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Summary. * In the middle of 1997 Bulgaria introduced a credible currency regime and opted for liberal external trade and capital regulations. Since then the country's economy returned to positive growth rates but its trade balance experienced a sharp deterioration with no signs of reversal so far. Calibrating and simulating a neoclassical growth model I investigate whether the current developments in the trade balance of Bulgaria could be explained as the equilibrium response of an optimizing undercapitalized small economy that was initially closed but in 1998 opened to trade with the rest of the world. The simulation of the model gives qualitatively and quantitatively acceptable results. According to the best-performing specification of the model's initial factors and parameters, Bulgaria will experience its largest trade deficit in 2005. The negative imbalance in the country's external trade will begin to diminish in the subsequent years with a full reversal to trade surplus predicted by the model for 2019. The model's results could be broadly interpreted as supporting the view that the current negative imbalance in Bulgaria's external trade is driven by the process of real convergence and does not stem from worsened competitiveness of the economy.

JEL classification: E52, E61
Key words: monetary policy, macroeconomic policy, exchange rate, catching up

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1. Introduction

While being notably successful in maintaining sizable economic growth since 1998, Bulgaria experienced a sharp deterioration in its trade balance, which in 2004 fell to a record deficit for the whole of its post-communist history. The increasing gap between domestic demand and domestic production for some goods and services seems to be a specific phenomenon for the period after the introduction of a Currency Board Arrangement in mid-1997.

During the first seven years of Bulgaria's transition to a market economy the net trade in goods and services was moving without a distinct direction within the range of minus 7.6 per cent and plus 5.4 per cent of the gross domestic product (GDP) *per* year. A pattern of persistent worsening, however, emerged after 1997, and especially since 1999, when the trade deficit went beyond five per cent of GDP and remained above this level to reach in 2004 the unprecedented 10.3 per cent of GDP. This dynamics seems to have been driven by a boom in consumption and investment.[1] Together with this, the Bulgarian lev appreciated by more than 30 per cent in real terms in the period 1997–2003.[2]

The natural questions that arise are how far these developments can go and how long they are supposed to last. Neither theorists, nor practitioners have agreed in general on any universal quantitative indicators for external imbalances that may signal a danger for the long-term stability of the economy.[3] The answers to these questions appear to be country specific.

One way of looking for an explanation of the external imbalances in small capital-poor economies is through the neoclassical growth paradigm. This approach is particularly appropriate for use in countries which operate a fixed exchange rate regime since the latter implies, in line with the neoclassical view, that changes in money supply are fully determined by the dynamics of real economic variables. Recent applications of neoclassical growth models to small open economies include Rebelo and Vegh (1995), Rebelo (1997), and Burstein, Neves and Rebelo (2003), who examine the consequences for the real economy of exchange rate based stabilization programs in countries like Argentina, Chile, Israel, Mexico, and Uruguay. Within the neoclassical

[1] In the period 1998–2003, the aggregate consumption grew by 5.3 per cent on average *per* year and the aggregate investment (exclusive of the change in inventories) – by 18.1 per cent on average *per* year. Truly, both aggregates were subject to large fluctuations during the period but they decidedly held on positive annual growth rates (all data from National Statistical Institute of Bulgaria (NSI) and United Nations Economic Commission for Europe (UN ECE); see the reference list).

[2] The reference currency is the German mark; Author's calculations (see Section 2.4 for details).

[3] For more on this issue see Calvo (2000).

framework, but from a slightly different angle, Fernandez de Cordoba and Kehoe (2000) combine the effects of stable currency and trade liberalization to study the behavior of some major aggregate economic indicators in Spain after the accession of the country to the European Community in 1986. Extending their work, Bems and Jönsson (2005) investigate whether the observed trade deficits in the Baltic states after the adoption of fixed exchange rates and de facto economic liberalization in early 90s are close to the ones implied by the theory. With its monetary reform in 1997, accompanied by active dismantling of barriers to the external trade and capital flows, Bulgaria offers a good avenue for application of a neoclassical growth model.

In this study I aim to show whether a plausibly parameterized neoclassical deterministic general equilibrium model is able to explain the current developments in the trade balance of Bulgaria. If the modeled time-path of the trade deficit after an economic liberalization in Bulgaria, which I assume to have taken place in 1997, captures the observed dynamics, then the latter could be thought of as the equilibrium response of an optimizing undercapitalized economy and should not be regarded as excessively large and posing a danger to the sustainability of economic growth. I will treat the country as a small, initially closed, economy that opens to trade with the rest of the world after 1997.

The definition of "closedness/openness" is a matter of convention here and plays a crucial role since the only shock to economy in this deterministic set-up is the inflow of capital through external trade upon the so-called "opening" or "liberalization". In reality, Bulgaria has been quite an open economy much before 1997 but it is also true that it became considerably more open to foreign goods and capital flows since then with the implementation of key administrative reforms. Thus, the terms "closedness" and "openness" should be thought of here in their broader meaning and related more to the stages of actual openness than to its strict economic definition.

I use the same model as the one in Bems and Jönsson (2005), with all the extensions these authors make to the basic work of Fernandez de Cordoba and Kehoe (2000). My choice is motivated by the close similarity in the dynamics of key real economic variables between Bulgaria and the Baltic states after the introduction of a currency board regime. Namely, they are: prolonged deterioration of the trade balance, substantial real exchange rate appreciation, impressive real output expansion, and a noticeable shift in economic activity towards industries relying solely on domestic demand. Any such parallel between Bulgaria and the Baltics, however, should take into account the fact that while the latter embarked on fixed exchange rates led largely by strategic considerations in the beginning of their economic transition, the former had to introduce a "hard peg" as the only reasonable option

after the severe financial crisis in late 1996 and early 1997. Thus, although 1997 marks an obvious change in behavior of the Bulgarian economy, it might not be indeed the best starting point for the medium- and long-term analysis that follows. Weighing the arguments in favour of with those against the specific role of 1997 for the model that I use here gives me enough of confidence to accept this year as the last one in which Bulgaria could be assumed to function as a closed economy.

The model is a standard dynamic general equilibrium model of a small open economy and belongs to the broad class of the so-called dependent economy models.[4] It has a traded good, a non–traded good, capital, labour, and an investment good which augments the capital stock. In both previous applications of the model – to Spain and to the Baltic states – it shows a good performance in qualitative terms. The extensions of Bems and Jönsson (2005) considerably improve its quantitative implications.

A key element of this model, putting a link between the capital flows and the real exchange rate fluctuations, is the investment sector that employs both traded and non-traded goods in the production of an investment good. Brock and Turnovsky (1993) were among the first to account for the composite nature of the aggregate investment in a model economy. According to their interpretation, the aggregate investment good should be thought of as comprised partly of equipment (traded good) and partly of structures (non-traded good).

The presence of specific investment technology could be rationalized in terms of the model with the limitation that it imposes on the import of traded goods, thus bringing the modeled trade deficit closer to the observed one. Put differently, if the investment good consisted only of tradables, the steady-state level of capital could have been accumulated very fast by a large imported quantity of traded goods. However, since the investment good is an amalgamation of tradables and non-tradables, there exists a natural barrier to the import of traded goods for investment purposes, as the latter implicitly require local production of non-traded goods in a certain proportion. Moreover, Fischer (2002) provides evidence on significant contribution to the real exchange rate appreciation in transition economies of – as named by him – the "investment demand channel". This channel, stemming from the same composite structure of the aggregate investment, where equipment and structures are complements, is found to work besides the usual supply channel, known

[4] As Brock and Turnovsky (1993) point, any model that includes non-traded sector and exogenously given world prices for the traded sector's output is a variant of the "dependent economy model". The first who introduced the term "dependent economy" is W.E.G. Salter in 1959.

as the Balassa-Samuelson effect,[5] in driving the prices of the non-traded goods upwards during a transition to a higher steady-state.

The model applied by Fernandez de Cordoba and Kehoe (2000), and extended by Bems and Jönsson (2005), exhibits frictions in the factor mobility and accounts for a time-varying risk premium in the real interest rate that the country faces in the world financial markets.[6] I use the same functional forms for the capital and the labor adjustment costs as specified by Bems and Jönsson (2005).

There is no existing study for Bulgaria, to the best of my knowledge, focusing from a general equilibrium perspective on the real side of the changes that occurred in the economy after the introduction of a currency board arrangement in mid-1997. Nenovsky and Hristov (1999) test the relationship between monetary aggregates and real economic variables and prove that the money supply under the currency board in Bulgaria is endogenously determined by the developments in the real variables. Yotzov (2000) and Knoester and Van der Windt (2003) both use approaches which mix the Keynesian and the neoclassical tradition in their modeling of the economic dynamics in Bulgaria. Chobanov and Sorsa (2004) perform econometric estimation of the determinants of real effective exchange rate (REER) in Bulgaria over the period 1997–2003 and find that there is no significant misalignment of the Bulgarian Lev with respect to what the economic fundamentals imply. However, these authors estimate reduced-form equations that are not derived from a structural model of the economy. In my work I disregard any nominal factors and examine whether a calibrated to the Bulgarian data neoclassical growth model could produce results that broadly capture the observed dynamics in the economy between 1997 and 2004.

The baseline calibration of the model is found to give qualitatively acceptable results, but it underperforms in terms of the quantitative implications. Recalibration stemming from a downward correction of the estimated initial stock of capital seems to improve the quantitative results while preserving the qualitative outcomes. According to the best-performing specification of the model's initial factors and parameters, Bulgaria will experience its largest trade deficit in 2005. The negative imbalance in the country's external trade, however, will begin to diminish in the subsequent years and a full reversal to trade surplus is predicted to occur in 2019.

The rest of the paper is organized as follows. In Section 2 I give a detailed

[5] For a comprehensive treatment of the Balassa – Samuelson effect and estimation of its presence in the transition countries see Halpern and Wyplosz (2001).

[6] The need for incorporating frictions in intertemporal models for a small open economy with internationally mobile capital and perfect foresight is well-argued by Fischer (2002).

argumentation on the choice of treating 1997 as the last closed year for the purpose of modeling and I present some stylized facts of the economic liberalization in Bulgaria. Section 3 introduces the model, while Section 4 deals with its calibration to the Bulgarian data. In Section 5 I explain the results from the performed simulations. Section 6 concludes, draws some policy lessons and suggests directions for further research.

2. Stylized Facts of the Economic Liberalization

In this section I present evidence on some major effects of the economic liberalization in Bulgaria after 1997. It is important to note that the process of liberalization was gradual and could not be entirely attributed to one single year.

Before looking at the outcomes from the liberalization, however, I explain why I choose 1997 as the last year in which Bulgaria should be considered as a closed economy. The main argument in favor of this choice is the fact that as late as the middle of 1997 Bulgaria was able to introduce a credible currency regime, which *per se* is a crucial prerequisite for having market-determined flows of capital and a truly complete liberalization of the capital movement. The implementation of the currency board arrangement on July 1, 1997 played a central role in stabilizing the Bulgarian financial system and the country's whole economy after the financial crisis in late-1996 and early-1997. The "hard peg" of the Bulgarian lev to the German mark made the business environment significantly more predictable, while the currency board reined in the inflation and brought down the interest rates.[7]

The landmark events for the liberalization of trade and capital transactions in Bulgaria were the Agreement on Accession to the CEFTA,[8] signed in mid-1998, and the beginning in early 2000 of negotiations for membership in the EU. At the same time, the legal framework was amended to enable the free movement of goods and capital. The Law on Encouraging Foreign Investments, adopted in October 1997, the introduction of full current account convertibility in September 1998, and the new Foreign Exchange Law, adopted in September 1999, are but three of the major acts paving the way of the gradual liberalization of trade and capital flows.

The privatization process in Bulgaria had its intensified development after

[7]Bulgaria fixed the lev to the German mark at a rate of exchange 1:1. For a comprehensive study of the effects of the currency board in Bulgaria see Miller (1999), and Zaimov and Hristov (2002).

[8]The Central European Free Trade Agreement (CEFTA) consisting then of the Czech Republic, Hungary, Poland, Slovakia, Slovenia and Romania.

1997, when most of the state-owned banks and those that went bankrupt during the financial crisis, together with some major enterprises, were sold mainly to foreign investors. As a result, the inflow of foreign direct investment in Bulgaria considerably increased after 1997, with an average annual value of USD 1,152 million in the period 1998–2004 compared to an average annual value of USD 234 million in the period 1992–1997.[9] At the same time the share of private sector in the gross domestic product (GDP) was permanently on the rise, reaching currently 66.3 per cent from a starting level of 56.7 per cent in 1997.[10] The presence of a relatively large private sector with competing firms is very important for the successful application of the model since the latter is based on the assumption of perfect competition.

Taking into account all these arguments I decide to accept 1997 as the last closed year and 1998 as the first open year for Bulgaria in terms of external trade and capital flows. The following stylized facts of the liberalization come into support of this choice, highlighting a difference in the behavior of some aggregate economic indicators after 1997. Moreover, these are the main empirical findings that I will try to explain with the model presented in the next section.

2.1 Trade Balance Deterioration

A marked deterioration of the trade balance in Bulgaria began in 1998, when although still positive at 0.2 per cent of GDP the net exports of goods and services decreased by 4.4 percentage points from their 1997 level.[11] The drop was even larger in 1999, when the trade balance went to a deficit of 5.8 per cent of GDP, and remained in the following years at levels higher (in absolute value) than the negative 5.0 per cent of GDP. The year 2004's trade deficit of 10.3 per cent of GDP is the highest one since the beginning in 1990 of the transition to a market economy in Bulgaria. The developments in the trade balance for the whole period 1997–2004 are shown in Appendix B, Figure 1.

2.2 Gross Domestic Product Expansion

The economic growth in Bulgaria returned to positive rates persistently after 1997. The recession in the early nineties (with exception of 1994 and 1995 when Bulgaria registered positive economic growth, but the latter proved to be very unsustainable) took its worst toll on the activity in 1996 when the GDP decreased by the record 9.4 per cent, amid the roaring finan-

[9]Data from InvestBulgaria Agency (see the reference list).
[10]Data from NSI.
[11]Data from NSI.

cial crisis.[12] With the pegging of the national currency to the German mark in mid-1997 and the implementation of key reforms that effectively opened the country to external capital and trade flows, Bulgaria enjoyed stable economic growth of over 4 per cent yearly in the period 1998–2004 (with exception of 1999 only, when the growth rate was 2.3 per cent). The dynamics in the real GDP growth in the period 1997–2004 is depicted in Appendix B, Figure 2.

2.3 Traded Sector Contraction

The large trade deficits observed in the period after 1997 were associated with a notable contraction of the share of traded sector output in GDP. Here, following a commonly applied convention in the literature on the division of industries into traded and non-traded,[13] I include in the traded sector agriculture and fishing, mining, manufacturing, and transport and communications. These industries consist of goods and services that have a comparatively homogenous nature across different countries and can be immediately exported or imported when the national trade borders are lifted up. All other industries form the non-traded sector of the economy. A detailed classification is given in Appendix B, Table 1.

Thus, as it is seen in Appendix B, Figure 3, the share of the traded sector in GDP decreased by some 10 percentage points in the period 1997–2003, starting from 55.4 per cent in 1997 and plunging immediately under 50 per cent in the first open year, 1998, to reach 45.3 per cent in 2003.[14] The shift in the economic activity from the traded to the non-traded sector is an anticipated consequence of the liberalization and is intrinsically connected to the trade balance deterioration and the real exchange rate appreciation.

2.4 Real Exchange Rate Appreciation

The production shift towards the non-traded sector was accompanied by an increase in the relative price of non-traded goods, which, on its part, led to an appreciation of the real exchange rate. The actual developments in the latter are shown in Appendix B, Figure 4 (the darker curve), where I plot the real exchange rate of the Bulgarian lev with respect to the German mark. Germany is taken here and hereafter to be the reference country, representing the rest of the world, since it is the major trading partner of Bulgaria. A substantial appreciation of more than 30 per cent for the period 1997–2003 in

[12] Data from UN ECE.

[13] For more on that see Bems and Jönsson (2005), p.11.

[14] Data from UN ECE.

the German mark – Bulgarian lev real exchange rate could be seen in that picture.

Within the model only the relative movements in the non-traded good's price affect the real exchange rate (RER). This is a natural consequence of the assumption that the law of one price holds for the traded goods. Formally, the RER of the Bulgarian lev with respect to the German mark is:

$$RER_t = NER_t \frac{P_t^{Ger}}{P_t^{Bul}} \quad (1)$$

where NER_t is the nominal exchange rate, expressed in Bulgarian levs per one German mark (effectively, 1:1 for the period into consideration: 1997–2003), and P_t^{Ger} and P_t^{Bul} are the aggregate price indices for Germany and Bulgaria respectively.

Using the approach of Betts and Kehoe (2001), the *RER* could be decomposed as follows:

- the assumption that the law of one price holds for the traded goods implies

$$PT_t^{Bul} = NER_t . PT_t^{Ger} \quad (2)$$

- substituting for *NER* from (2) into (1) gives an equation for the real exchange rate, when all traded goods satisfy the law of one price and the baskets of traded goods are the same in both countries:

$$\hat{RER}_t = \left(\frac{PT_t^{Bul}}{PT_t^{Ger}}\right)\left(\frac{P_t^{Ger}}{P_t^{Bul}}\right) = \frac{\left(P_t^{Ger}/PT_t^{Ger}\right)}{\left(P_t^{Bul}/PT_t^{Bul}\right)} \quad (3)$$

This last equation simply states that fluctuations in the real exchange rate can be explained by changes in the relative prices of non-traded goods, since the part of the price index P_t^i that is not PT_t^i is the price index for the non-traded goods (the superscript i stands for the country: $i \in \{Bul, Ger\}$).

With this expression in hand, which will be called "the explained" (by the model) *RER*, I obtain time-series for the period 1997–2003 using data from UN ECE.[15] As pointed by Betts and Kehoe (2001), the best price indices to use when calculating the *RER* are those for gross output. Due to lack of all required data for Bulgaria I use instead value added deflators, which are good proxies for the gross output deflators (see Betts and Kehoe, 2001). The same procedure is performed by Fernandez de Cordoba and Kehoe (2000). Following their steps, I derive the implied gross value added deflator for the traded sector (comprised here of agriculture and industry, exclusive of construction activities).[16]

[15] Unfortunately, data for Bulgaria for 2004 at the required level of dissagregation were not yet available at the time of writing this paper.

[16] The arithmetical procedure is explained in detail in Valev (2005), p.12.

Back to Figure 4, next to the real exchange rate (eq. 1) German mark – Bulgarian lev for the period 1997–2003, I plot the corresponding explained real exchange rate (eq. 3) (the lighter curve). As it is obvious from the picture, both curves co-move strikingly well. Indeed, the correlation between *RER* and $\hat{RER}$ is 0.98 for the period 1997–2003, which exceeds considerably the numbers found for other countries in the above-mentioned empirical studies. For example, Fernandez de Cordoba and Kehoe (2000) find correlation of magnitude 0.56 between the actual and the explained German mark – Spanish peseta real exchange rate for the period 1986–1996. Betts and Kehoe (2001), although working with gross output rather than gross value added deflators, find correlation of 0.82 between the actual and the explained US dollar – Mexican peso real exchange rate for the period 1980–1998.

The fraction of the variation in *RER* that is explained by the variation in $\hat{RER}$ – the coefficient of determination *R* – is equal to 0.82, which is again impressively high compared to the one of 0.26 found by Fernandez de Cordoba and Kehoe (2000) for the Spanish real exchange rate.[17] The corresponding numbers obtained by Bems and Jönsson (2005) for the Baltic states during the 1994–2001 period are 0.43 for Latvia, 0.30 for Estonia and 0.17 for Lithuania. However, the latter authors calculate the explained real exchange rate by proxying the aggregate price index with CPI and the traded sector price index with PPI for manufacturing, which according to Engel (1999) is not a very precise approach since the measures of the traded goods prices and those of the non-traded goods prices come from different surveys.

The interpretation of the coefficient for Bulgaria in terms of the model with one traded and one non-traded good, is that roughly 82 per cent of the fluctuations in the actual real exchange rate will be captured by the movements in the relative price of the non-traded good, which is to be modeled here. Seen alone, this is more than a good premise to start with. However, caution is called for when taking this number to account for the explanatory power of the model, since the division of the industries into traded and non-traded in the calculation of the $\hat{RER}$ was not exactly the same as the one presented in Table 1 due to data limitations.

3. Model

This section presents the model which I will use to study the dynamics of the Bulgarian economy after its liberalization in 1997. Bulgaria is modeled as a small, initially closed, economy that suddenly opens to trade with the rest of

[17] For computation of this coefficient see Valev (2005), p.13.

the world. There is a representative consumer in this economy and five goods in every period: traded good, non-traded good, capital, labor, and investment good that augments the capital stock in the subsequent period. The time unit in the model is one year.

The representative consumer solves the utility maximization problem, taking prices as given:

$$\max_{\{c_{Tt},c_{Nt},k_{t+1},b_{t+1}\}} \sum_{t=0}^{\infty} \beta^t \left[\frac{\left[\varepsilon c_{Tt}^{\eta} + (1-\varepsilon) c_{Nt}^{\eta} \right]^{\frac{\sigma}{\eta}} - 1}{\sigma} \right] \tag{4}$$

such that

$$c_{Tt} + p_{Nt} c_{Nt} + q_{t+1} k_{t+1} + b_{t+1} \leq w_t L + (1 + r_t^B) b_t + v_t k_t, \forall t \tag{5}$$

$$c_{Tt} \geq 0, \forall t$$

$$c_{Nt} \geq 0, \forall t$$

$$q_{t+1} k_{t+1} + b_{t+1} \geq -A, \forall t$$

$$b_{t+1} \begin{cases} \leq 0 \text{ if } \rho_{t+1}^B > 0 \\ \in \mathrm{R} \text{ otherwise} \end{cases} \tag{6}$$

$$k_0,\ b_0 \text{ given}$$

Here, c_{Tt} is the consumption of traded good, which is a numeraire in the model (i.e. $p_{Tt} = 1$); c_{Nt} is the consumption of non-traded good; p_{Nt} is the relative price of the non-traded good; k_{t+1} is the investment in domestic capital stock executed at the relative price of capital q_{t+1}; b_{t+1} is the investment in bonds denominated in the units of the traded good, earning a net interest of r_t^B, where the latter differs from the world interest rate r_t^* by a risk premium of ρ_t^B; L is the endowment of labour which is inelastically supplied at a wage w_t; and $v_t k_t$ is the income from selling the capital at the relative price v_t to firms producing traded or non-traded goods.

Importantly, q_{t+1} is the price at which the consumer acquires capital for period $t+1$ but the transaction actually takes place at the end of period t. On the other hand, the price at which the consumer sells capital in period t to the firms producing traded and non-traded goods is v_t.

Constraint (6) states that the representative consumer can not lend to the rest of the world if a positive risk premium is present. The wedge in the form of a risk premium between the interest rate that the country faces in the international financial markets r_t^B and the prevailing world interest rate r_t^* has an

important role in slowing down the capital flows in the model, thus making the adjustments more gradual and bringing them closer to the observed dynamics. The presence of a risk premium in the interest rates of external loans taken from the country is economically justified for the case of Bulgaria, since the country was not able to finance itself at the world interest rate immediately after the liberalization in 1997. The evidence on the risk premium for Bulgaria is discussed in the next section. Here it is necessary to note that the risk premium is an exogenous variable for the model.

The variable b_{t+1}, which is the net foreign asset position of the representative consumer, can take both negative and positive values. When negative, it means that the economy borrows from the rest of the world. The last inequality in (5) effectively rules out Ponzi-games, since it implies that consumer's assets in every period cannot be smaller than $-A$, for a sufficiently large A. Changing signs, A can be viewed as an upper bound for indebtedness of the economy.

As specified, the utility function exhibits a constant intratemporal elasticity of substitution in consumption between traded and non-traded goods $1/(1-\eta)$ and a constant intertemporal elasticity of substitution in consumption $1/(1-\sigma)$. The consumer's preferences towards traded goods are governed by the parameter ε, while the subjective discount factor is β.

The model allows two alternative specifications of the interest rate determination and the external borrowing or lending. The first one is when the economy is closed: the interest rate r_0^B is determined endogenously, and there is no external borrowing or lending $b_1 = 0$. The second one is when the economy is open: the interest rate is equal to the exogenously given world rate $r_t^B = r_t^*$ if the net foreign asset position is positive ($b_t > 0$), or to the world rate augmented by a time-varying risk premium (also exogenous here, as mentioned above), $r_t^B = (1 + r_t^*)(1 + \rho_t^B) - 1$, if the net foreign asset position is negative ($b_t < 0$). In this study I will assume that the Bulgarian economy opens up to trade with no initial endowment of foreign assets (or equivalently, absent of external debt), $b_0 = 0$.

The traded and the non-traded goods can be used not only for consumption, but also as inputs in the investment sector. Additionally, the traded good can be exported and imported. Thus, the total supply of traded good in the economy is augmented by the term $b_{t+1} - b_t(1 + r_t^B)$ which is exactly the economy's trade balance.

The investment good that augments the capital stock in the subsequent period is produced under a two-factor Cobb – Douglas technology, where the production inputs are traded and non-traded goods. The latter could be thought of as equipment and structures respectively. Thus, the familiar law of motion for the capital here becomes:

$$k_{Tt+1} + k_{Nt+1} - (1-\delta)\left(k_{Tt} + k_{Nt}\right) \leq G x_{Tt}^{\gamma} x_{Nt}^{1-\gamma}, \forall t \tag{7}$$

where δ is the depreciation rate, G and γ are parameters of the production function in the investment sector, and x_{Nt} and x_{Tt} are the inputs respectively of non-traded and traded good into the investment sector.

There is a perfect competition in the investment sector, and the firms take prices p_{Nt} and q_{t+1} as given when maximize in every period:

$$\max_{\{x_{Tt},\, x_{Nt}\}} q_{t+1} G x_{Tt}^{\gamma} x_{Nt}^{1-\gamma} - x_{Tt} - p_{Nt} x_{Nt} \tag{8}$$

The firms producing traded and non-traded goods operate under a perfect competition and taking prices as given maximize their infinite horizon profits:

$$\max_{\{k_{jt}, l_{jt}\}} \sum_{t=0}^{\infty} \beta^{t} \left[\prod_{\tau=0}^{t} \frac{U_{c_{\tau}}(c_{\tau+1})}{U_{c_{\tau}}(c_{t})} \right] \left(p_{jt} F_{jt}\left(k_{jt}, k_{jt-1}, l_{jt}, l_{jt-1}\right) + q_{t+1}(1-\delta) k_{jt} - w_t l_{jt} - v_t k_t \right) \tag{9}$$

where $j \in \{T, N\}$, $p_{Tt} = 1$ (since the traded good is the numeraire), and the production functions $F_{jt}(.)$ have the following form:

$$F_{jt}\left(k_{jt}, k_{jt-1}, l_{jt}, l_{jt-1}\right) = A_j k_{jt}^{\alpha_j} l_{jt}^{1-\alpha_j} - \Phi_{jt}\left(k_{jt}, k_{jt-1}\right) - \Psi_{jt}\left(l_{jt}, l_{jt-1}\right) \tag{10}$$

where

$$\Phi_{jt}\left(k_{jt}, k_{jt-1}\right) = \frac{\phi\zeta}{1+\zeta} \left(\frac{\left| k_{jt} - (1-\delta) k_{jt-1} \right|}{k_{jt-1}} \right)^{\frac{1+\zeta}{\zeta}} k_{jt-1}, \quad \zeta > 0, \quad \phi \geq 0 \tag{11}$$

$$\Psi_{jt}\left(l_{jt}, l_{jt-1}\right) = \psi \left(\frac{l_{jt} - l_{jt-1}}{l_{jt-1}} \right)^{2} l_{jt-1}, \quad \psi \geq 0 \tag{12}$$

The function in (11) $\Phi jt(.)$, introduces convex costs associated with investment. The specification of $\Phi jt(.)$ implies that capital frictions are present in steady state, because the costs are associated with the transformation of investment goods rather than the adjustment of the capital stock. The function in (12), $\Psi jt(.)$, represents quadratic costs, related to the adjustment of the labour force in each sector. This specification which is very similar to the one estimated by Cooper and Willis (2003) implies that there are costs of both hiring and firing of workers, and that the firm pays these costs for net hires (fires). The term in the square brackets in (9) comes from the usual Euler equation for the consumer's problem, where $U_{cT}(c_t)$ denotes the marginal utility of consumption of traded good.[18]

[18] For more on the model description see Valev (2005).

An ***equilibrium*** for the model economy is defined as sequences of prices $\{\hat{p}_{Nt}, \hat{w}_t, \hat{q}_{t+1}, \hat{v}_t, \hat{r}_{t+1}\}_{t=0}^{\infty}$ consumption and assets $\{\hat{c}_{Tt}, \hat{c}_{Nt}, \hat{k}_{t+1}, \hat{b}_{t+1}\}_{t=0}^{\infty}$, sectoral production plans $\{\hat{k}_{Tt}, \hat{l}_{Tt}\}_{t=0}^{\infty}$ and $\{\hat{k}_{Nt}, \hat{l}_{Nt}\}_{t=0}^{\infty}$ and inputs in the inve stment sector $\{\hat{x}_{Tt}, \hat{x}_{Nt}\}_{t=0}^{\infty}$ such that:

(i) Given the prices $\hat{p}_{Nt}, \hat{w}_t, \hat{q}_{t+1}$ and $\hat{v}_t$, the representative consumer solves the utility maximization problem in (4).

(ii) Given the prices $\hat{p}_{Nt}, \hat{w}_t, \hat{q}_{t+1}$ and $\hat{v}_t$, producers in the traded and the non-traded sectors solve the maximization problem in (9).

(iii) Given the prices $\hat{p}_{Nt}$ and $\hat{q}_{t+1}$, the firms in the investment sector solve the maximization problem in (8).

(iv) The goods markets clear in every period. If the economy is closed in period t, then $\hat{b}_{t+1} = 0$. If the economy is open in period t, then $\hat{r}_t^B = (1+\rho_t^B)(1+r_t^*) - 1$.

(v) The factor markets clear in every period.

From the first-order conditions in (i) it is easy to obtain a no-arbitrage condition for investment:

$$(1+\hat{r}_{t+1}^B)\hat{q}_{t+1} = \hat{v}_{t+1} \tag{13}$$

This equation simply states that the return on investment in physical capital and in bonds should be equal. Note that the prices $\hat{q}_{t+1}$ and $\hat{v}_{t+1}$ in fact refer to different periods, as mentioned in the beginning of this section.

4. Calibration

In this section I explain in detail the procedures performed for calibration of the model to the Bulgarian data. First, I present the methodology for obtaining an estimate of the capital stock in Bulgaria for the last closed year, 1997, and then I describe the calibration of all parameters and initial factors.

4.1 Capital Stock Estimation

The National Statistical Institute of Bulgaria (NSI) does not publish official data on the stock of capital in the economy. To obtain a measure for the capital stock available in the last closed year, 1997, I follow the route suggested by Bems and Jönsson (2005), where the total capital stock is the sum of fixed tangible assets of all enterprises and the stock of residential housing. Data on both variables could be found in the Statistical Yearbooks of NSI.

• ***Fixed Tangible Assets:***

Having the value in current prices for 2001 of the fixed tangible assets (from the Statistical Yearbook 2002), I obtain the value for 1997 by a backward iteration of the standard law of motion for the capital:

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

where *K* stands for the fixed tangible assets (FTA), *I* stands for gross fixed capital formation (GFCF), and δ is the depreciation rate.

Changing the letters in accordance with the national accounts terminology, and noting that $\delta K_{t-1} = CFC_t$, the law of motion becomes:

$$FTA_t = FTA_{t-1} + GFCF_t - CFC_t$$

Series for *GFCF* in constant (year 2000) prices is available from the UN ECE database, while series for *CFC* in current prices is taken from Eurostat. The latter, as well as the *FTA* value for 2001, I convert into constant prices with the deflator of *GFCF* (base year 2000). Thus, I obtain the value of *FTA* for 1997 in constant prices to be BGN 18, 991 million.[19]

• ***Residential housing:***

The value of the dwelling stock for 1997 at current prices could be obtained from the NSI Statistical Yearbook when the living floor space (in sq m) is multiplied by the average market price per 1 sq m living floor space. Converting the resulting number into constant prices (again dividing by the *GFCF* deflator), I arrive at a value of BGN 46,740 million for the residential housing (*RH*) in 1997.

• ***Capital stock:***

The sum of *FTA* and *RH* for 1997 is equal to BGN 65,731 million. Several remarks come naturally with respect to this value of the capital stock, which I will further use for the purposes of the calibration. First, the structure of the capital stock is very different from the ones in the Baltic states in the years immediately before their "opening" in terms of the model, as witnessed by Bems and Jönsson (2005). Thus, with fixed tangible assets comprising 28.9 per cent of the capital stock and residential housing taking over the remaining 71.1 per cent, in 1997 Bulgaria is just the opposite of what was Estonia in 1993, when *FTA* were 68.6 per cent of the total capital stock and the *RH* only 31.4 per cent. The comparison with Germany in 1997, however, is milder,

[19] On July 1, 1999 a denomination of the currency in Bulgaria was carried out, where 1000 old Bulgarian levs were replaced by 1 new Bulgarian lev. Hereafter all values will be expressed in new Bulgarian levs regardless of the year they refer to in order to make the analysis less complicated.

since the *FTA* share in the capital stock is 51.5 per cent and the *RH* share– 48.5 per cent (Deutsche Bundesbank, Monthly Report, November 1998). Possible explanation for these numbers in Bulgaria, besides the one with the imperfection of the estimation procedure applied here, is the fact that the average market price of the living floor space might be an upward biased estimator for the value of the residential housing. This is likely to be so because the market prices for the residential housing in Bulgaria published by NSI relate to new-built homes each year which are likely to be more expensive than the old existing ones. Since the new homes are just a tiny fraction of the total stock of dwellings, valuing the whole residential housing at a price that actually relates to a very small part of it is indeed not a very precise way. Unfortunately, it is the only possible one with respect to the available data.

Second, with GDP of BGN 23,857 million for 1997 in constant (year 2000) prices the capital-to-output ratio in Bulgaria in that year k_{97}/y_{97} is 2.76. This number appears to be considerably higher than the capital-to-output ratios for the Baltic states in the years before their opening as estimated by Bems and Jönsson (2005), with Estonia in 1993 having a capital-to-output ratio of 1.41, Latvia–1.40, and Lithuania–1.33. The number for Bulgaria comes somewhat closer to the capital-to-output ratio of 2.07 in Spain in 1986 – the reference year for the model of Fernandez de Cordoba and Kehoe (2000). Again, the explanation of the number for Bulgaria might be the biased estimate of the capital stock. However, it should be stressed that the backward iteration procedure that I apply here for obtaining the value of the *FTA* in 1997 implicitly takes into account the official revaluation of the assets that was carried out on December 31, 1997, in Bulgaria.[20] Furthermore, in 1997 Germany had a capital-to-output ratio (defined in the same way) of 3.67, which highlights the difference with Bulgaria in terms of capital abundance.[21] This difference is essential in explaining the observed trade deficits in Bulgaria as a natural result from the process of capital accumulation in an undercapitalized economy.

Using a different methodology and accounting for the fixed intangible assets, Ganev (2005) arrives at an estimate for the capital-to-output ratio in Bulgaria for 1997 which is even above 3.5. His explanation for the comparatively higher numbers in Bulgaria with respect to other transition countries is that in

[20] This revaluation was applied to all non-financial enterprises and was accompanied by full inventory of their available assets. It resulted in increase by a factor of seven of the capital stock for 1997, bringing it to the average market prices. (See United Nations Economic Commission for Europe (2003) *Measurement of Capital Stock in Transition Economies*).

[21] Calculations were done with data from Deutsche Bundesbank's Monthly Report (November, 1998) and Eurostat.

the nineties the state of the Bulgarian economy implied a low efficiency of capital in the creation of value.

4.2 Initial Factors and Parameter Values

The calibration of the model for Bulgaria is based on data from the input – output table for 1997. I aggregate the 53 sector input – output matrix for 1997, published by the NSI of Bulgaria, into a three-sector matrix, presented in Appendix B, Table 2. To this end I follow the classification of the industries as in Table 1.

In calibrating the model introduced in the previous section I use the equilibrium conditions of the model and normalize all prices to be 1 in 1997, except the rental price of the capital. The results of the baseline calibration are presented in Appendix B, Table 3. As postulated in the previous section, the time unit of the model is one year. I set the parameters $\sigma = -1$ and $\eta = -1$ which imply standard for the relevant literature results of intertemporal elasticity of substitution in consumption, $1/(1-\sigma)$, equal to 0.5, and intratemporal elasticity of substitution in consumption between traded and non-traded goods $1/(1-\eta)$ also equal to 0.5.

I take Germany to represent the rest of the world in the model, so I calibrate the depreciation rate δ to the German data. Using the law of motion for the capital I obtain series for the *FTA* in Germany from Deutsche Bundesbank and Eurostat databases. Series for *CFC* in constant prices is also available from Eurostat. Thus, I average the value of the depreciation rate in Germany for the period 1994–2004, according to the identity $\delta = CFCt/FTA_{t-1}$ and obtain $\delta = 0.0741$.

A basic assumption that underlies the simulations in the next section is that the German economy is in a steady state. Therefore, I calibrate the discount factor β again to the German data, using the identity that holds only in steady state $\beta = 1/(1+r^*)$. With data on 10-year Government bond yields from Eurostat, and CPI-based inflation rate from the Federal Statistical Office in Germany, I obtain an average real return for the period 1994–2004, $r^* = 0.0371$. Thus, the discount factor is $\beta = 0.9642$.

I calibrate the consumption preference parameter ε using the first-order conditions from the consumer's problem. The latter yield:

$$\varepsilon = \frac{\left(c_{T97}/c_{N97}\right)^{1-\sigma}}{1+\left(c_{T97}/c_{N97}\right)^{1-\sigma}}$$

where c_{T97} and c_{N97} are the consumption of traded and non-traded good respectively which can be obtained directly from the aggregated input–output matrix for 1997. The resulting value of ε is 0.4085, showing that consumer

preferences are tilted more towards the non-traded good. In this respect the Bulgarian economy is not any different from the Baltic states for example, where Bems and Jönsson (2005) found the preference parameters to be around 0.40. For Spain, the preference parameter found by Fernandez de Cordoba and Kehoe (2000) is even below 0.30.

To calibrate the parameters of the production function in the investment sector I use the empirical finding of Burstein, Neves and Rebelo (2004), that on average 41 per cent of the aggregate investment expenditures in OECD countries are allocated to traded goods. Moreover, Bems (2004) finds values of the investment expenditure share on non-traded goods very close to this number using a larger sample of countries, and concludes that there are no significant differences in this respect among different regions of the world, such as Europe, South-East Asia, Africa or Latin America. Taking this evidence, I set $\gamma = 0.41$. Using the first-order conditions for the investment sector it is straightforward to obtain the value of the shift parameter G:

$$G = \frac{1}{\gamma^{\gamma}(1-\gamma)^{1-\gamma}}$$

Plugging the value for γ one can get $G = 1.9677$.

I take the capital frictions parameters' values from Bems and Jönsson (2005), and I motivate this choice with the similarity of Bülgaria and the Baltic countries in terms of capital regimes. With the introduction of a currency board arrangement in 1997, Bulgaria opted for liberal capital regulations as much as the Baltic states did in 1993–1994. Bems and Jönsson (2005) use value of 1.22 for the convex component of the capital frictions ζ and set the level parameter ϕ to 1 in their baseline simulations.

In calibration of the production functions for traded and non-traded goods, I normalize the total output in the last closed year to 100 and obtain the proportions of traded and non-traded output from the input – output matrix for 1997. To obtain values for the initial production factors and the production functions parameters I solve a system of eight equations stemming from the first-order conditions of the model for the steady state of the Bulgarian economy in autarky. In calculating the income share of capital per sector I follow an approach suggested by Gollin (2002). The whole procedure is described in detail in Appendix A.

The next step is the calibration of the level parameter ψ for the labor adjustment costs. In their study, Bems and Jönsson (2005) set the value of ψ so that the maximum net job creation in the model matches the highest rates of job creation per sectors observed in the actual data. Since data on employment at the necessary level of dissagregation for Bulgaria were freely available from NSI only for the short period of 2000–2003, I can not perform the

same procedure without knowledge of the actual labour dynamics in the first two years of the liberalization. However, looking at the Bulgarian data one can observe that the largest net job creation in the mentioned period was 2.17 per cent, and it happened to be in the non-traded sector. Similar pattern is present in the Baltic states although the growth rates there are strictly higher (caution is called for in this comparison because of the missing data for 1998 and 1999). Thus, I take the parameter that Bems and Jönsson (2005) obtain for Lithuania, $\psi = 30.07$, since the maximum net job creation rate reported there comes closest to the one observed in Bulgaria.

Finally, I calibrate an interest rate risk premium for Bulgaria. In a standard set-up, the risk premium is derived from:

$$(1 + r_t^B) = (1 + \rho_t^B)(1 + r_t^G)$$

that is

$$\rho_t^B = \frac{r_t^B - r_t^G}{1 + r_t^G}$$

where $(1 + r_t^B)$ is the gross real interest rate faced by the consumers in Bulgaria on foreign currency denominated loans and $(1 + r_t^G)$ is the world (the German here) gross real interest rate. To obtain series for the risk premium, ρ_t^B, I take the annualized effective real interest rate on short-term (up to one year) loans in euro to the non-financial enterprises in Bulgaria r_t^B and in Germany r_t^G. The interest rates on foreign currency loans in Bulgaria are the relevant ones for the purpose of estimation here since using them any local currency risk will be eliminated. Moreover, loans to enterprises should be taken into account as more representative than those to the Government, because the share of private non-guaranteed debt in the gross external debt of Bulgaria has been steadily on the rise in the last six years, while the public external debt significantly decreased due to the active management strategy of the Bulgarian Government, especially in the period 2001–2004. Illustration of these developments is given in Appendix B, Table 4.

Data on interest rates for the period 1998–2004 in Bulgaria are obtained from the Bulgarian National Bank website. Interest rates data for Germany are available from the Eurostat database. Annual CPI-based inflation rates for Germany were used when calculating the real interest rates in both countries. It must be mentioned, however, that the German data were subjected to a methodological change in 2003 which makes the comparison between the two subsets – 1998–2002 and 2003–2004 – in the German interest rate series very difficult if not impossible.[22] To deal with this problem I restrict the

[22] See Deutsche Bundesbank (2004) *Monthly Report* (January).

period for calculation of the real interest rate risk premium to 1998–2002. Together with this I assume that the risk premium in the Bulgarian interest rates with respect to the German ones will reach zero in 2007 – the year in which it is expected Bulgaria to join the European Union (EU). Thus, I let the estimated for 2002 risk premium decline linearly in the following years to 2007.[23] The obtained risk premium per year is presented in Appendix B, Table 5, together with the risk-free German real interest rate (mirroring the world real interest rate here) and the resulting real interest rate for the model. In calculating the latter I make use of the identity:

$$r_t^B = (1+\rho_t^B)(1+r_t^*)-1$$

Figure 5 in Appendix B shows the dynamics of the real interest rate in the model. In the next section I present the results from simulation of the calibrated to Bulgarian data model.

5. Simulations

In this section I explain how the neoclassical growth model, introduced in Section 3 and calibrated to Bulgarian data in Section 4, performs in simulations. As postulated before, Bulgaria is regarded as a closed economy in 1997 which opens to trade with the rest of the world in 1998. A major simplifying assumption in this version of the "dependent economy" model is that the country operates the same technology over time. The latter means that the production functions' parameters A_j, α_j, where $j \in \{T,N\}$, as well as G and γ, are time-invariant constants. Thus, no shocks to productivity are allowed for here, and the economic growth is driven solely by capital inflows.

Furthermore, this model, similarly to the ones briefly reviewed in Section 1, does not distinguish on the sources of financing the trade deficit. Rather, it assumes that only borrowing in the world financial markets covers the negative imbalance in the country's external trade. Therefore, no role is assigned for the foreign direct investment which in reality might account for a large part of the trade deficit financing. Table 6 in Appendix B provides data on the ratio between foreign direct investment and trade deficit in Bulgaria for the period 1999–2004. In four of these six years the inflow of FDI is larger than the negative imbalance in the external trade. However, this is not to say that all of the imported goods and services in excess of the exported ones are covered by FDI. Rather, the part of trade deficit that consists of investment goods might be related to this equity financing, as opposed to the consumer goods whose

[23] Similar approach is undertaken by Bems and Jönsson (2005) when computing the risk premia for the Baltic states in the four years immediately before the EU accession of the countries.

import is typically financed by borrowing. I will come back to this point in the concluding section, but for now it is important to note that the model focuses on the implications for the economy from the process of accumulation of productive capital, while the question of how this accumulation is financed remains a side issue.

5.1 Results from the Baseline Calibration

Figure 6 in Appendix B compares the time paths of trade balance, real GDP growth, share of traded sector in GDP, and real exchange rate, as produced from the baseline-calibrated model, to the observed dynamics of these economic aggregates, previously shown in Figures 1 through 4. Apparently, the model is able to capture the directions in which all variables move in the period after 1997.

The divergent ways in which the modeled and the actual real exchange rates go after year 2000 should come as no surprise here, since even enhanced with additional friction as the risk premium, the model fails to capture entirely the persistence in the actual appreciation. Instead, it predicts higher initial appreciation of the real exchange rate with a quick twist of the direction towards depreciation from the third model period ahead. Nevertheless, the real exchange rate in the model remains appreciated in medium term.

The produced shrinkage of the traded sector, and respectively expansion of the non-traded sector (relatively to the GDP), appears to be larger than the observed one. Bems and Jönsson (2005) find similar discrepancy in the magnitudes for Latvia and Lithuania in their simulations of the model. Despite the match between both time-series is very far from perfect, qualitatively their dynamics is the same. Thus, the model proves that the optimal reaction of the Bulgarian economy to the liberalization of trade and capital flows is to initially import traded goods and specialize in production of non-traded goods.[24]

The contraction of real GDP in the first open period might also be considered as a standard implication, given its presence for all of the three model Baltic economies in the work of Bems and Jönsson (2005). These authors explain the result as coming from costly factor reallocation in response to the liberalization. Certainly, the effect is not present in the actual data for Bulgaria. Passing this initial adjustment, the model begins producing growth of the real GDP but the rates are very modest in comparison to the observed ones.

[24] As pointed by Fernandez de Cordoba and Kehoe (2000), and Bems and Jönsson (2005), in absence of frictions in the model, the optimal response of the economy would be to fully specialize in production of non-traded goods in the first open period.

The biggest flaw, both in qualitative and quantitative terms, in the performance of the baseline-calibrated model, however, is the predicted time-path of trade balance. As it is evident from Figure 6, the trade balance in the first two open periods is positive (i.e. in surplus) at almost five per cent and one per cent of GDP respectively, which means that the representative agent lends capital to the rest of the world. This violates constraint (6)[25] although it matches qualitatively the actual data for 1998, when a small trade surplus was present. Definitely, no resemblance is in place for 1999, when the first large trade deficit after 1997 was observed in reality. From a general point of view the model economy here looks initially as a capital-rich country that optimizes in a position of lender. This is hardly to be the case of Bulgaria given the level of its economic development in 1997. It might well be a result from calibration of the model at unrealistically high initial stock of capital.

5.2 Sensitivity Analysis

As suggested in Section 4.2, the estimate of capital stock in Bulgaria for 1997 is likely to be upward biased, because of potentially higher average market price of the residential housing. To see how the modeled time paths of the key economic variables of interest here will react to a decrease in the value of initial capital, I perform a sensitivity analysis with respect to the initial capital stock. In essence, I decrease the initial capital-to-output ratio by 10 per cent, 15 per cent, and 20 per cent, recalibrate the model's factors and parameters accordingly, simulate the model again, and compare each set of simulation results to the observed data. Summary of the outcomes is given in Appendix B, Table 7. The prediction of the baseline calibration, where capital-to-output ratio is 2.76, is that the minimum trade balance (maximum trade deficit) for Bulgaria will occur in 2006 at about minus eight per cent of the GDP. As discussed above, the baseline calibration fails to capture well the dynamics of the trade balance in Bulgaria since 1997.

When decreasing the initial estimate for the capital-to-output ratio one can observe that the model generally produces lower trade balance (higher trade deficit), higher real GDP growth, larger initial drop in the traded sector share in GDP, and a higher initial appreciation of the real exchange rate. Thus, while there is a sizable improvement in the results for trade deficit and economic growth, as compared to the baseline-calibration ones, there is also a

[25] Technically, the model solution is found without imposing constraint (6) on the first step. Then, the results for the net foreign asset position in all time-periods before $r_t^B = r_t^*$ are judged upon the conditions in (6). Since when $\rho_t^B > 0$ constraint (6) binds, positive values of b_t should be ruled out as implausible, but not suboptimal. In other words, constraint (6) is not part of the initial optimization program but enters the problem in the next stage.

worsening in the results for traded sector contraction and real exchange rate appreciation. Careful investigation of model's performance with each of the three, lower than the baseline one, capital-to-output ratios shows that best working for the purpose of capturing the observed dynamics in all variables simultaneously is the specification with capital-to-output ratio of 2.346 (i.e., a decrease of 15 per cent in the initial estimate). The medium-term results from the simulation of the model, recalibrated at $k_0/y_0 = 2.346$, are shown in Appendix B, Figure 7.

The best performing recalibration, whose parameters and initial factors I present in Appendix B, Table 8, predicts the minimum trade balance for Bulgaria to occur in 2005 at minus 10.5 per cent of GDP. The match between the modeled and the actual time path of the trade deficit is considerably better than the one obtained in the baseline case and in all of the other specifications tested. At the same time, the gap between the modeled and the actual economic growth is narrowed with no change in the directions of movement. Qualitatively, the traded sector share and the real exchange rate keep the same fit as in the baseline case with minor worsening of the magnitudes of quantitative deviation between the model and the actual data.

The long-term implications of the model, simulated with the best-performing (in medium-term) recalibration, are shown in Appendix B, Figure 8, where I plot the time paths of trade balance, real exchange rate and capital-to-output ratio. The model predicts the reversal of trade imbalances from negative to positive numbers to occur in 2019, while in 2012 the real exchange rate will begin to depreciate. In the year of trade balance reversal the capital-to-output ratio in Bulgaria is expected to be 3.69, according to the model's projections.

The intuitive meaning of these long-term patterns is the following: being a capital-poor economy that opens to trade with the rest of the world in 1998, Bulgaria starts accumulating productive capital through borrowing abroad and running deficits in its external trade; at the same time the economic activity shifts towards the relatively scarce, only home-produced, non-traded good (since the traded good could be readily imported); the latter is accompanied by a rise in the non-traded good's price, because of its increased demand for investment purposes (remember the specific composite investment technology in the model) resulting in sustained real exchange rate appreciation; when capital stock reaches its steady state (long-term equilibrium) level, the country starts repaying its debt (becomes a net payer to the rest of the world), while running surpluses in its external trade; this goes together with a shift (in relative terms) in economic activity back to the traded sector, decrease in the price of the non-traded good, and consequently – a real exchange rate depreciation.

It is important to note that the trade balance reverses at capital-to-output ratio of 3.69, which is roughly the same as the one in Germany in 1997, as reported in Section 4.1. To elaborate more, the model predicts that by 2019 Bulgaria will be able to achieve convergence in relative terms to Germany's steady state as of 1997. It also implies that despite being overestimated, the baseline value of initial capital stock is not very far away from the "true" one. In the next section I elaborate more on the model's implications, discuss its limitations, and sketch some lines for further research.

6. Conclusion

In this study I examined whether a plausibly parameterized neoclassical growth model is able to account for the observed dynamics in the Bulgarian economy after an introduction of a credible currency regime in mid-1997 and a policy shift towards more liberal external trade and capital regulations. I was particularly interested in model's predictions for the trade balance in Bulgaria, as the latter experienced a sharp deterioration since 1997, accompanied by a sustained real exchange rate appreciation, with no signs of reversal so far. The baseline-calibration of the model to Bulgarian data produced acceptable results on qualitative grounds, but failed to replicate quantitatively the actual data on trade balance, real GDP growth, share of traded in total output, and real exchange rate.

Recalibration at slightly lower than the baseline capital-to-output ratio improved considerably the match between modeled and observed time-paths of the trade balance and the economic growth, while preserving the qualitative results for the other two variables. According to the best performing in simulations specification of the model's initial factors and parameters, Bulgaria will experience its highest trade deficit in 2005 at 10.5 per cent of GDP, and a full reversal to a trade surplus will be in place in 2019. At that time, the Bulgarian economy will have accumulated its long-term equilibrium stock of capital at 3.69 to the output, which means that Bulgaria will have converged in real terms to the state of Germany's economy in 1997.

The main lesson from this numerical exercise can be summarized as follows: if the neoclassical framework is suitable for investigation of the developments in Bulgaria since 1997, then the observed trade deficit dynamics is the equilibrium response of an optimizing undercapitalized economy. Put differently, the increasing negative imbalance in the external trade of Bulgaria is in line with the theory predictions and does not result from excessive spending on the part of the economic agents, neither comes from worsened competitiveness of the economy due to the fixed exchange rate that it operates. An important policy implication might be that measures for correction of the cur-

rent imbalances in Bulgaria are not necessary. As Sachs (1981, p. 263) notes, in general the economic and political thinking is "caught up in the mercantilist idea that deficits reflect overspending and therefore require adjustment". However, the partial equilibrium approach to the external trade, focusing only on the relations between import and export, might often be misleading if used as foundation for policy-making. Elaborating more on that with the prescribed dose of caution for the model's limitations, the results of this study come into support to those of Chobanov and Sorsa (2004), who find that the real exchange rate appreciation in Bulgaria is driven by the process of real convergence and the widening current account deficit is not due to problems with competitiveness.

The model's results point that reversal in trade and capital flows in Bulgaria will occur about 15 years from now, while a moderate depreciation of the real exchange rate is expected to begin in 8 years. All these developments will imply a gradual shift of economic activity from the non-traded back to the traded sector. The anticipated sectoral readjustment draws another important policy lesson here: the factor markets should be flexible enough to enable smooth reallocation of resources. Thus, from a policy perspective, measures towards enhancing the flexibility of Bulgarian labor market will definitely prove beneficial in medium- and long-term.[26]

Any serious consideration of the model's predictions must take into account the limitations that were imposed on its construction. As mentioned in Section 5, the productivity is held constant here, which is a necessary simplification to isolate the effects of capital flows on the performance of economy. However, since initial capital inflows reverse in long-term, so does the economic growth. This will not be the case if there is another source of growth for the economy such as the advance in technology. Typically, transition countries exhibit tangible productivity growth as new technologies replace inherited ones from the past of the central-plan economy. Importantly, with no productivity growth in this model there is no role for the Balassa – Samuelson effect which implies on its own a real exchange rate appreciation during the catching-up process. Had it been allowed for here, the model would have produced a more sustained appreciation of the real exchange rate, thus capturing better the actual data.

Given that the model does not distinguish on the sources of financing the trade deficit, the net foreign asset position of the country in the model differs significantly from the actual one for Bulgaria in terms of structure. While fi-

[26] Comprehensive discussion and empirical investigation on the labor market flexibility in Bulgaria could be found in Nenovsky and Koleva (2001).

nancing of the trade deficit in the model comes entirely from borrowing abroad, in reality a great deal of net imports is covered by foreign direct investment (FDI) flows, as discussed in Section 5. Indeed, to the extent that FDI is a non-debt creating capital inflow the future repayment needs of the country might not be as big as those implied by the model. Equivalently, the trade surpluses after 2019 might be smaller than the modeled ones. To account for the FDI role in the model is an appealing but difficult objective, since this type of capital inflow has an exogenous nature – it depends on a myriad of factors that is hard to control for, such as the investors' sentiment towards the country (and often the region in which the country is located), the country's business environment (in legal, political, and social terms), etc. Last but not least, FDI also entails repayment on the part of the country in long-term, taking form of repatriated profit or intra company loan amortization, which ultimately does affect the external balance.[27]

This study might be extended in future along several lines. First, a broader sensitivity analysis, applied to all exogenously taken parameters, could be carried out in order to identify the robustness of the obtained results. Second, allowing for growth in productivity might improve model's predictions with respect to the economic growth and the real exchange rate appreciation. Third, the assumption of zero net foreign asset position in Bulgaria in 1997 is a very strong one, as the country entered the currency board regime at very high public external debt-to-GDP ratio. Although, as mentioned in Section 4.2, the fall in public external debt since 1997 was due to discretionary management on the part of Bulgarian government, and the rise of private external debt might be a better indicator for the real dynamics in the economy after its assumed opening in 1998, a carefully calibrated initial endowment of external debt will probably help the model resemble better the specifics of the Bulgarian case study.

[27] For more on this issue see Zanghieri (2004), with special focus on Bulgaria given by International Monetary Fund (2004) *Country Report* No.4/177.

APPENDIX A: Calibration of the Production Functions

In this appendix, I explain in greater details the calibration of the production functions for traded and non-traded goods. In brief, the purpose is to find the production functions' parameters A_T, A_N, α_T, α_N, and the initial factors k_{T0}, k_{N0}, l_{T0} and l_{N0}.

In the autarky steady state (the last year before liberalization), the output in each of the sectors is:

$$y_{T0} = A_T k_{T0}^{\alpha_T} l_{T0}^{1-\alpha_T} - \frac{\phi\zeta}{1+\zeta}\delta^{\frac{1+\zeta}{\zeta}} k_{T0} \qquad \text{(A. 1)}$$

$$y_{N0} = A_N k_{N0}^{\alpha_N} l_{N0}^{1-\alpha_N} - \frac{\phi\zeta}{1+\zeta}\delta^{\frac{1+\zeta}{\zeta}} k_{N0} \qquad \text{(A. 2)}$$

The last term in both equations relates to the cost of transformation of investment goods into capital. Following Bems and Jönsson (2005), I use here the fact that in equilibrium the capital in each sector must earn its marginal product, i.e.:

$$y_{T0} X_T = \left(\alpha_T A_T k_{T0}^{\alpha_T - 11} l_{T0}^{-\alpha_T} + Z\right) k_{T0} \qquad \text{(A. 3)}$$

$$y_{N0} X_N = \left(\alpha_N A_N k_{N0}^{\alpha_N - 11} l_{N0}^{-\alpha_N} + Z\right) k_{N0} \qquad \text{(A. 4)}$$

where $Z = \frac{1}{(1+r_2)}\phi\delta^{\frac{1}{\zeta}}\left(1-(1+r_2)-\frac{\zeta}{1+\zeta}\delta\right)$ comes from the investment transformation costs, while X_T and X_N are the income shares of capital and are obtained from the actual data.[28]

To calculate the income shares of capital, I follow one of the approaches suggested by Gollin (2002, p. 468), where:

$$X_{jt} = \frac{os_{jt} + cfc_{jt}}{os_{jt} + mix_{jt} + wl_{jt} + cfc_{jt}}$$

for $j \in \{T, N\}$, and t denoting the year. Here *os* stands for the operating surplus (the net business income of the incorporated enterprises), *mix* stands for the mixed income (the operating surplus of the private non-incorporated enter-

[28] Equations (A. 2) and (A. 3) follow from the first-order condition with respect to capital in the producer's problem in Section 3, if one uses the no-arbitrage condition (13) in Section 3, and noting that the price of capital q is 1, replaces $(r_0^B + \delta)k_{j0}$ with $y_{j0}X_j$.

prises), *wl* stands for the compensation of employees, and *cfc* is the consumption of fixed capital. As Gollin (2002) points out, in order to get income shares right one needs to distinguish strictly between the business income of the incorporated and the non-incorporated enterprises. It is more proper for the income of the latter group, consisting of self-employed people, to be categorized as labour income, since their businesses tend to be more labour intensive.

The input – output matrix for Bulgaria in 1997 provides information only on the combined *os/mix* component of the gross value added in the economy. Data on the division within *os/mix* are available in the NSI Statistical Yearbooks for the period 1997–2001. Using these data I compute the income shares of capital, according to the above formula, for each year and *per* both sectors – traded and non-traded. The average value of X_T for the period is 0.3372 with a standard deviation of 0.0619, while the average value of X_N is 0.5302 with a standard deviation of 0.0343. Although more varying, the income share of capital in the traded sector is in line with the findings of Gollin (2002) for a large sample of countries, as well as with those of Bems and Jönsson (2005) for the Baltic states. The higher income share of the capital in the non-traded sector, however, appears to be a specific feature of the Bulgarian economy, and could be easily explained by the great share of the imputed rent for the owner occupied residential housing. I use in my calibration the averages of the income shares of capital, computed for 1997–2001, in order to avoid the problem with the higher volatility of X_T, and to approximate better the technologies used in the analyzed period. Note, however, that X_j is expected to be lower than α_j in any of the sectors, because of the capital frictions that are present in the model.

The equilibrium conditions insist on equalization of the returns to capital and labour across the sectors:

$$\alpha_T A_T k_{T0}^{\alpha_T - 1} l_{T0}^{-\alpha_T} = \alpha_N A_N k_{N0}^{\alpha_N - 1} l_{N0}^{-\alpha_N} \quad \text{(A. 5)}$$

$$(1-\alpha_T) A_T k_{T0}^{\alpha_T} l_{T0}^{-\alpha_T} = 1 \quad \text{(A. 6)}$$

$$(1-\alpha_N) A_N k_{N0}^{\alpha_N} l_{N0}^{-\alpha_N} = 1 \quad \text{(A. 7)}$$

where the right hand sides of the last two equations are simply the normalized to 1 initial wages in the model. The condition for clearing the market for capital states is:

$$k_0 = k_{T0} + k_{N0} \quad \text{(A. 8)}$$

Thus, the eight equations in (A.1) – (A.8) are solved in a system to obtain the parameters and initial factors for the model. The values for y_{T0} and y_{N0} are taken directly from the input – output matrix for 1997 and scaled according to the adopted normalization y_0 = 100. More concretely,

y_{T0} = (9 049/15 747)100 = 57.4649, and y_{N0} = 100 – 57.4649 = 42.5351. All results are listed in Appendix B, Table 3.

As a final point, it deserves noting that the non-traded sector is more capital intensive in Bulgaria than the traded sector, i.e. $\alpha_N > \alpha_T$. This comes in contrast to the standard textbook assumption (Obstfeld and Rogoff (1996), Fischer (2002), that the export technology (the traded sector) relies relatively more on capital than the non-tradables technology. However, the results for Bulgaria are in line with those for Spain and the Baltic states, where Fernandez de Cordoba and Kehoe (2000), and Bems and Jönsson (2005) respectively, also find that the non-traded sector is more capital intensive than the traded sector.

APPENDIX B: Tables and Figures

Table 1

CLASSIFICATION OF INDUSTRIES INTO TRADED AND NON-TRADED SECTORS

Traded industries	*Non-traded industries*
Agriculture/Fishing	Electricity, gas and water supply
Mining	Construction
Manufacturing	Wholesale/Retail trade
Transport/Communications	Hotel and restaurant services
	Financial intermediation
	Real estate/Renting
	Education
	Health and social work
	Public administration and defense/ Compulsory social security
	Other service activities

Table 2

AGGREGATED INPUT–OUTPUT MATRIX FOR BULGARIA, 1997

(million Bulgarian levs [new*])

		Expenditures							
		1	2	1+2	C+G	I	X	C+G+I+X	**Total**
Receipts	1	9,005	2,810	11,815	5,586	-159	8,276	13,703	25,518
	2	2,045	1,817	3,861	6,722	960	1,402	9,084	12,945
	1+2	11,050	4,627	15,676	12,308	801	9,678	22,787	38,463
	wl	3,195	2,691	5,886					5,886
	rk	5,480	3,957	9,437					9,437
	cfc	686	471	1,157					1,157
	rk (net)	4,794	3,486	8,280					8,280
	T	374	50	424					424
	wl+rk+T	9,049	6,698	**15,747**					**15,747**
	M	5,420	1,620	7,040					7,040
	Total	25,518	12,945	38,463	12,308	801	9,678	22,787	

* See Section 4.1, footnote 19 for reference.

Source: Derived from "Input – Output Tables: 1996, 1997", National Statistical Institute of Republic of Bulgaria (2002).

1	traded sectors (agriculture/fishing, mining, manufacturing, transport/ communications)
2	non-traded sectors (others except services not for sale)
wl	compensation of employees
rk	business income (gross operating surplus/mixed income), of which:
cfc	consumption of fixed capital
rk (net)	net business income (net operating surplus/mixed income)
T	taxes and transfers
M	imports
C+G	private plus government consumption
I	investment (gross capital formation)
X	exports

Table 3

BASELINE CALIBRATION OF THE MODEL FOR BULGARIA

Initial Factors				*Parameters*			
y_0	100.0000	L	55.7673	A_T	1.0018	η	-1.0000
y_{T0}	57.4649	l_{T0}	37.0232	A_N	0.7142	ε	0.4085
y_{N0}	42.5351	l_{N0}	18.7441	α_T	0.3625	δ	0.0741
k_0	276.0000			α_N	0.5666	β	0.9642
k_{T0}	127.5510			γ	0.4100	ζ	1.2200
k_{N0}	148.4494			G	1.9677	ϕ	1.0000
				σ	-1.0000	ψ	30.0700

Table 4

EXTERNAL DEBT (PERCENTAGE OF GDP)

	1999	**2000**	**2001**	**2002**	**2003**	**2004**
Gross External Debt	89.2	86.9	78.6	65.1	60.5	63.0
Public Sector External Debt	77.2	72.2	63.8	48.2	40.1	33.1
Private Sector External Debt	11.9	14.7	14.7	17.0	20.4	30.0

Source: Bulgarian National Bank (the numbers in the last two rows do not add up exactly to the corresponding number in the second row due to roundings in reporting).

Table 5

REAL INTEREST RATE IN THE MODEL

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Risk Premium, ρ^B	0.0405	0.0144	0.0229	0.0208	0.0134	0.0108	0.0081	0.0054	0.0027	0.0000	0.0000
Real Interest Rate (Germany), r^*	0.0371	0.0371	0.0371	0.0371	0.0371	0.0371	0.0371	0.0371	0.0371	0.0371	0.0371
Real Interest Rate (Bulgaria), r^B	0.0790	0.0520	0.0608	0.0587	0.0510	0.0482	0.0455	0.0427	0.0399	0.0371	0.0371

Table 6

FOREIGN DIRECT INVESTMENT COVERAGE OF TRADE DEFICIT IN BULGARIA

million EUR	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
Foreign direct investment (FDI)	866	1103	903	980	1851	2114
Trade deficit (TD)	702	732	1324	1206	1676	1995
FDI to TD (per cent)	**123**	**151**	**68**	**81**	**110**	**106**

Source: Author's calculations based on data from Bulgarian National Bank.

Table 7

SENSITIVITY ANALYSIS WITH RESPECT TO THE INITIAL CAPITAL STOCK

Initial capital stock		*Minimum trade balance*		*Year of reversal*
percentage of the estimate	k_0/y_0	*percentage of GDP*	*year*	
100	2.760	7.98	2006	2021
90	2.484	9.61	2005	2019
85	2.346	10.50	2005	2019
80	2.208	11.50	2004	2018

Table 8

BEST PERFORMING RECALIBRATION OF THE MODEL FOR BULGARIA

Initial Factors				*Parameters*			
y_0	100.0000	L	56.1129	A_T	1.0623	η	-1.0000
y_{T0}	57.4649	l_{T0}	37.1829	A_N	0.7859	ε	0.4085
y_{N0}	42.5351	l_{N0}	18.9300	α_T	0.3588	δ	0.0741
k_0	234.60000			α_N	0.5612	β	0.9642
k_{T0}	108.4180			γ	0.4100	ζ	1.2200
k_{N0}	126.1820			G	1.9677	ϕ	1.0000
				σ	-1.0000	ψ	30.0700

Figure 1

TRADE BALANCE

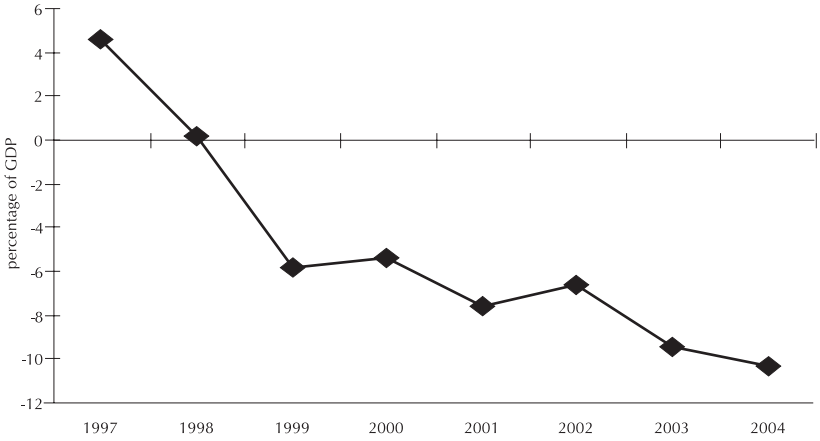


Figure 2

REAL GDP GROWTH

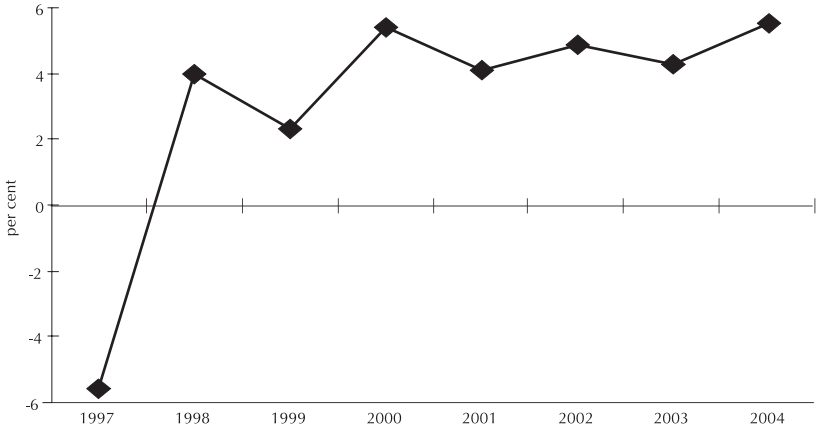


Figure 3

TRADED SECTOR

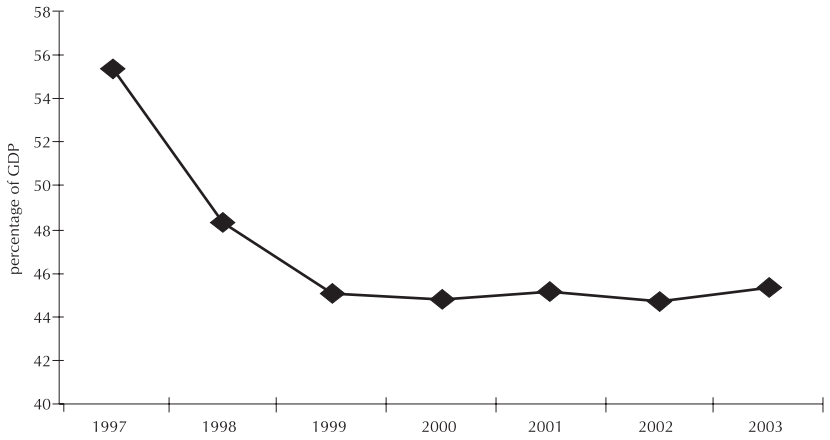


Figure 4

RER: GERMAN MARK – BULGARIAN LEV

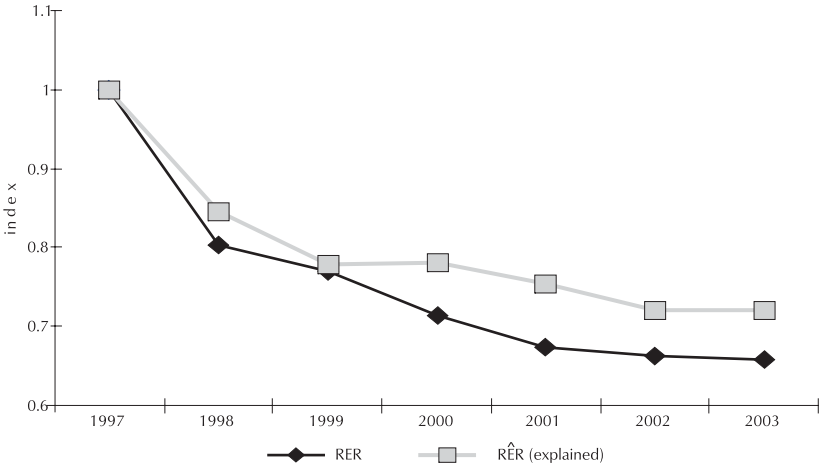


Figure 5

REAL INTEREST RATE IN THE MODEL, r^B

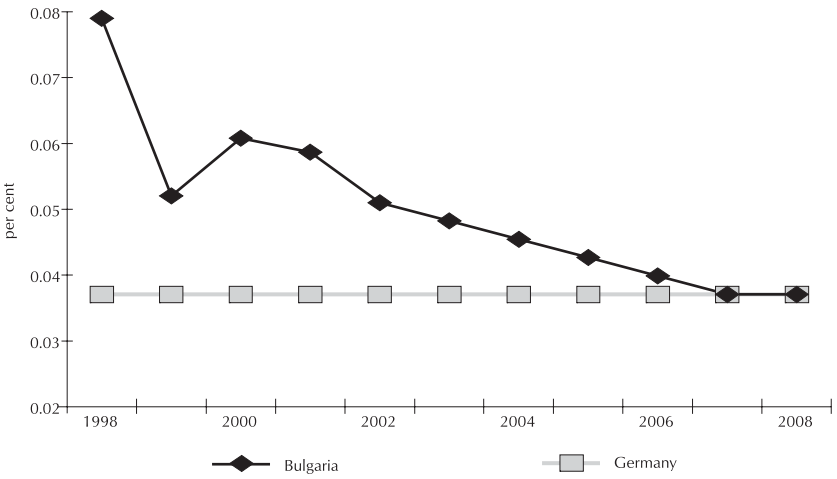
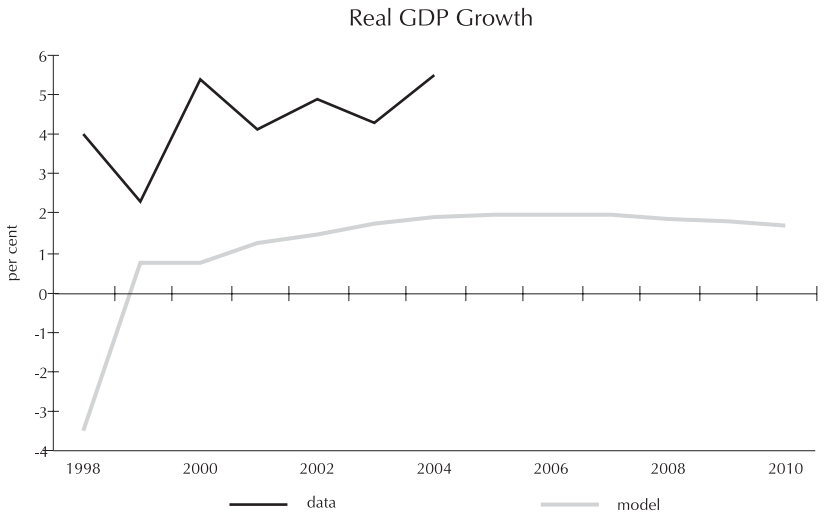
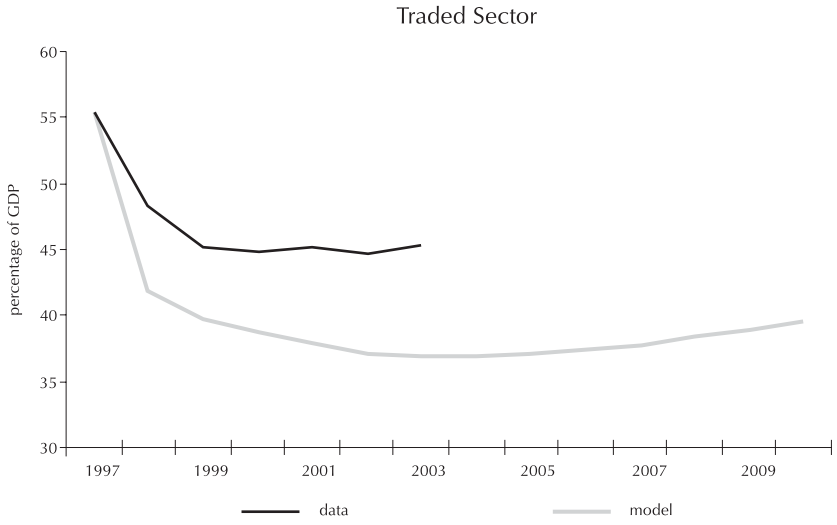


Figure 6

RESULTS FROM THE BASELINE CALIBRATION: MEDIUM-TERM PATTERNS


Real GDP Growth
per cent
6
5
4
3
2
1
0
-1
-2
-3
-4
1998
2000
2002
2004
2006
2008
2010
data
model


Traded Sector
percentage of GDP
60
55
50
45
40
35
30
1997
1999
2001
2003
2005
2007
2009
data
model

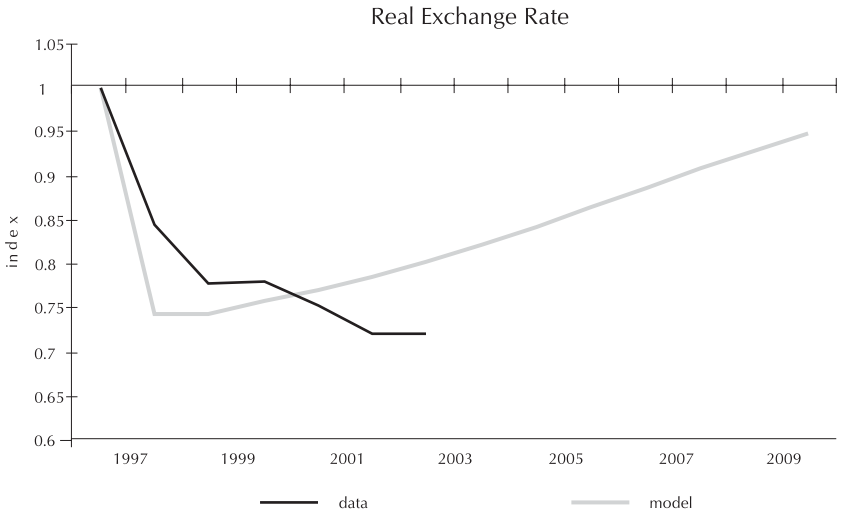
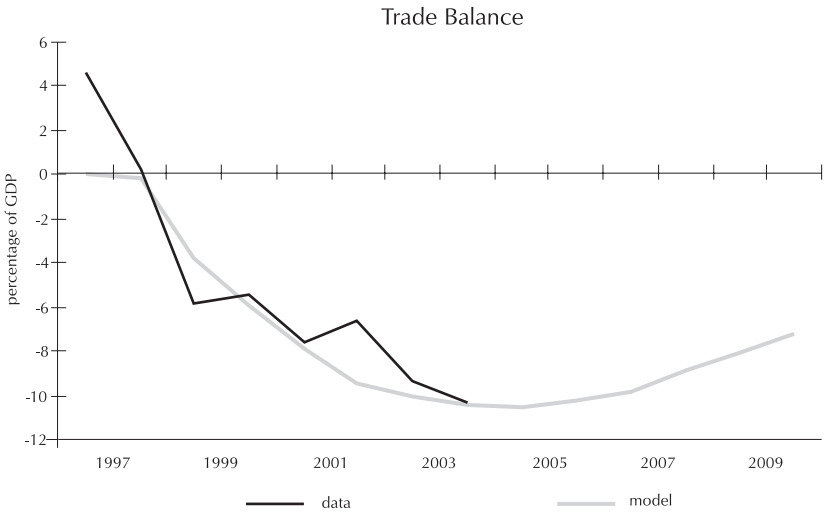
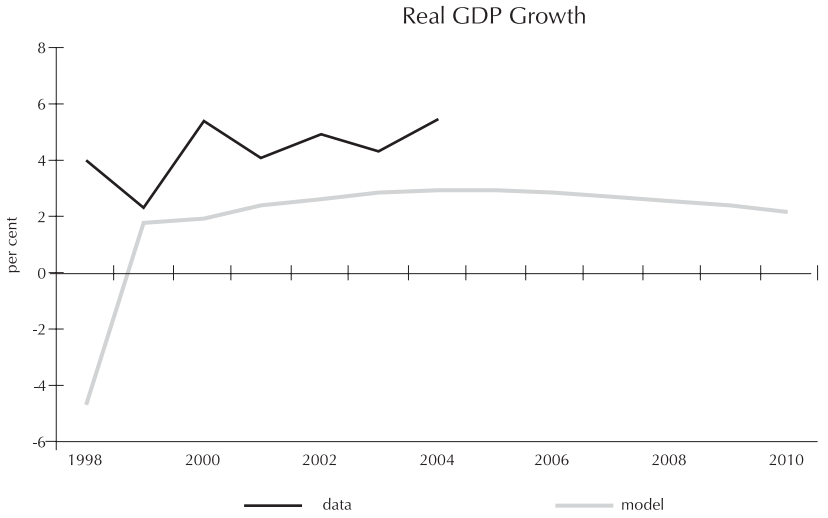
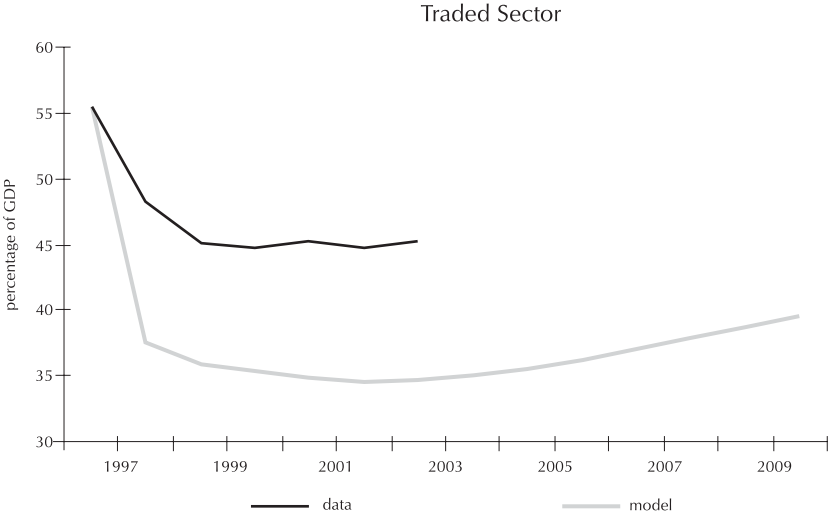


Figure 7

RESULTS FROM THE BEST PERFORMING RECALIBRATION: MEDIUM-TERM PATTERNS




Real GDP Growth
per cent
8
6
4
2
0
-2
-4
-6
1998
2000
2002
2004
2006
2008
2010
data
model


Traded Sector
percentage of GDP
60
55
50
45
40
35
30
1997
1999
2001
2003
2005
2007
2009
data
model

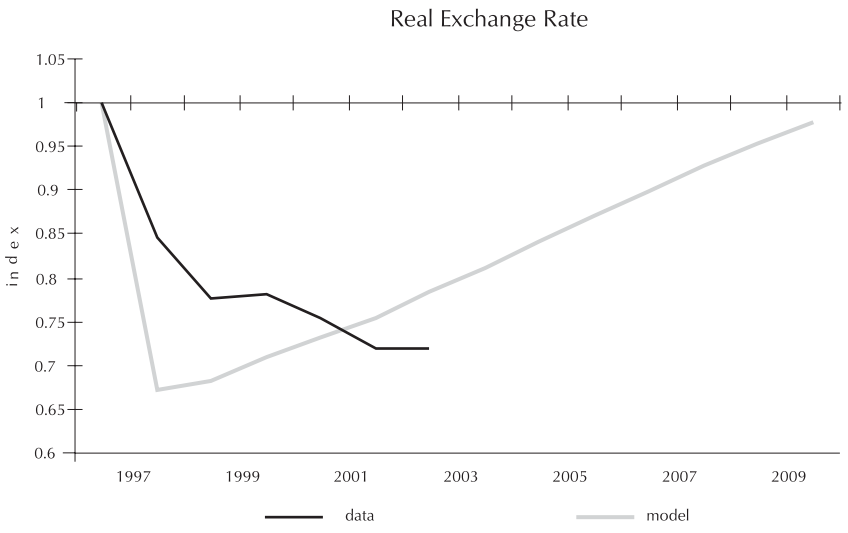
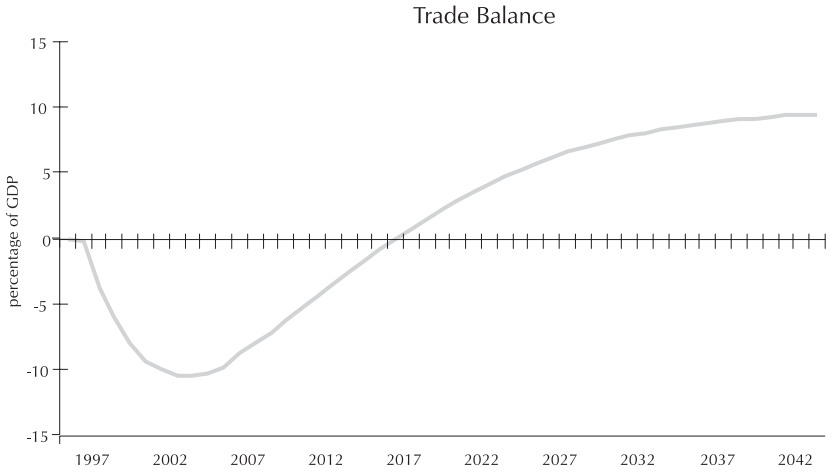
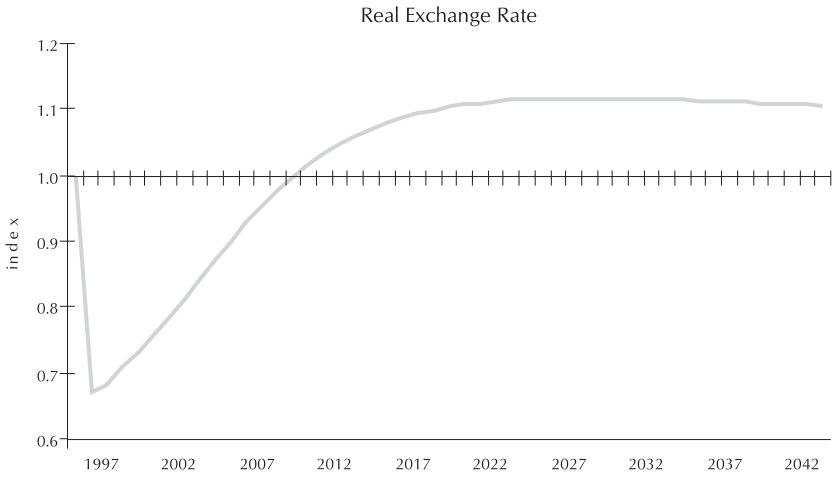
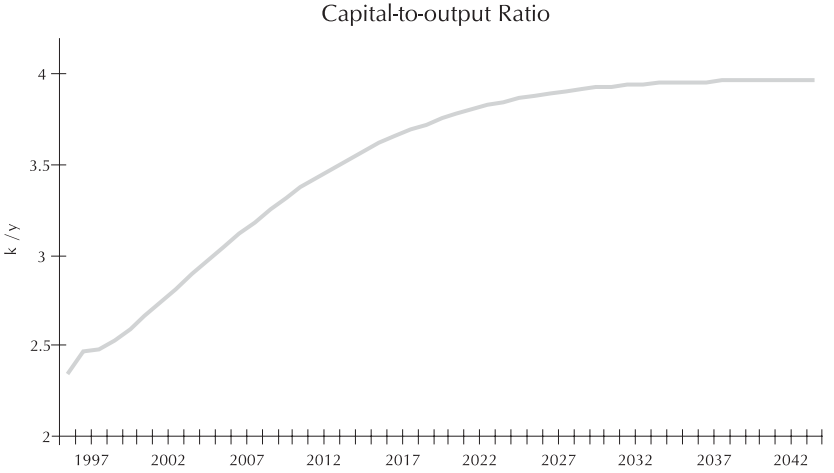


Figure 8

RESULTS FROM THE BEST PERFORMING RECALIBRATION: LONG-TERM PATTERNS




Real Exchange Rate
index
1.2
1.1
1.0
0.9
0.8
0.7
0.6
1997
2002
2007
2012
2017
2022
2027
2032
2037
2042


Capital-to-output Ratio
k /y
4
3.5
3
2.5
2
1997
2002
2007
2012
2017
2022
2027
2032
2037
2042

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