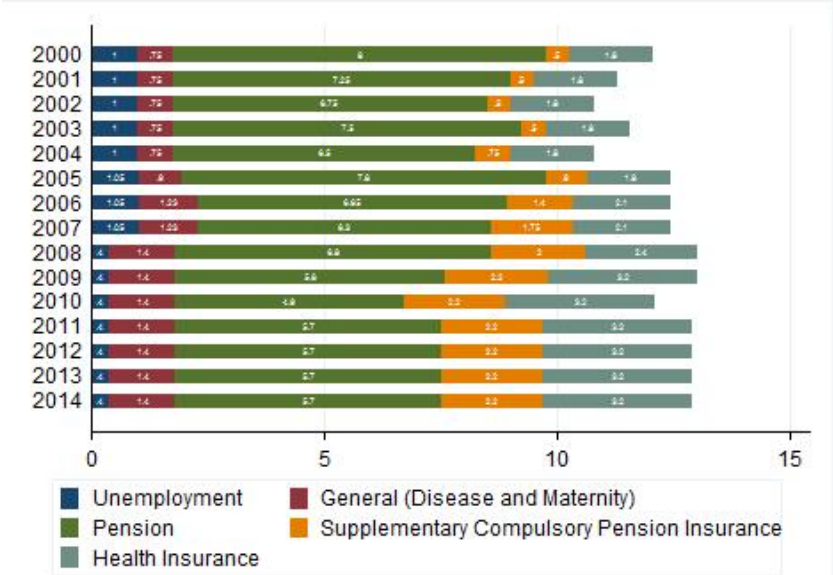
Last, but not least, Bulgaria was on the road to the EU accession and had to synchronize all its legislation to the European one, and close a substantial number of chapters during the negotiations. The fixed exchange rate regime, the reformist governments that achieved macroeconomic stability, and the expectations for EU accession, which helped the real interest rate to converge fast to the EU one, all helped the country develop faster and speed up growth. Bulgaria reoriented its trade to the EU member states, greatly benefitting from the Customs Union arrangement. More specifically, the absence of tariffs between EU member states stimulated trade (which, after all, is a form of technology) and allowed export-oriented firms to operate in a highly-competitive environment, which forced those firms to adopt very quickly the best practices in the field, and in the meantime generate very valuable know-how, which was missing before. The overall macroeconomic stability also attracted foreign investors, who set up companies in Bulgaria and not only added to the flow of foreign direct investment, but also brought a much needed Western managerial expertise.

Bulgaria also benefitted, and continues to benefit from the accession and structural funds from the EU, which were used, among other things, to rehabilitate, expand and thus develop further public infrastructure (highways, railways, urban transportation, electricity production and distribution, among others). It goes without saying, that the EU transfers to Bulgaria, coupled with consistent monitoring and oversight of how the spent funds are accounted for, increased productivity in many industries. In addition, fixing BGN to the Euro allowed for cheaper credit, which led to more production and reinforced the expectations of good times in the future. However, most of the growth was due to the increase in construction, and the cheap mortgages led to rapid appreciation in residential property, producing a bubble in housing prices. The balloon quickly dis-inflated during the financial crisis, which hit Bulgaria from the end of 2008 until 2012. The negative impact of the financial crisis (captured as a negative technology shock) disrupted economic activity in a major way, and the economy had not fully recovered ever since.

Similar pattern can be seen with the labor wedge. After the introduction of the currency board arrangement, and the reforms that followed, household's earnings in real terms were

stabilized and grew significantly. In addition, Bulgaria adopted flat (proportional) taxation of both individual income and corporate profit at the rate of 10%, replacing the progressive tax schedule that was place before. This reform has a positive effect on hours, as many workers found it in their interest to move from the grey economy to the official sector. Unfortunately, some of the gains from the tax reform were lost as the financial crisis unravelled in the same year of the flat tax introduction. Nevertheless, as of 2012, the labor wedge is increasing, which is a sign that the effective burden on labor is now lower. This might be due to the fact that in Bulgaria each worker has to make unemployment, health and pension contributions, which are payments deducted from the wage. Even though social security contributions are technically deferred income (in the case of pensions, or when becoming unemployed) or an inter-temporal transfer (in the case of hospital treatment), many economists view those as a *de facto* additional tax on labor. However, since there is no large change in the overall social security burden (less than a percentage point), as seen in Figure 4 below, it is not a good candidate to explain the behavior of the labor wedge over the 1999-2014 period.

Figure 4: Employee contributions (2000-2014).

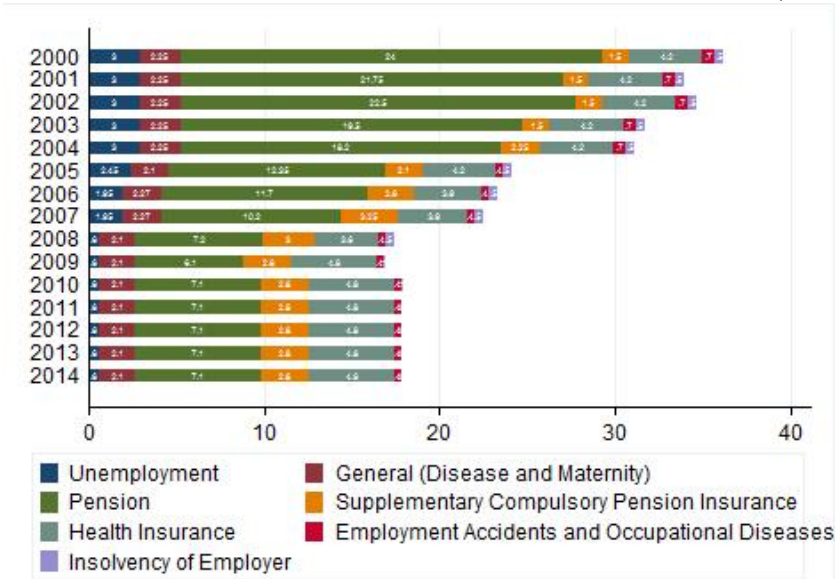


Source: Author's calculations

Another possible factor are the employers' social security contributions, or the contributions towards the same insurance pools, made by the employer on behalf of the worker. As we see

from the Figure 5 below, in contrast to the employee contributions, the overall burden on the employers fell by between a third over the period 1999-2008, which corresponds closely to the behavior exhibited by the labor wedge.

Figure 5: Employer's contributions (2000-2014).



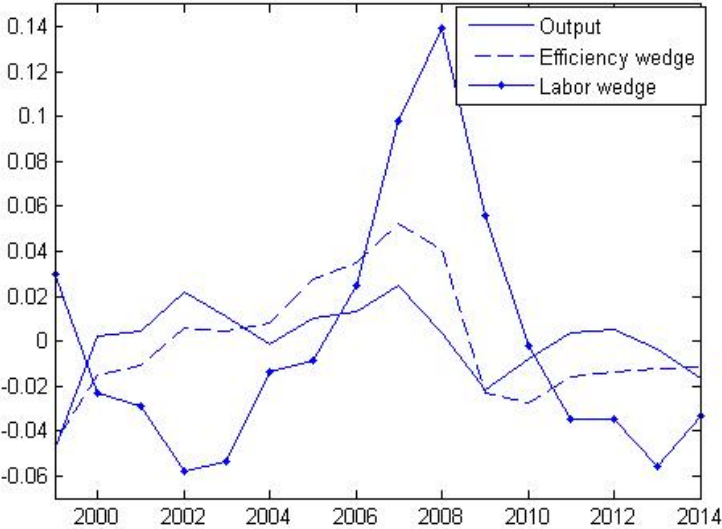
Source: Author's calculations

The link between the labor wedge and the size of the employer's contribution can be explained as follows: due to the excessive burden levied on the employer (from the employer's perspective, the cost of labor equals the worker's gross wage plus the employer's contributions) may have prevented the employer from paying the full product generated by the worker in the form of salaries. Moreover, during the financial crisis in Bulgaria (2009-2012), a lot of businesses went bankrupt. This disruption decreased the labor wedge (or, equivalently, increased the burden on labor), most probably through the increase in layoff costs, the existence of collective bargaining agreements, which were precluding mass layoffs, necessitating that advance notice be given to workers about to lose their jobs. We can add to those the judicial costs borne by employers when a worker was laid off in violation to the Bulgarian Labor code, and in case of a trial, the court often reinstated the worker to his/her former workplace, and decreed that penalty be paid to the worker as a compensation for the time off-work.

Another reason for the drop in the labor wedge could be that the laid-off workers received unemployment benefits that were too generous both in terms of the size of the replacement income relative to the previous wage, and the duration period. This might have resulted in some structurally unemployed workers, who have lost not only their working habits, but also made their education and training obsolete. The unreformed education system is adding to this problem, as graduates finish their studies lacking marketable and transferrable skills. Lastly, children benefits might be also playing a negative role for female labor supply, stimulating uneducated women to prefer to collect benefits instead of working for the minimum wage.

Next, we turn to the cyclical behavior exhibited by the two wedges, and compares the fluctuations to the output behavior over the business cycle. Figure 6 below displays detrended series for output per worker, and the detrended efficiency and labor wedges, all during the period 1999-2014 in Bulgaria.

Figure 6: Detrended output per worker, detrended efficiency and labor wedges, 1999-2014.



The efficiency wedge follows a very similar path to the fluctuations in the output per worker series. The labor wedge is highly procyclical and has a very similar amplitude to the one exhibited by output per capita. After the reforms complementing the introduction of the

currency board regime, which were mostly austerity measures, implementing cuts in government spending, output per capita recovered and was above trend until the financial crisis hit the economy in late-2008. Output plunged below trend, then started recovering. The recovery, however, has been feeble. The high oil prices and energy-intensive production are among the two main factors impeding a quick recovery.

The labor wedge, is much less pro-cyclical and tends to vary more than output. Nevertheless, its cyclical behavior is broadly aligned with the one exhibited by output, especially when we focus on the period 2002-2014. Thus, the two wedges are the major candidates to explain output behavior during the period. In the next section we will perform a computational experiment, where we will compute the combined effect of the two wedges, as well as their separate quantitative effects.

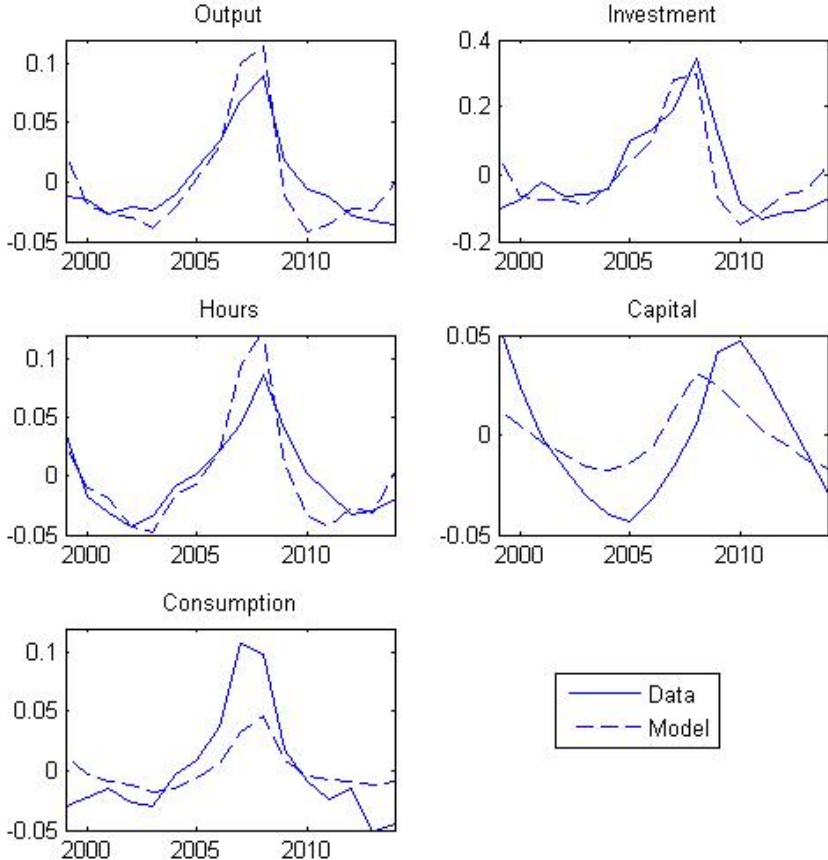
6 Counterfactual Analysis

Given the estimated series of the productivity and labor wedges, we estimate the stochastic process followed by those two variables using an unrestricted vector-auto-regression of order one, *i.e.*, a VAR(1). The two processes are highly persistent, and uncorrelated. The values are broadly consistent with the estimates for the same processes in other countries: $\rho_a = 0.89$, $\rho_l = 0.73$, where the estimates denote the computed degree of inertia for $\{\hat{A}_t\}_{t=1999}^{t=2014}$ and $\{1 - \hat{\tau}_t^h\}_{t=1999}^{t=2014}$, respectively. These coefficients are then fed into the log-linearized system of equations, which allows us to compute the approximate policy rules for capital, output, hours, investment, consumption, and government transfers. Government consumption $\{g_t\}_{t=1999}^{t=2014}$ is held equal to its steady value.¹⁵ Once the model is solved for, capital series are generated using the realized values of the efficiency and labor wedge processes. Then we feed the series of the state variables (efficiency, labor wedge, capital) into the policy functions for consumption, investment, hours and output to produce simulated series of length equal to the annual observations during the period 1999-2014. The series are then detrended using

¹⁵This is done for simplicity; allowing government purchases to enter the VAR(1) system described above produces an AR(1) process for government spending with low persistence, and non-correlated with the efficiency and labor wedge series. Such a process turns out not to be quantitatively important in explaining business cycle fluctuations in Bulgaria over the period studied, and is hence not included in the analysis.

the Hodrick-Prescott filter in order to compare the model-generated series to their detrended empirical counterparts. As in Chari et al. (2002), the effect of the investment wedge is measured residually, as the difference between the combined contribution of the efficiency and labor wedges to simulated output and the empirical output series. After all, when all the three wedges are fed into the model, the simulated output series and the empirical output series are identical. Figure 7 below presents the results when the model is run with both an efficiency and labor wedge.

Figure 7: Model with both an efficiency and labor wedge.



As seen from Figure 7 above, the combined effect of the two wedges explain most of the

cyclical behavior of output, hours, and investment.¹⁶ The time-varying investment wedge is important in explaining capital accumulation and a bit of consumption behavior over the period, as the investment wedge enters the consumption-Euler equation, and variability in the wedge produces variability in capital stock. Still, it is a well-known fact that in this class of models capital does not vary much over the business cycle. Still, in the presence of a time-varying labor wedge, hours fluctuate as much as in data, and since labor and capital are complements in the Cobb-Douglas production function, the model generates the same amplitude and phase in the simulated capital sequence, as the one featured by empirical capital series. Alternatively, the policy function for capital is a function of the labor wedge, so that when we feed the empirical realizations of the labor wedge, the dynamics of the model-generated capital approximates better the observed dynamics in capital.

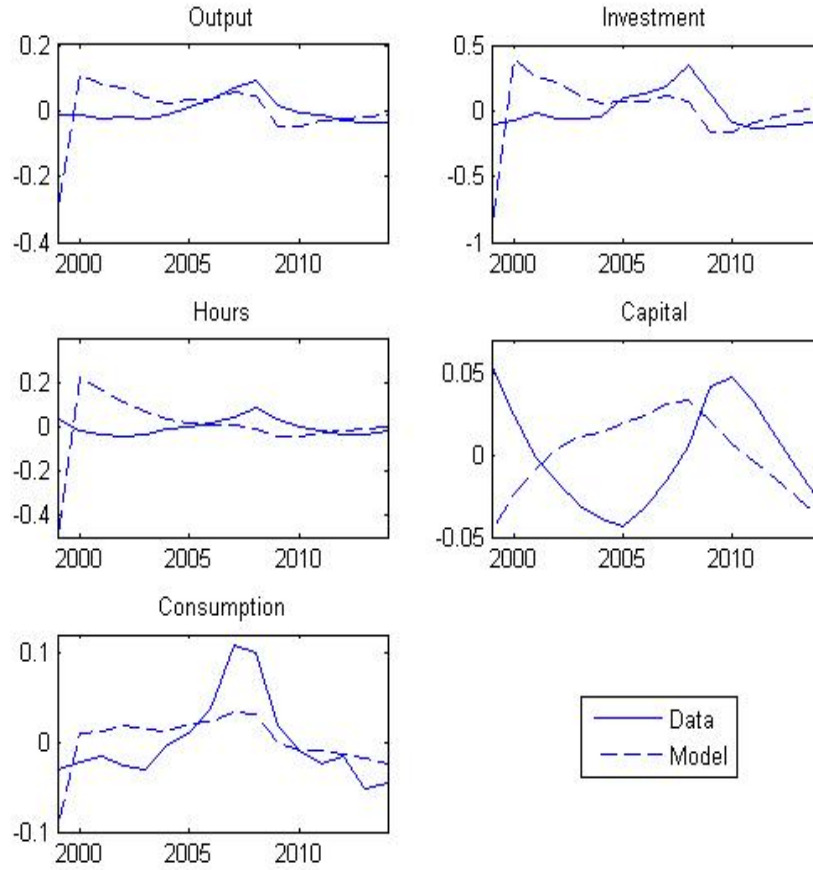
In addition, the model with two wedges slightly under-predicts the peak in consumption. This is due to the fact that over the period government spending tends to decrease at the expense of increase in consumption, an effect which is one-to-one. This is something that the model misses, as we have set government spending equal to its average value over the period 1999-2014. The model also predicts a much stronger recovery than the one observed in data. However, as shown in Kehoe and Prescott (2007) and Cavalcanti (2007), this is a typical shortcoming of a large class of Real-Business-Cycle (RBC) models when the framework is applied to study recent depressions in both the US and Western European countries. Overall, the model with the two wedges explains most of the variability in allocations over the period.¹⁷

Next, we conduct some counterfactual experiments and start by isolating the effect of each of the two wedges and discuss possible institutional aspects and policies that might affect their behavior during the period considered in this paper. Figure 8 on the next page presents the results generated when the model is run with only an efficiency wedge, while setting the labor wedge equal to its steady-state value.

¹⁶The difference between the observed and the simulated series might be driven by the investment wedge, as well as possible utility and/or production function misspecifications.

¹⁷As shown in Conesa et al. (2007), a model with technology shocks, taxes and government consumption also fits Finnish experience over the period 1980-2005 quite well.

Figure 8: Model with a time-varying efficiency wedge only.

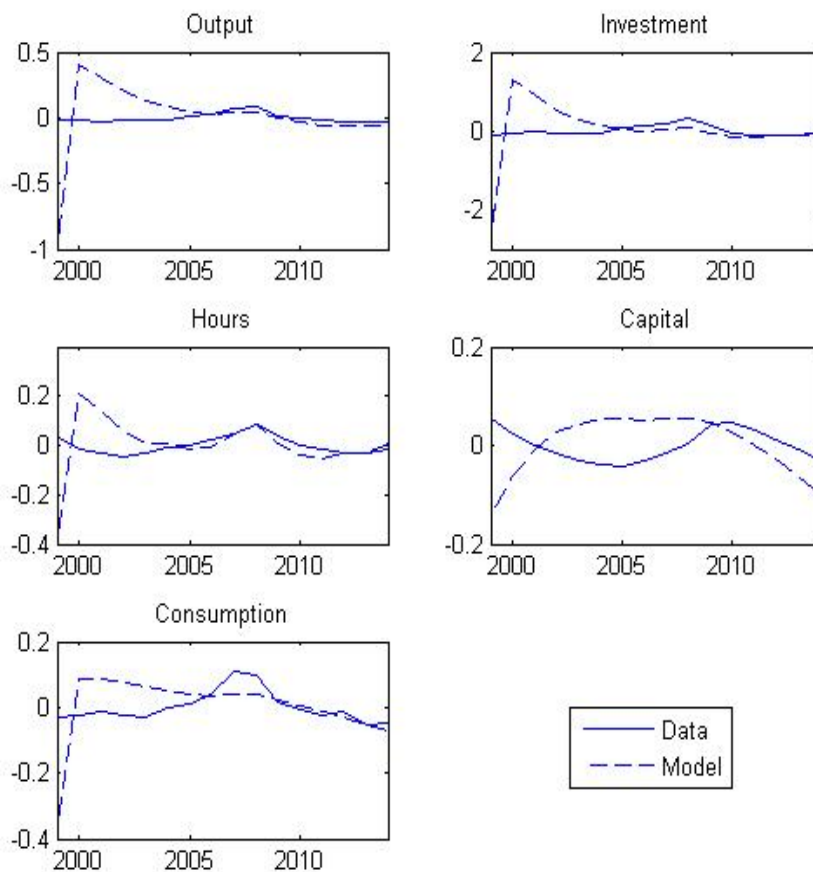


As seen from Figure 8 above, with a time-varying efficiency wage only, the fit is still very good. However, the variability in the model has decreased significantly, which is a strong indicator that having a time-varying labor wedge is quantitatively important to describe fluctuations in Bulgarian economy over the period 1999-2014. The worsening in the fit can be seen in consumption, investment, and capital series. The reason is that the model with only an efficiency wedge misses the substantial improvements in the labor wedge over the period 2001-07, which could be due to the decrease in the employer's contributions, and thus led to a more equitable sharing of the value of the match between an employer and an employee. Other possible explanations could be the price liberalization in output markets and the improvements in wage flexibility. Lastly, as argued in Vasilev (2015b), the income tax reform

may have led to a significant relocation of labor from the grey economy to the official sector.¹⁸

The second counterfactual exercise is to isolate the effect of labor frictions. Thus, we simulate the model with a time-varying labor wedge only, and keep the level of efficiency equal to its steady-state value over the period. Figure 9 presents the results generated from this computational exercise below.

Figure 9: Model with a time-varying labor wedge only.



As seen from Figure 9 above, in the absence of efficiency (technology) shocks the fit of the

¹⁸Unfortunately, during the financial crisis (2008-12), as shown in Vasilev (2016), VAT evasion has been on the rise, which increases the effective burden on labor and depresses hours of work. Note that if we include a constant consumption tax τ^c in the model, the time-varying tax rate faced by the household would be $\frac{\tau^c + \tau_t^h}{1 + \tau^c}$. Inclusion of a consumption tax does not change quantitatively the results obtained in this paper.

model worsens. There is almost no variation in either output, hours, or investment. The fit of capital and consumption is also worse than before. This is because technology shocks, or the time varying efficiency wedge, is a very important propagation mechanism in this class of models. We can safely claim that the model with a labor wedge only performs worse than a model with only a time-varying efficiency wedge. In the next section, the paper outlines several policy implications that could be drawn from the business cycle accounting exercise.

7 Policy Implications

Over the period studied (1999-2014), Bulgaria entered the EU and implemented a lot of structural reforms. Bulgaria fixed the currency to the Euro and liberalized most of its markets. Most of the state assets were privatized through direct sales during the period. Public finances were put in order, and the economy started trading with the other EU member states reorienting its exports to Western European countries. Therefore, the EU accession process is an example of a substantial improvement in overall economic activity as many chapters dealing with economic and legal aspects had to be closed, thus synchronizing Bulgarian legislation with the EU laws. Next, the EU funds provided to Bulgaria, together with the strong conditionality and accountability attached, also contributed to improvements in efficiency, as those were invested in transportation infrastructure, which decreases both delivery and commuting times.

As seen from the counterfactual exercises, labor market reforms are also quantitatively important in the case of Bulgaria: The labor wedge captured significant distortions between the marginal rate of substitution between consumption and hours, and the relative prices of the two, a friction which could be at least partly attributed to the progressive taxation regime which was in place until end-2007, the above-market wages in some public sectors, and the too generous unemployment benefits, among many other factors. In addition, the decrease in overall burden levied on employer allowed workers to receive salaries closer to their marginal product of labor, thus allowing for more equitable rent-sharing and distribution of income. The adoption of proportional income taxation as of 2008, featuring a lower effective tax rate also increased labor productivity, by giving workers a strong incentive to move out from the

grey economy.

The model in this paper suggests that Bulgaria can benefit more from more flexibility in labor markets, and more competition, as suggested in Bailly and Solow (2001). Firing costs are still substantial, and industry-level tri-partite (Government/Finance Ministry, Employer Associations and Labor Unions) bargaining is still prevalent in the economy, which also raises hiring costs. Hiring part-time workers should be made easier, and overtime legislation might need to be reviewed. Ex post and complete indexation of nominal wages should be discontinued.

On a more structural level, reforms in education reforms are also much needed, as many graduates enter the workforce without marketable skills and obsolete knowledge. This generates substantial asymmetries and makes it harder for skilled workers to find a match quickly, due to the reluctance on the employers's side to engage into a match with uncertain value.¹⁹ Fixed costs of working should be also addresses: building inter-city highways is important, but providing efficient urban transportation and adequate infrastructure, and cheap public housing is equally important. For those who have children, adequate possibilities for childcare should be provided.

Furthermore, given the demographic profile of the country, the aging population and the migration of younger people to the older EU member states, incentives should be given to more experienced workers to stay an extra year in the labor force and postpone retirement. To make that a possibility, adequate healthcare needs to be provided so that workers remain in good health over their life cycle. On the other hand, the paid sick leave policy is too generous and needs to be reconsidered as well, as it stimulates workers to call in sick. The number of holidays and paid vacation is also too high relative to the other EU member states.

Aside from certain rigidities in the labor markets, Bulgaria can gain relative to the EU average by speeding up the structural transformation in the economy away from agriculture and manufacturing and towards services, increase mechanization through fast innovation and

¹⁹For more on this issue, the interested reader is to consult Alvarez and Veracierto (1999), and Bertola and Rogerson (1997), and the references therein.

technology adoption/adaptation. Rule of law and reforms in the judicial system are a step in the right direction.

Lastly, capital utilization is still a problem, as Bulgaria inherited a lot of old non-marketable capital from the Communist era. Allocation of investment at micro level and lack of access to credit for small- and medium enterprises remains a problem faced by entrepreneurs.²⁰ Furthermore, the absence of a strong recovery could be due to rigidity in government effectiveness, and absence of legislative and institutional reforms, resulting in a weak rule of law, with imperfect protection of property rights, lengthy trials with uncertain outcomes. Many firms still operate semi-legally, in both the official and the unofficial sector, and not paying workers the full amount of the wage earned. Despite all the shortcomings listed above, Parente and Prescott (2000) believe in the potential of backward countries to catch up fast to the industry leader, which could be done by reducing the monopoly power of certain industries by lowering the barriers to entry and exit. Despite the openness of the EU, there are still some impediments at local level, such as licensing regimes and corruption, which are faced by both domestic and foreign businesses in Bulgaria.

8 Conclusions

This paper focused on the economic fluctuations in Bulgaria after the introduction of the currency board arrangement and covers the period of the recent financial crisis as well. Following the business cycle accounting procedure developed by Chari *et al.* (2002), most of the volatility in output per capita in Bulgaria over the period is due to variations in efficiency. The paper is a first attempt to apply the modern neoclassical methodology to an Eastern European country, and hopefully will attract the attention of researchers in the region. Still, further research is needed if more concrete policy recommendations are to come out of the study. Those, however, are beyond the scope of this paper. Thus, there is need for further, more in-depth and more focused research.

²⁰Antunes and Cavalcanti (2003), among others, show that financial institutions and credit market policies can have a strong effect on economic activity: creditconstrained entrepreneurs are forced to reduce the size of their projects, thus having to operate at a suboptimal scale and productivity levels.

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