External Deficits in the Baltics 1995 - 2007: Catching Up or Imbalances?*

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Abstract

This paper studies external deficits in the Baltic States between 1995 and 2007. It uses a calibrated small-open-economy dynamic general equilibrium model incorporating a financial accelerator in order to give a quantitative assessment of the extent to which deficits can be explained by productivity growth, a fall in spreads and increasing access to household credit. The results show that the external deficit and other key macroeconomic aggregates can be well fitted by the equilibrium response of the model economy. Productivity growth is found to have played a predominant role at the beginning of the period with the role of the other factors increasing in the second half of the sample. Diverging trends in the Baltics in the final years of the sample may have been signs of imbalances.

1 Introduction

The Baltic States' external deficits seemed to have broken all previous records over the past decade with both the current account and the trade deficits averaging at close to 10% of GDP between 1995 and 2007 in each Estonia, Latvia and Lithuania and showing an increasing trend towards the end of the period. As this trend has abruptly been reversed at the end of 2007, it is all the more important to understand what has been driving the developments in the past.

In recent years, the increasing external deficits led many analysts to warn about an overheating and growing imbalances in the Baltic economies. Indeed, a run-up in housing prices is one of the best leading indicators of financial crisis in countries experiencing large capital inflows. Increasing GDP growth rates

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also belong to the crisis indicators.[1] In the Baltics, all of these factors were present simultaneously. At the same time, macroeconomic theory considers external deficits to be equilibrium phenomena. According to theory, external deficits can be expected in catching-up economies and are not considered to be a problem as long as foreign funds are well invested allowing for a progressive repayment of debt over time.

The most frequently cited factors driving external deficits in the Baltics are productivity growth and growth differentials, a fall in spreads related to the EU accession and the increasing access to credit for households also leading to a boom in the housing market.

In this paper, we assess to what extent the external deficits of the Baltic States between 1995 and 2007 can be explained by these factors. We use the European Commission's QUEST model calibrated to the Baltic economies to give a quantitative answer to this question. QUEST is a small-open economy dynamic general equilibrium model with a traded and a non-traded goods production sector producing final and intermediate goods as well as a house production sector. The model also features a financial accelerator specified through a collateral constraint for a fraction of households building on Iacoviello (2005) and Monacelli (2008).

The exercise we conduct is similar in spirit to those in Cordoba & Kehoe (1999), Bems & Joensson (2006) and Bems (2008) in using a calibrated DGE model to understand past developments. At the same time, the focus of our paper is different from those in these studies. Also, the model we use incorporates a more detailed specification of trade linkages which may be expected to better capture foreign-trade-related developments. In addition, the extension for the housing sector allows us to study the impact of credit growth on the housing market and on other parts of the economy.

Our main results are as follows.

First, the three factors together yield a good fit of the external deficit and other key macroeconomic indicators over the period under consideration.

Second, TFP growth and TFP growth differentials with respect to the euro-area are found to account well for trends until around 2001. The role of TFP growth seems to have decreased in driving developments thereafter while the fall in spreads and the increasing access to credit are found to have played an increasingly significant role in driving observed trends in these more recent years.

Third, in the last years of the sample, the fit of some aggregates (consumption, housing investment, housing prices) deteriorates. Also, the model predicts a progressive restructuring towards the traded sector and a decrease in the trade deficit with a view of repaying the accumulated debt. In contrast, observed traded - non-traded aggregates seem to have continued to shift towards the non-traded sector suggesting that the turn predicted by the model had not been taken by the Baltics until the second half of 2007. These diverging trends may indicate imbalances.

[1] For financial crisis indicators see e.g. Reinhart & Rogoff (2008) and references therein.

Finally, it is important to mention, that our simulations are based on the assumption of a continuation of productivity growth and of the rise in the access to credit for many years. Also, the fall in spreads is modelled to be permanent. According to our model, a less positive outlook would have implied smaller trade deficits in earlier periods with faster restructuring and earlier debt repayment. Moreover, a sudden deterioration of expectations is shown to require substantial restructuring and a fall in the external-debt-financed domestic demand.

The remainder of the paper is organised as follows. Section 2 describes major economic trends observed in the Baltic economies between 1995 and 2007. Section 3 outlines the model. Section 4 describes the simulated impact of the three factors and section 5 concludes.

2 Baltic economies 1995 to 2007

After the liberalization of the Baltic economies in the first half of the nineties, GDP was growing at a very fast pace averaging at around 7% per year in each Baltic country since 1995 and even increasing in the second half of the sample. Table 1 summarises key indicators for each country.[2]

Growth was largely domestically driven, with both households' consumption growth and particularly investment growth exceeding GDP growth in each country.

Parallel to this, external deficits were very high throughout the entire period. Trade and current account deficits averaged at close to 10% of GDP in each country over the entire period and showed an increasing trend towards the end of the sample. Deficits have reached two-digit levels in each country by 2006; in Latvia, the trade deficit exceeded even 20% of GDP.

In addition, the Baltic currencies significantly appreciated in real terms. HICP deflated real exchange rate with EA-15 appreciated by around 20 % in Estonia and Latvia between 1995 and 2007 and by 30% in Lithuania over the same period. Part of this appreciation can be attributed to a change in relative prices between the traded and non-traded sectors. The price of traded goods relative to non-traded goods significantly decreased between 1995 and 2007 in Estonia and Latvia (by around 30%) and to a lesser extent also in Lithuania (10%). At the same time, Baltic traded goods prices also increased significantly faster than euro-area traded goods' prices over the period.

Three factors are likely to have contributed most to the observed external deficits in the Baltics. First, the Balassa-Samuelson effect driven by productivity growth differentials is likely to have played a significant role. Indeed, productivity growth in the traded sector in the Baltic economies exceeded that in the non-traded sector throughout the entire period. And, even more importantly for explaining external deficits through the Balassa-Samuelson effect,

[2] For a description of the Baltic economies over the past decade see also the second chapter in the European Commission's (2007) assessments of the Convergence Programme (update of December 2006 / January 2007) of these countries.

traded - non-traded productivity growth differentials in the Baltics exceeded those in the euro-area. The productivity differential was the most marked in Estonia in the second half of the nineties and decreased thereafter. Latvia had a similar pattern with smaller differences, whereas in Lithuania, the difference has increased in the second half of the sample.

Second, as pointed out e.g. by Luengnaruemitchai & Schadler (2007), the Baltics, like other new EU Member States, benefited from a fairly benign market risk perception. Before and around the EU accession, external risk premia fell significantly in these countries. The authors estimate a steady 50-100 basis point advantage of new Member States relative to other emerging markets since 2003. Bems & Joensson (2005) also point to the role of falling risk premia in explaining trade deficits in the Baltic States starting from 2001. Interestingly, the fall in the foreign risk premia does not seem to be related to the external debt stock as spreads were falling at a period when the external indebtedness of the Baltic economies was dramatically increasing. Studies point to institutional factors related to EU membership behind the decrease in the premia.

Third, many analysts highlight role of the increasing access to credit for households over the past couple of years. According to this explanation, excessive mortgage and consumption credit growth would have led to an overheating of the Baltic economies especially by fuelling a boom in the housing sector. This interpretation points out that foreign funds were used for consumption and non-productive housing investment which jeopardise the sustainability of the external deficits.

The data show indeed a very fast increase in the ratio of household indebtedness starting from 2001 and accelerating in more recent years. The ratio of households' gross debt to GDP increased from below or around 5% in 2000 to around 40% by 2007 in Estonia and Latvia and to close to 30% of GDP in Lithuania. At the same time, these ratios still remain below the euro-area average of around 50%.

Data on housing investment do not clearly point to an excessive increase in the housing sector either. In fact, housing investment was growing at a fast pace over the entire period in Estonia and Latvia and starting from 2000 also in Lithuania. At the same time, the growth rate of housing investment was below or around that of total investment with the exception of the spectacular 23% annual average growth in Estonia in the second half of the sample. Also, as a ratio of GDP, housing investment still remains relatively low at around 3% in Latvia and Lithuania while Estonia has just caught up with some euro-area economies like Germany, France and Belgium.

Similarly, from the production side, the financial and real estate sectors appear to have been the most important contributors to the growth in non-traded value added in Estonia starting from the year 2000. In Lithuania and Latvia these sectors were growing at a pace close to or slightly above the average of the non-traded sector.

In contrast, the increase in housing prices is more clearly pointing to a bubble in the housing market. Since 2000, housing prices have quadrupled relative to consumer prices in Estonia and Lithuania. In Latvia, real housing prices almost doubled between April 2005 and their peak in April 2007.[3] To compare, relative housing prices decreased in Germany over the same period, increased by around 60 percent in Belgium, 70 percent in France and even in Spain did the increase not exceed 85 percent over the period of 2000 - 2006.

As pointed out in Reinhart & Rogoff (2008), the run-up in housing prices is the best leading indicator of financial crisis in countries experiencing large capital inflows. High and increasing GDP growth rates also belong to the crisis indicators. In contrast, the afore-mentioned three factors of productivity growth (differentials), fall in spreads and increasing access to credit can theoretically lead to external deficits without being imbalances. Of course, this requires the decrease in the deficits and the repayment of the debt over time.

A simple inspection of the trends observed in the Baltics does not allow concluding how much each individual factor has contributed to the observed developments. It does not make it possible either to decide how much of the observed trends was a build-up of imbalances or in contrast, simply the reflection of a convergence process. In what follows, we use a dynamic general equilibrium in order to give a quantitative assessment of the contribution of each factor.

3 The QUEST Model

The model we use for this study is an extended version of a small open economy DSGE model in which households are assumed to gain utility from housing services and a fraction of households is assumed to be collateral constrained, i.e. can only borrow up to a certain ratio of the value of its house stock. Our extension closely follows Monacelli (2008). We also introduce a house production sector.

Otherwise, the model is fairly standard with monopolistically competing firms producing traded and non-traded goods using capital, labour and intermediate inputs. Fiscal policy is assumed to follow a debt rule and the central bank follows a fixed exchange rate rule as has been the case in each Baltic country over the sample period. The model also comprises a set of nominal and real frictions.

3.1 Households

The household sector consists of a continuum of households $i \in [0;1]$. A fraction s^r of all households are Ricardian and indexed by r and s^c households are credit constrained and indexed by c. The period utility function is identical for each household type and separable in consumption C_t^h, leisure $\left(1 - L_t^h\right)$, housing services H_t^h and real cash balances $\frac{M_t^h}{P_t^{GDP}}$. We also allow for external habit persistence in consumption. The period utility function is hence:

[3] Latvian data only available from April 2005.

$$U_t = U\left(C_t^i\right) + prefhZ\left(H_t^i\right) + preflV(1 - L_t^i) + prefmW\left(\frac{M_t^i}{P_t^{GDP}}\right)$$

where

$$U\left(C_t^i\right) = (1 - h^c)\log\left(C_t^i - h^c C_{t-1}^j\right) \qquad j = r, c$$

$$V\left(1 - L_t^i\right) = \frac{prefl}{1+\kappa}\left(1 - L_t^j\right)^{1+\kappa} \qquad j = r, c$$

and

$$Z\left(H_t^i\right) = \log\left(H_t^i\right) \qquad j = r, c.$$

Since money demand adjusts recursively to other endogenous variables in case of a separable utility function, for the ease of exposure we will abstract from decisions on cash balances in what follows.

All three types of households supply differentiated labour services to unions which maximise a joint utility function for each type of labour i. It is assumed that all types of labour are distributed equally over the three types of household. Nominal rigidity in wage setting is introduced by assuming that the household faces adjustment costs for changing wages. These adjustment costs are borne by the household.

3.1.1 Ricardian consumers

Ricardian households have full access to financial markets. They are assumed to own all firms and the entire capital stock of the economy. Specifically, they hold domestic government bonds $\left(B_t^{G,r}\right)$, bonds issued by other domestic households $\left(B_t^{priv,r}\right)$ as well as foreign currency denominated bonds issued by foreign households $\left(B_t^{F,r}\right)$; real capital stocks of the tradable and non tradable sector $\left(K_t^T, K_t^{NT}\right)$ and cash balances (M_t^r). The household receives income from labour, financial assets, rental income from lending capital to firms plus profit income from firms owned by the household. We assume that all domestic firms are owned by Ricardian households. Income from labour is taxed at rate t^w, rental income at rate t^k. In addition, households pay lump-sum taxes T^{LS} and receive lump-sum transfers Tr_t as well as unemployment benefits Ben_t.

Ricardian households face the following maximisation problem:

$$\max U_0 = E_0 \sum_{t=0}^{\infty} (\beta^r)^t \left[U\left(C_t^r\right) + prefhZ\left(H_t^r\right) + preflV(1 - L_t^r)\right]$$

with respect to consumption C_t^r, housing services for own use and those provided to liquidity constrained households H_t^j $(j = r, rl)$, investment to the house stock $I_t^{H,j}(j = r, rl)$, financial assets $B_t^{j,r}$ $(j = G, priv, F)$,capital stock in both production sectors K_t^j $(j = T, NT)$ and investment to capital $I_t^j(j = T, NT)$.

The maximisation is subject to the following constraints.

- The period budget constraint:

$$\frac{P_t^C(1+t_t^c)}{P_t^{GDP}}C_t^r + \frac{P_t^H}{P_t^{GDP}}\sum_{j=r,rl} J_t^{H,j} + \frac{1}{s^t}\sum_{j=T,NT}\frac{P_t^{K,j}}{P_t^{GDP}}J_t^{,j} + \frac{\gamma^w}{2}\left(\frac{W_t}{W_{t-1}}-1\right)^2 L_t^r +$$
$$B_t^{G,r} + B_t^{priv,r} + \frac{1}{s^r}rer_t B_t^F + \frac{T_T^{LS}}{P_t^{GDP}} =$$

$$= \Pi_t^{\text{real}} + (1-t_t^w)\frac{W_t}{P_t^{GDP}}L_t^r + \frac{Ben_t}{P_t^{GDP}}(1-L_t^r) + \frac{Tr_t}{P_t^{GDP}} + \frac{1+i_{t-1}}{1+\pi_t^{GDP}}\left(B_{t-1}^{G,r}+B_{t-1}^{priv,r}\right) +$$
$$\frac{1}{s^r}rer_t\left(1+risk_t\right)\frac{1+i_{t-1}^F}{1+\pi_t^*}B_{t-1}^F + \frac{1}{s^t}\sum_{j=T,NT}\frac{P_t^{K,j}}{P_t^{GDP}}\left(\left(1-t_t^k\right)r_t^{k,j} + t_t^k\delta^j\right)K_{t-1}^j +$$

$$\frac{P_t^H}{P_t^{GDP}}\left(\left(1-t_t^k\right)r_t^h + t_t^k\delta^h\right)H_{t-1}^r,$$

where Π_t^{real} stands for real profits; W_t is the wage rate; i_t is the risk-free domestic nominal interest rate; $rer_t \equiv \frac{e_t P_t^*}{P_t^{GDP}}$ is the real exchange rate expressed as price level deflated nominal exchange rate (increase denotes an appreciation); $r_t^{k,j}$ is the real return on capital, r_t^h similarly the return on rented housing services and δ^i $(i = T, NT, h)$ stands for the depreciation rate in the respective capital/house stocks. $P_t^{GDP}, P_t^C, P_t^{K,j}, P_t^H$ are the GDP deflator and the prices of total consumption, capital in the traded and non-traded sectors and of houses, respectively; $\pi_t^j \equiv \frac{P_t^j}{P_{t-1}^j} - 1$, the net inflation rate of the respective price level; finally, t_t^c denotes the tax rate on consumption.

The foreign interest rate i_t^F is exogenous to the small domestic economy. At the same time, a risk premium $risk_t$ is introduced which depends on the foreign debt stock[4].

- Capital and house accumulation equations:

$$K_t^j = \left(1-\delta^j\right)K_{t-1}^j + I_t^j \qquad \text{for } j = T, NT;$$

$$H_t^j = \left(1-\delta^h\right)H_{t-1}^j + I_t^{H,j} \qquad \text{for } j = r, rl.$$

The investment decisions w. r. t. physical capital and housing are subject to convex adjustment costs. Therefore, we make a distinction between real investment expenditure $\left(J_t^j, J_t^H\right)$ and physical investment $\left(I_t^j, I_t^H\right)$. Investment expenditure of households including capital adjustment costs is given by

$$J_t^j = I_t^j + \frac{\gamma^j}{2}\left(\frac{I_t^j}{K_{t-1}^j} - \delta^j\right)^2 \quad \text{with } \gamma^j \geq 0$$

[4] This is necessary to close down a small open economy model. See e.g. Schmitt-Grohe & Uribe (2001).

and

$$J_t^{H,j} = I_t^{H,j} + \frac{\gamma^h}{2}\left(\frac{I_t^{H,j}}{H_{t-1}^r} - \delta^h\right)^2 \qquad \text{with } \gamma^h \geq 0.$$

Ricardian consumers can borrow or lend without constraints in the financial markets. Their decision on house investment is similar to the capital investment decision with the only difference being that the return on the house stock used for own services is the marginal rate of substitution between utility gained from housing services and utility gained from consumption. The house stock owned for rental purposes is treated as a pure capital good.

The no-arbitrage condition between domestic and foreign bonds implies an interest rate parity condition for the small domestic economy. Specifically, the condition is:

$$1 + i_t = (1 + risk_t)\left(1 + i_t^F\right) E_t \frac{e_{t+1}}{e_t} + U_t^{UIP}.$$

Here, the variable $risk_t$ is the part of the spread linked to the foreign debt stock while U_t^{UIP} is an exogenously determined variable driving a wedge between domestic and foreign interest rates.

The problem of the Ricardian household is fairly standard, therefore we do not discuss the optimality conditions in detail at this place.

3.1.2 Collateral-constrained consumers

Credit constrained households do not own firms, nor capital stock. Hence their only income source is their labour income plus transfers and benefits. They differ from Ricardian households in two respects. First, they are assumed to be more impatient, i.e. discount the future more ($\beta^c < \beta^r$). Second, they face a collateral constraint on their borrowing. They borrow exclusively from domestic Ricardian households. Ricardian households in turn have the possibility to refinance themselves via the international capital market.

The maximisation problem of the collateral-constrained households is then:

$$\max U_0 = E_0 \sum_{t=0}^{\infty} (\beta^c)^t \left[U\left(C_t^c\right) + prefhZ\left(H_t^c\right) + preflV(1 - L_t^c)\right]$$

with respect to consumption C_t^c, housing services for own use H_t^c, investment to the house stock $I_t^{H,c}$ and household debt $B_t^{priv,c}$.

Their decision is subject to the following constraints:

- The period budget constraint:

$$\tfrac{P_t^C(1+t_t^c)}{P_t^{GDP}} C_t^c + \tfrac{P_t^H}{P_t^{GDP}} J_t^{H,c} + \tfrac{\gamma^w}{2}\left(\tfrac{W_t}{W_{t-1}} - 1\right)^2 L_t^c + \tfrac{1+i_{t-1}}{1+\pi_t^{GDP}} B_{t-1}^{priv,c} =$$

$$= \left(1 - t_t^w\right) \tfrac{W_t}{P_t^{GDP}} L_t^c + B_t^{priv,c} + \tfrac{Ben_t^c}{P_t^{GDP}}\left(1 - L_t^c\right) + \tfrac{Tr_t^c}{P_t^{GDP}} - \tfrac{T_T^{LS,c}}{P_t^{GDP}};$$

- The house accumulation equation:

$$H_t^c = \left(1 - \delta^h\right) H_{t-1}^c + I_t^{H,c},$$

where the real housing investment expenditure is related to the real physical investment identically as for the Ricardian households:

$$J_t^{H,c} = I_t^{H,c} + \frac{\gamma^h}{2}\left(\frac{I_t^{H,c}}{H_{t-1}^c} - \delta^h\right)^2;$$

- And finally a collateral constraint:

$$B_t^{priv,c} \leq (1 - \chi_t)\frac{P_t^H}{P_t^{GDP}} H_t^c.$$

The constraint defines the collateral as the current real value of the household's housing stock multiplied by an institutionally given loan-to-value ratio $(1 - \chi_t)$. The time subscript of the downpayment rate χ_t indicates that we allow for exogenous changes in this variable. Indeed, the increased access to credit will be captured by an increase in this parameter.

The collateral-constrained households' optimality conditions differ from the standard Ricardian consumers' constraints in the following respects.

First, the intertemporal consumption Euler equation is:

$$\left(1 - \lambda_t^{\text{house}}\right) = \beta^c \frac{1 + i_t}{1 + \pi_{t+1}^{GDP}} \frac{\lambda_{t+1}^c}{\lambda_t^c}$$

where λ_t^{house} and λ_t^c denote the Lagrange multipliers of the collateral constraint and the budget constraint respectively with

$$\lambda_t^c = \frac{P_t^{GDP}}{P_t^C (1 + t_t^c)} U_{C,t}^c,$$

and with $U_{C,t}^c$ denoting the c households' marginal utility of consumption.

The Euler equation shows that the collateral-constrained households' intertemporal consumption path would be different from that of the Ricardian households in that they discount the value of future consumption more than the Ricardians. Therefore, ceteris paribus, collateral-constrained agents would tend to tilt their consumption path towards earlier periods. As opposed to this, the constrained access to credit limits the households' current consumption possibilities and creates a trade-off: investing in their house stock today instead of consuming today allows these agents to have access to more credit and hence to consume more in the future. The shadow value of the collateral constraint λ_t^{house} can also be interpreted as a risk premium on the interest rate which fluctuates positively with the tightness of the constraint.

Second, the investment decision of the collateral-constrained households is described by the following two equations. On one hand, the shadow price of the house stock $Q_t^{H,c}$ can be expressed as:

$$Q_t^{H,c} = \frac{prefhZ_{H,t}^c}{U_{C,t}^c}\frac{P_t^C(1+t_t^c)}{P_t^H} + \lambda_t^{\text{house}}(1-\chi_t) +$$

$$+\beta^c \frac{\lambda_{t+1}^c}{\lambda_t^c}\frac{1+\pi_{t+1}^H}{1+\pi_{t+1}^{GDP}}\frac{1}{U_t^{QH}}\left[\left(1-\delta^h\right)Q_{t+1}^{H,c} + \gamma^h\left(\frac{I_{t+1}^{H,c}}{H_t^c} - \delta^h\right)\frac{I_{t+1}^{H,c}}{(H_t^c)^2}\right];$$

on the other hand, from the optimal investment decision we have:

$$Q_t^{H,c} = 1+\gamma^h\left(\frac{I_t^{H,c}}{H_{t-1}^c} - \delta^h\right)\frac{1}{H_{t-1}^c} + \gamma^{h,1}\left(I_t^{H,c} - I_{t-1}^{H,c}\right) + \beta^c\frac{\lambda_{t+1}^c}{\lambda_t^c}\frac{1+\pi_{t+1}^H}{1+\pi_{t+1}^{GDP}}\frac{1}{U_t^{QH}}\gamma^{h,1}\left(I_{t+1}^{H,c} - I_t^{H,c}\right).$$

While the investment decision rule (second equation) is identical to the Ricardian households' optimality condition, the first equation shows that the 'return' on current housing is the utility its services directly yield to households augmented by the utility value by which it increases the amount of available credit. U_t^{QH} is an exogenous variable which will capture risk premia on the house investment.

3.1.3 Intratemporal optimisation

Consumption and investment in capital are composite bundles of traded and non-traded goods which in turn are CES aggregates of differentiated goods. The structure of these consumption bundles is as follows. The aggregate bundle is an aggregate of traded T and non-traded NT goods:

$$X_t = \left[(s_{Tx})^{\frac{1}{\sigma}}\left(X_t^T\right)^{\frac{\sigma-1}{\sigma}} + (1-s_{Tx})\left(X_t^{NT}\right)^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}}$$

with the traded goods being an aggregate of domestic TD and imported TF traded goods:

$$X_t^T = \left[(s_{TDx})^{\frac{1}{\sigma^T}}\left(X_t^{TD}\right)^{\frac{\sigma^{TD}-1}{\sigma^{TD}}} + (1-s_{TDx})\left(X_t^{TF}\right)^{\frac{\sigma^{TD}-1}{\sigma^{TD}}}\right]^{\frac{\sigma^{TD}}{\sigma^{TD}-1}}$$

Assuming identical preferences across household groups, the demand for each type of good can then be expressed as:

$$X_t^T = s_{Tx}\left(\frac{P_t^{Tx}}{P_t^x}\right)^{-\sigma}X_t,$$

$$X_t^{NT} = (1-s_{Tx})\left(\frac{P_t^{NTx}}{P_t^x}\right)^{-\sigma}X_t,$$

with the aggregate price level given by:

$$P_t^x = \left[s_{Tx} \left(P_t^{Tx} \right)^{1-\sigma} + (1 - s_{Tx}) \left(P_t^{NTx} \right)^{1-\sigma} \right]^{\frac{1}{1-\sigma}} .$$

And similarly within the traded goods:

$$X_t^{TD} = s_{TDx} \left(\frac{P_t^{TDx}}{P_t^{Tx}} \right)^{-\sigma^{TD}} X_t^T ,$$

$$X_t^{TF} = (1 - s_{TDx}) \left(\frac{e_t P_t^*}{P_t^x} \right)^{-\sigma^{TD}} X_t^T ,$$

with the price level of the traded good given by:

$$P_t^{Tx} = \left[s_{TDx} \left(P_t^{TDx} \right)^{1-\sigma^{TD}} + (1 - s_{TDx}) \left(e_t P_t^* \right)^{1-\sigma^{TD}} \right]^{\frac{1}{1-\sigma^{TD}}} .$$

The variable X_t can be consumption C_t as well as investment into capital used in the production in the traded sector I_t^T and the non-traded sector I_t^{NT}, respectively.

The economy being a small open economy, the foreign price level P_t^* is considered to be exogenous.

World demand for domestically produced traded goods EXP_t is similarly defined as:

$$EXP_t = \left(\frac{P_t^{TDx}}{e_t P_t^*} \right)^{-\sigma^*} X_t^* ,$$

with X_t^* denoting foreign aggregate demand.

3.1.4 Wage setting

A trade union is maximising a joint utility function for each type of household i where it is assumed that types of labour are distributed equally over constrained and unconstrained households with their respective population weights. The trade union sets wages by maximising a weighted average of the utility functions of these households. The wage rule is obtained by equating a weighted average of the marginal utility of leisure to a weighted average of the marginal utility of consumption times the real wage of these two household types, adjusted for a wage mark up. Denoting by $V_{1-L,t} \equiv prefl \left(s^r V_{1-L,t}^r + s^c V_{1-L,t}^c \right)$ and by $U_{C,t} \equiv s^r U_{C,t}^r + s^c U_{C,t}^c$, the wage setting equation is as follows:

$$\frac{1-t_t^l}{1+t_t^c} \frac{W_t}{P_t^C} = \frac{\theta}{\theta-1} \left(\frac{V_{1-L,t}}{U_{C,t}} + \frac{Ben_t}{(1+t_t^c) P_t^C} \right) -$$

$$- \frac{\gamma^w}{\theta-1} \left(\pi_t^w \left(1 + \pi_t^w \right) - \beta \frac{U_{C,t+1}}{U_{C,t+1}} \frac{1+\pi_{t+1}^{GDP}}{1+\pi_{t+1}^C} \frac{L_{t+1}}{L_t} \pi_{t+1}^w \left(1 + \pi_{t+1}^w \right) \right) .$$

Hence, the trade union sets the consumption wage as a constant mark up over the reservation wage adjusted for the time-dependent costs of wage adjustment. The reservation wage is the ratio of the marginal utility of leisure to the marginal utility of consumption plus the benefits in terms of consumption goods.

3.1.5 Aggregation:

Households being identical within each group, the aggregate of any household specific variable in per capita terms is given by $\int_0^1 X_t^h dh = s^r X_t^r + s^c X_t^c$.

3.2 Firms

There are three production sectors. A traded goods sector, a non-traded non-durable goods sector and a residential construction sector. In each production sector, there is a continuum of monopolistically competing firms whose size is normalised to 1.

3.2.1 Producers of tradable and non-tradable non-durable goods

Firms operating in the tradable and non tradable sector are indexed by TD and NT, respectively. Domestic firms in the tradable sector sell consumption goods and services to private domestic and foreign households and the domestic and foreign government and they sell investment and intermediate goods to other domestic and foreign firms. The non tradable sector sells consumption goods and services only to domestic households and the domestic government and they sell investment and intermediate goods only to domestic firms including the residential construction sector. Preferences for varieties of tradables and non tradables can differ resulting in different mark-ups for the tradable and non tradable sector.

Output O_t^j, $j = TD, NT$ is produced with a CES production technology using capital, production workers and intermediate production goods Int_t^j :

$$O_t^j = \left[(1 - s_{int})^{\frac{1}{\sigma^{int}}} \left(Y_t^j \right)^{\frac{\sigma^{int}-1}{\sigma^{int}}} + (s_{int}) \left(Int_t^j \right)^{\frac{\sigma^{int}-1}{\sigma^{int}}} \right]^{\frac{\sigma^{int}}{\sigma^{int}-1}}, \quad j = TD, NT,$$

where

$$Y_t^j = \left[A_t^j \left(L_t^j - LO_t^j \right) \right]^{\alpha} \left(ucap_t^j K_t^j \right)^{1-\alpha}.$$

Labour used by firms is a CES aggregate of differentiated labour supplied by individual households with $L_t^j = \left[\int_0^1 L_t^j (i)^{\frac{\theta-1}{\theta}} di \right]^{\frac{\theta}{\theta-1}}$. The parameter $\theta > 1$ determines the degree of substitutability among different types of labour. Overhead labour LO_t^j is exogenous. In addition, firms also decide about the optimal degree of capacity utilisation $ucap_t^j$. The exogenous technology coefficient is denoted by A_t^j. Shocks to A_t^j are labour augmenting.

Intermediate goods are defined as a CES aggregate of domestic and imported traded as well as non-traded goods. Their structure is identical to those of the consumption or the investment goods; firms' demand for each subcategory is hence also determined identically (see the Intratemporal optimisation subsection of the consumers' problem).

Firms also face quadratic adjustment costs for changes in their price, their employment and in capacity utilisation. The following convex functional forms are chosen:

$$adj^P(P_t^j) = \frac{\gamma^P}{2}\left(\frac{P_t^j - P_{t-1}^j}{P_{t-1}^j}\right)^2 O_t^j,$$

$$adj^L(L_t^j) = \frac{\gamma^L}{2}\left(L_t^j - L_{t-1}^j\right)^2 W_t,$$

$$adj^{ucap}(ucap_t^j) = \left(\gamma^{ucap,1}(ucap_t^j - 1) + \frac{\gamma^{ucap,2}}{2}\left(ucap_t^j - 1\right)^2\right) P_t^{K,j} K_t^j.$$

Price setting rigidities can be the result of the internal organisation of the firm or specific customer-firm relationships associated with certain market structures. Costs of adjusting labour have a strong job specific component (e.g. training costs) but higher employment adjustment costs may also arise in heavily regulated labour markets with search frictions. Costs associated with the utilisation of capital can result from higher maintenance costs associated with a more intensive use of a piece of capital equipment.

The profit of firms in sector j $\left(\Pi_t^j\right)$ in each period is given by:[5]

$$\Pi_t^j = P_t^j O_t^j - W_t L_t^j - P_t^{K,j} r_t^{K,j} K_t^j - P_t^{Int,j} Int_t^j - \left(adj^P(P_t^j) + adj^L(L_t^j) + adj^{ucap}(ucap_t^j)\right).$$

The presence of adjusment costs makes the firms' problem intertemporal. Hence, individual firms in each sector set their price $P_t^{O,j}$ to maximise the future discounted flow of their profits taking input factor prices and aggregate demand as given. Along with this, they also determine their input factor demand for labour, capital, capacity utilisation as well as for intermediate goods produced in the non-traded sector and the traded sector, respectively. Given this setup, output prices will be determined as a constant mark-up over the marginal cost plus a time-varying term depending on current and future inflation rates.

3.2.2 House Production Sector

There is a continuum of atomistic firms $i \in [0.1]$ producing houses from non-traded investment goods $I_t^{H,inp}$, and an exogenously fixed quantity of land *land* using a CES technology:

[5] For ease of exposition, we drop the index of individual firms. Since firms are identical, they all choose the same price and quantity in equlibrium.

$$I_t^H = \left[(1 - s_{land})^{\frac{1}{\nu}} \left(I_t^{H,inp} \right)^{\frac{\nu-1}{\nu}} + s_{land}^{\frac{1}{\nu}} land^{\frac{\nu-1}{\nu}} \right]^{\frac{\nu}{\nu-1}}.$$

Expressing house-producing firms real marginal cost η_t^h as:

$$\eta_t^H = \left[(1 - s_{land}) \left(\frac{P_t^{NT}}{P_t^H} \right)^{1-\nu} + s_{land} \left(\frac{P_t^{land}}{P_t^H} \right)^{1-\nu} \right]^{\frac{1}{1-\nu}}$$

The demand for each individual firm's production is

$$I_t^H(i) = \left(\frac{P_t^H(i)}{P_t^H} \right)^{-\tau^h} I_t^H.$$

Firms are assumed to set their prices to maximise their future discounted flow of profits facing price adjustment costs of similar form as firms producing in the non-durable goods sectors, with a rigidity parameter of γ^{PH}. The price setting equation is then given by:

$$1-\tau^h+\tau^h\eta_t^H = \gamma^{PH} \left[\left(1 + \pi_t^H\right) \pi_t^H - \beta^r \frac{U_{C,t+1}^r}{U_{C,t}^r} \frac{1 + \pi_{t+1}^H}{1 + \pi_{t+1}^{GDP}} \frac{I_{t+1}^H}{I_t^H} \left(1 + \pi_{t+1}^H\right) \pi_{t+1}^H \right]$$

Finally, the demand for the input production factors is determined as:

$$land = s_{land} \left(\frac{P_t^{land}}{P_t^H} \right)^{-\nu} I_t^H$$

and:

$$I_t^{H,inp} = (1 - s_{land}) \left(\frac{P_t^{NT}}{P_t^H} \right)^{-\nu} I_t^H.$$

3.3 Policy

3.3.1 Fiscal policy

Fiscal policy is assumed to follow a debt rule, according to which the instrument of the labour income tax reacts to deviations of the government debt from its target and to the deficit. Specifically, the government is assumed to spend on government consumption G_t^C, government investment G_t^I on unemployment benefits at a benefit rate Ben_t and on lump-sum transfers T_t^{LS}. Government consumption, government investment and lump-sum transfers Tr_t^{LS} are assumed to be a fixed share of GDP[6]:

$$G_t^C = gs^C GDP_t + u_t^{GC}$$

[6] GDP_t is defined on accounting basis as the difference between total production and intermediate inputs.

$$G_t^I = gs^I GDP_t + u_t^{GI},$$

where both G_t^C and G_t^I are composite bundles of traded and non-traded goods identical to the CES aggregators of households.

$$Tr_t = trshareGDP_t + u_t^{Tr}$$

The unemployment benefit rate is a fixed share of wages:

$$Ben_t = benrW_t + u_t^{ben}$$

On the other hand, government earns revenues from taxes on consumption, capital income and labour income as well as from lump-sum taxes. The tax rates for consumption and capital income t^c and t^k are given exogenously. Lump-sum taxes are a fixed share of GDP:

$$T_t^{LS} = taxshareGDP_t + u_t^T.$$

Government revenues can then be written as:

$$R_t^G = t^w W_t L_t + t_t^c P_t^C C_t + t_t^k \left[\sum_{j=T,NT} P_t^{K,j} \left(r_t^{k,j} - \delta \right) K_{t-1}^j + P_t^H \left(r_t^h - \delta^j \right) H_{t-1}^{rl} \right] + T_t^{LS}.$$

The government debt B_t^G then evolves according to:

$$B_t^G = (1 + i_{t-1}) B_{t-1}^G + P_t^C \left(G_t^C + G_t^I \right) + Ben_t(1 - L_t) + Tr_t - R_t^G,$$

and the labour income tax is set to

$$t_t^w = t_{t-1}^w + \tau^{g1} \left(\frac{B_t^G}{4GDP_t} - b^{TARG} \right) + \tau^{g2} \left(B_t^G - B_{t-1}^G \right) + u_t^{tw},$$

where b^{TARG} is an exogenous debt target.

3.3.2 Monetary policy

The monetary policy is governed in a fixed exchange rate regime. Hence, $e_t = \bar{e}$, with $\bar{e}$ being an exogenous constant.

3.4 Market clearing

In equilibrium all markets clear. Specifically, equilibrium in the domestic traded goods market requires:

$$O_t^{TD} = C_t^{TD} + G_t^{C,TD} + G_t^{I,TD} + I_t^{T,TD} + I_t^{NT,TD} + Int_t^{T,TD} + Int_t^{NT,TD} + EXP_t + tac_t^T,$$

where tac_c^T stands for terms related to adjustment costs in the traded sector.

The equilibrium in the non-traded goods sector is given by:

$$O_t^{NT} = C_t^{NT} + G_t^{C,NT} + G_t^{I,NT} + I_t^{T,NT} + I_t^{NT,NT} + Int_t^{T,NT} + Int_t^{NT,NT} + I_t^{H,inp} + tac_t^{NT}.$$

Market clearing in the house production sector is described by:

$$I_t^H = s^c I_t^{H,c} + s^r I_t^{H,r} + tac_t^{IH}.$$

Equilibrium in the labour market requires:

$$L_t^T + L_t^{NT} = s^r L_t^r + s^c L_t^c.$$

Equilibrium in the bonds markets can be described as follows.

First, all government bonds are owned by domestic Ricardian households. Therefore:

$$B_t^G = s^r B_t^{G,r}.$$

Second, since collateral-constrained households are also restricted to borrow from domestic Ricardian households, equilibrium requires:

$$s^c B_t^{priv,c} = s^r B_t^{priv,r}.$$

Finally, given the above equilibrium conditions, the economy's external debt (in real foreign currency terms evolves) according to the current account equation:

$$B_t^F = (1 + risk_t) \frac{1 + i_{t-1}^F}{1 + \pi_t*} B_{t-1}^F + \frac{P_t^{TD}}{e_t P_t^*} EXP_t - IMP_t,$$

where

$$IMP_t = C_t^{TF} + G_t^{C,TF} + G_t^{I,TF} + I_t^{T,TF} + I_t^{NT,TF} + Int_t^{T,TF} + Int_t^{NT,TF}.$$

4 Simulations in a Model Calibrated to Baltic economies

We use our model to quantitatively assess the dynamic effects of TFP growth, a fall in foreign risk premia and increasing access to credit on the Baltic economies.

The data used in our calibration are quarterly national account data for Estonia, Latvia and Lithuania from 1995Q1 to 2007Q2 as well as input-output table figures from the year 2000[7]. A detailed description of our sources and the time series used are summarised in the Appendix.

The results reported below are based on the following parameterization. One period in the model represents one quarter. The Ricardian households' discount factor is $\beta^r = 0.9875$ implying a steady state annual real interest rate of 5%. We assume log utility in consumption and housing; the inverse Frisch elasticity of labour supply κ is set to 2.3. These specifications are standard in literature.

[7] Input - output tables were only available for Estonia and Lithuania.

Steady-state prices and GDP are normalised to 1. The QUEST model is calibrated first, to set key steady-state ratios of various expenditure-to-GDP items to their empirical counterparts. These ratios and other parameter values are summarised in Table 2. The weights of the utility of housing and leisure in the total utility are set so as to match the steady-state ratios of housing investment-to-GDP and employment[8], respectively. We use data from input-output tables and the import-to-GDP[9] ratio to calibrate trade linkages. The resulting traded sector value added-to-GDP ratio is around 40%, in line with its share in the Baltic economies.

The elasticity of substitution between domestic and foreign traded goods σ^{TD} and σ^{*} are set to 2, a relatively high value by which we mean to capture the relatively high degree of competition in Baltic export markets. While this value does not imply an exact purchasing power parity between the price of domestic and foreign traded goods, it is sufficient to generate some Balassa-Samuelson effects.

The calibration of the collateral-constrained household sector is based on parameters reported in related literature; see e.g. Iacoviello (2005), Campbell & Hercowitz (2006), Iacoviello & Neri (2008) or Monacelli (2008). The share of collateral-constrained households in set to 40%. The depreciation rate of houses $\delta^{h} = 0.0025$ which corresponds to an annual depreciation rate of 1%. The discount factor of the impatient collateral-constrained households is $\beta^{r} = 0.97$. The initial value of the down-payment rate χ_0 is calibrated to roughly match the gross household debt-to-GDP ratio in the Baltics before the beginning of the credit boom (around 3%).

For the calibration of the house-production sector, the elasticity of substitution between house investment goods and land, ν is set to 0.5. This value captures a relatively low degree of substitutability between the two factors. The share of land in total new houses s_{land} equals 0.25. This value is somewhat higher than Davis & Heathcote (2005) or Iacoviello & Neri (2008). The robustness of our results to this calibration will be discussed later. Finally, the mark-up in the sector is set to 5% similar to goods producing sectors.

The calibration of the adjustment costs is set to match impulse responses to standard productivity shocks as reported e.g. by Coenen et al. (2007) based on the ECB's New Area Wide Model; see Figure 1 for the impulse response of selected variables to a simultaneous TFP shock in the traded sector and non-traded sectors. The price adjustment costs in the goods' producing sectors and wage adjustment costs are set to imply an average duration of price and wage contracts of 5 quarters. Price adjustment cost in the house production sector implies an average duration of 2 quarters capturing the higher flexibility of

[8] Note that our calibration corresponds to the employment rate in the data. It can be interpreted as the share of household members working full time with the others not working assuming full insurance within a household.

[9] The steady-state trade balance is in equilibrium, the steady-state export-to-GDP ratio equals this value.

durable goods' prices as discussed e.g. in Monacelli (2008). Capital adjustment costs are set such that a net investment of 10% of the steady-state capital stock implies adjustment costs of around 12%. This is broadly in line with the capital adjustment cost calibration in Bems (2007) and as he discusses also in line with literature on capital adjustment costs. The labour adjustment cost coefficient γ^{l} is set to 40 in both sectors. Estimates of this parameter in the euro-area were around 60 (Ratto et al. 2007). This somewhat lower value is meant to capture the relatively high degree of flexibility in the Baltic labour markets. The calibration of the capacity utilisation adjustment cost parameter $\gamma^{ucap,1}$ is set to ensure a steady-state capacity utilisation of 1 (see Ratto et al. 2007).

4.1 TFP growth

TFP in both sectors is calibrated such that the implied trajectories of labour productivity match their empirical counterparts. The model assumes constant annual world growth rate of 1.5% in both sectors. Therefore, to neutralise the actual impact of non-constant and non-equal growth across sectors in the Baltic trading partners' productivity, we normalised the Baltic productivity in each sector by the productivity of the euro-area in the same sector. Hence, the time series we calibrate the model's TFP variable to is capturing the productivity *differentials* with respect to the euro-area. This normalisation then also discounts the impact of TFP on growth. Therefore, the macroeconomic variables against which the simulation results are being evaluated were also normalised by the relevant euro-area productivity time series. Price indexes were also adjusted.

The simulation of TFP growth starts in 1995Q1 and assumes the continuation of the trends after the end of the sample period. Since agents are assumed to have perfect foresight, this is equivalent to assuming that they base their decisions today on a long-lasting productivity growth in both sectors. The expected long-run TFP increase in the traded sector is set to around 400% and in the non-traded sector to 310%. Until the end of 2007, this corresponds to a 150% increase in the traded sector and a 120% increase in the non-traded sector. The implied labour productivity series roughly match the evolution of the observed series, both in terms of absolute levels as well as in the ratio between traded and non-traded sector productivity (see Figure 2).

Our results suggest that productivity growth and growth differentials, i.e. the Balassa-Samuelson effect can reasonably well track developments in the Baltic economies until around 2001 both qualitatively and quantitatively. The simulated impact of TFP growth fits the evolution of GDP as well as both the value added in the traded and non-traded sectors. Consumption and housing investment are relatively well captured until 2002-03. The model also predicts an increase in private capital investment, though of a lesser extent than it has taken place in the Baltic economies.

It should be emphasised that our model generates sizable trade deficits as a consequence of the observed productivity growth patterns. The simulated series are roughly matching the observed data until around 2001. The initial restructuring of employment between the two sectors is also relatively well captured in the first half of the sample. Some initial decrease in the relative traded - non-traded prices is also reproduced although its persistence as well as its size is smaller than in the data.

Note that the increase in relative prices is influenced by the elasticity of substitution between domestic and foreign traded goods, σ^{TD} and σ^{*}. A robustness check showed that increasing this parameter would improve the fit of the change in relative prices at the beginning of the sample. At the same time, the impact of this change on the quantities is far larger than its impact on relative prices. This may be due to our assumption of free mobility of production factors between sectors, which seems to allow for quicker quantitative adjustments than in reality.

4.1.1 TFP growth - the role of expectations

In contrast to our perfect foresight assumption, it is more likely that all of the realised TFP growth had not been perfectly anticipated at the beginning of the period. To capture some unexpected effect, we recalibrated the TFP growth introducing an unexpected break around 2000. This also allows us to better track the observed trends in productivity. The impulse responses are displayed in Figure 3. As can be seen, the unexpected break somewhat improves the fit of relative prices at the beginning of the period. In addition, the simulation results suggest that an unexpected acceleration in the non-traded sector productivity may have contributed to increasing the trade deficit after 2001. However, even with this break, TFP growth alone cannot match the observed trends in the second half of the sample.

The continuation of TFP growth trends after the end of our sample is another crucial assumption in driving our results. Figure 4 displays the evolution of the trade balance based on the alternative assumption of zero growth starting from 2008. Note that both the benchmark and the alternative assumptions for TFP trends after 2008 are assumed to be perfectly foreseen in the simulations. The simulation results show a huge impact of the future growth expectations on the trade balance. This is because agents choose optimal consumption and investment paths over their expected lifetime income. A less positive outlook implies lower lifetime income. Therefore, agents choose to spend less on external-debt-financed domestic demand items. As a result, both initial trade deficits and future debt service remain lower.

Moreover, a sudden turn-around of optimistic expectations implies a quick reversal of the trade balance as the earlier level based on positive expectations is no longer sustainable. This then requires a substantial restructuring of production from the non-traded to the traded sector and from household consumption and housing investment towards capital investment (see Figure 5).

4.2 Decreasing foreign risk premia

The uncovered-interest-rate-parity based risk premium of the Baltic countries with respect to the euro area shows a fall of over 100 basis points between the average in the years before and after the Russian crisis (1998 - 2000). Admittedly, this measure has the flaw of not well capturing agents' expectations. Still, our measure is broadly in line with other calculations; see e.g. Luengnaruemitchai & Schadler (2007) or Bems & Joensson (2006). As already discussed in section 2, this fall is likely to be related to institutional factors which are exogenous to our model.

For our simulations, we calibrate a permanent 100 basis point decrease in U_t^{UIP} starting from 2001[10] (see Figure 6). Our simulation results confirm the significant role of a decrease in spreads in generating a persistent trade deficit starting from 2001. This is driven by the decline in the real interest rates which decreases the cost of investment and also enhances consumption smoothing. The shock also explains some shift from the traded towards the non-traded sector which may have offset the restructuring necessitated by the TFP growth's implications as suggested by our previous simulations. At the same time, quantitatively, this factor seems to have only partly accounted for the observed changes starting from 2001, especially so in later periods. Note also, that neither TFP growth nor the fall in foreign risk premia generates an increase in housing investment comparable in size to that observed in the data.

4.3 Credit growth

The last factor we consider is households' increasing access to credit.

As already pointed out in section 2, households indebtedness dramatically increased in each Baltic country in recent years from below 5% of GDP in 2000 to close over 40% by 2007 in Estonia and Latvia and to close to 30% in Lithuania. Parallel to this, there have also been signs of a housing boom as well as fears of a house price bubble over the past years.

The increase in the access to household credit is captured in the model by the collateral-constrained households' loan-to-value (LTV) ratio $(1 - \chi_t)$. For our simulations, the path of χ_t is set to match the trajectory of the gross households' debt-to-GDP ratio in the Baltics between 2001 and 2007 (see Figure 7). We model the increasing growth to be unanticipated by agents.

The rising access to credit has a large impact on housing investment and also generates sizable trade deficits according to our simulation results. It also

[10] Conceptually, this is equivalent to considering our initial steady state interest rate as the one including a higher risk premium which is then phased out when the spread falls. It should be noted however, that the steady state real interest rate in the model is determined by the discount factor of Ricardian households. Therefore, the nominal interest rates with and without a risk premium can only correspond to two different steady states if either the inflation target or the discount factor is changing.

has a positive but much smaller impact on output, consumption and capital investment.

These result are driven by the assumption that collateral-constrained households can borrow up to a certain level of the value of their housing stock. As a result, housing investment, in addition to directly yielding utility through housing services, also has the value of increased access to credit in the future for these agents. This then influences the trade-off between consumption and housing investment and may be expected to lead to increased demand for housing investment and higher relative housing prices in the case of increasing access to credit. At the same time, through the increase in credit demand, real interest rates are rising, which dampens the reaction of other demand items.

Overall, the increasing access to credit is confirmed to be a major driver of both the external deficit and the increase in housing investment in the second half of the sample. At the same time, our simulations suggest that a credit boom *per se* is theoretically not sufficient to lead to an overall boom in the economy. It should also be noted that the impact of the credit boom on housing prices remains significantly below the observed fourfold multiplication of real housing prices in the Baltics.[11]

4.4 Combined impact

Figure 8 displays the joint impact of the (progressively phased in) TFP growth, a fall in spreads and the (progressively phased in) increase in the loan-to-value ratio.

Overall, according to our simulations, the three factors together account well for the evolution of most key variables over the period of 1995 to 2007. In particular, the observed trends in total GDP and value added in both sectors are well tracked over the entire period. In addition, the simulation results broadly fit the pattern in consumption, housing investment and the shift in employment from the traded towards the non-traded sector, especially until 2004. At the same time, while the simulation results qualitatively also match changes in investment and real housing prices, quantitatively, they remain substantially different from the data.

As regards investment, various factors may have contributed to its very fast growth which are not captured in our model. First, the capital stock installed in the Baltics at the beginning of the period is likely to have been obsolete and needed to be replaced to be adapted to new production technologies. Along with this, decreasing risk premia on corporate loans, increasing access to credit for corporations, FDI as well as a shift in production towards capital with a

[11] Checking the robustness of our results to the share of land s_{land} in the house production function we found that a smaller share of land significantly increases the credit growth's impact on housing investment. At the same time, it decreases the impact on housing prices. Moreover, housing prices are not monotonous in this parameter: setting s_{land} above the baseline to 0.5 would decrease the impact of the credit growth both on housing investment and on housing prices.

higher depreciation rate may also have played a role in driving the observed extremely fast capital accumulation.

Similarly, house prices may have increased more than our model predicts because the initial prices short after transition were not yet reflecting the true market value of houses. Other potential factors driving up housing prices might be an improvement in the quality of the housing stock and / or the increasing housing investment of foreigners in the region. At the same time, as already noted earlier, the fourfold multiplication of real housing prices over the horizon of 2000 and the acceleration since 2004 are most likely signs of imbalances which are difficult to capture in general equilibrium model.

The individual contribution of each TFP growth (differentials), the fall in spreads and the increase in the access to credit depends on the periods and the variables under consideration. As already pointed out earlier, TFP per se yields a very good fit of most variables until around 2001. In the period after 2001, TFP growth is still found to be the major driver of production growth. In contrast, the trade deficit is driven by all three factors by approximately equal weights with the role of TFP decreasing and the role of LTV increasing over time. The role of the low foreign risk premia appears to be the most persistent of these factors.

Finally, the loss of track of some variables around 2004 may indeed point to the build-up of imbalances in the Baltics in the last years of the sample. In particular, while the model predicts a progressive restructuring towards the traded sector so as to decrease external deficits and service the accumulated debt, the observed diverging trends in consumption, housing investment, relative prices and in the trade balance towards the end of the sample do not seem to fulfill this equilibrium requirement.

5 Conclusion

This paper studies the role of three major factors in driving external deficits and other key macroeconomic aggregates in the Baltics over the period of 1995 to 2007. The factors are first, productivity growth and sectoral productivity growth differentials both within the Baltic economies as well as between the Baltics and their trading partners. Second, a fall in external risk premia observed around 2001; and finally the increasing access to credit.

For our quantitative assessment, we use the European Commission's QUEST model. The specification we use is a small open economy dynamic general equilibrium model including traded and non-traded goods production sectors and a house production sector as well as a financial accelerator modelled through a collateral constraint for a fraction of households. The model is calibrated to the Baltic economies.

Our main results are as follows.

First, the three factors together yield a good fit of the trade balance and of other key macroeconomic indicators over the period under consideration.

Second, TFP growth and TFP growth differentials with respect to the euro-area are found to account well for trends until around 2001. The role of TFP growth seems to have decreased in driving developments thereafter while the fall in spreads and the increasing access to credit are found to have played an increasingly significant role in driving observed trends in these more recent years.

Third, in the last years of the sample, the fit of some aggregates (consumption, housing investment, housing prices) deteriorates. Also, the model predicts a progressive restructuring towards the traded sector and a decrease in the trade deficit with a view of repaying the accumulated debt. In contrast, observed traded - non-traded aggregates seem to have continued to shift towards the non-traded sector suggesting that the turn predicted by the model had not been taken by the Baltics until the second half of 2007. These diverging trends may indicate imbalances.

Finally, it is important to mention, that our simulations are based on the assumption of a continuation of productivity growth and of the rise in the access to credit for many years. Also, the fall in spreads is modelled to be permanent. According to our model, a less positive outlook would have implied smaller trade deficits in earlier periods with faster restructuring and earlier debt repayment. Moreover, a sudden deterioration of expectations is shown to require substantial restructuring and a fall in the external-debt-financed domestic demand.

While our model seems to match data well for most variables, our results are the least convincing for capital investment. In particular, the model is not able to capture the observed fourfold increase in this variable. While a number of factors, such as a low initial capital stock or a decrease in corporate risk premia may explain some of the increase we did not capture in our simulations, this may not be all to the story. Further research needs to be devoted in order to better understand what drove investment in the Baltics and in general what drove investment in transition economies.

6 Appendix: Data

For the calibration of our model, we use data of the European Commission's quarterly database TRIMECO as well as national central banks' and national statistical offices' databases. Trade linkages are calibrated on the basis of input-output tables for Estonia and Lithuania for the year 2000.[12]

6.1 Time series

GDP, household consumption, investment, housing investment, imports and the trade balance are based on national account figures. Private investment is the difference between total investment and government investment.

Value added in the traded and non-traded sectors is based on national account data by branch of activity. The classification of branches in traded and non-traded sectors is as follows. Traded sectors: agriculture, hunting, forestry and fishing; mining; transport, storage and communication; manufacturing. Non-traded sectors: electricity, gas and water supplies; construction; wholesale and retail trade; hotels and restaurants; financial intermediation, real estate; other services. This classification follows Bems & Joensson (2006).

Available data series for the euro area were less detailed. Therefore, for the euro area, traded sector consists of the value added in agriculture, hunting, forestry and fishing; industry including energy. The non-traded sector includes construction; wholesale and retail trade; hotels and restaurants; financial intermediation, real estate; other services.

Productivity is calculated as value added / employment. Traded and non-traded prices are the value added deflators in the given sectors.

Interest rates for the calculation of the risk premium are short-term (3 month) nominal rates.

Gross household debt is the stock of total loans to individuals from central bank databases for Estonia and Lithuania. Latvian data from EcoWin.

Housing prices for Estonia are average purchase sale price per square meter of dwellings in Tallin (Bank of Estonia) For Lithuania, housing price is the index the average annual price per square meter of the total housing stock (source: Real Estate Registration Centre). For Latvia, it is the average price per square meter of a standard apartment in Riga (source: real estate companies: Latio, Balsts).

6.2 Normalisation

All aggregates are expressed in per capita terms using working age population data from the European Commission's annual database AMECO. We assumed constant population within each year.

Since the model abstracts from productivity growth and growth differentials in the external country, we had to normalise the Baltic countries' data with the respective euro-area aggregates.

[12] For Latvia, no input-output table was available.

The figures we use for the calibration of the shocks and for the evaluation of simulation results are aggregated normalised per capita variables for each country. The weight of each country in the aggregation, is the country's share in the total nominal GDP (in euro terms calculated at official exchange rates). For years where data were missing in one or more countries, we took the average of the available data.

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Table 1: Selected macroeconomic indicators

Estonia	95-00	01-07	95-07
Current Account Balance$^{(i)}$	−7.5	−10.8	−9.3
Trade Balance$^{(i)}$	−8.0	−7.4	−7.7
GDP$^{(ii)}$	6.0	8.5	7.5
Household consumption$^{(ii)}$	7.1	9.9	8.7
Investment$^{(ii)}$	11.1	13.7	12.6
Housing investment$^{(ii)}$	7.9	23.9	17.0
Productivity growth differential (T-NT)$^{(iii)}$	8.3	3.1	5.5
Real exchange rate (total change)$^{(iv)}$	−14.5	−9.8	−22.9
Real house prices (total change)$^{(iv)}$		313.7	

Latvia	95-00	01-07	95-07
Current Account Balance$^{(i)}$	−5.4	−12.2	−9.0
Trade Balance$^{(i)}$	−7.4	−14.6	−11.3
GDP$^{(ii)}$	5.4	9.1	7.6
Household consumption$^{(ii)}$	5.3	9.5	8.8
Investment$^{(ii)}$	19.6	15.4	17.2
Housing investment$^{(ii)}$	10.6	15.7	13.7
Productivity growth differential (T-NT)$^{(iii)}$	3.7	1.1	2.6
Real exchange rate (HICP based)$^{(iv)}$	−28.1	6.3	−23.6
Real house prices$^{(iv)}$		87.9*	

Lithuania	95-00	01-07	95-07
Current Account Balance$^{(i)}$	−9.5	−7.1	−8.2
Trade Balance$^{(i)}$	−9.8	−7.6	−8.6
GDP$^{(ii)}$	4.7	7.9	6.7
Household consumption$^{(ii)}$	5.4	8.4	6.9
Investment$^{(ii)}$	9.5	14.0	12.2
Housing investment$^{(ii)}$	−0.6	12.6	7.8
Productivity growth differential (T-NT)$^{(iii)}$	2.7	3.9	3.9
Real exchange rate (total change)$^{(iv)}$	−35.2	−3.2	−37.3
Real house prices (total change)$^{(iv)}$		331.2	

Notes: $^{(i)}$: in % of GDP; $^{(ii)}$: annual average growth rates; $^{(iii)}$: percentage points; $^{(iv)}$: total change in %. For the real exchange rate, a negative change shows an appreciation. *: between April 2005 and April 2007.

Table 2: QUEST - Calibration

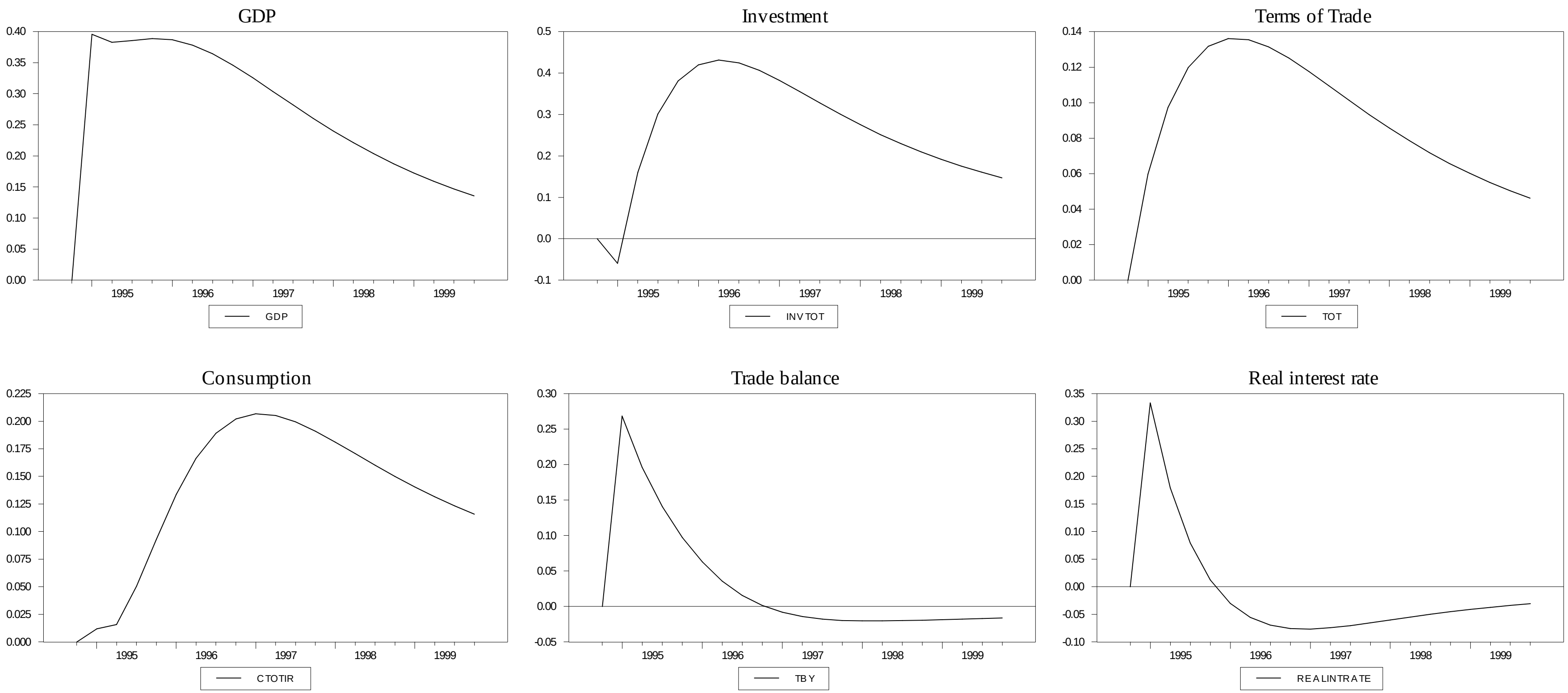
Steady-state ratios

Ratio	Value
Private consumption-to-GDP	0.59
Private investment-to-GDP	0.18
Housing investment-to-GDP	0.02
Total government revenue-to-GDP	0.34
Import-to-GDP	0.64
Traded Value Added-to-GDP	0.42
Gross household debt-to-GDP	0.03
Employment	0.65

Parameter values

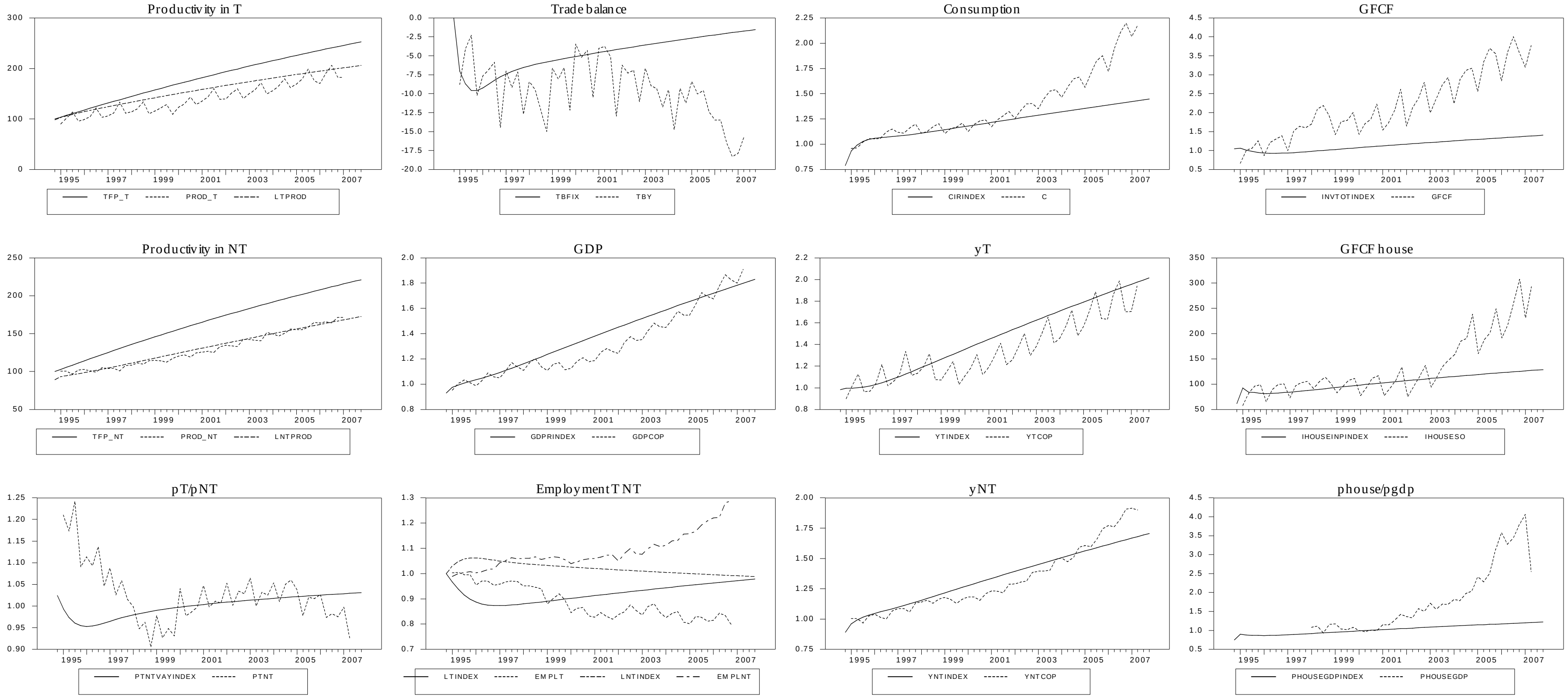
Parameter	Value	Description
β^r	0.9875	Discount factor Ricardian households
β^c	0.97	Discount factor collateral-constrained households
κ	2.3	Inverse of the Frisch elasticity of labour supply
h^c	0.6	Habit persistence on consumption
s^c	0.4	Share of collateral-constrained households
δ^T, δ^{NT}	0.015	Depreciation rate of capital the T and NT sector
δ^h	0.0025	Depreciation rate of house
σ	0.5	Elasticity of substitution between T and NT goods
σ^{TD}, σ^*	2	Elasticity of substitution between domestically and foreign produced T goods
ν	0.5	Elasticity of substitution between housing investment and new land
σ^{int}	0.5	Elasticity of substitution between intermediate goods and Y_t
θ	10	Elasticity of substitution between diversified labour input
τ^h	20	Elasticity of substitution between diversified $I_t^H(i)$
γ^P	20	Price adjustment cost
γ^{PH}	2	Housing price adjustment cost
$\gamma^T, \gamma^{NT}, \gamma^h$	15	Capital adjustment cost
γ^l	40	Labour adjustment cost
γ^w	20	Wage adjustment cost
t^c	0.17	Consumption tax rate
t^w	0.24	Labour tax rate
t^k	0.28	Corporate tax rate
gs^C	0.2	Share of government consumption in GDP
gs^I	0.04	Share of government investment in GDP
$trshare$	0.08	Share of transfers in GDP
$benr$	0.08	Benefit replacement rate
$taxshare$	0.02	Share of lump-sum tax in GDP
$btarg$	0.50	Debt target for public debt

Figure 1: Productivity shock (T & NT)



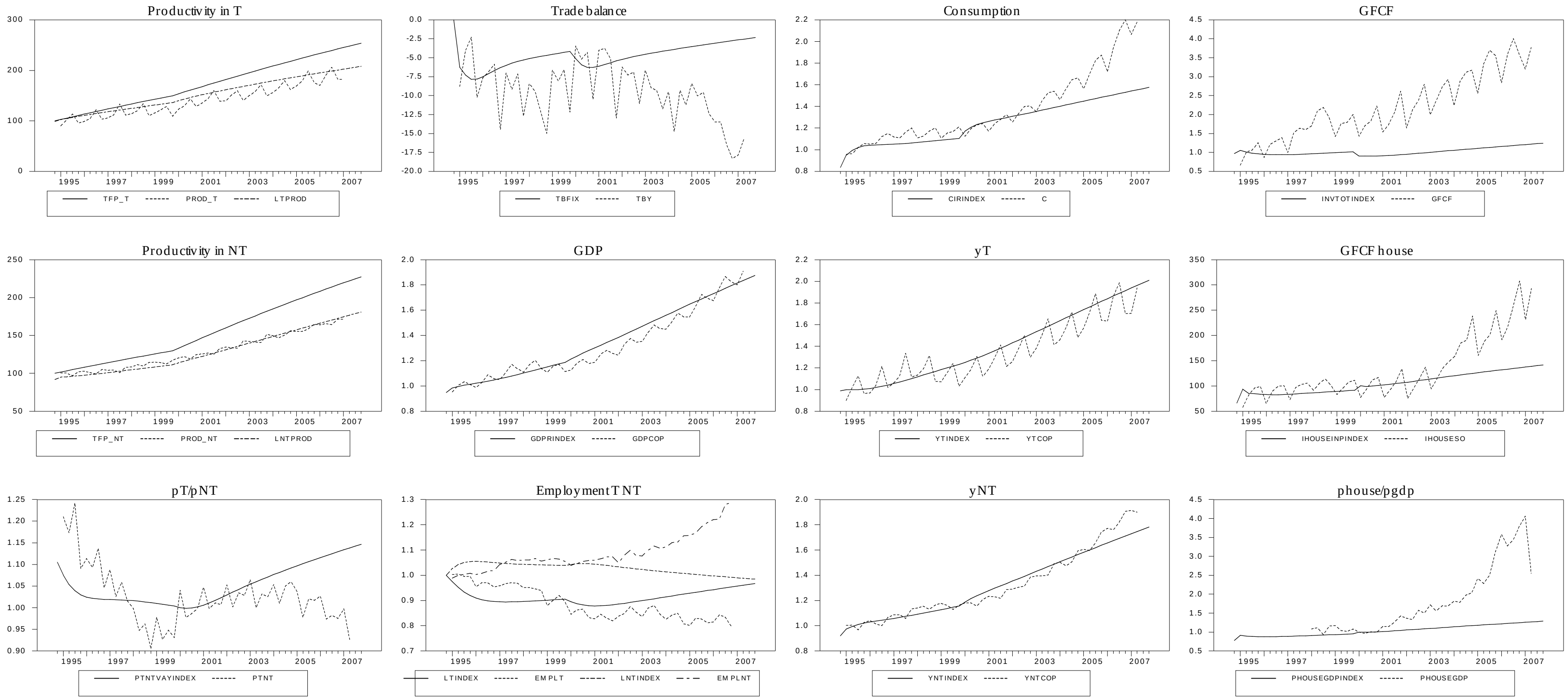
Note: Impact of 1% shock to TFP in both T and NT sectors with an autoregressive coefficient of 0.9.

Figure 2: TFP growth



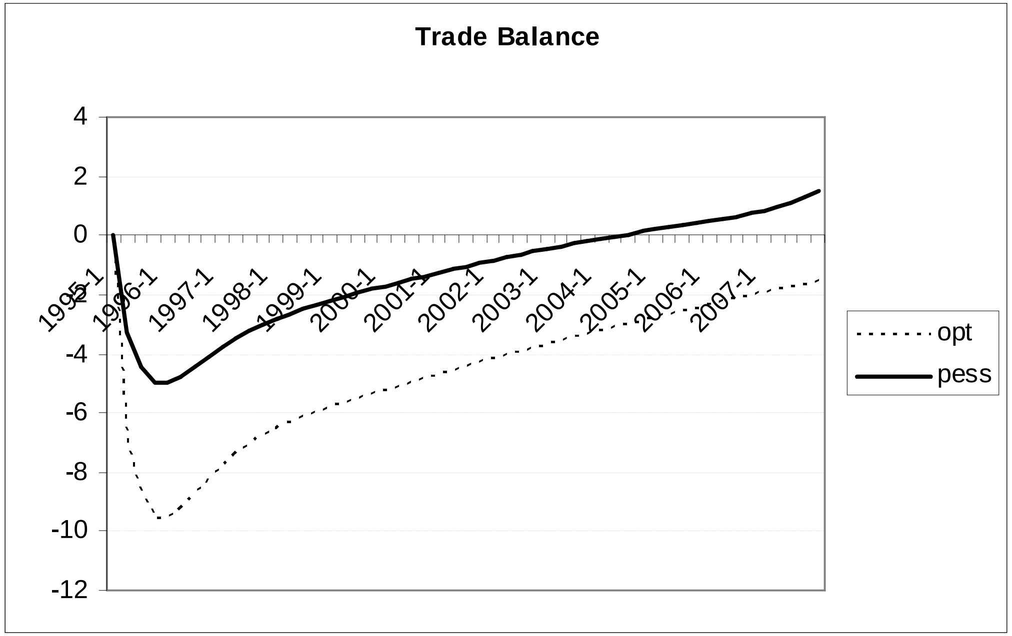
Note: Impact of TFP growth. Calibration of TFP to match labour productivity growth.

Figure 3: TFP growth - Unforeseen Break



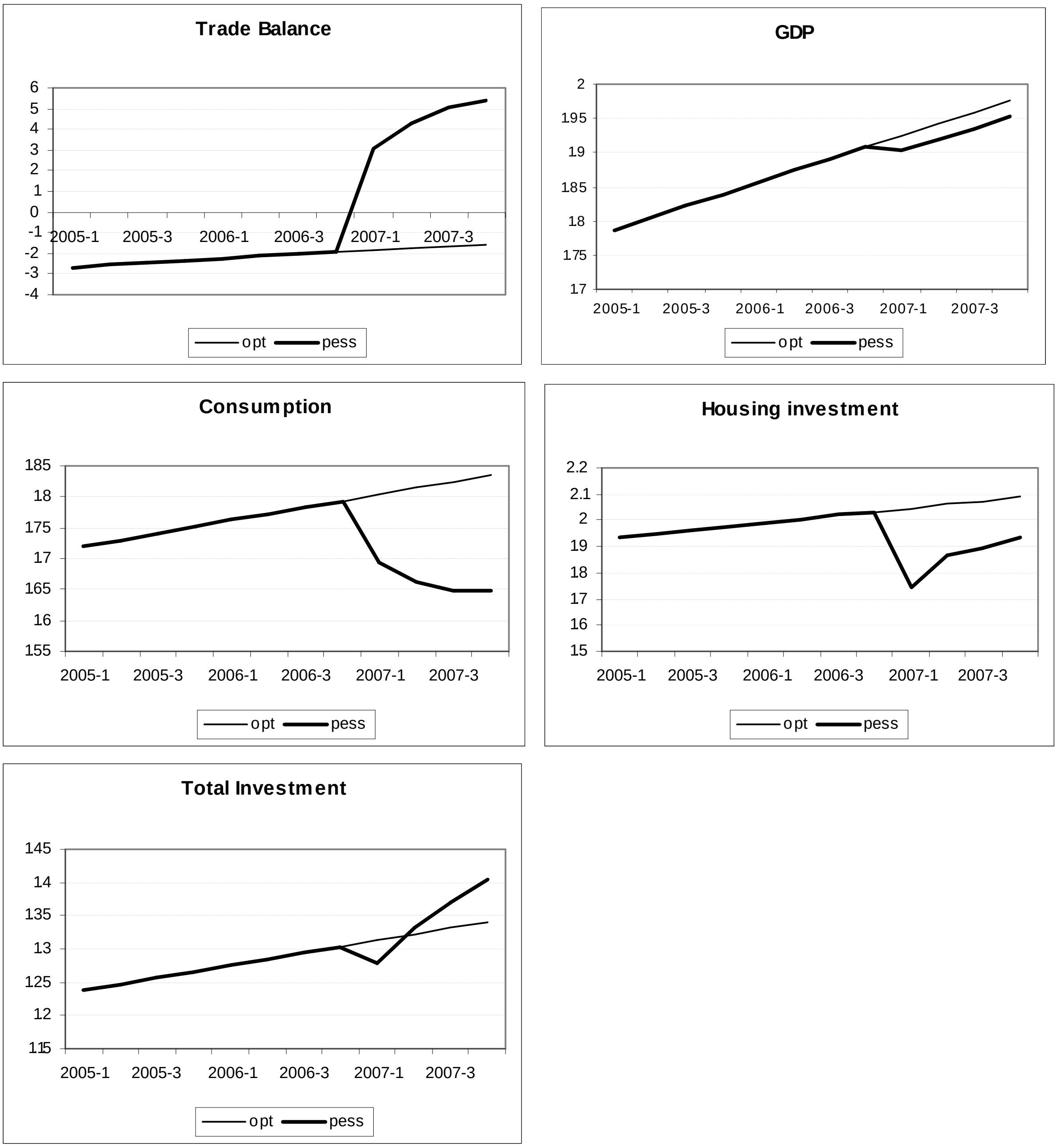
Note: Impact of TFP growth. Calibration of TFP to match labour productivity growth. Unforeseen break in the NT sector TFP growth at 2000Q1.

Figure 4: Trade balance with optimistic and pessimistic growth outlook



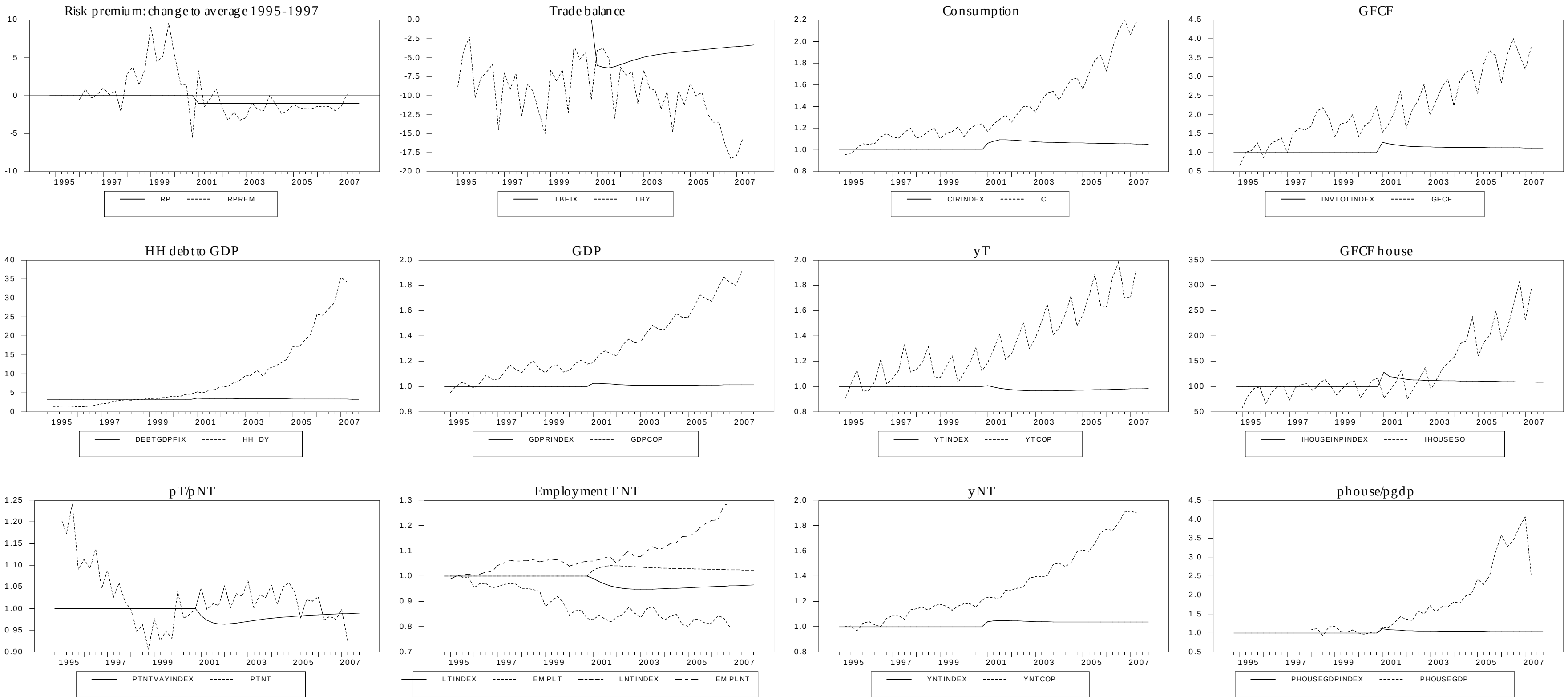
Note: Impact of TFP growth without break calibrated to observed labour productivity patterns over the sample of 1995Q1 to 2007Q2. Optimistic outlook is based on the continuation of growth trends after the end of the sample. Pessimistic growth outlook is based on no TFP growth starting from 2008Q1.

Figure 5: TFP growth with Revision of Outlook in 2007Q1



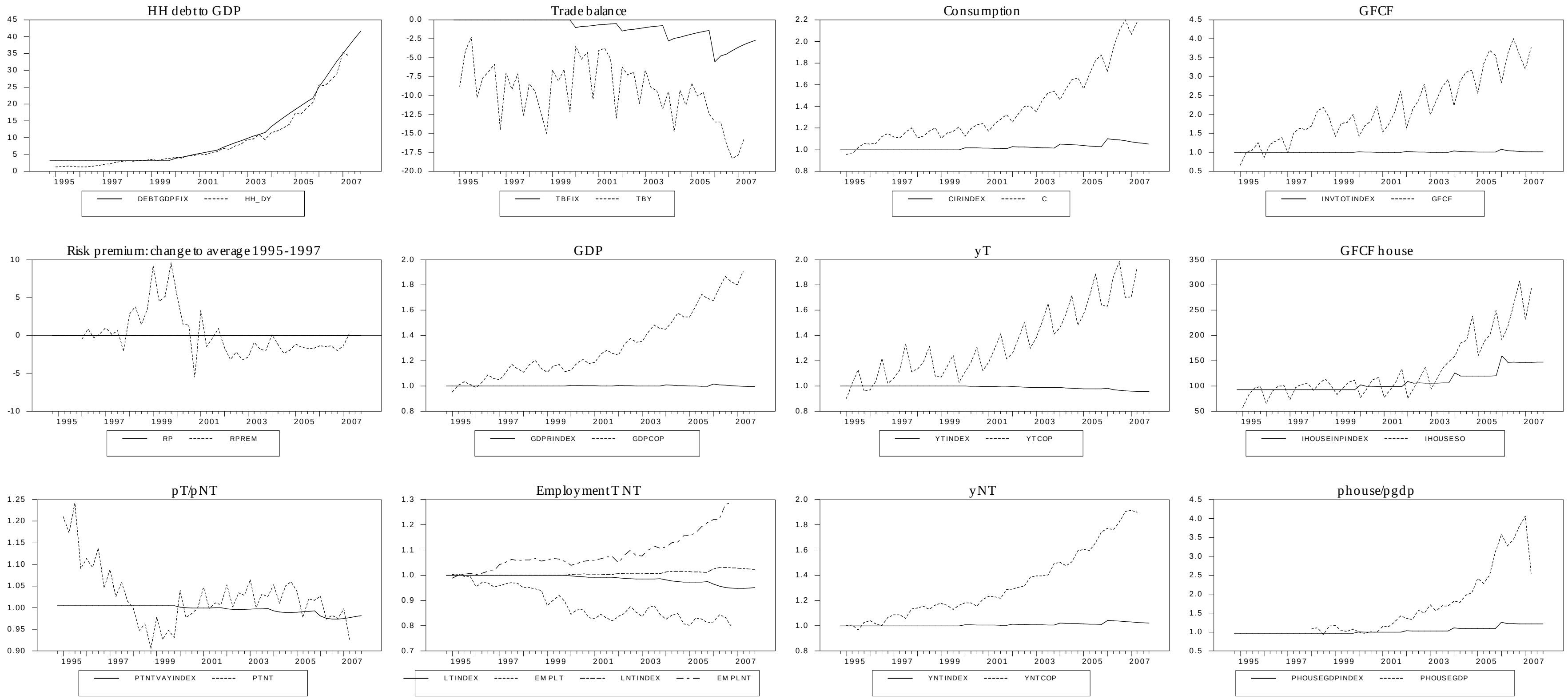
Note: Impact of TFP growth with a revision of growth outlook for the periods from 2008Q1 onward in 2007Q1. The baseline scenario is based on the optimistic outlook of a continuation of growth trends. The revision expects zero TFP growth from 2008Q1.

Figure 6: Fall in Foreign Risk Premium



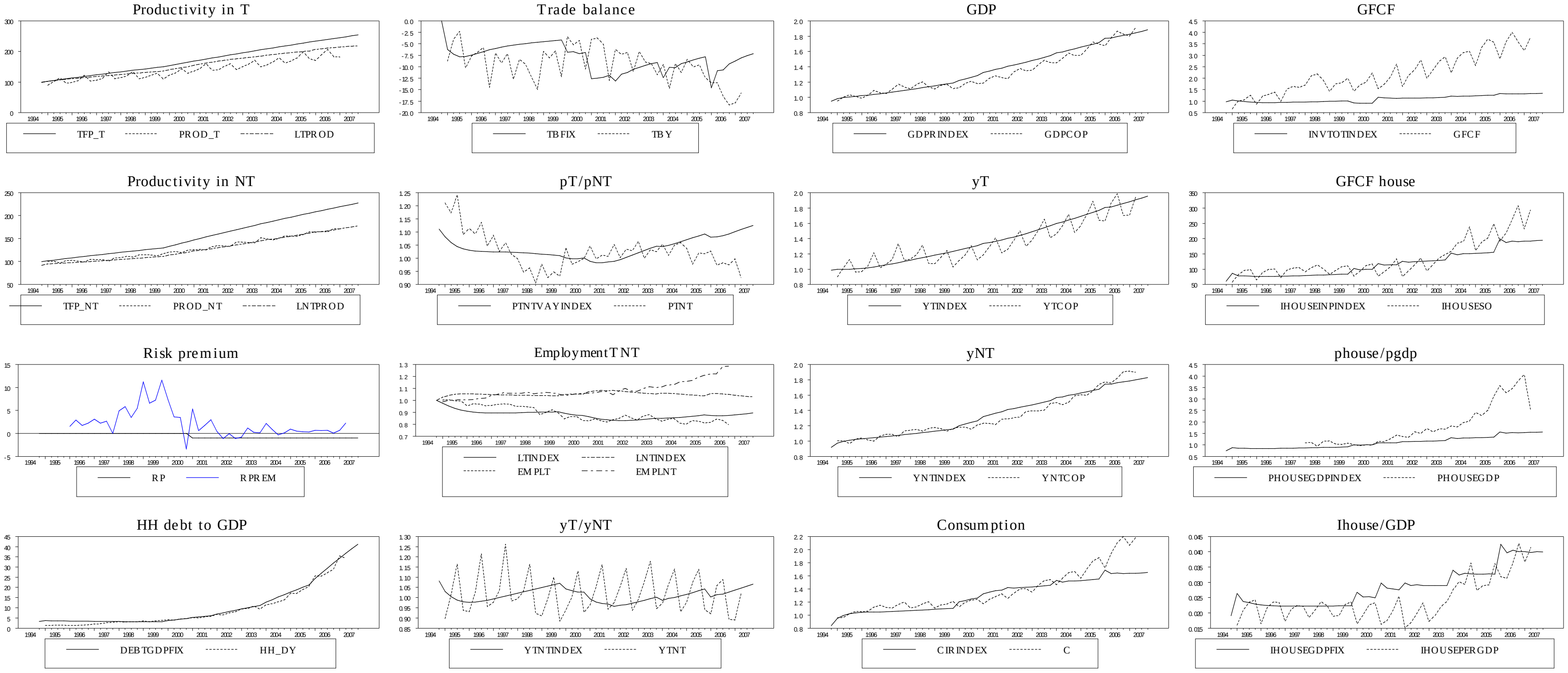
Note: Impact of a 100 basis point permanent fall in foreign risk premium.

Figure 7: Increasing access to credit - unanticipated



Note: Impact of an unforeseen accelerating credit growth. Loan-to-value ratio calibrated to match the increase in households' gross debt-to-GDP ratio.

Figure 8: Combined impact of 3 factors



Note: Combined impact of TFP growth (with unforeseen break in 2000 in the NT sector), 100 bp permanent fall in foreign risk premium as of 2001Q1 and of the accelerating increase in the Loan-to-value ratio.