The European Journal of Comparative Economics
Vol. 14, n. 2, pp. 197-219
ISSN 1824-2979

Business Cycle Accounting: Bulgaria after the introduction of the currency board arrangement (1999-2014)

Aleksandar Vasilev*

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, 2007) 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

1. Introduction and Motivation

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. In this way the current study tries to fill an important gap in the literature on transition economies: More specifically, 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, as in Chari et al. (2002, 2007), when applied to Bulgaria can produce results which are comparable with findings in other countries.[2]

Over the period studied in this paper (1999-2014), Bulgarian governments implemented a lot of structural reforms that achieved macroeconomic stability, fulfilled all the accession criteria and the country joined the EU as a new member state.[3] First, following an episode of a banking and financial crisis, in mid-1997 Bulgaria fixed its exchange rate by setting its currency, Bulgarian lev (BGN), initially at par to the German mark, and from 2001 onwards - to the Euro (1 Euro =1.95583 BGN) and liberalized most of its markets, and continued privatizing state assets. Government finances were

* American University in Bulgaria. E-mail: avasilev@aubg.bg.

[1] For a recent study on Central European countries (Hungary, Poland and Czech Republic), see Konya (2013), who uses a combination of two methodologies.

[2] A 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. More recent studies are Chakraborty (2009) and Cho and Doblas-Madrid (2013) on Asian countries, and Simonovska and Soderlind (2015) on Chile.

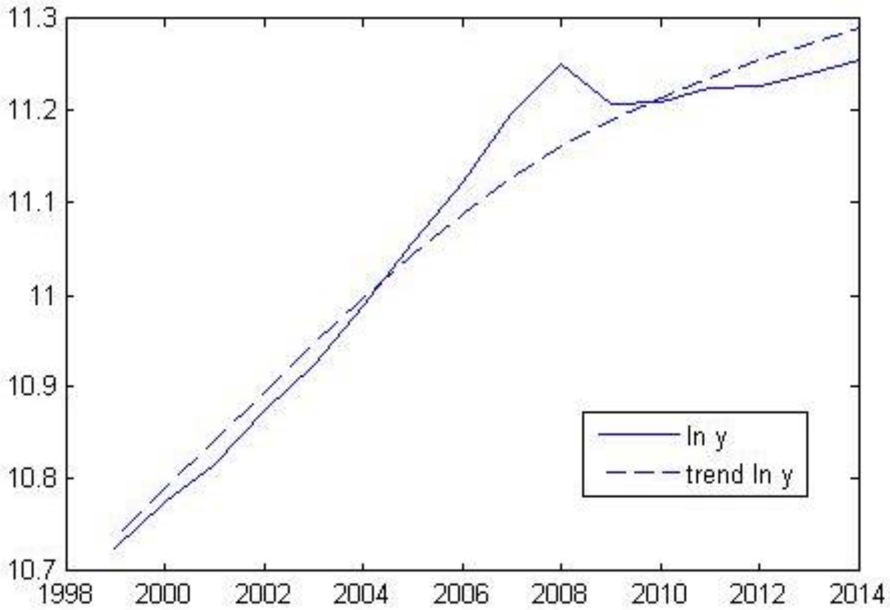
[3] Earlier years were excluded due to the (i) lack of sensible data during the initial years of transition; (ii) the very high volatility during most of the decade and the slowdown in the reform process; (ii) the financial and banking crisis during the 1996-97 period, which represented a significant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

http://dx.doi.org/10.25428/1824-2979/201702_197-219

put in order, subsidies to loss-making state enterprizes, as well as any form of state aid, were discontinued, and the economy started re-orienting its export markets 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 (or, "cohesion," as they are also called) 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 are easy to be incorporated within the neoclassical paradigm - trade shocks would be measured as productivity shocks in a closed-economy setup when one regards trade as a technology that allows countries to convert inputs into outputs at a lower opportunity cost.

As seen from Figure 1 on the next page, the period covered in this study (1999-2014) 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] As seen from the plot, the global financial crisis hits Bulgaria in 2009, and as of 2014, the economy still has not fully recovered from the slump.

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



Next, before we proceed with the business cycle accounting, we start by decomposing the growth rate in Bulgaria into its elements in order to understand the major forces at work during the last fifteen years, and as a motivation for the computational experiment to be performed. The results from the growth accounting procedure are presented in the next section. The rest of the paper is organized as follows: Section 3 describes the model and the equilibrium concept to be utilized in the paper. Section 4 discusses the data to be used and describes the model calibration procedure. Section 5 solves for the steady-state. Section 6 computes the wedges using

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

both the model and data. Section 7 conducts the counterfactual analysis. Section 8 provides some policy recommendations, and Section 9 provided conclusions.

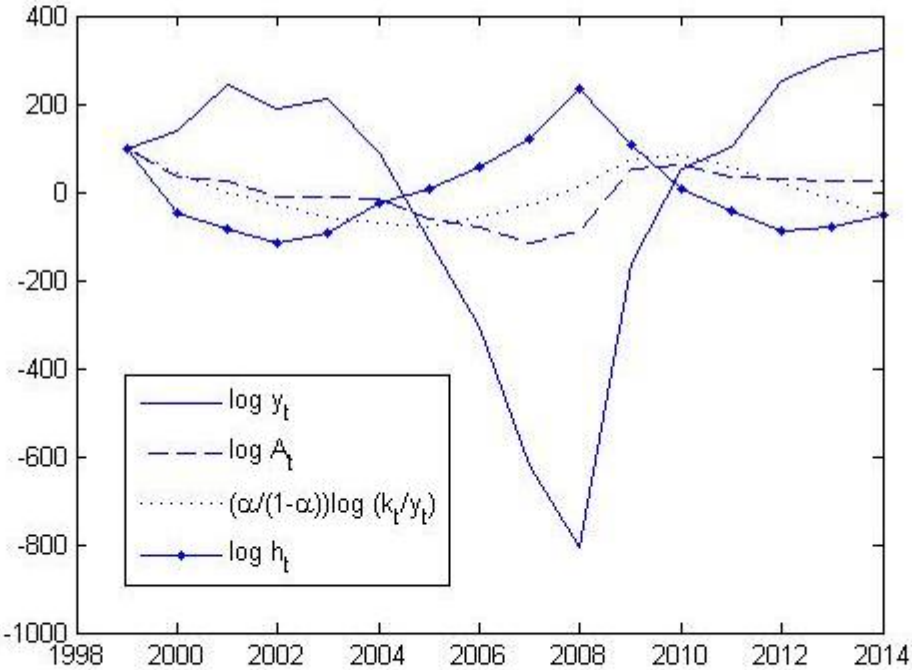
2. Growth Accounting

Next, as an additional motivation of our study, we follow Prescott (2002) and Cavalcanti (2007): We define the aggregate production function as a Cobb-Douglas one with a time-varying trend, *i.e.* $Y_t=(A_t\gamma^t)K^{\alpha}_t(N_t h_t)^{1-\alpha}$, 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:

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

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 forth one is the labor factor.[5] Those are plotted in Figure 2 below, where the index value for all variables is normalized to 100.

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



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

As seen from Fig. 2, 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 is not going to be an important explanatory factor of business cycle fluctuations in Bulgaria over the period covered in this study.

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

Year	GDP Factor	Productivity Factor	Capital Factor	Labor
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%

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 results from the growth accounting exercise in Table 1 on the next page suggest that, as in Cavalcanti (2007) for the case of Portugal, Bulgarian economy could also 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 institutional quality (e.g. as suggested in Prescott 2002).[7]

Next, we will implement business cycle accounting for Bulgaria, as pioneered in Chari *et al.* (2002, 2007). The method consists of two major components: The first component is an equivalence result, which states that a large class of dynamic general

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

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

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 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, 2007) 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) and then improved in Chari *et al.* (2007), 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, 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 wedges as well.

[8] This is because financial shocks can be viewed as 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.

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

3. Model Setup

This is a relative standard representative-agent model. The stand-in individual household 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.

3.1 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

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

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<β<1, and ψ>0 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. The household's physical capital evolves according to the following law of motion:

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

where 0<δ<1 is the depreciation rate on capital.

Finally, the household owns all firms in the economy, and receives all profit (π_t) in the form of dividends. The household's budget constraint is

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

[10] Note that with logarithmic specification of utility, the Frisch elasticity of labor supply equals $\frac{1}{h} - 1 = 2$ 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 that relevant in this paper.

where $\{\tau_t^h, \tau_t^k\}_{t=0}^{\infty}$ denote the time-varying tax rates on labor and capital, respectively, and $\{T_t\}_{t=0}^{\infty}$ are government transfers.[11] The household 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 the initial condition for the 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:

$$c_t : c_t^{-1} = \lambda_t \tag{5}$$

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

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

$$TVC : \lim_{t\to\infty} \beta^t c_t^{-1} k_{t+1} = TVC : \lim_{t\to\infty} \beta^t c_t^{-1} k_{t+1} = 0, \tag{8}$$

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]

---

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

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

3.2 Stand-in Firm

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

$$y_t = A_t k_t^{\alpha} h_t^{1-\alpha}, \tag{9}$$

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 $\{w_t, r_t\}_{t=0}^{\infty}$ as given, and chooses $k_t, h_t, \forall t$ to maximize firm's static profit:

$$\pi_t = A_t k_t^{\alpha} h_t^{1-\alpha} - r_t k_t - w_t h_t. \tag{10}$$

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

$$w_t = (1-\alpha)\frac{y_t}{h_t}, \tag{11}$$

$$r_t = \alpha\frac{y_t}{k_t}. \tag{12}$$

3.3 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 household. The government budget constraint is then

$$\tau_t^k r_t k_t + \tau_t^h w_t h_t = g_t + T_t. \tag{13}$$

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, so the level of government spending would vary with output. Finally, lump-sum transfers will be residually determined: it will adjust to ensure the government budget constraint is balanced in every time period.

3.4. 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.

4. Data and model calibration

The model is calibrated to Bulgarian data at the 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 Author (2015a), capital income share is set to its average value α=0.429, and the labor income share is $1-\alpha$=0.571. Next, using Author's (2015a) estimate that the annual depreciation rate on physical capital δ=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 ψ=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 below 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

5. 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 on the next page.

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
$\bar{w}\bar{h}/y$	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.

6. Constructing the Wedges

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

$$A_t = \frac{y_t}{k_t^{\alpha} h_t^{1-\alpha}} \tag{14}$$

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

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

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

where $\{A_t\}$ is the efficiency wedge series, $\{(1-\tau^{h,t})\}$ is the labor wedge series, and $\{(1-\tau^{k,t+1})\}$ 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 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

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

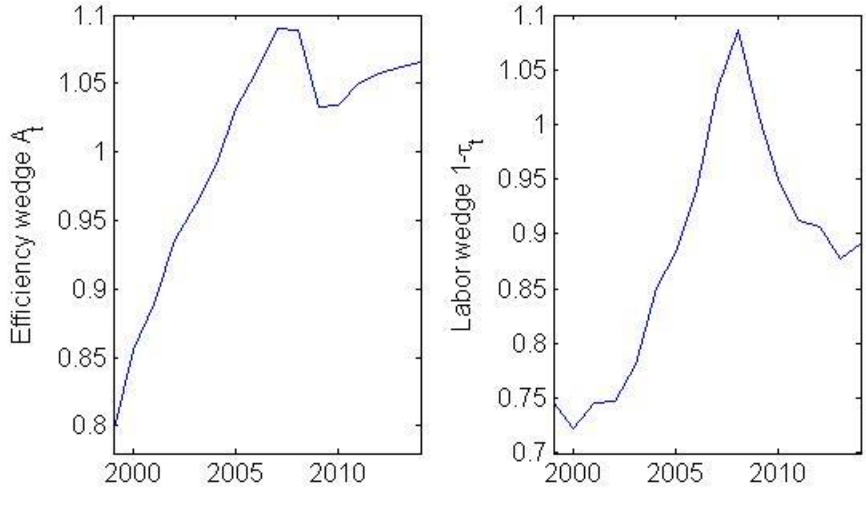
values in data. The obtained $\{A_t\}$ process is the realized total factor productivity sequence during the period 1999-2014.

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 HP-filtered series for hours, consumption, and capital. The obtained labor wedge process $\{(1-\tau^{h,t})\}$ 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 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), barriers to entry, 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 and Davis (2006), which find that the investment wedge is not a major quantitative factor explaining the fluctuation in output in other developed and developing countries.[15] 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.



[14] In 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.

[15] These findings come in contrast to the findings in Chakraborty (2009) and Cho and Doblas-Madrid (2013) on Asian countries, and Simonovska and Soderlind (2015) on Chile.

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 the 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 (NSI 2016).

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 (NSI 2016). 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.[16] 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 (NSI 2016), 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).[17] 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 (Zhelev and Tzanov 2012). 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 (NSI 2016).

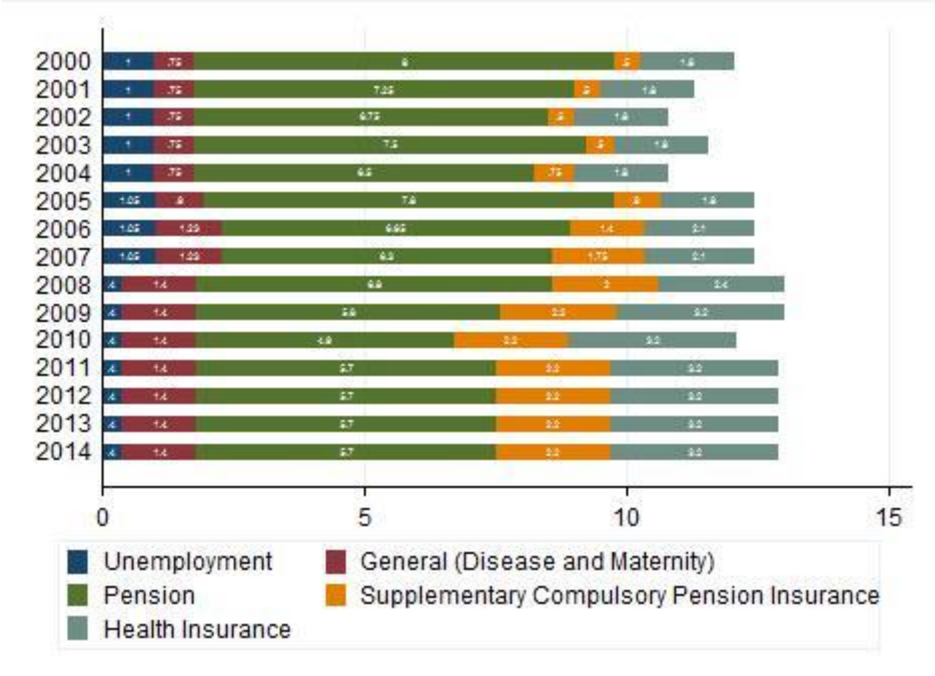
Similar pattern can be seen with the labor wedge. After the introduction of the currency board arrangement, and the reforms that followed, household's earnings in real terms were stabilized and grew significantly. In addition, Bulgaria adopted flat (proportional) taxation of both individual income and corporate profit at the rate of

[16] This can be seen by looking deeper in the structure of the current account deficit in Bulgaria (NSI 2016), which was due to imports of capital goods. Shortly after, once those machines were installed and the new capital became productive, the current account registered a surplus.

[17] Indeed, if one subtracts the effect of EU funds, growth in GDP is not statistically different from zero (NSI 2016).

10%, replacing the progressive tax schedule that was in place before. This reform has a positive effect on hours worked, as many workers found it in their interest to move from the grey economy to the official sector (Author 2015b). 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.

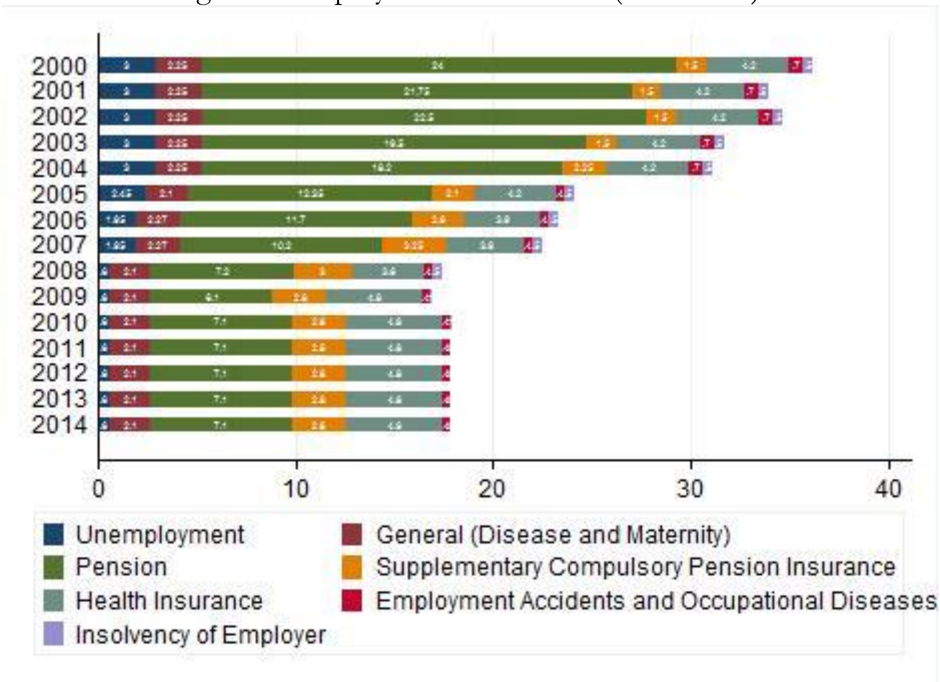
Figure 4: Employee contributions (2000-2014).



Source: Author's calculations

Another possible factor could be 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 on the next page, 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).



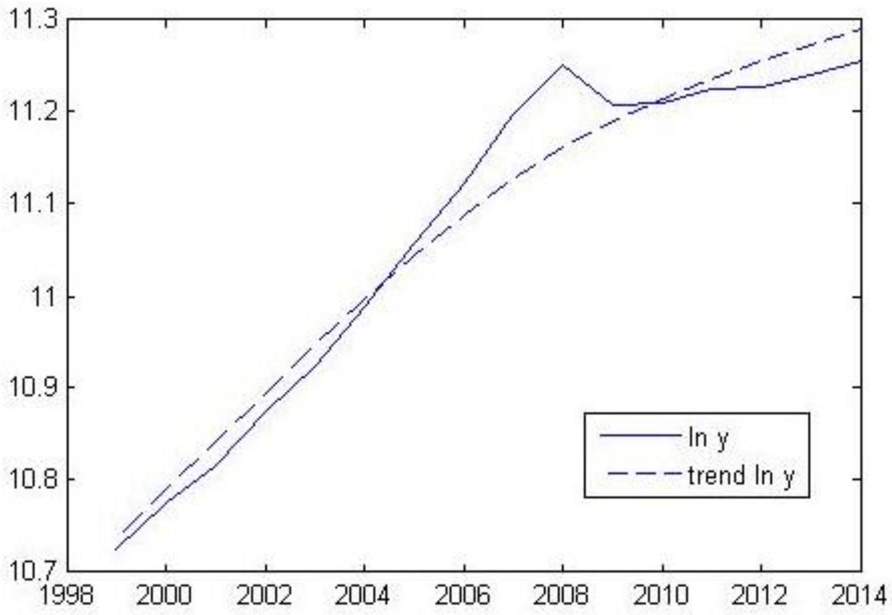
Source: Author's calculations

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 (Author 2015c, 2016a). 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 (Paskaleva 2016). Yet 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 (NSI 2016). 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, and had to accept minimum wage jobs even in the grey economy (Author 2015b). The unreformed education system is adding to this problem, as graduates finish their studies lacking marketable and transferrable skills.[18]

[18] According to NSI (2016), a large proportion of recent graduates are taking positions that do not require university degree.

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 on the next page 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 efficiency wedge is highly pro-cyclical 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.

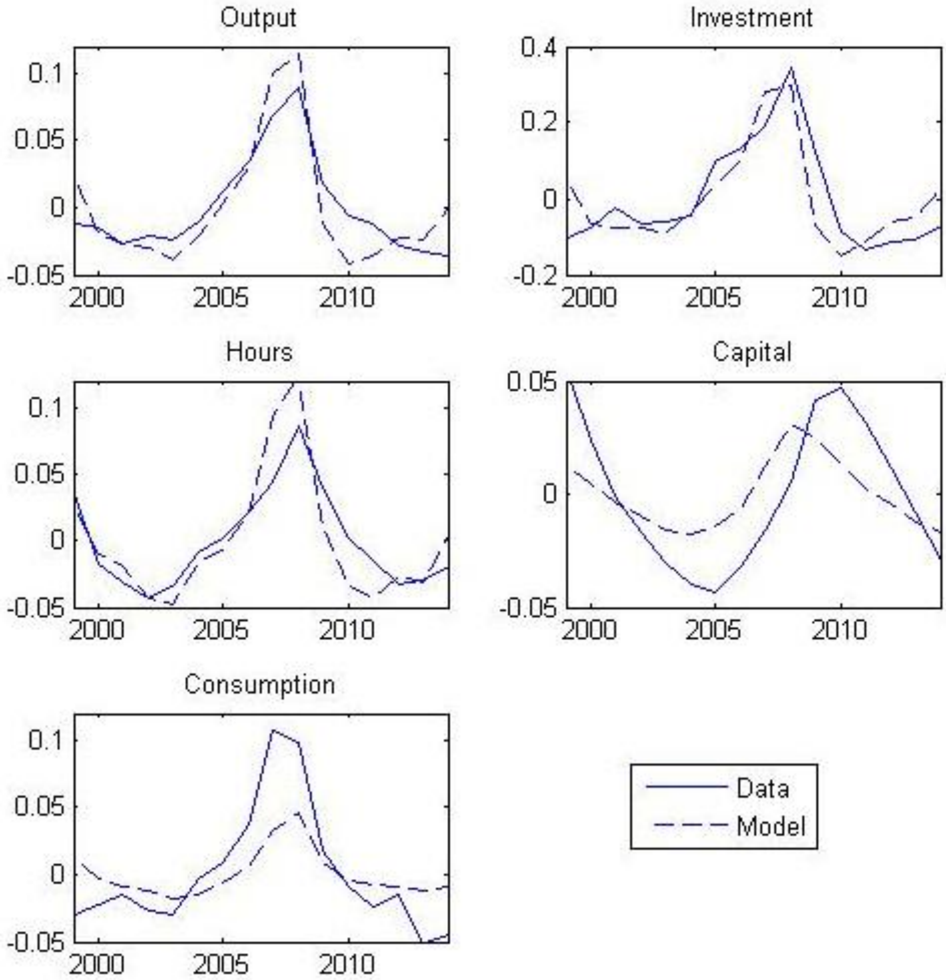
The labor wedge, is much less pro-cyclical and tends to vary more than output. Nevertheless, its cyclical behavior is broadly aligned with the one exhibited by output, especially when we focus on the period 2002-2014. Thus, the two wedges are the major candidates to explain output behavior during the 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.

7. 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 worked, investment, consumption, and government transfers. Government consumption share $\{g_t/y_t\}_{t=1999}^{t=2014}$ is held equal to its steady value.[19] Thus, the level of government consumption is allowed to vary with output. 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 worked and output to produce simulated series of length equal to the annual observations during the period 1999-2014. The series are then transformed using the Hodrick-Prescott filter in order to compare the model-generated series to their HP-filtered 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.

[19] This is done for simplicity; allowing as in Chari et al. (2007) 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. As in Chari et al. (2007), 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.

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



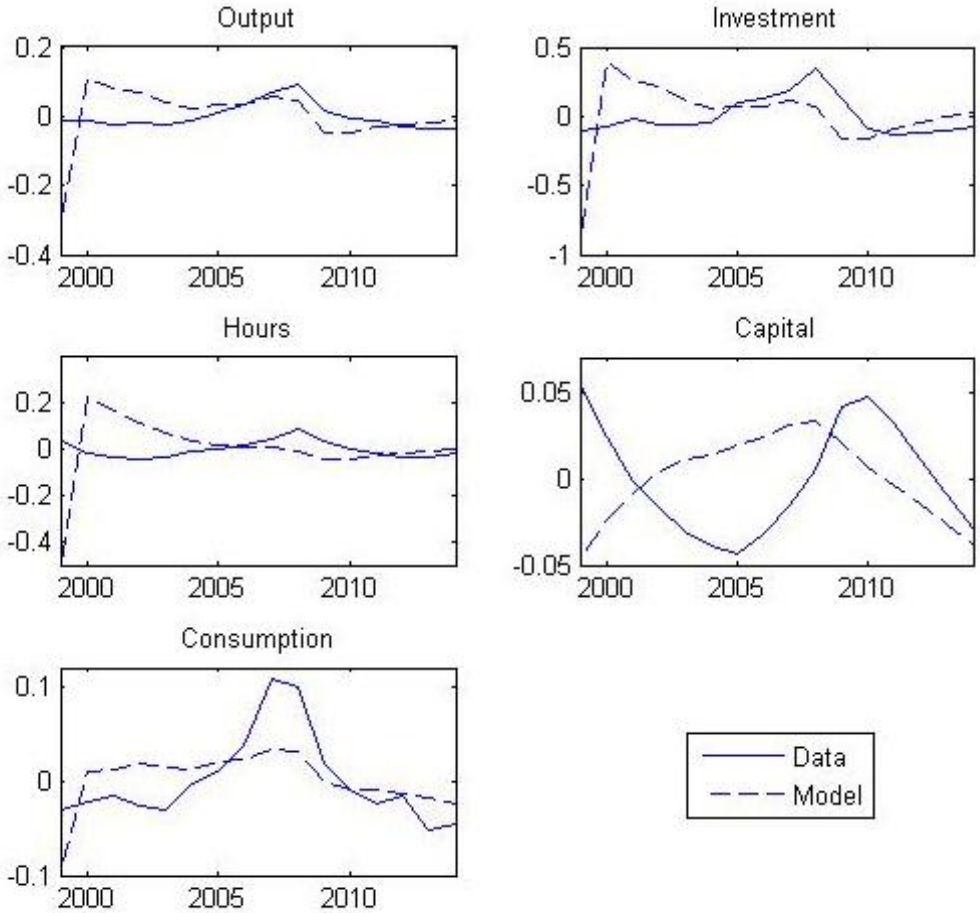
As seen from Figure 7 above, the combined effect of the two wedges explain most of the cyclical behavior of output, hours worked, and investment.[20] The time-varying investment wedge is important in explaining capital accumulation and a bit of consumption behavior over the period, as the investment 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 worked 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.

[20] The difference between the observed and the simulated series might be driven by the investment wedge, as well as possible utility and/or production function mis-specifications.

In addition, the model with two wedges slightly under-predicts the peak in consumption. This is mainly due to the fact that the model is a closed-economy one and misses some important dynamics in net exports. 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.[21]

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.

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



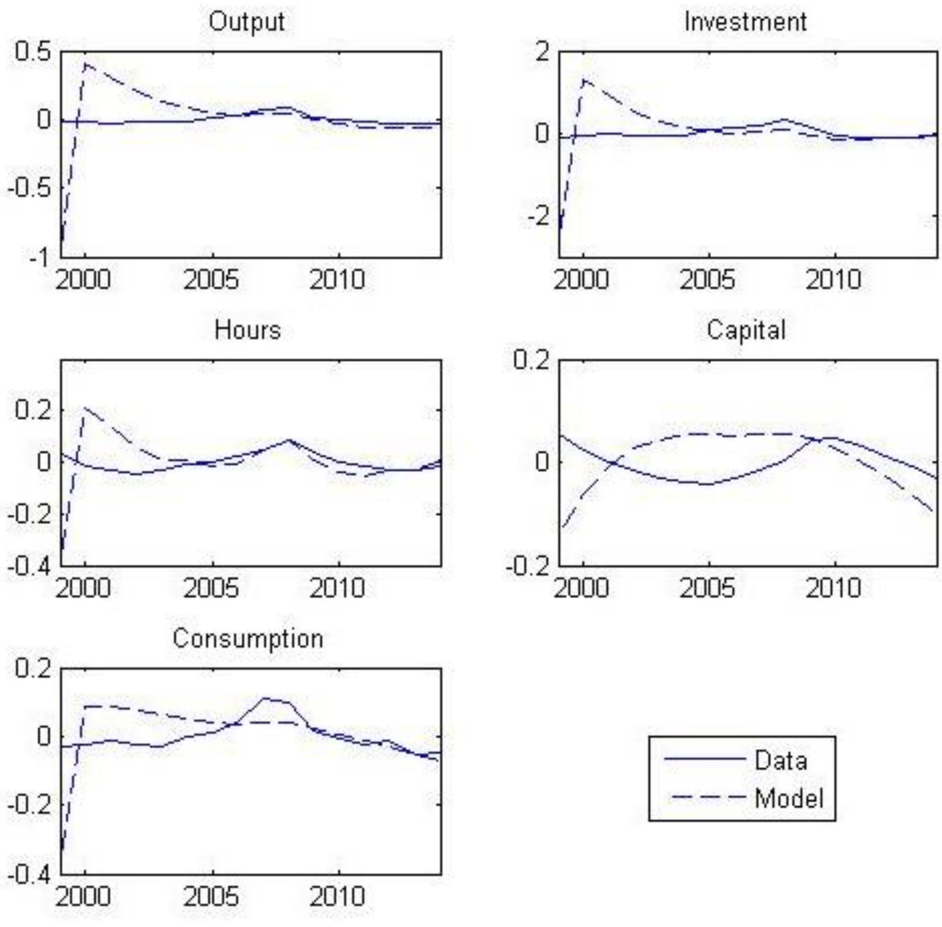
With a time-varying efficiency wage only, the fit is still very good. However, the variability in the model has decreased significantly, which is a strong indicator that having a time-varying labor wedge is quantitatively important to describe fluctuations in Bulgarian economy over the period 1999-2014. The worsening in the fit can be seen in

21 As 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.

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 Author (2015b), the income tax reform may have led to a significant relocation of labor from the grey economy to the official sector.[22]

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 on the next page presents the results generated from this computational exercise.

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



[22] Unfortunately, during the financial crisis (2008-12), as shown in Author (2015c), 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.

In the absence of efficiency (technology) shocks the fit of the model worsens. There is almost no variation in either output, hours worked, 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.

We also document the explained variation in the macroeconomic variables by individual wedges, as well as the joint effect of the efficiency and the labor wedges.

Table : Wedge Decomposition: Explained variation

Variable	Efficiency and labor wedges	Efficiency wedge only	Labor wedge only
y	1.29	2.64	8.10
c	0.39	0.68	2.36
i	0.95	2.07	5.97
k	0.47	0.76	1.95
h	1.34	4.41	3.46

As seen from the Table 4 on the next page, the model with both efficiency and labor wedge over-predicts output and labor variations by 30 percent, under-predicts consumption and capital variability by more than a half, and matches closely investment fluctuations. With efficiency wedge only at work, variability of model variables more than doubles: fluctuations in consumption and capital increase, but now the model predicts more than 200 percent of volatility in output and investment, and more than 400 percent of hours worked. Finally, with a time-varying labor wedge only at work, the model substantially over-predicts variability in empirical variables - by a factor of two for capital and consumption, by a factor of four for hours worked, and by a factor of eight for output.

8. 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 (WDI 2016). 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 (Zhelev and Tsanov 2012).

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 worked, 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 (Author 2015d), and the too generous unemployment benefits, among many other factors (Paskaleva 2016). 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 (Author 2015b).

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 (Author 2015d). Hiring part-time workers should be made easier, and overtime legislation might need to be reviewed (Paskaleva 2016)

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' side to engage into a match with uncertain value.[23] 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.

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.[24] To make that a possibility, adequate healthcare needs to be provided so that workers remain in good health over their life cycle, especially in light of the fact that life expectancy in Bulgaria is shorter when compared to the EU-average one. On the other hand, the paid sick leave policy is too generous (DICE 2016) and needs to be reconsidered as well, as it stimulates absenteeism from the workplace (WHO 2016). 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 technology adoption/adaptation (Prescott 2002). 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.[25] Furthermore, the absence of a strong recovery could be due to rigidity

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

[24] This is very important, as the participation rate in Bulgaria are around 52%, much lower than the rate in the EU, and the US (NSI 2016).

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

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 (Author 2016b). 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.

9. 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, 2007), most of the volatility in output per capita in Bulgaria over the period is due to variations in efficiency and labor wedges. 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.

References

Alvarez F., Veracierto M. (1999) 'Labor market policies in an equilibrium search model', *1999 NBER Macroeconomic Annual,* **14**, 263-304.

Antunez A., Cavalcanti T.V. (2003), 'Corruption, credit market imperfections, and economic development', *Quarterly Review of Economics and Finance,* **43(4)**, 627-642.

Bailly M. N., Solow R. M. (2001), 'International productivity comparisons built from the firm level', *Journal of Economic Perspective,* **15(3)**, 151-172.

Bertola G., Rogerson R. (1997), 'Institutions and labor reallocation', *European Economic Review,* **41(6)**, 1147-1171.

Cavalcanti T.V. (2007), 'Business Cycle and Level Accounting: The Case of Portugal', *Portuguese Economic Journal,* **6(1)**, 47-64.

Chakraborty S. (2009), 'The boom and the bust of the Japanese economy: A quantitative look at the period 1980-2000', *Japan and the World Economy,* **21**, 116-131.

Chari V. V., Kehoe P. J., McGrattan E. R. (2002), 'Accounting for the Great Depression', *American Economic Review*, **92(2)**, 22-27.

Chari V. V., Kehoe P. J., McGrattan E. R. (2007), 'Business Cycle Accounting', *Econometrica,* **75**, 781-836.

Cho D., Doblas-Madrid A. (2013), 'Business cycle accounting East and West: Asian finance and the investment wedge', *Review of Economic Dynamics,* **16**, 724-744.

Christiano L., Davis J. (2006), 'Two Flaws in Business Cycle Accounting', *NBER Working Papers,* **12647**, National bureau of Economic Research, Inc.

Conesa J. C., Kehoe T.J., Ruhl K. (2007), 'Modeling Great Depressions: The Depression in Finland in the 1990s', in: *Great Depressions of the Twentieth Century*, by Kehoe, T.J., and Prescott, E. (eds), 427-475, Federal Reserve Bank of Minneapolis, Minneapolis, US.

DICE (2016), *CES-Ifo DICE Database*. Available on-line at: www.cesifo-group.de. Last accessed on Nov. 30, 2016.

Kehoe T.J., Prescott E. (2007), *Great Depressions of the Twentieth Century*, Federal Reserve Bank of Minneapolis, Minneapolis, US.

Konya I. (2013), 'Development accounting with wedges: the experiences of six European countries', *B.E. Journal of macroeconomics,* **13(1)**, 245-286.

Lucas R.E. (1980), 'Methods and problems in business cycle theory', *Journal of Money, Credit, and Banking,* **12(4)**, 696-715.

National Statistical Institute (2016), *Aggregate Statistical Indicators*. Available on-line at www.nsi.bg. Accessed on Nov. 30, 2016.

Parente S. L., Prescott E. C. (2000), *Barriers to Riches*, MIT Press: Cambridge, US.

Paskaleva, D. (2016), 'Labour Cost and Price Adjustment Practices of Bulgarian Firms in the Period 2009-2013. Wage Dynamics Network Firm-level Survey Evidence', *BNB Discussion paper,* **101/2016**, Sofia, Bulgaria.

Prescott E. (2002), 'Prosperity and depression', *American Economic review,* **92(2)**, 1-15.

Simonovska I., Soderlind L. (2015), 'Business cycle accounting for Chile', *Macroeconomic Dynamics,* **19**, 990-1022.

Vasilev A. Z. (2015a), 'Welfare effects of flat income tax reform: the case of Bulgaria', *Eastern European Economics*, **53(3)**, 205-220, July.

Vasilev A. Z. (2015b), 'Welfare gains from the adoption of proportional taxation in a general-equilibrium model with an informal sector: the case of Bulgaria's 2008 flat tax reform', *Economic Change and Restructuring*, **2**, 169-185, May.

Vasilev A. Z. (2015c), 'VAT Evasion in Bulgaria: A General-Equilibrium Approach,' *Bulgarian Economic Papers,* **09-2016**, Center for Economic Theories and Policies, Sofia University St. Kliment Ohridski, Sofia, Bulgaria.

Vasilev A. Z. (2015d), 'Macroeconomic Effects of Public-Sector Unions,' *LABOUR*, **29(2)**, 101-126.

Vasilev A. Z. (2016a), 'Search and Matching Frictions and Business Cycle Fluctuations in Bulgaria,' *Bulgarian Economic Papers,* **03-2016**, Center for Economic Theories and Policies, Sofia University St. Kliment Ohridski, Sofia, Bulgaria.

Vasilev A. Z. (2016b), 'Productivity, Taxation and Evasion: A Quantitative Exploration of the Determinants of the Informal Economy', *EconStor Preprints,* **144164**, ZBW - German National Library of Economics.

WDI (2016) *World Bank Development Indicators*. Available on-line at: www.databank.worldbank.org/wdi. Last accessed on Dec. 1, 2016.

WHO (2016) *World Health Organization: Health for All Database*. Available on-line at: www.who.int/en/. Last accessed on Nov. 29, 2016.

Zhelev P., Tzanov T. (2012), 'Bulgaria's export competitiveness before and after EU accession', *East-West Journal of Economics and Business*, **XV(1&2)**, 107-128.