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

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## Abstract

This paper studies external deficits in the Baltics between 1995 and 2007. It uses a calibrated small-open-economy dynamic general equilibrium model incorporating a financial accelerator to assess to what extent deficits can be explained by productivity growth, fall in spreads and increasing access to credit. Results suggest that the external deficit and other key macroeconomic aggregates can be well fitted by the equilibrium response of the model economy. Real convergence is found to have been dominant in the first half of the sample. More reversible financial factors became increasingly important towards the end of the period pointing to growing vulnerability. Positive growth outlook is also likely to have played a significant role in the build up of the foreign debt. Reversal scenarios confirm the need for a sizable readjustment.

**JEL Classification Codes:** F41, C68

**Keywords:** Baltic States, current account, financial accelerator, dynamic general equilibrium

## 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.

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As this trend has abruptly been reversed at the end of 2008, 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, external deficits along with a run-up in house prices are among the best leading indicators of financial crisis in countries experiencing large capital inflows. Increasing GDP growth rates also belong to the crisis indicators.<sup>1</sup> 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 continuous servicing of the debt over time.

In this paper, we try to disentangle real and financial factors behind the observed trends and to identify risks and vulnerabilities related to these developments. In particular, we consider three factors likely to have significantly contributed to the evolution of the Baltic economies between 1995 and 2007: productivity growth, a fall in spreads related to the EU accession and the easing access to credit for households. We use the European Commission's QUEST model<sup>2</sup> calibrated to the Baltic economies to assess to what extent the external deficits of the Baltic States between 1995 and 2007 can be explained by each of these factors. The version of QUEST used in this study is a small-open economy dynamic general equilibrium model with traded and non-traded goods production sectors 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 (2009).

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 is 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 is found to account well for trends until around 2001. Thereafter, the role of TFP growth seems to have decreased and financial factors are found to have played an increasingly dominant role in driving the observed trends. These financial factors represent higher risks for two reasons: their impact on production is found to be significantly smaller than that of TFP

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<sup>1</sup>For financial crisis indicators see e.g. Reinhart & Rogoff (2008) and references therein.

<sup>2</sup>QUEST has been developed by staff of the Research Directorate of the DG for Economic and Financial Affairs. For detailed description and estimation of the model see e.g. Ratto *et al.* (2009) and Roeger & In't Veld (2009).

growth; thereby, these factors do not ensure production levels from which debt could be serviced at later stages without a decrease in consumption and / or an increase in work effort. In addition, these factors are more easily reversible than the level of productivity.

Third, during the entire period, positive growth outlook is likely to have played a significant role in the build-up of the external debt position. Simulation results illustrate the impact of expectations in the model: a less positive outlook implies smaller trade deficits in earlier periods with lower external-debt-financed domestic demand.

Finally, reversal scenarios confirm the need for a painful readjustment of the external debt position. In particular, if either future growth expectations become more pessimistic or benign financing and credit conditions are reversed, the model shows a sudden turn around in the trade balance which requires substantial restructuring and a fall in 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 economic liberalization in the first half of the nineties, GDP was growing at a very fast pace in the Baltic States, averaging at around 7% per year between 1995 and 2007 (See Table 1).<sup>3</sup> Growth was largely domestically driven, with both households' consumption growth and investment growth exceeding GDP growth in each country. Parallel to this, external deficits were very high, averaging at close to 10% of GDP over the entire period.

Starting from around 2001-02, this pattern became more accentuated as GDP, consumption, investment and especially housing investment accelerated enhanced by falling risk premia and easing access to credit. As a result, external deficits reached two-digit levels in each country by 2006; in Latvia, the trade and the current account deficit exceeded even 20% of GDP in 2006 and 2007.

The boom in the housing sector was also accompanied by a very fast rise in real house prices: house prices relative to consumer prices quadrupled in Estonia and Lithuania between 2000 and 2007 and almost doubled in Latvia between April 2005 and their peak in April 2007<sup>4</sup>. To compare, relative house prices decreased in Germany over the same period, increased by around 60 percent in Belgium and Ireland, 70 percent in France and around 85% in Spain over the period of 2000 - 2006.<sup>5</sup>

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<sup>3</sup>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 Programmes (updates of December 2006 / January 2007) of these countries. For a comprehensive study of the Baltic economies see also European Commission (forthcoming): Cross-country study: Economic policy challenges in the Baltics.

<sup>4</sup>Latvian data only available from April 2005.

<sup>5</sup>Note that the largest part of the increase in housing prices in Ireland took place before

In a benign reading, much of these trends could be interpreted as part of a real or a financial convergence process. Between 1995 and 2007, per capita GDP rose from around 35% of EU average to 60% by 2007 in Latvia and Lithuania and to 70% in Estonia. The share of housing investment-to-GDP also converged to Western-European levels over the period: it still remains relatively low in Latvia and Lithuania (around 3% of GDP) whereas Estonia has caught up with some euro-area economies (e.g. Germany, France, Belgium) by 2007. Similarly, 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% in Lithuania. These ratios still remain below the euro-area average of around 50%.

At the same time, the observed fast growth coupled with high external deficits increasingly raised concerns about the sustainability of the developments. On the one hand, according to economic theory, external deficits are part of a fast catching-up process as capital is expected to flow to countries with high return opportunities. Such external deficits can be considered equilibrium phenomena and are not problematic as long as foreign funds are well invested allowing for a continuous servicing of the debt over time or generating a sufficient return on equity in the case of FDI. On the other hand, however, high and increasing GDP growth rates as well as the run-up in house prices are the best leading indicators of financial crisis in countries experiencing large capital inflows and large external deficits.<sup>6</sup> In the Baltic States, all of these factors were present simultaneously.

In this paper, we try to disentangle real and financial factors behind the trends and to identify risks and vulnerabilities related to the observed developments.<sup>7</sup> In particular, we consider three factors driving convergence: productivity growth, a fall in external risk premia and easing access to credit. These factors may reasonably be assumed to have significantly contributed to driving the Baltic economies between 1995 and 2007.

First, figures show that labour productivity in each Baltic economy was growing very fast in both the traded and the non-traded sectors by far exceeding growth rates in the euro-area (see Table 2). Trends driven by productivity growth will be considered as 'real convergence'.

Second, as pointed out e.g. by Luengaruemitchai & 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 with comparable fundamentals 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

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2000. However, even considering the period 1996-2006, real housing prices in Ireland multiplied 3.4 fold, which is still less than the increase in the Baltic States over the shorter time horizon.

<sup>6</sup>See e.g. Reinhart & Rogoff (2008).

<sup>7</sup>For an empirical study on growth in new EU Member States see Boewer & Turrini (2009).

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 the 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.

Trends driven by the fall in spreads as well as the easing access to credit will be regarded as 'financial convergence'.

### 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 (2009). We also introduce a house production sector.

On the production side, monopolistically competing firms are producing traded and non-traded goods using capital, labour and intermediate inputs. In addition, a house production sector assembles non-traded investment goods and new land to build new houses. 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.

At this place we only outline the problem of each sector and the equilibrium conditions. A more detailed description of optimality conditions in a similar set-up can be found in Roeger & in't Veld (2009).

#### 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  $C_t^i$ , leisure  $(1 - L_t^i)$ , housing services  $H_t^i$  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:

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

where

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

$$V(1 - L_t^i) = \frac{1}{1 + \kappa} (1 - L_t^i)^{1 + \kappa} \quad i = r, c$$

and

$$Z(H_t^i) = \log(H_t^i) \quad i = r, c.$$

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.

Both 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 ( $B_t^{G,r}$ ), bonds issued by other domestic households ( $B_t^{priv,r}$ ) as well as foreign currency denominated bonds issued by foreign households ( $B_t^{F,r}$ ); real capital stocks of the tradable and non-tradable sector ( $K_t^T, K_t^{NT}$ ) 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  $T_t^{LS}$  and receive lump-sum transfers  $Tr_t$  as well as unemployment benefits  $Ben_t$ .

Ricardian households face the following maximisation problem:

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

with respect to consumption  $C_t^r$ , housing services for own use  $H_t^r$ , investment to the house stock  $I_t^{H,r}$ , 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:



$$\begin{aligned}
& \frac{P_t^C(1+t_t^c)}{P_t^{GDP}} C_t^r + \frac{P_t^H}{P_t^{GDP}} J_t^{H,r} + \frac{1}{s^t} \sum_{j=T,NT} \frac{P_t^{K,j}}{P_t^{GDP}} J_t^j + \frac{\gamma^w}{2} \left( \frac{W_t}{W_{t-1}} - 1 \right)^2 L_t^r + B_t^{G,r} + \\
& B_t^{priv,r} + \frac{1}{s^r} rer_t B_t^F + \frac{T_r^{LS}}{P_t^{GDP}} = \\
& = \Pi_t^{\text{real}} + (1 - t_t^w) \frac{W_t}{P_t^{GDP}} L_t^r + \frac{Ben_t}{P_t^{GDP}} (1 - L_t^r) + \frac{T_r}{P_t^{GDP}} + \frac{1+i_{t-1}}{1+\pi_t^{GDP}} \left( B_{t-1}^{G,r} + B_{t-1}^{priv,r} \right) + \\
& \frac{1}{s^r} rer_t (1 + risk_t) \frac{1+i_{t-1}^F}{1+\pi_t^*} B_{t-1}^F + \frac{1}{s^t} \sum_{j=T,NT} \frac{P_t^{K,j}}{P_t^{GDP}} \left( (1 - t_t^k) r_t^{k,j} + t_t^k \delta^j \right) K_{t-1}^j,
\end{aligned}$$

where  $\Pi_t^{\text{real}}$  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);  $J_t^j$  ( $j = T, NT$ ),  $J_t^H$  stand for real investment expenditure in the traded, non-traded and housing sectors;  $r_t^{k,j}$  is the real return on capital and  $\delta^j$  ( $j = T, NT$ ) stands for the depreciation rate in the respective capital 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.<sup>8</sup>

- Capital and house accumulation equations:

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

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

with  $\delta^h$  standing for the depreciation rate of the housing stock.

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  $(J_t^j, J_t^H)$  and physical investment  $(I_t^j, I_t^H)$ . Investment expenditure of households including capital adjustment costs is given by

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

and

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

<sup>8</sup>This is necessary to close down a small open economy model. See e.g. Schmitt-Grohe & Uribe (2001).

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

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

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

Collateral-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:

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

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:

$$\begin{aligned} & \frac{P_t^C(1+t_t^c)}{P_t^{GDP}} C_t^c + \frac{P_t^H}{P_t^{GDP}} J_t^{H,c} + \frac{\gamma^w}{2} \left( \frac{W_t}{W_{t-1}} - 1 \right)^2 L_t^c + \frac{1+i_{t-1}}{1+\pi_t^{GDP}} B_{t-1}^{priv,c} = \\ & = (1 - t_t^w) \frac{W_t}{P_t^{GDP}} L_t^c + B_t^{priv,c} + \frac{Ben_t^c}{P_t^{GDP}} (1 - L_t^c) + \frac{Tr_t^c}{P_t^{GDP}} - \frac{T_t^{LS,c}}{P_t^{GDP}}; \end{aligned}$$

- The house accumulation equation:

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

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 households' housing stock multiplied by an institutionally given loan-to-value ratio  $(1 - \chi_t)$ . The time subscript of the downpayment rate  $\chi_t$  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:

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

where  $\lambda_t^{\text{house}^c}$  and  $\lambda_t^c$  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 is 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 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  $\lambda_t^{\text{house}^c}$  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:

$$Q_t^{H,c} = \frac{prefhZ_{H,t}^c P_t^C(1+t_t^c)}{U_{C,t}^c} + \lambda_t^{\text{house}} (1 - \chi_t) + \\ + \beta^c \frac{\lambda_{t+1}^c}{\lambda_t^c} \frac{1+\pi_{t+1}^H}{1+\pi_{t+1}^{GDP}} \frac{1}{U_t^{QH}} \left[ (1 - \delta^h) Q_{t+1}^{H,c} + \gamma^h \left( \frac{I_{t+1}^{H,c}}{H_t^c} - \delta^h \right) \frac{I_{t+1}^{H,c}}{(H_t^c)^2} \right];$$

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:

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

with  $X_t = C_t, I_t^T$  and  $I_t^{NT}$ .<sup>9</sup>

The traded goods are an aggregate of domestic  $TD$  and imported  $TF$  traded goods:

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

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

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

<sup>9</sup>Note that it is assumed that both production sectors use investment goods from the each sector to build up their capital. Hence,  $I_t^T$  stands for investment in the traded sector and is composed of traded investment goods  $I_t^{T,T}$  and non-traded investment goods  $I_t^{T,NT}$ .

with the aggregate price level given by:

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

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:

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

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 both types of households. 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  $V_{1-L,t} \equiv \text{prefl}(s^r V_{1-L,t}^r + s^c V_{1-L,t}^c)$  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:

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

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

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; they sell investment and intermediate goods to other domestic and foreign firms. The non-tradable sector firms sell 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:

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

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

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

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  $j$  ( $\Pi_t^j$ ) in each period is given by:<sup>10</sup>

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

The presence of adjustment 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 new land (*land*) using a CES technology:

<sup>10</sup>For ease of exposition, we drop the index of individual firms. Since firms are identical, they all choose the same price and quantity in equilibrium.

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

Expressing house-producing firms real marginal cost  $\eta_t^h$  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  $\gamma^{PH}$ . The price setting equation is then given by:

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

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  $T_t^{LS}$  are assumed to be a fixed share of GDP<sup>11</sup>:

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

<sup>11</sup>  $GDP_t$  is defined on accounting basis as the sum of gross output minus intermediate inputs in all sectors.



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

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:

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

The government debt  $B_t^G$  then evolves according to:

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

and the labour income tax is set to

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

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:

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

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:

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

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 in the Baltic economies.

We use quarterly national account data for 1995Q1 to 2007Q2 as well as input-output tables<sup>12</sup> for 2000. A detailed description of the sources and the time series used is given 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  $\beta^r = 0.9875$ . We assume log utility in consumption and housing and CRRA utility in leisure with the inverse Frisch elasticity of labour supply  $\kappa$  set to 2.3. These specifications are standard in the literature.

<sup>12</sup>Input - output tables were only available for Estonia and Lithuania.

Steady-state prices and GDP are normalised to 1. The values of structural parameters are summarised in Table 3. The calibration captures some characteristics of the Baltics. In particular, the preference parameters are set to match the ratio of housing investment-to-GDP observed in the Baltics in the first half of the sample (2%). Similarly, the weight of leisure in total utility allows us to roughly match the employment rate in the the Baltic States (60 – 65% on average).<sup>13</sup> We use data from input-output tables and import-to-GDP<sup>14</sup> ratios to calibrate trade linkages. The resulting traded sector value added-to-GDP ratio is around 40%, in line with the ratio in the Baltic economies in the first half of the sample. The steady-state import-to-GDP share is set to 64% roughly corresponding to its observed average values in the Baltic States. The parameterisation of the government sector implies a government expenditure-to-GDP ratio of 34% in line with observed values.

The elasticity of substitution between domestic and foreign traded goods  $\sigma^{TD}$  and  $\sigma^*$  are set to 2. This relatively high price elasticity of demand for domestic goods allows us to capture the relatively high degree of competition Baltic traded-goods-producing firms are facing.

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), Monacelli (2009). 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 share of collateral-constrained households is set to 40%. This value is in line with the previously cited papers which were mainly focussing on the US economy. It may be considered a conservative parameterisation for the Baltic economies where the average income of households is lower and the share of households constrained in their access to credit is likely to be higher than in the US. The aggregate results are not too much influenced by the choice of this parameter. Given the share of credit constrained households, the initial value of the down-payment rate  $\chi_0$  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,  $\nu$  is set to 0.5 reflecting the relatively low degree of substitutability between these two factors. The share of land in total new houses  $s_{land}$  equals 0.25, in the order of magnitude of values in 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 that in goods-producing sectors.

The calibration of the adjustment costs is set to match impulse responses to

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<sup>13</sup>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.

<sup>14</sup>The steady-state trade balance is in equilibrium, therefore, the steady-state export-to-GDP ratio equals this value.

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 and non-traded sectors. 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 higher flexibility of durable goods’ prices as discussed e.g. in Monacelli (2009). 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). The labour adjustment cost coefficient  $\gamma^l$  is set to 40 in both sectors. Estimates of this parameter for the euro-area were around 60 (Ratto *et al.* 2009). 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).

The simulations are implemented in TROLL using the Newton-Raphson algorithm to find the non-linear dynamic perfect foresight solution of the model. TROLL also allows for the simulation of sequential unexpected shocks by stacking a sequence of perfect foresight simulations. This procedure is used for the analysis of multiple unforeseen changes in exogenous variables.

#### 4.1 Real convergence: TFP growth

TFP in both sectors is calibrated such that the implied trajectories of labour productivity match observed trends.<sup>15</sup> The simulation of TFP growth starts in 1995Q1 and assumes the continuation of the trends after the end of the sample period (1995Q1 to 2007Q2). The implied labour productivity series roughly match the evolution of the observed series (see Figure 2).

Our results suggest that productivity growth can reasonably well track developments in the Baltic economies until around 2000-01, both qualitatively and quantitatively. In particular, TFP growth trends appear to well explain the evolution of value added in the traded and non-traded sectors and also allow us to reproduce the sizable trade deficits in the first half of the sample.

Growing income and the assumed positive future growth outlook induce agents in the model to borrow more externally in early periods so as to smooth their consumption. Debt is serviced in later periods when productivity has risen

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<sup>15</sup>The model assumes constant annual growth rate of 1.5% for the ROW in both sectors. To neutralise the impact of non-constant growth in the Baltic trading partners’ productivity on observed capital and trade flows, we normalised the Baltic productivity in each sector by the productivity of the euro-area in the respective sector. Hence, the time series we calibrate the model’s TFP variable to is capturing the productivity *differentials* with respect to the euro-area. Other macroeconomic variables were normalised as well in line with the productivity time series. Price indexes were also adjusted.

to higher levels.<sup>16</sup> This mechanism also allows productivity growth to track the evolution of consumption and the reallocation from the traded to the non-traded sector observed in the Baltics in the first half of the sample. At the same time, TFP growth in the model does not do too well in reproducing the evolution of investment: while actual data showed a very fast investment growth, the model predicts a slow increase in investment in early periods and faster increase at later stages.

The previously described simulation assumed that the entire trajectory of TFP growth was foreseen at the beginning of the sample period. Allowing instead for an unexpected break in TFP in 2001 helps improve the fit of GDP, traded and non-traded sector value added and, to a lesser extent, also that of consumption, housing investment and of the trade balance. However, even with this break, TFP growth *per se* falls short of matching the observed trends in the second half of the sample (see Figure 3). Specifically, the growing external deficits, the increasing reorientation of production towards the non-traded sector as well as the acceleration in households' consumption and housing investment do no longer seem to be justified by the observed TFP developments.

Finally, it should be noted that *optimistic expectations about future productivity growth* are likely to have played a crucial role in the build-up of the foreign debt position over time. To illustrate the role of expectations, Figure 4 displays the evolution of the trade balance under two alternative assumptions: first, the benchmark assumption of the continuation of growth trends after the end of the sample and second, the alternative assumption of zero growth starting from 2008Q1. Note that both the benchmark and the alternative assumptions for TFP trends after 2007 are assumed to be perfectly foreseen in the simulations. The simulation results show a marked 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 over the entire period. As a result, both initial trade deficits and future debt service remain lower.

## 4.2 Financial convergence

### 4.2.1 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

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<sup>16</sup>It should be noted that FDI is not explicitly specified in the model, i.e. we do not make any distinction between various types of foreign assets and liabilities. FDI in the domestic economy is therefore considered as foreign debt, and repatriated profits on FDI as interest payments on foreign liabilities.

measure is broadly in line with other calculations; see e.g. Luengaruemitchai & 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 the exogenous  $U_t^{UIP}$  starting from 2001<sup>17</sup> (see Figure 5). Our simulation results confirm the significant role of a decrease in spreads in generating a persistent trade deficit starting from 2001. The decline in the real interest rate leads to a capital inflow in the model and also enhances consumption smoothing. The shock also explains some shift in employment from the traded towards the non-traded sector which may have offset the reallocation 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 trends 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.

#### 4.2.2 Credit growth

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

As already pointed out in section 2, households indebtedness 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.

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  $\chi_t$  is set to match the trajectory of the gross households' debt-to-GDP ratio in the Baltics between 2001 and 2007 (see Figure 6). To capture the unexpected nature of credit expansion, we model the credit growth stepwise introducing an acceleration unanticipated by agents.

The easing 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. Easy credit primarily benefits households who are bound by a collateral constraint in their borrowing abilities. These households use the easier financing opportunity to increase both their consumption and their housing investment. This also contributes to generating growing trade deficits and leads to a further reorientation of production towards the non-traded sector as well as to an increase in house prices. At the same time, the impact of easing access to credit on aggregate production and investment remains rather limited

<sup>17</sup>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.

suggesting that a credit boom *per se* is not sufficient to lead to an overall boom in the economy.

It should also be noted that the impact of the credit boom on house prices remains significantly below the observed fourfold multiplication of real house prices in the Baltics. This finding is robust to the parameterization of the house production sector. In particular, choosing higher values for the fixed new land's share  $s_{land}$  in the house production function does not improve the fit of real house prices while it deteriorates the fit of housing investment.<sup>18</sup>

### 4.3 Combined impact

Figure 7 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.

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. At the same time, while the simulation results qualitatively also match changes in investment and real house prices, quantitatively, they remain substantially different from the data.

The model may underpredict investment for several reasons. First, the positive future growth outlook in the model induces agents to delay investment until later periods. While this mechanism allows us to capture well the evolution of the trade balance and of consumption, it misses to track well the observed investment growth over the sample. In addition, some potential factors behind the observed investment growth in the Baltic economies are not captured in our model. Specifically, the capital stock in place in the Baltics at the beginning of the period is likely to have been obsolete and needed to be replaced to adapt 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 higher depreciation rate may have played a role in driving the observed extremely fast capital accumulation.

Similarly, the larger than predicted increase in house prices may to a certain extent reflect the impact of lower-than-equilibrium initial house prices or an improvement in the quality of the housing stock and / or the increasing housing investment of foreigners in the region, neither of which is specified in the model. At the same time, as already noted earlier, the fourfold multiplication of real house prices over the horizon of 2000 to 2007 and the acceleration since 2004 are most likely signs of imbalances which are difficult to capture in a general equilibrium model.

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<sup>18</sup>In fact, house prices were found to be non-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.

## 4.4 Growing vulnerabilities

Various features of the above results point to the growing vulnerability of the Baltic economies from the beginning of this decade.

First, the progressive shift from real to financial factors (low risk premium and easy access to credit) in generating the build-up of the foreign debt stock from around 2001 implies higher costs of future debt service in terms of domestic consumption and labour. To see why, note that both real and financial factors have qualitatively similar effects in leading to higher production but also in leading to higher indebtedness and thereby to higher debt service in later periods. The major difference between real and financial factors lies in the relative size of these impacts: productivity growth is found to have been the major driver of GDP growth over the entire period. The contribution of financial factors to GDP growth via a reduction in capital costs (risk premium) and via an increasing demand (easing access to credit) is found to have been significantly lower and insufficient to fully offset the negative wealth effect of higher debt service on the increased debt stock. These results suggest that the observed productivity growth ensured a GDP growth sufficient to service debt without requiring a decrease in domestic consumption or an increase in work effort while the GDP impact of financial factors was not sufficient to avoid lower consumption and leisure over time.

Second, the build-up of the external debt seems to have been fuelled increasingly by factors which are easily reversible. As discussed in subsection 4.1, optimistic expectations about future growth prospects are likely to have played a role from the beginning of the period. The growing weight of market sentiment and easy access to credit represented an additional source of risk from this perspective. A sudden turn-around in either of these factors renders the previously acquired external position suboptimal and requires a readjustment which has repercussions on the real economy.

To illustrate, Figure 8 displays reversal scenarios for a turn-around in productivity growth expectations (left-hand side panel) and in external financing conditions (right-hand side panel). The results show that in both cases the reversal implies a sizable correction of the external debt, the housing stock and capital stock positions which were taken up during the preceding optimistic growth phase. In particular, the turn-around scenarios show a quick reversal of the trade balance. On the production side, this requires a swift restructuring towards the traded sector. On the demand side, households' consumption, housing investment and capital investment are found to fall significantly. The fall in GDP also depends on the flexibility of the economy: the quicker restructuring can take place between sectors the smaller the costs in terms of GDP turn out to be.

It is interesting to point out that the reversal in expectations may imply real effects before the lower productivity growth rates are realised.



## 5 Conclusion

This paper studies the role of real and financial factors in driving external deficits and other key macroeconomic aggregates in the Baltics over the period of 1995 to 2007 and identifies risks and vulnerabilities related to the observed developments. Three driving factors are considered which are likely to have played a significant role over the observation period: (a) productivity growth, (b) fall in external risk premia observed around 2001; and (c) easing 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 financial factors, i.e. the fall in spreads and the easing access to credit are found to have played an increasingly significant role in driving observed trends in these more recent years. This increasing dominance of more reversible factors points to the growing vulnerability of the external debt position over time. Indeed, external debt induced by financial factors may be considered more vulnerable than debt induced by productivity growth for two reasons. First, financial factors are found to not have ensured production levels sufficient to service debt without decreasing consumption and / or leisure at later stages. Second, financial factors are arguably more easily reversible than productivity.

Third, positive growth outlook is likely to have played a significant role in the build-up of the foreign debt. Simulations show that less positive outlook theoretically implies smaller trade deficits in earlier periods with lower external-debt-financed domestic demand.

Reversal scenarios both for the growth outlook and for financial factors indicate a sizable adjustment of the foreign debt stock requiring substantial restructuring and a fall in domestic demand.

## 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. All series are seasonally adjusted using the X11 method. Trade linkages are calibrated on the basis of input-output tables for Estonia and Lithuania for the year 2000.<sup>19</sup>

### 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.

House 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.

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<sup>19</sup>For Latvia, no input-output table was available.

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.

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

| <b>Estonia</b>                                   | 95-00 | 01-07 | 95-07 |
|--|-------|-------|-------|
| Current Account Balance <sup>(i)</sup>           | -7.5  | -10.8 | -9.3  |
| Trade Balance <sup>(i)</sup>                     | -8.0  | -7.4  | -7.7  |
| GDP <sup>(ii)</sup>                              | 6.0   | 8.5   | 7.5   |
| Household consumption <sup>(ii)</sup>            | 7.1   | 9.9   | 8.7   |
| Investment <sup>(ii)</sup>                       | 11.1  | 13.7  | 12.6  |
| Housing investment <sup>(ii)</sup>               | 7.9   | 23.9  | 17.0  |
| Real house prices (total change) <sup>(iv)</sup> |       | 313.7 |       |
| <b>Latvia</b>                                    | 95-00 | 01-07 | 95-07 |
| Current Account Balance <sup>(i)</sup>           | -5.4  | -12.2 | -9.0  |
| Trade Balance <sup>(i)</sup>                     | -7.4  | -14.6 | -11.3 |
| GDP <sup>(ii)</sup>                              | 5.4   | 9.1   | 7.6   |
| Household consumption <sup>(ii)</sup>            | 5.3   | 9.5   | 8.8   |
| Investment <sup>(ii)</sup>                       | 19.6  | 15.4  | 17.2  |
| Housing investment <sup>(ii)</sup>               | 10.6  | 15.7  | 13.7  |
| Real house prices <sup>(iv)</sup>                |       | 87.9* |       |
| <b>Lithuania</b>                                 | 95-00 | 01-07 | 95-07 |
| Current Account Balance <sup>(i)</sup>           | -9.5  | -7.1  | -8.2  |
| Trade Balance <sup>(i)</sup>                     | -9.8  | -7.6  | -8.6  |
| GDP <sup>(ii)</sup>                              | 4.7   | 7.9   | 6.7   |
| Household consumption <sup>(ii)</sup>            | 5.4   | 8.4   | 6.9   |
| Investment <sup>(ii)</sup>                       | 9.5   | 14.0  | 12.2  |
| Housing investment <sup>(ii)</sup>               | -0.6  | 12.6  | 7.8   |
| Real house prices (total change) <sup>(iv)</sup> |       | 331.2 |       |

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

Table 2: Productivity growth - Baltic economies vs. Euro Area

|                               | 95-00 | 01-06 | 95-06 |
|-------------------------------|-------|-------|-------|
| <b>Estonia</b>                |       |       |       |
| Productivity growth T sector  | 13.7  | 8.6   | 10.9  |
| Productivity growth NT sector | 5.4   | 5.6   | 5.5   |
| <b>Latvia</b>                 |       |       |       |
| Productivity growth T sector  | 8.0   | 7.3   | 7.8   |
| Productivity growth NT sector | 4.4   | 6.2   | 5.2   |
| <b>Lithuania</b>              |       |       |       |
| Productivity growth T sector  | 6.8   | 8.9   | 8.7   |
| Productivity growth NT sector | 4.1   | 5.0   | 4.8   |
| <b>Euro Area</b>              |       |       |       |
| Productivity growth T sector  | 3.2   | 2.4   | 2.7   |
| Productivity growth NT sector | 0.5   | 0.2   | 0.3   |

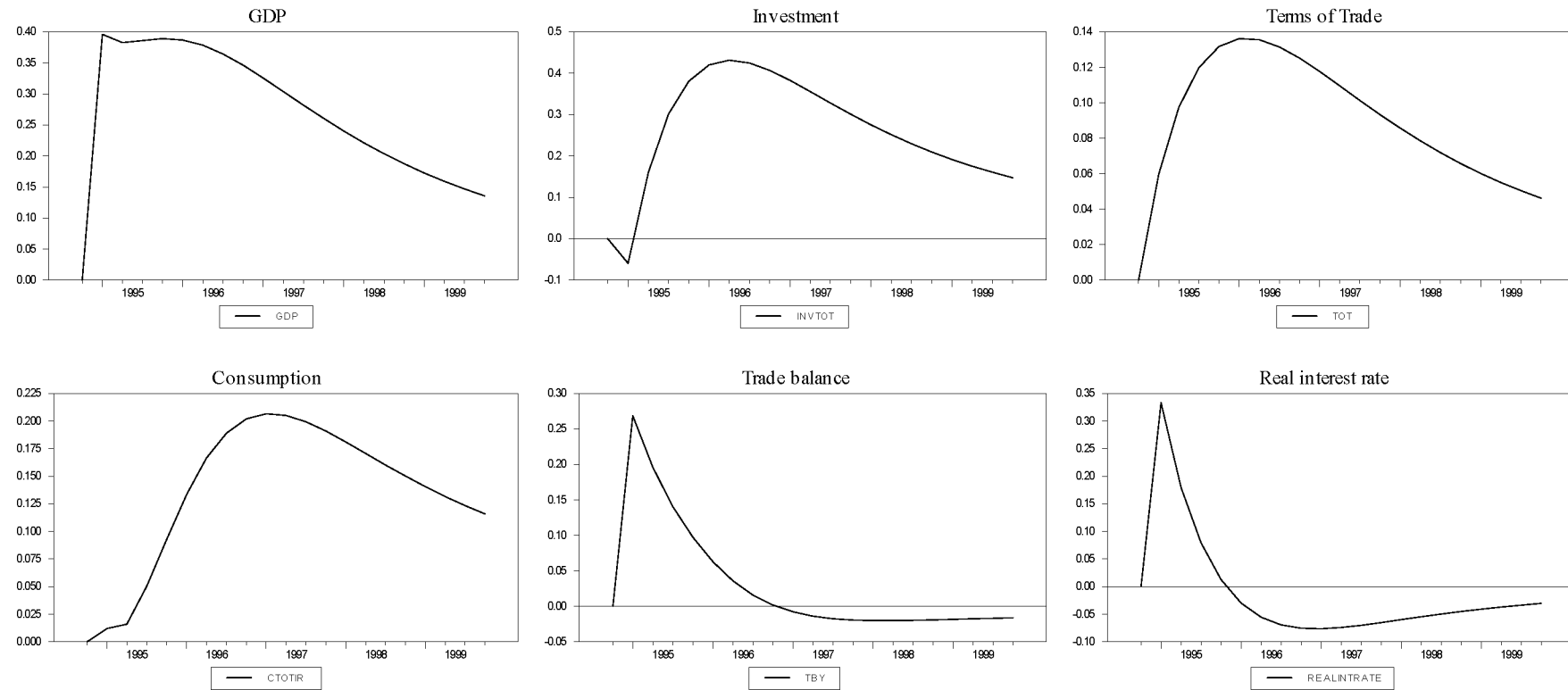
Notes: Annual average growth rates.

Table 3: QUEST - Calibration

| <b>Parameter values</b>           |        |  |
|-----------------------------------|--------|--|
| Parameter                         | Value  | Description  |
| $\beta^r$                         | 0.9875 | Discount factor Ricardian households   |
| $\beta^c$                         | 0.97   | Discount factor collateral-constrained households                            |
| $\kappa$                          | 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                                   |
| $\delta^T, \delta^{NT}$           | 0.015  | Depreciation rate of capital the T and NT sector                             |
| $\delta^h$                        | 0.0025 | Depreciation rate of house   |
| $\sigma$                          | 0.5    | Elasticity of substitution between T and NT goods                            |
| $\sigma^{TD}, \sigma^*$           | 2      | Elasticity of substitution between domestically and foreign produced T goods |
| $\nu$                             | 0.5    | Elasticity of substitution between housing investment and new land           |
| $\sigma^{int}$                    | 0.5    | Elasticity of substitution between intermediate goods and $Y_t$              |
| $\theta$                          | 10     | Elasticity of substitution between diversified labour input                  |
| $\tau^h$                          | 20     | Elasticity of substitution between diversified $I_t^H(i)$                    |
| $\gamma^P$                        | 20     | Price adjustment cost  |
| $\gamma^{PH}$                     | 2      | Housing price adjustment cost  |
| $\gamma^T, \gamma^{NT}, \gamma^h$ | 15     | Capital adjustment cost  |
| $\gamma^l$                        | 40     | Labour adjustment cost   |
| $\gamma^w$                        | 20     | Wage adjustment cost   |

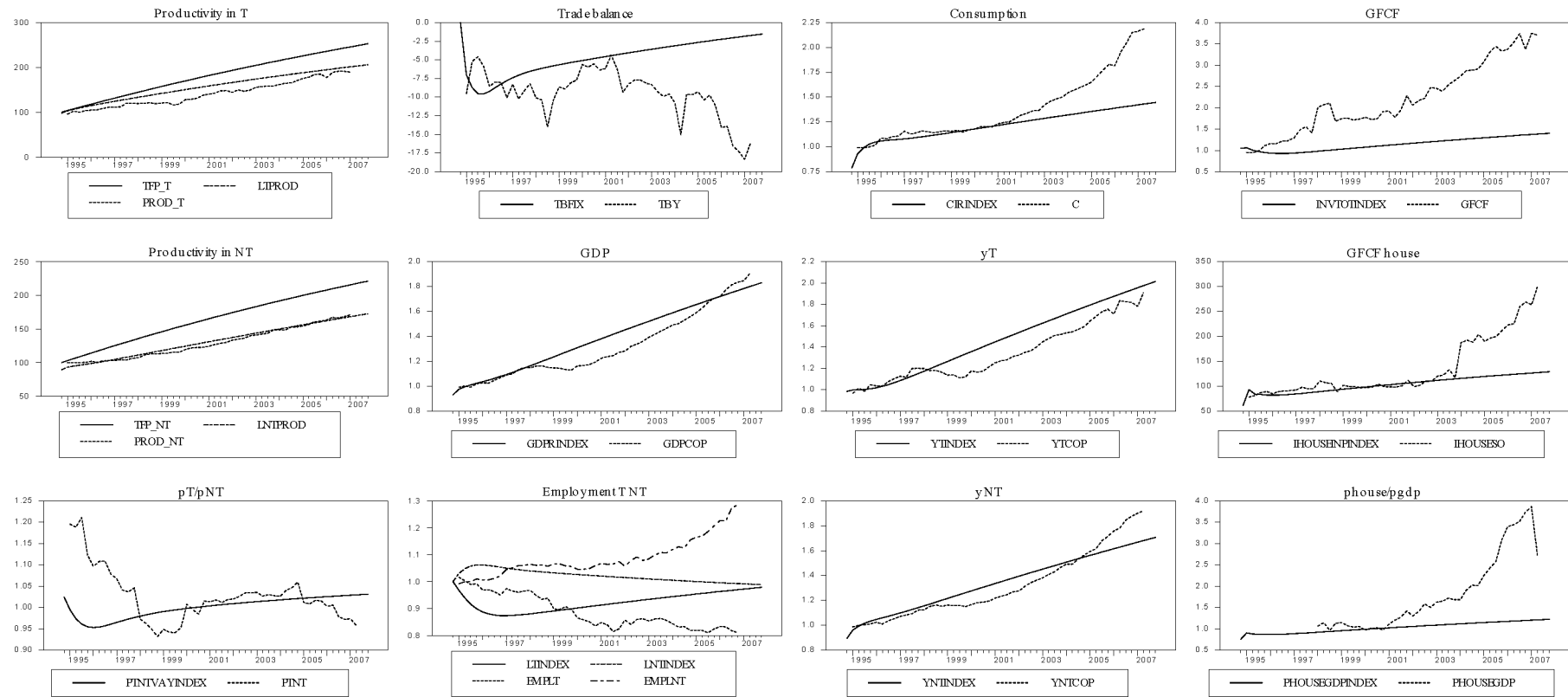


# Figure 1: Productivity shock (T & NT)



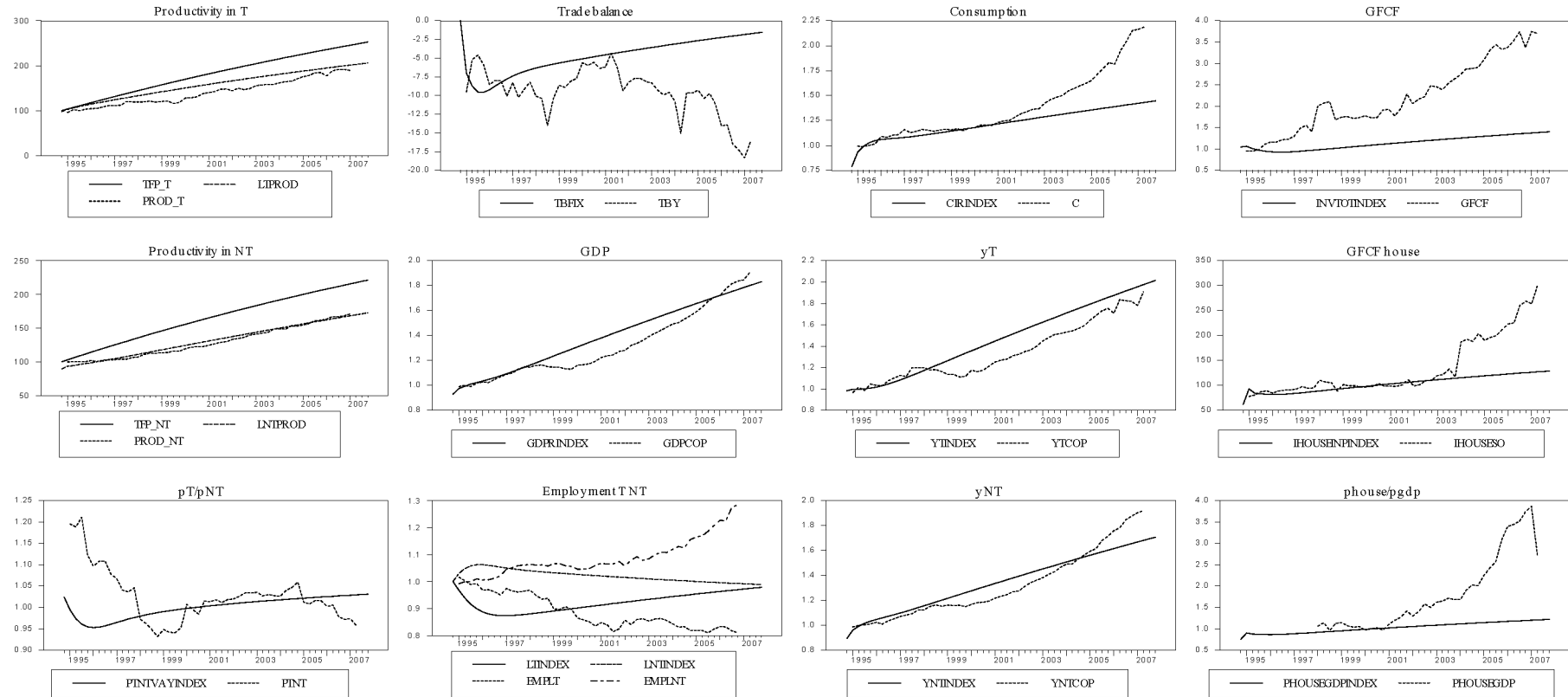
Note: Impact of 1% shock to TFP in both T and NT sectors with an autoregressive coefficient of 0.9.

## Figure 2: TFP growth



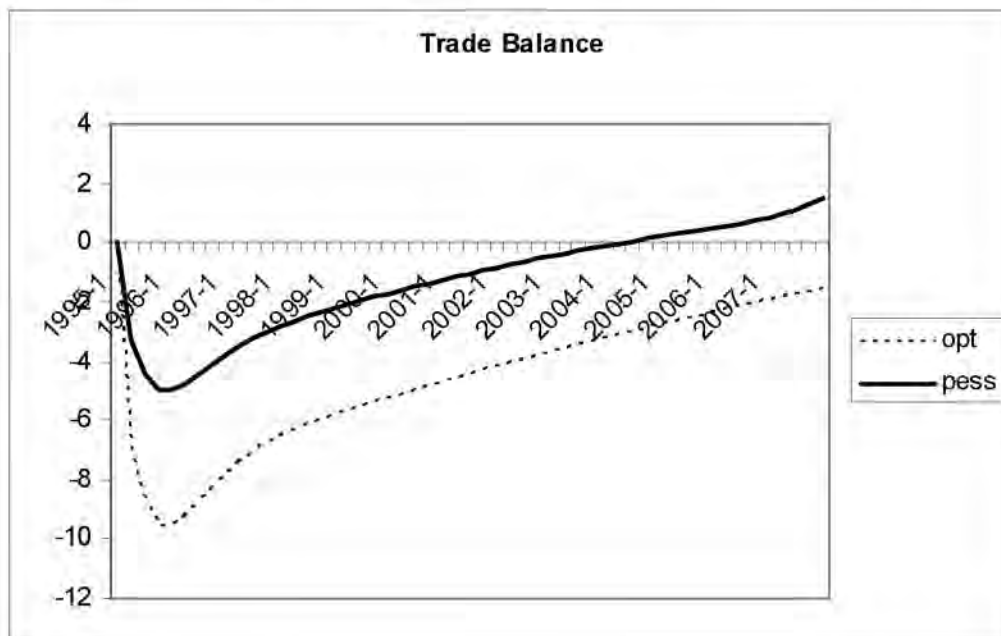
Note: Impact of TFP growth. Calibration of TFP to match labour productivity growth.

# Figure 3: TFP growth - Unforeseen Break



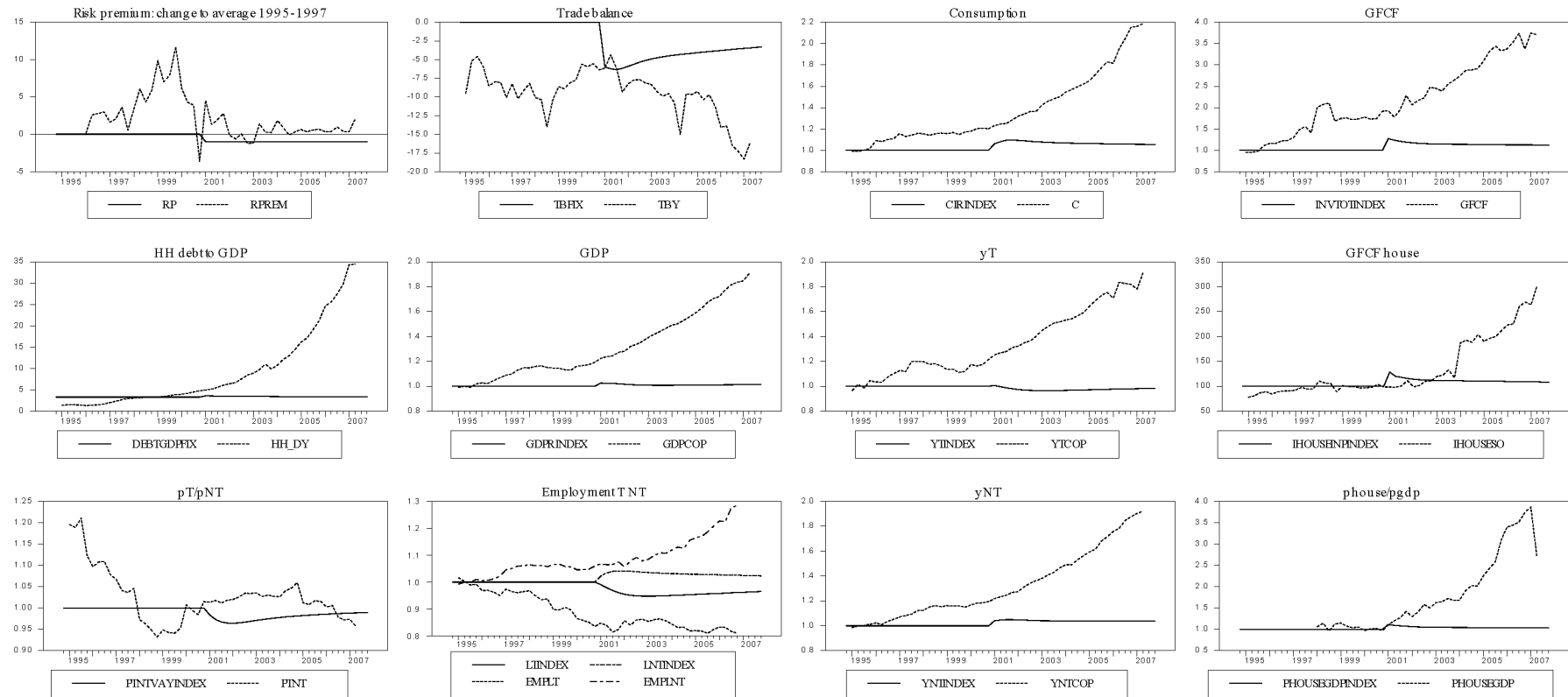
Note: Impact of TFP growth. Calibration of TFP to match labour productivity growth. Unforeseen break in the NT sector TFP growth at 2000Q1.

Figure 4: Trade balance with optimistic and pessimistic growth outlook



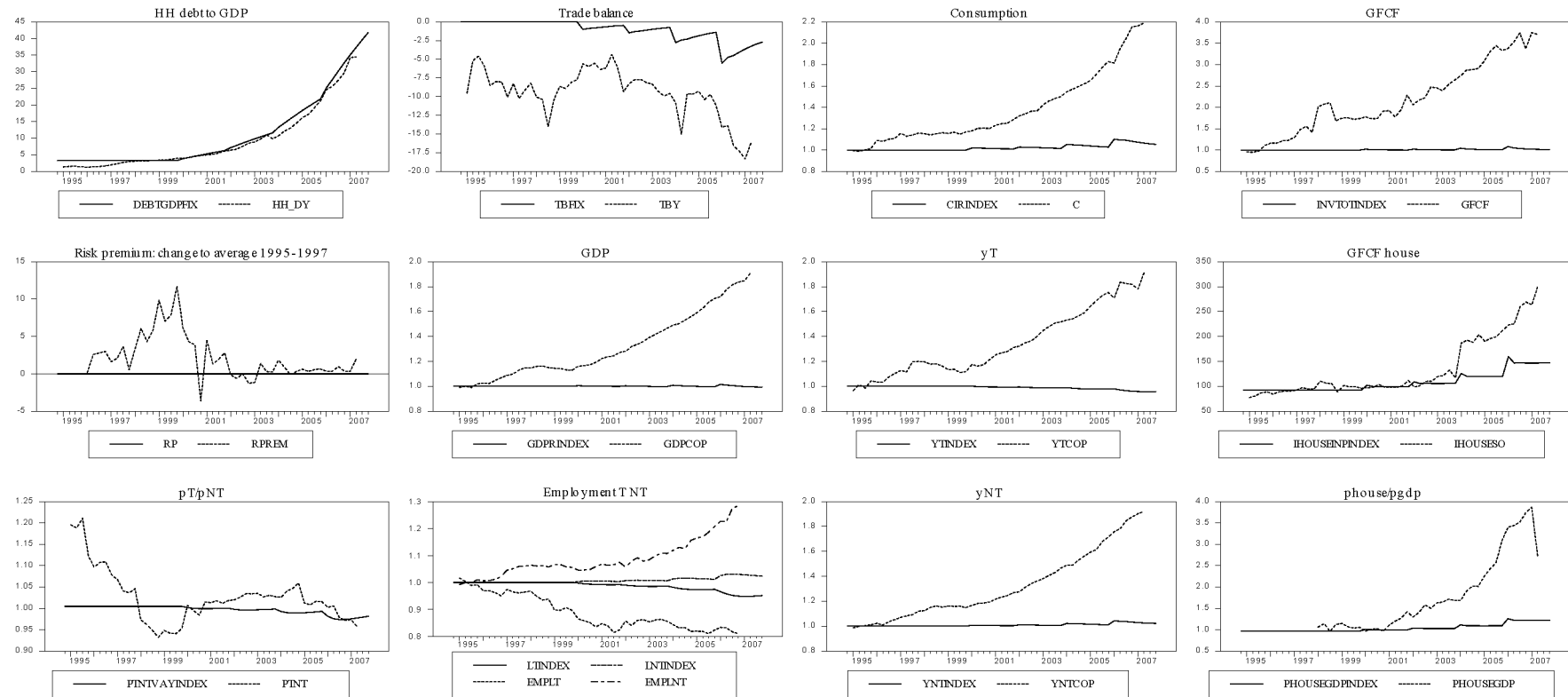
Note: Impact of TFP growth without break calibrated to observed labour productivity patterns over the sample of 1995Q1 to 2007Q2. Optimistic outlook is based on the continuation of growth trends after the end of the sample. Pessimistic growth outlook is based on no TFP growth starting from 2008Q1.

# Figure 5: Fall in Foreign Risk Premium



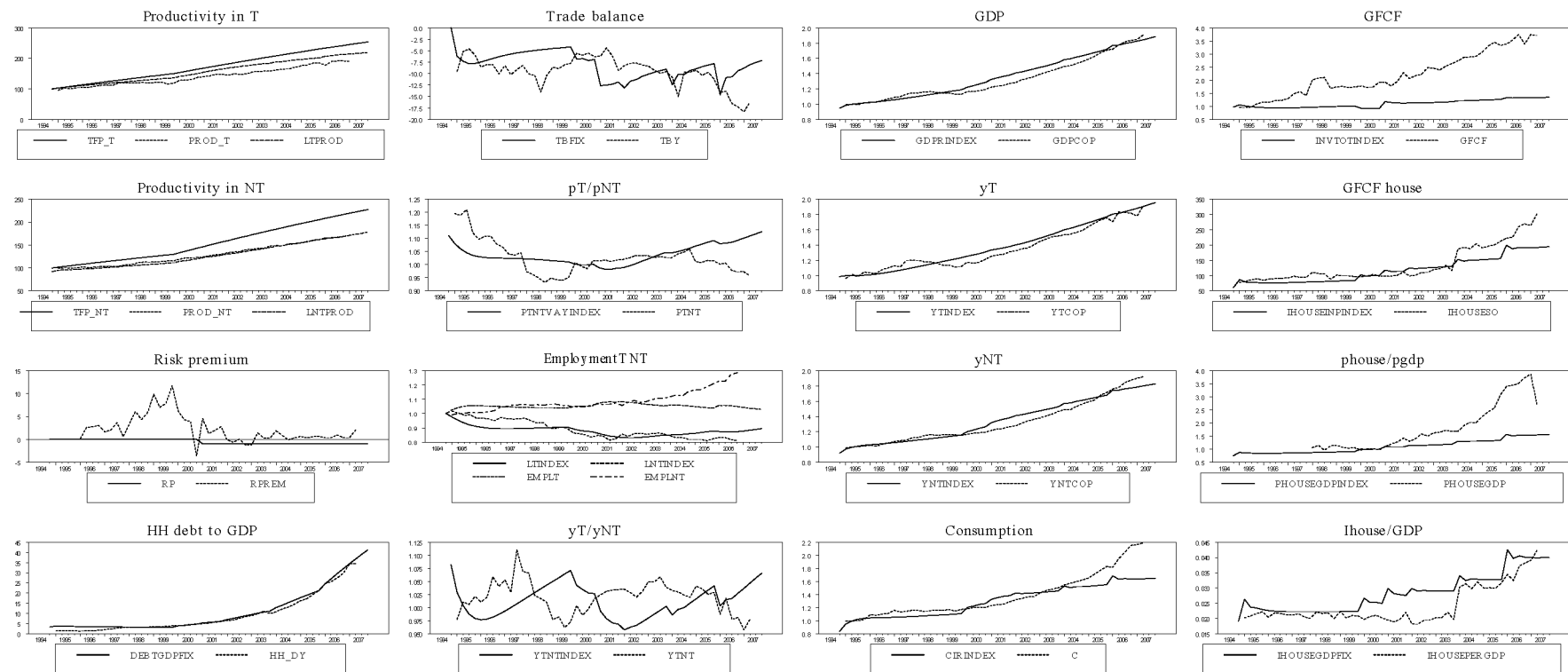
Note: Impact of a 100 basis point permanent fall in foreign risk premium.

# Figure 6: Easing 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 7: Combined impact of 3 factors



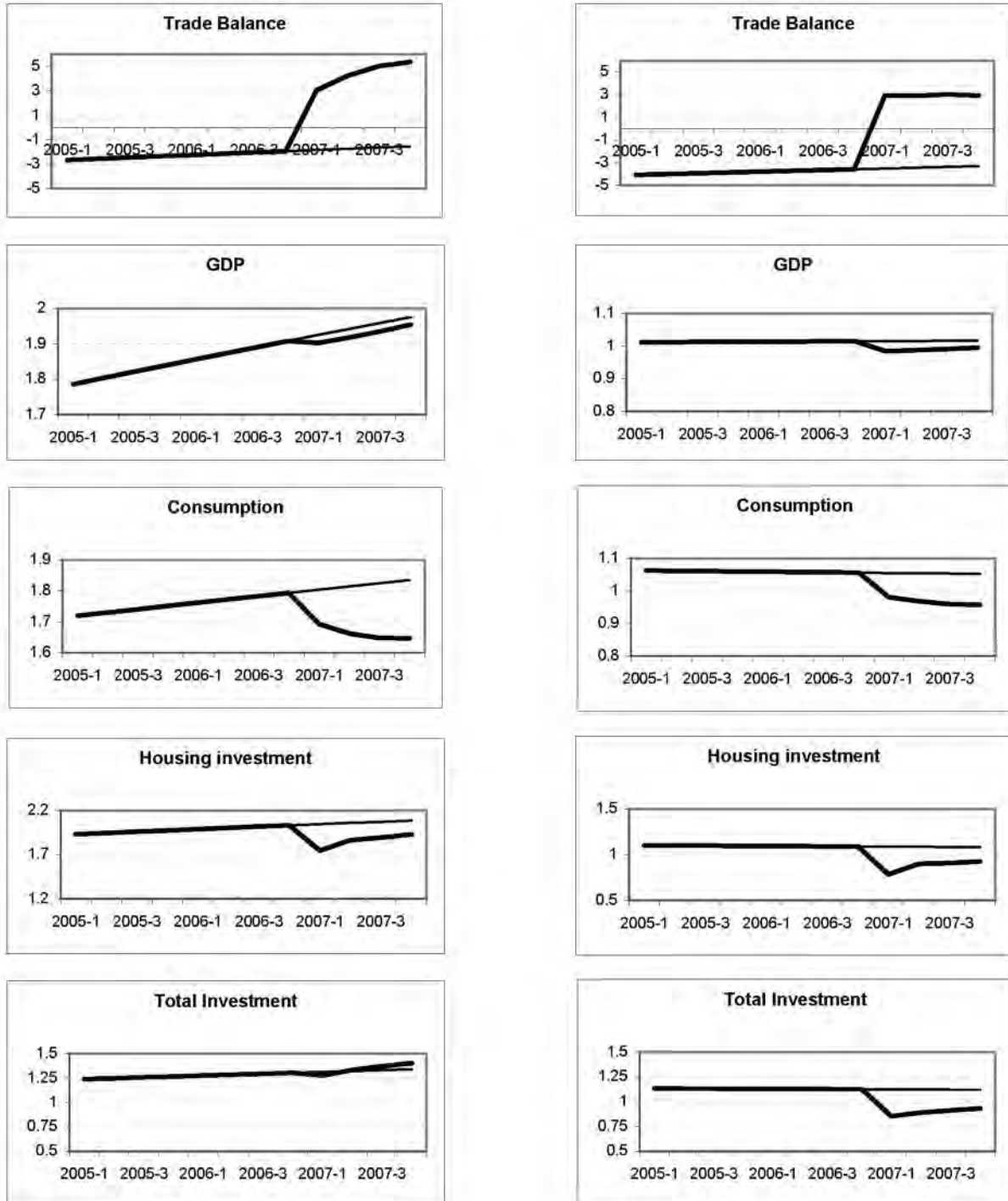
Note: Combined impact of TFP growth (with unforeseen break in 2000 in the NT sector), 100 bp permanent fall in foreign risk premium as of 2001Q1 and of the accelerating increase in the Loan-to-value ratio.

**Figure 8: Reversal Scenarios**

**8.a Growth outlook**

**8.b External Risk Premium**

Thin lines: Baseline scenario; Bold lines: Reversal scenario



Note:

(a) Impact of TFP growth with a revision of growth outlook in 2007Q1 for the periods from 2008Q1 onward. The baseline scenario is based on the optimistic outlook of a continuation of growth trends (see Figure 2). The revision expects zero TFP growth from 2008Q1.

(b) Impact of the reversal of low external spreads. Optimistic scenario:  $U_t^{upp} = -100\text{bp}$  from 2001Q1 to the end of the simulation period (see Figure 5). Reversal:  $U_t^{upp} = 0\text{bp}$  from 2007Q1.