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Abstract

In this paper we analyse determinants of the recent boom-and-bust cycle of the Lithuanian economy with the help of a medium-sized macroeconometric model that incorporates a functional financial block. Special emphasis is put on the role of credit market conditions during the overheating episode. We quantitatively estimate the impact of credit conditions and externally funded bank lending on macroeconomic developments. There is evidence that easy credit conditions and active credit expansion contributed moderately to real economic growth but significantly added to overheating pressures by pushing up real estate prices, encouraging concentration of labour and capital into procyclical sectors and increasing private sector's debt burden. During the boom episode buoyant external environment provided strong background for export-led growth, which was later strongly affected by temporary foreign trade collapse at the outset of the economic crisis. Model results also suggest that government's discretionary fiscal policies may have contributed to economic overheating and severity of the ensuing crisis by not adopting sufficiently prudent fiscal stance during the boom episode. The model confirms that more favourable interest rate environment and accommodating fiscal policies are important for providing a temporary relief for the crisis-stricken economy but deep structural transformation of the economy is needed for the sustainable recovery to take hold.

Keywords: structural macroeconometric modelling, macrofinancial linkages, economic cycles, credit, banking sector, housing price bubble
JEL classification: E10, E17, E37, E51

Santrauka

Šiame straipsnyje nagrinėjami pastarojo ekonominio bumo ir nuosmukio veiksniai, pasitelkiant vidutinės apimties makroekonometrinį modelį, kuriame įtrauktas ir finansinis blokas. Darbe daug dėmesio skiriama kredito rinkos sąlygų ir bankų skolinimo, finansuojamo užsienio finansiniais ištekliais, poveikiui šalies makroekonominiams procesams kiekybiškai įvertinti. Yra požymių, rodančių, kad palankios kreditavimo sąlygos ir aktyvus kreditavimas realųjį ekonomikos augimą skatino nuosaikiai, tačiau gana reikšmingai didino ekonominio perkaitimo riziką, nes turėjo stiprų skatinantį poveikį nekilnojamojo turto kainoms, darbo jėgos ir kapitalo koncentracijai į ciklišku pasižyminčius sektorius bei lėmė didėjančią išaugusio įsiskolinimo aptarnavimo naštą. Stipri užsienio paklausa bumo metu sudarė sąlygas spačiai augti eksportui, o jos žymus laikinas sumažėjimas krizės metu stipriai neigiamai paveikė šalies ekonomikos raidą. Modelio rezultatai patvirtina, kad bumo metu vykdyta diskrecinė išlaidų politika, kuomet nebuvo įgyvendinta pakankamai atsargi fiskalinė pozicija, galėjo prisidėti prie ekonominio perkaitimo susidarymo ir apsunkinti krizės padarinius. Modelio rezultatai taip pat rodo, kad palankesnė palūkanų normų aplinka bei skatinanti fiskalinė politika yra svarbūs veiksniai, galintys bent laikinai palengvinti krizės naštą ekonomikai, tačiau siekiant tvaraus ekonomikos atsigavimo būtina kartu vykdyti rimtas struktūrines ūkio reformas.

1. Introduction

The Lithuanian economy was among those hardest hit by the global financial crisis that erupted in 2008. The crisis also exposed economists' potential misperceptions of the drivers behind economic growth during this decade. Prior to the crisis, it was widely believed that the Lithuanian economy was fundamentally sound, driven by rising productivity and financial deepening, and the apparent overheating pressures were expected to subside in an orderly fashion in response to tightening monetary conditions. Now it seems that the economic cycle was considerably more reliant on excessive borrowing, overspending and non-productive overinvestment than was generally perceived a priori.

The interplay between the macroeconomy and the financial sector in Lithuania has not captured much attention in the economic literature yet. Almost all existing macroeconometric models were developed prior to or at the early stages of the credit and housing boom and did not explicitly incorporate the financial sector, indebtedness of the economy and property prices. Unsurprisingly, they were not well suited to discern between economic activity driven by increasing productivity and growth based on excessive borrowing. For this reason some models tended to produce overly optimistic estimates of potential (or sustainable) economic growth. So there is an urgent need to reassess the recent boom-and-bust episode and try to deepen our understanding about the implications of cyclical developments in the credit and property markets for the broader structural macroeconomic trends and viability of the economy.

In this paper we present a medium-sized structural econometric model of the Lithuanian economy. The model includes a stylised banking sector and assigns a role for property prices. Financial variables affect the real economy not only directly fuelling demand for consumption goods or facilitating investment projects but also via financial accelerator and credit multiplier effects. The model is primarily aimed at examining the relative importance of financial developments in the recent and economic cycle (constrained, by the availability of data, from the beginning of 2000 to mid-2009). For this purpose we conduct the shock analysis and experiment with different scenarios. The results can be interesting from the policy makers' perspective. Our conducted out-of-sample investigation of the adequacy of the model suggests that the model or at least its specific equations and blocks could be useful for the short-term forecasting. In general, the present model can be regarded as a reasonably coherent framework for the analysis of the recent economic cycle.

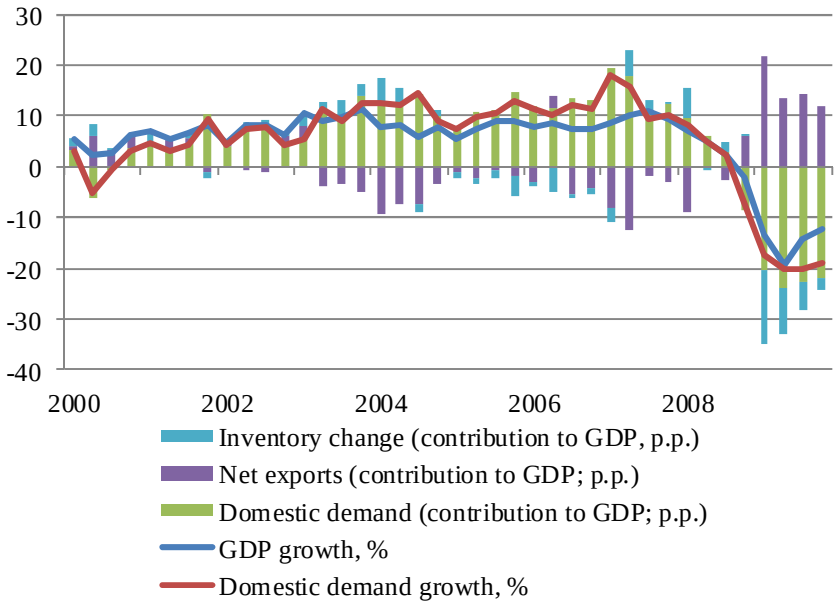
The model suffers from the usual econometric problems associated with the relatively small data sample (and just one economic cycle episode), and there is also lack of solid economic theory for the case of an overheating transition economy. Therefore, limitations of any structural macroeconometric model under such circumstances must be clearly understood, and model results always have to be interpreted with caution. For this reason we do not fixate on the technical presentation of the model but rather put considerable amount of effort into presenting the broader macroeconomic background and economic interpretation of results.

The rest of the paper is structured as follows. In Section 2 we provide a brief overview of economic developments during the overheating and downturn periods in Lithuania. Section 3 contains extensive presentation of the model. In Section 4 we present the model solution outcome, assess the model's in-sample and out-of-sample performance, and implement shock analyses. To analyse the importance of selected financial, policy and external variables for the economic cycle, we conduct the scenario analysis and report its results in Section 5. Section 6 concludes.

2. Overview of recent economic developments

As one of the main objectives of the current paper is to understand macroeconomic determinants of the recent economic and financial crisis, let us start by putting the current economic downturn into perspective. For most of the decade Lithuania enjoyed a very strong economic boom: in the period from 2000 to 2007 its GDP grew on average by almost 8%. However, in the second half of 2008 economic activity suddenly stalled, and in 2009 the economy experienced a striking 15% contraction. One of the main drivers of the boom-and-bust cycle has been the dynamics of domestic demand (see Figure 1). Credit-fuelled domestic demand provided a powerful stimulus for the overall economic activity during the boom years but it collapsed along with the burst of the house price bubble and with more stringent lending conditions.

Figure 1. Drivers behind economic growth in Lithuania

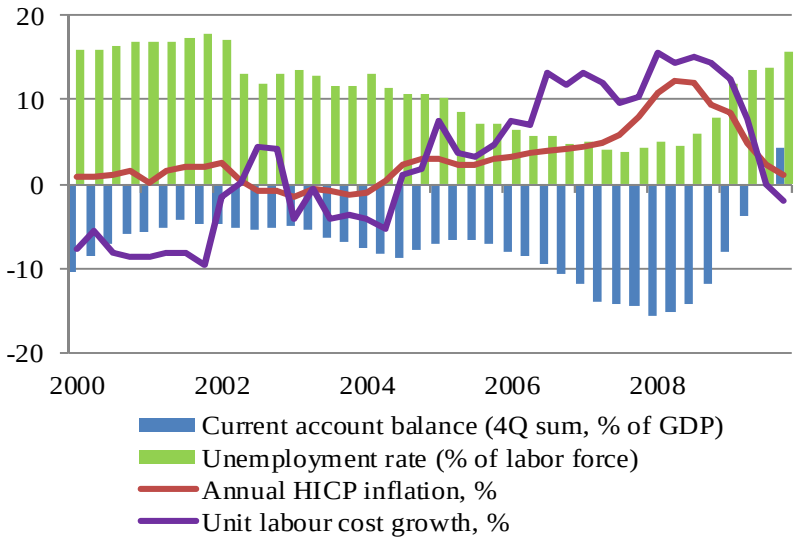


Of the GDP expenditure components, investment took the biggest hit. Following an extended period of buoyant growth exceeding 10% per annum, the trend reversed in 2008, and in 2009 real investment expenditure plunged by 39%. Investment in manufacturing equipment and transport equipment contracted by 38% and 80%, respectively, while residential investment was slow to react initially but rapidly deteriorated in 2010. Despite exhibiting slower average growth than investment during the economic upturn, private consumption (being a larger expenditure component in the GDP) contributed considerably more to the economic growth figures. From 2000 to 2007, pro-cyclically rising incomes and abundant credit ensured average annual private consumption growth of 9%. In contrast, real household consumption tumbled by 18% in 2009.

During the episode of rapid economic expansion the fiscal policy was quite pro-cyclical, even though the government managed to keep both fiscal deficits and public debt levels in check. More specifically, government spending was most active in the overheating period between 2005 and 2008, when government expenditure grew on average by almost 20% per annum. It should be noted that rising nominal GDP boosted the tax base and tax revenue, which allowed budget deficits to remain comfortably below 3% of GDP. Public debt even declined

gradually to 16% of GDP by the end of 2008. However, the economic boom masked deep structural imbalances of the public finances. As the crisis deepened, government revenue plunged by 17% in 2009 (the slump in the tax revenue was even larger and amounted to 31%). Soaring cyclical social spending and relatively rigid long-term commitments based on optimistic revenue projections implied that government expenditure remained at elevated levels. As a result, the budget deficit rose to 9% of GDP and the public debt reached 28% of GDP at the end of 2009. The fiscal policy, remaining essentially expansionary, turned anti-cyclical. This helped to stabilise the economy but at the cost of very steeply rising public indebtedness.

Figure 2. Indicators of overheating pressures



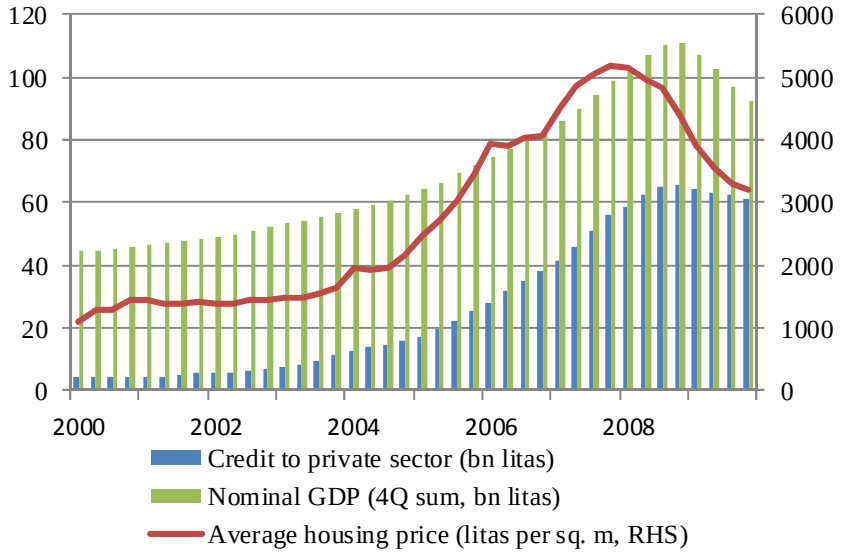
Analysing important factors behind the economic recession, one cannot underestimate the negative impact of the global trade crisis on Lithuanian exports and thereby on the economic activity. During the boom period, growth of real exports outpaced GDP growth. Export growth was very robust and resilient to appreciation of the real effective exchange rate. In the fourth quarter of 2008 exports started to deteriorate very sharply as a result of collapsing external demand – in 2009 real exports declined by 13%, whereas in nominal terms exports tumbled by 25%.

Economic downturn was also clearly associated with sharp unwinding of accumulated domestic imbalances. As can be seen from Figure 2, some overheating pressures emerged back in 2005 and were gradually building during subsequent years. On the back of strong domestic demand, imports boosted and trade imbalances widened. The labour market was becoming tighter, setting the wage growth above the rate of productivity improvements. Consumer price inflation, pushed by rising unit labour costs and pulled by strong credit-driven demand, was gradually rising during the boom period, though inflationary pressures were mitigated by consumers' switching to imported goods.

Sharp unwinding of accumulated imbalances started in the second half of 2008, against the background of progressively deteriorating real estate markets, vanishing credit flows to the private sector and plunging revenue from exports. In 2009, the current account balance turned positive, as imports fell considerably more than exports. Consumer price inflation was brought down effectively to zero, whereas unit labour cost growth turned negative. The labour market adjusted more in real rather than nominal terms. Unemployment rate surged to 16% at the end

of 2009 from its lows of 4%. Wages were slower to react, especially in the public sector, but the subsequent wage decline was quite substantial. Much of the lost employment and depressed economic activity was closely related to the pro-cyclical sectors, namely, construction, trade and certain manufacturing sectors. A sharp increase in the number of corporate bankruptcies, coupled with surging long-term structural unemployment, indicate that the economy is in the process of deep structural transformation, which may have a profound effect on the potential of economic development in the future. Under these circumstances, estimation of potential economic growth or forecasts of future economic convergence, based on the neoclassical modelling framework or on simple econometric extrapolation, may be confronted with insurmountable problems.

Figure 3. Credit deepening and housing prices

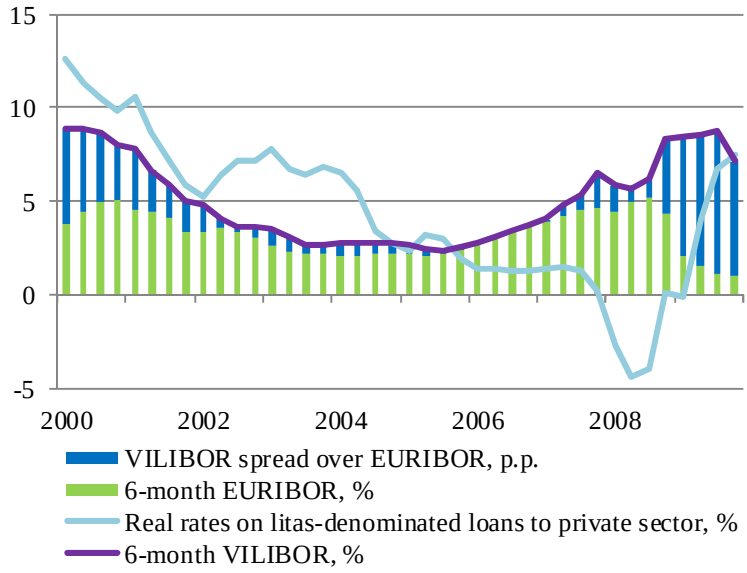


Credit growth and property price developments shed more light on the recent boom-and-bust cycle, as they were essentially a flipside of the processes in the real economy. Starting from miniscule levels in 2003, bank credit to the private sector grew on average by 47% per annum until it reached its peak at the end of 2008. House prices more than tripled over the same period before market liquidity dried up at the beginning of 2008 (see Figure 3). They had plunged by more than 40% from the peak by end-2010. Considerably more than a half of bank loans to the private sector directly relate to the development or acquisition of commercial or residential real estate, so the bust of the real estate price bubble had a sizeable impact on bank balance sheets. In 2009, bank credit to the private sector contracted by 14%, as a result of large write-offs and credit rationing in the face of changing risk perceptions. Losses incurred by the banking system in the aftermath of the crisis essentially wiped out bank profits earned during the whole decade.

The crisis episode coincided with sharp rises in interest rates, especially on litas-denominated loans. One of the most significant developments was a dramatic decoupling of interbank rates (Vilibor) from commensurate euro zone interbank rates (see Figure 4), which basically reflected loss of confidence in the interbank market amid huge economic uncertainty and banks' urge to price in previously neglected risks. As rates on litas-denominated variable-rate loans are associated with interbank rates, private sector borrowing cost rose sharply. The private sector's real debt servicing burden was exacerbated by deflationary environment, falling wages and decreasing employment. In addition, credit risk premia for non-financial sector

borrowers have been revised upwards materially, and generally there were many indications of the imposed credit rationing. An increase in the price of credit and its reduced availability arguably had a strong negative impact on the real economic activity, though there must, of course, be two-directional causality in this regard.

Figure 4. Bank interest rate environment



There could be several possible economic explanations as to why the economic slump has been so severe in Lithuania. First, the credit and housing price boom has been especially strong – low initial indebtedness and low real estate prices provided additional impetus for extremely dynamic developments and masked the severity of overheating pressures. Second, it seems that due to the peg of the national currency to euro, foreign banks active in Lithuania tended to underestimate currency and inflation risks (and, ultimately, overheating and credit risks) of the Lithuanian economy, which resulted in extremely favourable interest rate environment and lending conditions during the boom years. Third, following the burst of the bubble the currency peg prevented depreciation of the nominal exchange rate and may have contributed to the stronger real adjustment. Fourth, the policymakers were not able to resort to active monetary policy instruments or ensure an effective pass-through of the accommodative monetary policy implemented in the euro area, as the tied-hands monetary policy and an ineffective interbank market resulted in divergence from respective euro zone interbank rates and thereby much higher litas-denominated loan rates (both for new and many existing borrowers). Fifth, the Lithuanian economy, like some other countries in the region, lacked a solid industrial "backbone" and was therefore more vulnerable to severe shocks to the non-tradable sector and domestic demand in general. Finally, pro-cyclical government spending during the boom years boosted economic growth figures but eventually resulted in unsustainable financial commitments and very little room for manoeuvre for strategically tackling the consequences of the crisis with fiscal policy tools.

3. The model

The model includes the following building blocks: aggregate supply (production function), aggregate demand, income block, labour market, fiscal block, external sector, financial sector, rudimentary real estate market and price block (see Appendix A). Most of the blocks are highly stylised as we attempt to keep the number of variables low and try to maintain a tractable model structure.

3.1. Economic modelling considerations

A most common approach to modelling Lithuanian economy or similar emerging market economies is to assume that in the long term the economy follows some equilibrium growth path[1], which is obtained by blending theoretical postulations, calibration of parameters, and extrapolation of in-sample values of important variables. Short-term dynamics of the economy is usually modelled by ad hoc regressions. Assumptions about long-term balanced development are important for ensuring models' structural coherence and help to obtain smoother and more easily interpretable model responses to shocks. Unfortunately, as the recent massive structural transformation has proven, it was virtually impossible to have correct a priori estimates of balanced growth path of an emerging economy because its balanced-growth features (e.g. parameters describing technological convergence, capital or labour productivity) are path-dependent and in principle a priori indeterminate. In other words, such factors as indebtedness or economic capital structure, which change dramatically during a bubble episode, inevitably have a deep impact on the economic growth potential. In such case, somewhat superficial imposition of postulated semi-theoretical long-term constraints can hardly ensure the correct structure of the model economy. Moreover, if economic time series are short, there is an additional risk that balanced growth estimates will be influenced by current developments and those developments in turn will be deemed closer to the balanced growth than they actually are.

Qualitative analysis of the recent overheating episode in Lithuania also suggests that standard macroeconomic theories, based on strong neoclassical assumptions about efficient markets, balanced growth or rational optimising agents, may not constitute an adequate analytical framework for the case of an overheating emerging economy. The fundamental problem is that if one is willing to analyse or forecast out-of-equilibrium phenomena, such as formation of economic imbalances, one cannot safely resort to equilibrium theories or balanced-growth theories. And it is precisely the imbalanced development that was the primary characteristic of the Lithuanian economy during a large part of the decade: there was overconsumption, overinvestment, excessive government spending, overborrowing of the private sector, procyclical concentration of capital and labour into booming sectors, bottleneck effects in labour and product markets, etc.

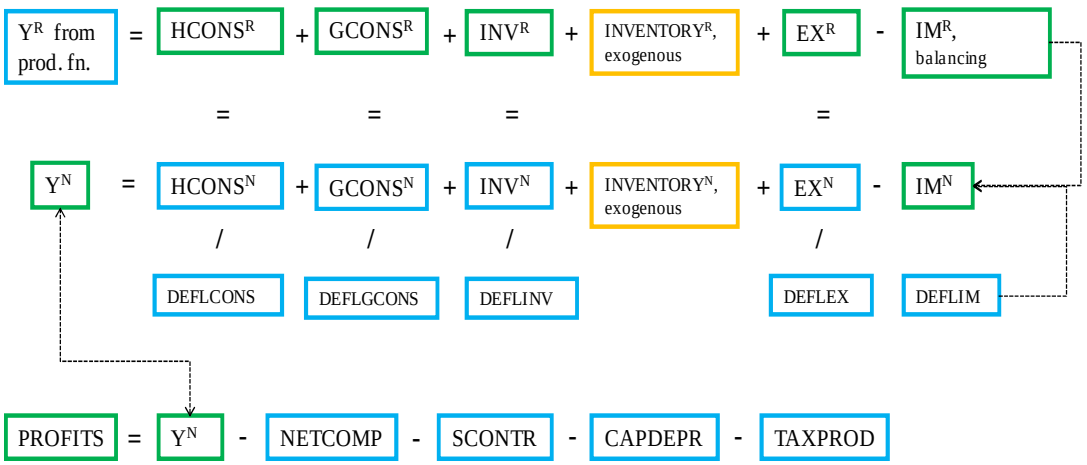
It is quite obvious that during the analysed boom-and-bust episode firms and owners of production inputs did not base their economic decisions on long-term equilibrium considerations, thus theoretical equilibrium conditions related, for instance, to wage setting behaviour, investment or production decisions, can be of little use for enhancing internal model

[1] See Celov et al. (2003), Vetlov (2004), Rudzkis and Kvedaras (2005) for some of the few existing macromodels of the Lithuanian economy; see also the macromodel for the Estonian case develeoped by Kattai (2005) and the Latvian macromodel built by Benkovskis and Stikuts (2006), both of which share similar modelling framework to Vetlov (2004).

structure. Therefore, instead of imposing long-term structural restrictions, we concentrate on ensuring contemporaneous internal consistency of the model, primarily by using the National Accounts identities as a basic framework.

The simplified structural background of the model is laid out in Figure 5 (see Appendix E for variable explanations). The blue-contoured textboxes contain variables that are modelled in behavioural equations, variables in green-contoured textboxes are obtained from identities, and variables in yellow-contoured textboxes are exogenous. We loosely interpret real output in the upper-most GDP identity as the aggregate supply determined by production inputs and productive technology. Aggregate supply changes slowly in response to changes in employed capital, labour or technology. Aggregate demand is determined on the nominal side of the economy (see the second line in Figure 5). For instance, household income, availability of credit and corporate profits determine how much people and firms are willing to spend on consumption and investment. It is very important to note that money creation via credit issuance or via government borrowing from abroad is not immediately neutralised by rising prices, and these adjustment processes are further hampered by the fixed exchange rate regime effective in Lithuania, as the nominal exchange rate cannot adjust. So it is reasonable to assert that nominal shocks primarily create imbalances between aggregate demand and aggregate supply.

Figure 5. Model's structural background



There are three main channels of adjustment of supply and demand in the model: real activity adjusts, prices adjust, and imports adjust. Various price deflators in the model depend on measures of balance between aggregate demand and supply, and on other specific factors. Once aggregate demand is determined in both real and nominal terms, the remaining imbalance between what is actually produced and what is demanded in the model economy is reconciled by adjusting real imports, which serve as a balancing variable. Generally, in response to excess demand prices rise, and this leads to higher sales revenue and higher profits of domestic producers (though this is dampened somewhat by the increasing imports share). As a result, firms are willing to step up investment, hiring and production activities, thereby substantiating yet another channel of real adjustment. The preceding discussion also motivates our choice of imports rather than inventories as the residual balancing variable – in response to excess demand imports rise and weigh down on domestic producers' profits and, eventually, on household incomes, which has a stabilising dampening impact on aggregate demand. If

inventories were allowed to adjust, it would be difficult to economically interpret the impact of their adjustment on profits and the overall economic activity. Moreover, inventory indicators are compiled essentially as a balancing variable by Statistics Lithuania. In the analysed sample, inventory statistics contain a lot of noise and occasionally exhibit quite peculiar behaviour, therefore they are considered exogenous in the model.

A very important feature of the model is that it has an explicit financial sector. In our view, linkages between financial sector developments and the overall economy are crucial for understanding the recent economic cycle. Therefore, unlike many traditional models, the current model differentiates between loans to households and loans to firms, as well as between sight and term deposits, and allows for different interest rates. Credit market developments are modelled in the context of the broader economy and intuitively relate to both supply and demand side of the economy. It is also recognised that not only do credit flows matter but so does the overall debt levels in the economy (as debt has to be serviced).

3.2. Model data and type

The proposed model is a medium-sized structural macroeconometric model. It consists of around 30 estimated equations and 20 identities. There are about 60 endogenous and 20 exogenous variables in the model. Most of the estimated equations have the error-correction form. They are estimated following a two-step procedure: first long-term relationships among variables are estimated in the cointegration regressions and lagged residuals from these regressions (i.e. deviations from the long-term relationship) are then included in the dynamic regressions among time-differenced variables. All behavioural equations are estimated on the individual basis by the Ordinary Least Squares estimation method. The model is estimated using EViews econometric software package.

The model is estimated based on a sample of quarterly observations that span the period from 2000 Q1 to 2009 Q2. Six more quarters (up to 2010 Q4) were used for the assessment of model's out-of-sample adequacy. The data sample is individually adjusted for lagged observations in individual regressions. Where necessary, variables are seasonally adjusted by applying the standard Census X12 procedure.

It should also be noted that in most cases variables enter the model in normal (non-logarithmic) form. This is necessitated by several circumstances. First, some of the principal variables, such as credit flows, can turn negative. Second, log-linear regressions are used for the analysis of relationships between growth rates of variables (and thus are very useful for macromodels with a focus on long-term balanced-growth) but in the current case some variables, especially credit variables, exhibited tremendous variation in growth rates due to a low initial base. For this reason it often proved economically unreasonable to expect stable relationships among variables in their logarithmic form. The downside of this choice is that it makes economic interpretation of regression coefficient values less straightforward.

3.3. Modelling productive capacity of the economy

We start our detailed exposition of the model structure with the analysis of the productive capacity of the economy. It is determined directly by the existing technology (production function) and employment of production factors, namely, capital and labour. Firms gradually change supply in response to conditions in the factor markets and profitability prospects.

3.3.1. Aggregate production function

The supply side is modelled by the aggregate production function approach. Like in the basic Cobb-Douglas production function, real capital stock (K^R) and labour (L) employed in the production process are main determinants of productive capacity. On the other hand, it is important to account for heterogeneity of capital. During the recent economic cycle capital employed in productive activities (manufacturing) and capital employed in procyclical activities (non-tradable sector and, in particular, real estate development) were likely to contribute differently to the overall economic activity and long-term economic fundamentals. Since reliable statistical data on the capital structure in Lithuania are not available, we use investment in manufacturing machinery ($INVM^R$) and investment in construction ($INVC^R$) as proxies for capital structure in the aggregate output (Y^R) supply regressions:

$$\ln(\bar{Y}^R) = \underset{(2.37)}{0.17}\ln(K^R) + \underset{(6.43)}{0.68}\ln(L) + \underset{(4.67)}{0.18}\ln(TREND) + \underset{(6.36)}{0.15}\ln(INVM^R) + \underset{(3.94)}{0.13}\ln(INVC^R_{-1}) \quad (1)$$

R^2 = 0.993; *D.W.* = 1.511; obs. 38; adjusted sample: 2000Q1-2009Q2.

$$\Delta\ln(Y^R) = \underset{(-4.10)}{-0.74}\ln(Y^R_{-1}/\bar{Y}^R_{-1}) + \underset{(2.63)}{0.50}\Delta\ln(K^R) + \underset{(2.87)}{0.56}\Delta\ln(L) + \underset{(5.43)}{0.14}\Delta\ln(INVM^R) + \underset{(3.09)}{0.11}\Delta\ln(INVC^R_{-1}) \quad (2)$$

R^2 = 0.717; *D.W.* = 1.535; obs. 37; adjusted sample: 2000Q2-2009Q2.

Here, variable *TREND* is a time trend. Operator "ln" denotes natural logarithm and Δ is the temporal difference operator, which gives a quarterly change of a variable at hand. A bar over a variable denotes the estimated dependent variable in the long-term regressions. Superscript "*R*" indicates real variables, whereas numerical subscripts indicate lags of a given variable. In the parenthesis below each regression coefficient we provide its associated *t*-statistic. For each regression we also report the basic *R*-squared and Durbin-Watson statistics, the number of observations in the regression and the actual estimation period.

A few observations regarding the output equation are in place. The constant term in the levels regression was statistically insignificant and was removed. Investment in construction is lagged for a better fit. Is should also be noted that analysis of various specifications of the production function reveals that a robust empirical relationship between aggregate output and the capital stock cannot be easily determined for the data sample at hand, so one has to be extremely careful postulating theoretical relationship and deriving theoretical factor demand functions. The problem is aggravated by the circumstance that reliable statistical data on the capital stock are not available, and we have to construct it by the perpetual inventory method as accumulated real investment less depreciation. Capacity utilisation at the economy level is not known and we do not assume any sort of physical capital destruction aside from natural depreciation, so the downward rigidity of capital in the output equation makes it very difficult to explain the deep downturn of the level of output during the recession. This provides at least a partial explanation of why the estimated long-term sensitivity of output with respect to the capital stock is rather low. The investment variables used in this regression not only serve as rough proxies for the capital structure but may also reflect the utilisation of productive

capacities – a decline in investment activity during the economic downturn should also be indicative of declining productive capacity utilisation.

3.3.2. Modelling dynamics of production inputs

Traditional structural macromodels usually derive factor demands from the production function assuming profit maximisation, as well as perfect competition in product markets and factor markets. While this could cleraly have some rationale in the case of forecasting models with (very) long analysis horizon, this is certainly not the case when we are dealing with a relatively short overheating episode characterised by unsustainable growth of factor demands and severe bottleneck effects in various markets. We therefore do not require that firms maximise their profits in the model but make a considerably weaker assumption that labour hiring and capital accumulation positively depend on profits, as strong profits generally reflect business expansion opportunities.

3.3.2.1. Wage and employment determination in the labour market

The basic line or reasoning with regard to labour hiring decisions is that in pursuit of increasing profits firms make budgeting decisions and determine what part of their revenue to allocate for aggregate compensation of employees. At the same time, economic and labour market conditions determine allocation of these funds, i.e. the actual level of employment and average wage. For instance, a firm may consider profitable expansion opportunities but in order to do so it needs to allocate more resources for its employees – it may result in new hiring or/and longer working hours of currently employed labour force (which means higher monthly salaries) depending many factors such as tension in the labour market, labour contracts, etc.

In the model, aggregate nominal compensation of employees (*GROSSCOMP*), which includes employees' social contributions, depends simply on profits in the economy (*PROFITS*), as measured by the operating surplus and mixed income indicator from the National Accounts, and on nominal government consumption (*GCONS*):

$$\overline{GROSSCOMP} = \underset{(-16.22)}{-2334.10} + \underset{(12.66)}{0.53}\, PROFITS + \underset{(24.76)}{1.86}\, GCONS \qquad (3)$$

R^2 = 0.993; *D.W.* = 2.144; obs. 38; adjusted sample: 2000Q1-2009Q2.

$$\Delta GROSSCOMP = \underset{(-2.81)}{-0.46}\,(GROSSCOMP_{-1} - \overline{GROSSCOMP}_{-1}) + \underset{(3.03)}{0.21}\,\Delta PROFITS + \underset{(4.88)}{0.92}\,\Delta GCONS + \underset{(3.77)}{0.44}\,\Delta GROSSCOMP_{-1} \qquad (4)$$

R^2 = 0.690; *D.W.* = 1.928; obs. 37; adjusted sample: 2000Q2-2009Q2.

Nominal government consumption is included in the regressions because a significant fraction of the labour force is employed in the public sector, and government spending is to a large extent comprised of compensation of public sector employees. Not surprisingly, government spending decisions are confirmed to be a very important determinant of the aggregate wage level and, notably, its regression coefficient is much higher than 1 but smaller than 2. This makes economic sense: public sector employees earn their wages and spend a large part of them on domestically produced goods and services, and then a significant fraction of these funds again turn into wages of the private sector employees. This also implies that

government spending can potentially have a very strong temporary stimulating impact on the economy, especially if it is financed by borrowing from abroad rather than by the tax revenue. However, the related issue of the sustainability of the economic recovery supported by fiscal measures should never be ignored.

Whether an increase in compensation of employees will be associated with wage rises or with higher employment is determined by employment equations. In the model employment (L) positively depends on net aggregate compensation of employees[2] (*NETCOMP*), exogenous labour force (*LF*) and investment in construction ($INVC^R$) and negatively depends on consumer price level (*DEFLCONS)*, which erodes real wages:

$$\bar{L} = \underset{(4.71)}{842.71} + \underset{(4.62)}{0.04}\, NETCOMP - \underset{(-5.86)}{627.25}\, DEFLCONS + \underset{(4.84)}{0.59}\, LF + \underset{(2.23)}{0.04}\, INVC^R \qquad (5)$$

R^2 = 0.943; *D.W.* = 0.858; obs. 38; adjusted sample: 2000Q1-2009Q2.

$$\Delta L = - \underset{(-5.48)}{0.65}\,(L_{-1} - \bar{L}_{-1}) + \underset{(2.32)}{0.02}\,\Delta NETCOMP - \underset{(-3.80)}{380.84}\,\Delta DEFLCONS + \underset{(9.34)}{0.77}\,\Delta LF + \underset{(4.24)}{0.04}\,\Delta INVC^R + \underset{(5.16)}{0.39}\,\Delta L_{-1} + \underset{(2.99)}{0.28}\,\Delta L_{-2} \qquad (6)$$

R^2 = 0.863; *D.W.* = 1.404; obs. 37; adjusted sample: 2000Q2-2009Q2.

Equations (5) and (6) can be seen as a reduced-form expression of a very simple model for labour supply and demand. In this light, budgets for labour compensation set up by companies can be seen as a demand-side factor, which positively affects actual employment. The labour force variable is a supply-side determinant of employment. It is notable that over the analysed period employment and labour force exhibited quite different, and sometimes opposite, trends but we get an economically meaningful positive relationship. Sensitivity of employment to labour supply changes is rather low but it is not surprising: for example, if labour force increases due to natural demographic processes, such as young people entering the labour force, it is quite likely that these job seekers remain unemployed for a while. Inclusion of construction investment in the employment regression helps to specifically capture the impact of the real estate boom and the subsequent bust during the analysed period. Construction is highly labour-intense economic activity, and we get empirical confirmation in the model that investment in construction affected demand for labour. Finally, in line with stylised facts about employment we find that changes in employment have a pronounced element of inertia.

3.3.2.2. Capital formation

Capital used in the production process is another crucial determinant of aggregate output. Unfortunately, statistical data on real capital stock are not available, so we resort to the quite standard perpetual inventory method and obtain the estimate of the capital stock by adding up real investment accumulated over a long period and deducing cumulative real depreciation of capital. Real investment is taken from the National Accounts, and real capital depreciation is calculated as consumption of fixed capital (from GDP decomposition by income approach) deflated by the investment deflator. The unknown initial stock of capital is calibrated so that the average real quarterly depreciation of capital is equal to 2%.

[2] It is gross compensation less social contributions.

Investment is approximated in the model by the sum of investment in construction, manufacturing and transport equipment. Each of these investment types is modelled separately. Investment demand is modelled in nominal terms. As it is real investment that matters for aggregate production, we also model investment prices for each type of investment.

Nominal expenditure on construction investment (*INVC*) is explained in the model by profits of nonfinancial corporations (*NFCPROFITS*), changes in credit to households ($\Delta HCREDIT$) and firms ($\Delta FCREDIT$)[3], housing price index (*HPI*) and adjusted firm loan rates (*FLRATE*):

$$\overline{INVC} = \underset{(7.76)}{611.22} + \underset{(4.47)}{0.16}\, NFCPROFITS_{-1} + \underset{(2.46)}{0.26}\,\Delta HCREDIT_{-3} + \underset{(3.42)}{0.20}\,\Delta FCREDIT_{-4} + \underset{(7.89)}{5.86}\, HPI_{-1} - \underset{(-2.54)}{1422.29}(FLRATE - (Y^R / Y^R_{-4} - 1)) \quad (7)$$

R^2 = 0.993; *D.W.* = 1.416; obs. 33; adjusted sample: 2001Q1-2009Q2.

$$\Delta INVC = - \underset{(-4.03)}{0.76}\,(INVC_{-1} - \overline{INVC}_{-1}) + \underset{(5.36)}{0.14}\,\Delta NFCPROFITS_{-1} + \underset{(1.71)}{0.15}\Delta(\Delta HCREDIT_{-3}) + \underset{(3.22)}{0.16}\,\Delta(\Delta FCREDIT_{-4}) + \underset{(6.01)}{5.86}\,\Delta HPI_{-1} - \underset{(-2.50)}{1939.85}\,\Delta(FLRATE - (Y^R / Y^R_{-4} - 1)) \quad (8)$$

R^2 = 0.884; *D.W.* = 1.858; obs. 32; adjusted sample: 2001Q3-2009Q2.

The above regressions produce logical results and all coefficient signs are as expected. Investment in construction positively depends on lagged corporate profits, as profits are both an important source of investment financing and an information signal guiding companies' decisions regarding business expansion. Likewise, past expansion of bank credit to the private sector can constitute external sources of financing for construction activity (and investment). Quite low regression coefficients for these explanatory variables are explained by the fact that corporate profits and credit flows are aggregate, economy-wide variables. Higher real estate prices, as measured by the housing price index, and more favourable external financing conditions, i.e. exogenous firm loan rates weighed against real economic growth, are also found to affect positively investment in construction.

We weigh nominal loan rates against real output growth in investment equations for several reasons. First of all, actual and anticipated increase in real output helps to explain why nominal loan rate increases did not deter the enormous construction boom[4]. Secondly, companies are arguably more concerned with their revenue or output growth rather than consumer price growth when assessing the burden of interest rates. And finally, investment activity is often explained by real economic activity in structural models.

Construction prices are estimated by the following regressions in the model:

$$\overline{DEFLCONSTR} = \underset{(1.61)}{0.25} + \underset{(1.73)}{0.35}\, CMD + \underset{(4.77)}{0.24}\, WAGE + \underset{(3.86)}{1.41}\, INVC / Y^R \quad (9)$$

R^2 = 0.982; *D.W.* = 0.656; obs. 38; adjusted sample: 2000Q1-2009Q2.

[3] *Changes* in credit stock enter the long-term regression because a net change in credit stock rather than the credit stock itself constitute actual funds that can be invested in a given quarter.

[4] Nominal rates would result in the economically wrong sign in the regressions explaining construction investment.

$$\Delta DEFLCONSTR = \underset{(-3.51)}{-0.34}(DEFLCONSTR_{-1} - \overline{DEFLCONSTR}_{-1}) + \underset{(2.13)}{0.15}\,\Delta WAGE + \underset{(2.34)}{0.63}\,\Delta(INVC / Y^{R}) + \underset{(3.55)}{0.48}\,\Delta DEFLCONSTR_{-1} \quad (10)$$

R^2 = 0.736; *D.W.* = 1.514; obs. 37; adjusted sample: 2000Q2-2009Q2.

Here *DEFLCONSTR* denotes the deflator of construction investment, *CMD* denotes (exogenous) foreign competitors' import prices in the domestic currency and *WAGE* is the nominal average net quarterly salary, equal to *NETCOMP / L*. The latter two variables in the deflator equation help to capture cost-push factors. The last explanatory variable in the long-term equation (9), namely, the ratio between the nominal investment in construction and real aggregate output, helps to gauge demand pressures on construction prices. It should be noted that we use similar constructs as explanatory variables in other deflator equations, too. They are very convenient to use as in each case there are specific equations that govern the associated demand component (in this case, nominal expenditure on construction investment) and the supply side (real GDP). It is common to include the GDP deflator as an explanatory variable in other deflators' regressions, and the ratios used in our model play a similar role, only are more specific.

Nominal investment in manufacturing equipment (*INVM*) is positively related to credit to the corporate sector and some measure of real economic activity in foreign trading partner countries (*WDUR*) and negatively linked to the external borrowing cost:

$$\overline{INVM} = \underset{(-5.32)}{-1095.17} + \underset{(1.89)}{0.07}\,\Delta FCREDIT + \underset{(9.15)}{1760.84}\,WDUR^{R} - \underset{(-2.62)}{896.45}(FLOANRATE - (Y^{R} / Y^{R}_{-4} - 1)) \quad (11)$$

R^2 = 0.930; *D.W.* = 1.430; obs. 37; adjusted sample: 2000Q2-2009Q2.

$$\Delta INVM = \underset{(-4.95)}{-0.86}\,(INVM_{-1} - \overline{INVM}_{-1}) + \underset{(2.15)}{1685.52}\,\Delta WDUR^{R} - \underset{(-2.66)}{1180.76}\,\Delta(FLOANRATE - (Y^{R} / Y^{R}_{-4} - 1)) \quad (12)$$

R^2 = 0.604; *D.W.* = 1.940; obs. 36; adjusted sample: 2000Q3-2009Q2.

The rationale for including *WDUR* as a proxy for foreign demand is that a large share of Lithuanian manufacturing production is exported, thus expansion of manufacturing activities should reflect economic developments in foreign trading partners.

It is rather difficult to explain price dynamics of investment in manufacturing equipment (*DEFLM*). In the present model we set up the following regressions:

$$\overline{DEFLM} = \underset{(17.70)}{1.38} - \underset{(-5.57)}{0.73}\,WDUR^{R} + \underset{(2.30)}{0.33}\,CMD \quad (13)$$

R^2 = 0.632; *D.W.* = 2.027; obs. 38; adjusted sample: 2000Q1-2009Q2.

$$\Delta DEFLM = \underset{(-5.69)}{-0.97}(DEFLM_{-1} - \overline{DEFLM}_{-1}) - \underset{(-1.26)}{0.59}\,\Delta WDUR^{R} + \underset{(1.07)}{1.48}\,\Delta(INVM / Y^{R}) \quad (14)$$

R^2 = 0.503; *D.W.* = 1.945; obs. 37; adjusted sample: 2000Q2-2009Q2.

In these regressions prices of acquired manufacturing equipment, which is mostly imported, are negatively linked to the level of economic activity in foreign trading partners (*WDUR*). A

plausible explanation is that economic progress in mature economies could be associated with technological advances, which makes manufacturing equipment imported by Lithuanian firms cheaper. Manufacturing equipment prices are positively linked to foreign competitors' import prices (*CMD*) and – in the short term – to demand pressures. They are measured as the ratio of nominal investment in manufacturing equipment to real GDP. However, statistical significance of this explanatory variable is low.

Nominal investment in transport equipment is related to the trade balance (transport activity was closely linked to the consumption boom and, by the same token, high trade deficits), external borrowing conditions (in the long-term regression) and the short-term dynamics of corporate profits:

$$\overline{INVTR} = \underset{(5.27)}{123.97} - \underset{(-12.96)}{0.17}(EX - IM) - \underset{(-2.64)}{565.07}(FLOANRATE - (Y^R / Y^R_{-4} - 1)) \quad (15)$$

R^2 = 0.859; *D.W.* = 2.099; obs. 38; adjusted sample: 2000Q1-2009Q2.

$$\Delta INVTR = - \underset{(-5.65)}{0.99}(INVTR_{-1} - \overline{INVTR}_{-1}) - \underset{(-6.75)}{0.15}\,\Delta(EX - IM) + \underset{(1.99)}{0.03}\,\Delta NFCPROFITS + \underset{(2.04)}{0.03}\,\Delta NFCPROFITS_{-2} \quad (16)$$

R^2 = 0.709; *D.W.* = 1.963; obs. 35; adjusted sample: 2000Q4-2009Q2.

Here *EX* and *IM* denote nominal exports and imports, respectively.

Prices of transport equipment (*DEFLTR*) in the model are explained by just exogenous factors, i.e. importers' prices (*CMD*) and commodities prices (*PEI*):

$$\overline{DEFLTR} = \underset{(2.44)}{0.38} + \underset{(3.78)}{0.68}\,CMD - \underset{(2.41)}{0.11}\,PEI \quad (17)$$

R^2 = 0.318; *D.W.* = 1.507; obs. 38; adjusted sample: 2000Q1-2009Q2.

$$\Delta DEFLTR = - \underset{(-5.60)}{0.86}(DEFLTR_{-1} - \overline{DEFLTR}_{-1}) - \underset{(-2.34)}{0.87}\,\Delta CMD_{-1} \quad (18)$$

R^2 = 0.475; *D.W.* = 1.955; obs. 37; adjusted sample: 2000Q1-2009Q2.

Higher commodity (and oil) prices are associated with investment in cheaper transport equipment. Oddly enough, coefficient on importers prices is positive in the long-term equation but negative in the dynamic equation. Several peculiar swings and an apparently poor quality of the statistical data series make it extremely difficult to provide robust economic explanation of transport (as well as manufacturing) equipment price dynamics. However, importance of these variables in the model is limited, so simplistic analysis of investment price dynamics is justified in this case.

3.4. Demand side

In this subsection we analyse the demand side of the economy, namely, we form individual regressions for the GDP components decomposed by the expenditure approach. All components are modelled both in real and nominal terms, thus we also report deflator regressions.

3.4.1. Household consumption

Nominal household consumption expenditure (*HCONS*) is explained in the model by dynamics of personal disposable income (*YDP*), other income (*YDO*) and lagged credit flows to the household sector (*HCREDIT*):

$$\overline{HCONS} = \underset{(2.35)}{629.29} + \underset{(21.52)}{1.15}\, YDP + \underset{(2.79)}{0.29}\, YDO + \underset{(5.11)}{0.56}\, \Delta HCREDIT_{-1} \tag{19}$$

R^2 = 0.995; *D.W.* = 1.646; obs. 36; adjusted sample: 2000Q3-2009Q2.

$$\Delta HCONS = \underset{(-2.92)}{-0.60}\,(HCONS_{-1} - \overline{HCONS}_{-1}) + \underset{(8.83)}{1.23}\,\Delta YDP + \underset{(4.63)}{0.34}\,\Delta YDO + \underset{(2.71)}{0.42}\,\Delta(\Delta HCREDIT_{-2}) \tag{20}$$

R^2 = 0.779; *D.W.* = 2.048; obs. 34; adjusted sample: 2001Q1-2009Q2.

Here personal disposable income *YDP* is obtained by adding net compensation of employees and social transfers from the government sector and subtracting net debt servicing cost, which equals interest paid on loans minus interest earned on term deposits. The other part of the household sector income, *YDO*, is comprised of operating surplus and mixed income (from the National Accounts data), income balance and current transfers balance from the Balance of Payments (BOP). The reason for using this "other income" variable separately is that it is difficult to determine the share of operating surplus or the aforementioned BOP items that can be attributed to the household sector and could be readily used for consumption. Indeed, as can be seen from equations (19) and (20), propensity to consume out of different income sources is hugely different. It is natural that propensity to consume out of the primary income sources is very large. Actually, the coefficient on the *YDP* variable is even larger than one. This excess sensitivity of consumption to personal disposable income could relate to the grey economy, as unaccounted income must be highly correlated to official earned income and could boost consumption figures. If we aggregate both income sources (i.e. *YDP* and *YDO*), the coefficient on aggregate income becomes 0.86, which is broadly in line with stylised economic facts and with findings in other studies.

Modelling results are generally in line with earlier findings of research on private consumption determinants in Lithuania conducted by Ramanauskas and Jakaitienė (2007), confirming an explicit role of credit in the consumption function. Moreover, not only credit flows but also actual indebtedness and the associated debt servicing costs influence consumption expenditure (in the current model – via the impact on the disposable income variable *YDP*).

To obtain estimates of real household expenditure, we set up regressions for private consumption deflator *DEFLCONS*:

$$\overline{DEFLCONS} = \underset{(15.65)}{0.37} + \underset{(29.41)}{1.03}\, HCONS_{-1} / Y^R_{-1} + \underset{(3.95)}{0.36}((EX - IM)/Y) \tag{21}$$

R^2 = 0.963; *D.W.* = 1.296; obs. 38; adjusted sample: 2000Q1-2009Q2.

$$\Delta DEFLCONS = \underset{(-2.09)}{-0.22}\,(DEFLCONS_{-1} - \overline{DEFLCONS}_{-1}) + \underset{(2.78)}{0.20}\,\Delta(HCONS_{-1}/Y^R_{-1}) + \underset{(1.95)}{0.15}\,\Delta((EX - IM)/Y) + \underset{(3.97)}{0.50}\,\Delta DEFLCONS_{-2} \tag{22}$$

R^2 = 0.363; *D.W.* = 1.919; obs. 37; adjusted sample: 2000Q2-2009Q2.

One of the crucial determinants of consumer prices is the balance between aggregate demand and supply. Like in regressions for other deflators, the demand and supply balance is proxied by the ratio of nominal household consumption expenditure to the actual real output. The sign of the associated coefficient is as expected, and higher demand (relative to supply) is naturally associated with stronger inflationary pressures. Another explanatory variable in the consumer price equations is the foreign trade balance. The positive coefficient sign confirms economic intuition that during demand-driven booms surging trade deficits of a small open economy may alleviate inflationary pressures as people switch their consumption to competitively priced imported goods. Finally, regression (22) confirms a considerable level of inertia of consumer prices.

3.4.2. Government consumption and fiscal block

The model contains a stylised fiscal block. Its main purpose is to endogenise government consumption, which plays a very important role for the development of the broader economy.

Government consumption, *GCONS*, is modelled simply as a function of general government income and the real growth rate of the economy, which serves as a crude measure of the phase of the business cycle. General government income is proxied by the sum of three main government income sources, namely income and wealth taxes (*TAXINC*), taxes on production and imports (*TAXPROD*) and social contributions (*SCONTR*). These income sources make up on average just under 90% of general government income. The regression estimation results are as follows:

$$\overline{GCONS} = \underset{(11.52)}{918.22} + \underset{(43.89)}{0.57}\,(TAXINC_{-1} + TAXPROD_{-1} + SCONTR_{-1}) - \underset{(-5.15)}{2650.52}(Y^{R}_{-1}/Y^{R}_{-5} - 1) \quad (23)$$

R^2 = 0.984; *D.W.* = 1.917; obs. 37; adjusted sample: 2000Q2-2009Q2.

$$\begin{aligned}\Delta GCONS = &\underset{(-5.55)}{-0.86}\,(GCONS_{-1} - \overline{GCONS}_{-1}) \\ &+ \underset{(5.16)}{0.26}\,\Delta(TAXINC_{-1} + TAXPROD_{-1} + SCONTR_{-1}) \\ &+ \underset{(3.80)}{0.34}\,\Delta(TAXINC_{-2} + TAXPROD_{-2} + SCONTR_{-2})\end{aligned} \quad (24)$$

R^2 = 0.718; *D.W.* = 2.19; obs. 35; adjusted sample: 2000Q4-2009Q2.

Nominal government consumption expenditure positively depends on lagged government revenue. It also has a pronounced anti-cyclical element, which basically shows that government consumption expenditure tends to grow (fall) more slowly than government income during the boom (bust) episode, which serves as some economic stabilisation mechanism.

Dynamics of government consumption deflator followed quite closely the overall GDP deflator, especially in the first part of the decade. For the lack of theoretical guidance and due to the element of subjective judgement in the published statistical data, the dynamics of government consumption deflator, *DEFLG*, in the model is explained by simply regressing it on the GDP deflator (in levels only):

$$DEFLG = \underset{(-4.55)}{-0.27} + \underset{(23.92)}{1.27}\ DEFLY \quad (25)$$

R^2 = 0.941; *D.W.* = 1.861; obs. 38; adjusted sample: 2000Q1-2009Q2.

Government revenue sources are explained in the model by the dynamics of commensurate tax bases (or their proxies) and the phase of the economic cycle, when it is significant. Thus, revenue from income tax, *TAXINC*, is regressed on the sum of net employee compensation (*NETCOMP*) and operating surplus and mixed income (*PROFITS*), and on the real GDP growth rate:

$$\overline{TAXINC} = \underset{(-3.75)}{-277.67} + \underset{(26.96)}{0.15}\,(NETCOMP + PROFITS) + \underset{(3.02)}{1069.46}(Y^R / Y^R_{-4} - 1) \tag{26}$$

R^2 = 0.954; *D.W.* = 0.846; obs. 38; adjusted sample: 2000Q1-2009Q2.

$$\Delta TAXINC = \underset{(-4.08)}{-0.59}\,(TAXINC_{-1} - \overline{TAXINC}_{-1}) + \underset{(4.95)}{0.13}\,\Delta(NETCOMP + PROFITS) + \underset{(4.12)}{0.39}\,\Delta TAXINC_{-1} \tag{27}$$

R^2 = 0.734; *D.W.* = 1.745; obs. 37; adjusted sample: 2000Q2-2009Q2.

The obtained estimates of effective tax rates seem economically reasonable. It should be noted that a positive coefficient sign for the cycle phase variable suggests that income tax revenue exhibits even larger cyclicality than procyclical dynamics of corporate and personal incomes. This could be related to procyclical dynamics of unaccounted economy but also could be affected by changes in income tax rates.

Production and import taxes are explained by nominal GDP, whereas the output growth turned out insignificant in this equation:

$$TAXPROD = \underset{(2.23)}{183.80} + \underset{(22.56)}{0.09}\,Y \tag{28}$$

R^2 = 0.934; *D.W.* = 1.596; obs. 38; adjusted sample: 2000Q2-2009Q2.

Similarly, social contributions depend on net compensation of employees:

$$SCONTR = \underset{(-5.24)}{-148.84} + \underset{(64.39)}{0.29}\,NETCOMP \tag{29}$$

R^2 = 0.991; *D.W.* = 0.443; obs. 38; adjusted sample: 2000Q2-2009Q2.

We also model a few other fiscal variables. One of them is social transfers, *STRANSF*. It is important for the model economy, as it constitutes a composite part of households' aggregate disposable income. In our model social transfers depend on social contributions but also have a very strong countercyclical element:

$$\overline{STRANSF} = \underset{(7.82)}{546.22} + \underset{(30.89)}{1.11}\,SCONTR - \underset{(-10.97)}{4140.25}(Y^R / Y^R_{-4} - 1) \tag{30}$$

R^2 = 0.976; *D.W.* = 1.250; obs. 38; adjusted sample: 2000Q1-2009Q2.

$$\Delta STRANSF = \underset{(-3.68)}{-0.62}(STRANSF_{-1} - \overline{STRANSF}_{-1}) + \underset{(3.25)}{0.80}\,\Delta SCONTR - \underset{(-4.15)}{3090.91}(Y^R / Y^R_{-4} - 1) \tag{31}$$

R^2 = 0.388; *D.W.* = 1.973; obs. 37; adjusted sample: 2000Q2-2009Q2.

In general, large part of general government revenue and expenditure is endogenised in the model, and the remaining revenue and expenditure sources are added up as exogenous residual variables. This makes it possible to track general government's total revenue and expenditure, budget deficits, debt and its servicing costs (assuming exogenously given interest rates).

3.4.3. Investment and inventory accumulation

We presented investment regressions in Section 3.3.2.2, which dealt with capital formation. Here our aim is only to remind that investment is also a component of aggregate demand. It should also be noted that another constituent of gross capital formation, namely inventory accumulation, is held exogenous in the model mainly because of statistical data quality problems. In contrast to some other structural models, inventories do not have the role of balancing model's demand and supply.

3.4.4. Foreign trade

Nominal exports are found to positively depend on (real) foreign demand and export prices set up by domestic exporters and (in the short term) competitors' exports prices in domestic currency:

$$\overline{EX} = \underset{(-11.57)}{-6730.91} + \underset{(28.88)}{12930.11}(WDUR^{R} \cdot DEFLEX) \quad (32)$$

R^2 = 0.959; *D.W.* = 0.504; obs. 38; adjusted sample: 2000Q1-2009Q2.

$$\Delta EX = \underset{(-2.01)}{-0.24}(EX_{-1} - \overline{EX}_{-1}) + \underset{(7.06)}{10888.02}\,\Delta(WDUR^{R} \cdot DEFLEX) + 8362.15\Delta CXD \quad (33)$$

R^2 = 0.762; *D.W.* = 1.772; obs. 37; adjusted sample: 2000Q2-2009Q2.

Since we chose to model expenditure components in nominal terms, we multiply (real) foreign demand variable by export price deflator *DEFLEX*. So higher export prices are associated with higher exports in nominal terms. One could expect that higher prices should weaken demand for exports but this does not necessarily has to be the case if price developments are mainly determined by external factors. Lithuanian export volumes and prices indeed seem quite resilient to price, wage or exchange rate developments over the analysed period. Export prices are found to depend positively on competitors' prices in export markets (*CXD*), commodity prices (*PEI*) and internal wage developments (*WAGE*):

$$\overline{DEFLEX} = \underset{(1.08)}{0.10} + \underset{(6.02)}{0.68}\,CXD + \underset{(7.55)}{0.13}\,PEI + \underset{(5.01)}{0.03}\,WAGE \quad (34)$$

R^2 = 0.973; *D.W.* = 1.048; obs. 38; adjusted sample: 2000Q1-2009Q2.

$$\Delta DEFLEX = \underset{(-3.14)}{-0.45}(DEFLEX_{-1} - \overline{DEFLEX}_{-1}) + \underset{(2.26)}{0.37}\,\Delta CXD + \underset{(7.13)}{0.13}\,\Delta PEI + \underset{(2.55)}{0.05}\,\Delta PEI_{-1} \quad (35)$$

R^2 = 0.812; *D.W.* = 1.829; obs. 37; adjusted sample: 2000Q2-2009Q2.

The data of the analysed period suggest that exports were determined mostly outside of the economy.

As was mentioned earlier, real imports are allowed to vary as a residual variable, balancing supply and demand in the model. Technically, imports variable is special because imported goods and services are already included in other components of aggregate demand and thus are implicitly estimated. A separate imports regression could potentially harm integrity of the model or lead to explosive loops of the model economy.

Though real imports adjust to equate supply and demand in the model, we still need a regression explaining import prices. Import price deflator (*DEFLIM*) is regressed on competitors' import prices *CMD*, commodity prices *PEI* and the nominal effective exchange rate *NEER*:

$$\overline{DEFLIM} = \underset{(8.91)}{0.57} + \underset{(8.85)}{0.75}\,CMD + \underset{(3.54)}{0.07}\,PEI - \underset{(-7.68)}{0.0004}\,NEER \tag{36}$$

R^2 = 0.937; *D.W.* = 0.631; obs. 38; adjusted sample: 2000Q1-2009Q2.

$$\Delta DEFLIM = \underset{(-2.82)}{-0.32}\,(DEFLIM_{-1} - \overline{DEFLIM}_{-1}) + \underset{(2.50)}{0.40}\,\Delta CMD + \underset{(4.46)}{0.07}\,\Delta PEI - \underset{(-1.88)}{0.0003}\,\Delta NEER + \underset{(2.06)}{0.04}\,\Delta PEI_{-1} \tag{37}$$

R^2 = 0.811; *D.W.* = 1.750; obs. 37; adjusted sample: 2000Q2-2009Q2.

Coefficient signs in the regression are as expected. The negative coefficient on the *NEER* variable confirms that higher nominal effective exchange rate of domestic currency is associated with lower prices of imported products (in domestic currency). As can be seen from the above regressions, import prices in the model are mostly determined outside the domestic economy.

3.5. Financial sector

In earlier sections we already saw that dynamics of credit variables accounted for some variation in household consumption, investment and other variables. Here, we try to endogenise some of the more important financial variables so that the financial sector can be more fully incorporated in the broader economy.

We start with the analysis of credit to households. In the model the long-term dynamics of the portfolio of bank loans to households (*HCREDIT*) is determined by main sources of banks' loanable funds, namely residents' deposits (*DEPOSITS*) and banks' external debt (*BANKDEBT*), whereas in the short term the flow of credit to households also depends on lagged housing prices and real interest rates (nominal household rates, *HLRATE*, weighed against deflator-based inflation):

$$\overline{HCREDIT} = \underset{(-6.53)}{-3588.69} + \underset{(10.06)}{0.51}\,DEPOSITS + \underset{(13.8)}{0.62}\,BANKDEBT \tag{38}$$

R^2 = 0.995; *D.W.* = 0.651; obs. 38; adjusted sample: 2000Q1-2009Q2.

$$\Delta HCREDIT = \underset{(-1.06)}{-0.10}\,(HCREDIT_{-1} - \overline{HCREDIT}_{-1}) + \underset{(5.67)}{0.45}\,\Delta DEPOSITS + \underset{(3.02)}{0.19}\,\Delta BANKDEBT + \underset{(4.72)}{1.89}\,HPI_{-1} - \underset{(-3.45)}{3855.42}(HLRATE - (DEFLY / DEFLY_{-4} - 1)) \tag{39}$$

R^2 = 0.827; *D.W.* = 1.560; obs. 37; adjusted sample: 2000Q2-2009Q2.

Bank borrowing from abroad and interest rates on loans are held exogenous because, from our modelling perspective, they are largely seen as control variables determined by strategic decisions of banks or their parent institutions. The coefficient on real loan rates has a negative sign, indicating mostly demand-side dependency whereby a falling cost of real interest rates strengthens demand for credit. We should also note that we work with "effective" rates on existing loans (deposits), i.e. loan (deposit) rates are averaged over different maturities and currencies. This implies that the rates include time-varying exchange risk premia. Since exchange rate risks did not materialise during the analysed period owing to the currency peg, effective rates quite accurately reflect actual costs incurred by borrowers (or depositors' gains).

Similarly to bank credit to households, credit to firms (*FCREDIT*) also depends on banks' deposits, their foreign borrowing and real interest rates. In addition to this, profits of nonfinancial corporations (*NFCPROFITS*), as an indicator of firms' ability to repay debt, is another important determinant in the regression:

$$\begin{aligned}\Delta\overline{FCREDIT} &= \underset{(1.68)}{96.80} + \underset{(2.76)}{0.18}\,\Delta DEPOSITS + \underset{(7.59)}{0.25}\,\Delta BANKDEBT \\ &- \underset{(-5.21)}{3265.70}(FLRATE - (Y^{R}/Y^{R}_{-4} - 1)) + \underset{(6.51)}{0.28}\,NFCPROFITS\end{aligned} \tag{40}$$

R^2 = 0.944; *D.W.* = 1.720; obs. 37; adjusted sample: 2000Q2-2009Q2.

$$\begin{aligned}\Delta\Delta FCREDIT &= -\underset{(-4.59)}{0.84}\,(\Delta FCREDIT_{-1} - \Delta\overline{FCREDIT}_{-1}) + \underset{(3.82)}{0.18}\,\Delta\Delta DEPOSITS \\ &+ \underset{(8.32)}{0.22}\,\Delta\Delta BANKDEBT - \underset{(-2.40)}{3495.96}\,\Delta(FLRATE - (Y^{R}/Y^{R}_{-4} - 1)) + \underset{(4.34)}{0.23}\,\Delta NFCPROFITS\end{aligned} \tag{41}$$

R^2 = 0.864; *D.W.* = 1.929; obs. 36; adjusted sample: 2000Q3-2009Q2.

Note that unlike in regression (39), here we work with credit flows in the cointegrating regression, as we found it easier to link credit variables to lending conditions in this form. In general, there are uncertainties about the order of integration of credit variables, and formal unit root tests are rather uninformative due to the short time series. It should be noted that modelling this economic environment is very challenging, and we were very often forced to seek compromise between economic intuition and technical rigour, and we are generally in favour of the former.

In regressions (40-41) nominal rates on loans to firms (*FLRATE*) are weighed against real output growth. This is one of many possible indicators of real interest rate burden, and it was preferred to some other tried measures (e.g. deflator-based real interest rates) for a better statistical fit.

Turning to banks' liabilities side, household term deposits (*HTDEPOSITS*) are regressed on total disposable income (*YD*, which is the sum of *YDP* and *YDO*) and inflation-adjusted term deposit rates (*HTDRATE*):

$$\begin{aligned}\overline{HTDEPOSITS} &= \underset{(-18.16)}{-7585.86} + \underset{(35.40)}{1.17}\,YD \\ &+ \underset{(10.57)}{31694.82}(HTDRATE - (DEFLY/DEFLY_{-4} - 1))\end{aligned} \tag{42}$$

R^2 = 0.977; *D.W.* = 0.894; obs. 38; adjusted sample: 2000Q1-2009Q2.

$$\Delta HTDEPOSITS = \underset{(-3.08)}{-0.22}\,(HTDEPOSITS_{-1} - \overline{HTDEPOSITS}_{-1}) + \underset{(3.74)}{0.38}\,YD + \underset{(3.30)}{0.42}\,\Delta HTDEPOSITS_{-1} + \underset{(1.81)}{0.25}\,\Delta HTDEPOSITS_{-3} \quad (43)$$

R^2 = 0.662; *D.W.* = 2.282; obs. 34; adjusted sample: 2001Q1-2009Q2.

It turned out quite difficult to find an explicit statistical relationship between private savings and dynamics of household term deposits. It seems that one of the main determinants of term deposits during the analysed period is private disposable income. We also find that dynamics of term deposits exhibits a large degree of inertia, which is very natural given the fact that money is usually deposited in a bank for several quarters. Interestingly, at the beginning of the financial crisis, household term deposits continued growing and reached the peak one year into the crisis. This is explained in the model mainly by a sharp rise of real interest rates with the onset of the crisis due to both falling inflation and rising nominal rates.

Sight deposits constitute an important component of broad money in the economy. Given that money supply under the currency board regime automatically adjusts to money demand, the monetary dynamics is mainly determined by money demand. In line with the standard monetary theory, money demand could be modelled as a function of nominal interest rates and a measure of economic activity. Accordingly, sight deposits (*SDEPOSITS*) are regressed on nominal rates of term deposits (as an alternative cost of holding money) and personal disposable income. In addition to these standard variables, we include outstanding credit to firms and households because according to the credit multiplier principle, banks effectively create money (sight deposits) by expanding credit. Dynamics of sight deposits is therefore governed by the following regressions:

$$\ln \overline{SDEPOSITS} = \underset{(-0.71)}{-0.78} - \underset{(-15.27)}{7.07}\,HTDRATE + \underset{(4.06)}{0.70}\ln YD + \underset{(6.66)}{0.36}\ln(HCREDIT + FCREDIT) \quad (44)$$

R^2 = 0.996; *D.W.* = 1.144; obs. 38; adjusted sample: 2000Q1-2009Q2.

$$\Delta \ln SDEPOSITS = \underset{(-3.25)}{-0.54}\ln(SDEPOSITS_{-1} / \overline{SDEPOSITS}_{-1}) - \underset{(-4.40)}{7.10}\,\Delta \ln HTDRATE + \underset{(2.82)}{0.49}\,\Delta \ln YD + \underset{(5.37)}{0.42}\,\Delta \ln(HCREDIT + FCREDIT) \quad (45)$$

R^2 = 0.555; *D.W.* = 1.949; obs. 37; adjusted sample: 2000Q2-2009Q2.

Here we again chose to work with logs in order to obtain better econometric properties of the regressions. The signs of obtained coefficients are as expected, and the results are qualitatively consistent with earlier studies (see Vetlov, 2005). Also note that credit expansion has a strong impact on the dynamics of sight deposits in the banking system but it is also recognised in the model that deposits constitute a source of credit financing (see equations (38-41)). This two-directional dependency is at the heart of credit propagation mechanism, features of which can be summarised as follows: as a result of their normal lending activity banks create money, credit dynamics is path-dependent and multiple equilibrium paths are possible, circular nature of credit expansion may lead to credit cycles, and credit can stimulate aggregate demand resulting in higher than the potential growth of real activity for protracted periods. The downside of the credit cycle is that overindebtedness, malinvestment, changes in risk perception, impaired banks' access to financial resources or other triggers may result in a vicious circle of credit

rationing, souring credit quality, depressed aggregate demand and economic stagnation (for an extended discussion see Ramanauskas (2005, 2006, 2007) and Kuodis and Ramanauskas, 2009).

3.6. Housing prices

Housing prices are important in the model mostly because they directly affect construction investment and credit flows to the household sector. More credit is needed to acquire housing at higher prices, and rising prices also facilitate larger individual loans because perceived worth of collateral increases. Of course, the perceived improvement of collateral quality can largely be regarded as myopic and non-rational or may reflect principle-agent problems among bank owners and managers. In any case, the observed relationship between house price rises and credit growth during the analysed boom episode in Lithuania is beyond doubt. Furthermore, housing has a dual purpose as consumption and investment good. Demand for housing, unlike for normal goods, may increase as housing price goes up because speculative motives or fears for ever decreasing housing affordability may spur buying and outweigh the negative impact of a price rise. In reaction to rising demand, housing supply gradually rises as housing developers increase construction investment.

In the model housing prices are determined by disposable income dynamics and availability of credit, while real interest rates are also marginally significant in the dynamic equation:

$$\overline{HPI} = \underset{(-7.87)}{-109.90} + \underset{(17.49)}{0.02}\, YD + \underset{(8.32)}{0.05}\, \Delta HCREDIT_{-1} \qquad (46)$$

R^2 = 0.976; *D.W.* = 1.214; obs. 36; adjusted sample: 2000Q3-2009Q2.

$$\Delta HPI = \underset{(-4.19)}{-0.50}\,(HPI_{-1} - \overline{HPI}_{-1}) + \underset{(3.33)}{0.01}\,\Delta YD + \underset{(3.43)}{0.02}\,\Delta\Delta HCREDIT_{-1}$$
$$\underset{(-1.80)}{-124.08}\,\Delta(HLRATE_{-1} - (NETCOMP_{-1} / NETCOMP_{-5} - 1)) + \underset{(4.21)}{0.44}\,\Delta HPI_{-1} \qquad (47)$$

R^2 = 0.720; *D.W.* = 1.886; obs. 35; adjusted sample: 2000Q4-2009Q2.

As can be seen from the above equations, housing prices are associated with highly procyclical determinants and their dynamics has a pronounced autoregressive element, which explains why they followed the boom-and-bust cycle. Another important thing to note is that the real interest rate burden is modelled by weighing nominal household rates against wage inflation. The regression results suggest that in the context of extremely strong wage growth during the boom period (and thus widespread expectations of falling real borrowing costs) modest interest rate movements would have had a very limited impact on the booming real estate market.

3.7. Income decomposition

One major current model's difference from many other structural macromodels is related to the role of corporate profits. In standard models the long-term (or "desired") values of some important variables, such as real wages, employed labour and capital, are derived from firms' profit maximisation exercise. Yet actual corporate profits are essentially left out of scope of the standard analysis. That means that no track is kept of actual profit dynamics and the observed profitability of firms does not influence production decisions. In our view, it is a serious drawback because the models rely too much on strong and not very realistic assumptions about profit maximisation in the long term but at the same time they fail to recognise that actual and

not necessarily optimised profits also constitute a major driver behind economic activity in the short- and medium- term. In contrast, profits are not optimised in the current model but they have a clear role in influencing employee hiring and remuneration, borrowing and investment, as we saw in earlier sections. An explicit role for profits is arguably very important for ensuring model's internal consistency, which poses a real problem in policy-relevant time horizons in most standard models.

In the model, mixed income and operating surplus variable (*PROFITS*) is essentially obtained from the national income identity. Since this identity does not hold exactly due to seasonal adjustment of the model variables, we form the following auxiliary regression:

$$PROFITS = \underset{(-0.46)}{-20.51} + \underset{(141.22)}{1.00}\,(Y - NETCOMP - SCONTR - CAPDEPR - TAXPROD) \qquad (48)$$

R^2 = 0.998; *D.W.* = 2.452; obs. 38; adjusted sample: 2000Q1-2009Q2.

In the parenthesis we have the identity expression for mixed income and operating surplus. Here *CAPDEPR* denotes nominal consumption of fixed capital (capital depreciation).

Mixed income and operating surplus is a composite variable, and only a fraction of it constitutes nonfinancial corporations' profits. In order to endogenise *NFCPROFITS* variable, in yet another auxiliary regression we regress *NFCPROFITS* on operating surplus excluding bank profits (proxied by interest received on loans less interest paid on deposits) and a few dummy variables to account for outliers and trend changes in the *NFCPROFITS* dynamics.

Endogenised nonfinancial corporations' profits essentially close the model. Being the centrepiece economic variable of the model economy, profits also have a profound role in ensuring stability of the system. For instance, increased demand leads to higher profits and overall economic activity but explosive profit growth is prevented because higher demand for labour raises wages, whereas higher investment and larger capital stock is associated with higher depreciation costs. This, together with rising imports, dampens further growth of domestic producers' profits.

4. Shock analysis

Individually estimated regressions together with identities constitute the complete model. The dynamics of the system is simulated by standard Newton solution method provided in EViews. As a result of the dynamic simulation, we get the model baseline scenario, whereby actual values of endogenous variables in all system's equations are replaced by estimated values of those variables. The baseline scenario serves several purposes. First, comparing baseline to the actual dynamics of the system we get the basic indication of general adequacy of the model. Second, it provides the comparative basis for the shock analysis and other simulations.

4.1. Evaluating model performance and forming baseline scenarios

Simulated and actual dynamics of some of the more important model variables are shown in Figure B1 in Appendix B. Given a relatively small set of exogenous variables, the overall dynamics of the model system is reasonably close to the actual developments of the economy over the model solution sample from 2002 Q1 to 2009 Q2. However, towards the end of the

estimation period, when the economy experienced serious overheating, the model slightly underestimates it, as simulated consumer and housing prices, household indebtedness and bank deposits are all somewhat lower than actual values. This shows, in hindsight, that economic developments and thereby overheating pressures were becoming abnormally intense around 2007.

Once we have a qualitative confirmation of good in-sample performance of the model, it is interesting to check model's out-of-sample performance and the long-term stability of the system. For these purposes we solve the model for the period from 2009 to 2030. Out-of-sample data are available from 2009 Q3 to 2010 Q4. For this period we use actual exogenous variables and compare model's solution for endogenous variables with actual dynamics of those variables. From 2011 onwards, all exogenous variables are frozen at their last observed values. Of course, freezing of exogenous variables implies that the associated model solution cannot be regarded as a forecast. Rather, it has two purposes: the out-of-sample solution serves as a baseline for the shock analysis implemented in the following sections and it is also indicative of natural adjustment of accumulated imbalances the model economy (absent specific changes in the external environment). Model solution for selected endogenous variables is presented in Figure B2.

Let us first concentrate on the comparison of model's out-of-sample solution to the available actual data. As can be seen from Figure B2, the model generally captures the short-term trends quite well. The model correctly describes the basic features of internal devaluation environment: downward nominal adjustment of wages, deflating housing bubble and deleveraging pressures[5]. The model also projects sharp real adjustment in the economy – strong declines of real GDP and its main expenditure components, as well as a strong dip in employment levels.

There are several important aspects in which model's out-of-sample solution differs considerably from actual developments: the dip in modelled real activity and foreign trade is overestimated, model deposits are considerably lower than actual, and government balances in the model are too optimistic (income too high, expenses and general government debt too low) as compared to the actual data. Yet this discrepancy is not surprising at all. During the crisis episode the government was fortunate to still have sufficient room for manoeuvre and was able to borrow vast amounts of funds to keep up its social obligations. This provided an important cushion for the overall economic activity but resulted in a sharp increase of general government debt. Moreover, since the government debt was mainly financed by foreign funds, the influx of these funds eventually helped to stabilise the stock of domestic deposits in the banking sector and the expected drop in deposits did not materialise. As regards foreign trade, unprecedented and a priori econometrically unpredictable accommodative economic policies implemented by governments and central banks around the world constituted a major driving force behind the forceful recovery of global foreign trade, and Lithuanian exports in particular. It is interesting to note that by making government consumption, social transfers and nominal exports exogenous in the model, much of the systemic discrepancy between model's out-of-sample solution and the actual data can be removed.

Turning to the long-term dynamics of the model economy, the model suggests that, without fiscal intervention and buoyant recovery of exports, the process of adjustment of past economic imbalances would have been considerably longer and more severe. In that case one could have

[5] At the same time it should be noted that downward adjustment of both actual and model series for consumption deflator and GDP deflator is virtually nonexistent.

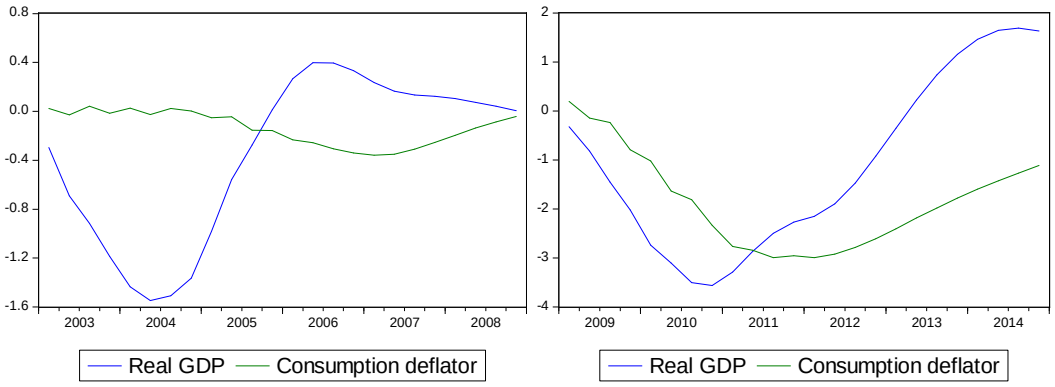
expected a period of stagnation until 2015-2016 followed by gradual recovery. Fiscal policy has obviously alleviated economic stress in the medium-term but at the expense of sharply rising government debt. On the other hand, fiscal policy based on excessive budget deficits not only did backstop the crisis but possibly hindered natural economic adjustment processes, and it is far from clear whether the long-term economic implications of this policy are positive. There indications that nominal adjustment of wages and prices, including housing prices, could be considerably deeper should the economy be allowed to run its course.

4.2. Temporary increase in loan interest rates

Several isolated shocks to the model economy are introduced and the system's response is analysed. In the highly dynamic and volatile economic environment, the system's response clearly depends on the timing of shocks. For this reason, we arbitrarily divide the data into two periods, namely 2003 Q1 to 2008 Q4 ("baseline scenario") and 2009 Q1 to 2014 Q4 ("baseline out-of-sample scenario"), and economic shocks are assumed at the beginning of each of the two periods. As was mentioned above, in the out-of-sample analysis exogenous variables take known actual values until end-2010 and are frozen subsequently.

We first examine a temporary rise in nominal interest rates on loans to households and firms (*HLRATE* and *FLRATE*). In two experiments, they are raised by 1 percentage point for eight consecutive quarters starting at 2003 Q1 and 2009 Q1.

Figure 6. Percentage change in real GDP and consumer prices in response to the interest rate shock



As could be expected, a temporary interest rate rise during the boom period has a moderate inhibiting effect on the economy (see Table C1 in Appendix C). One of the most pronounced channels of the interest rate pass-through seems to be related to investment demand. In response to the interest rate shock, declines in investment reach 3.3% in year 2 after the shock. The impact is accompanied and reinforced by a sizeable fall in housing prices (by 4.8% in year 2). A rise in interest rates means worsening of financing conditions and thus directly negatively affects credit flows to firms and households. Impeded capital accumulation dents aggregate supply, therefore consumer prices initially are relatively rigid to deflationary pressures (see Figure 6). However, the decline in the GDP deflator, which captures broader price tendencies, reaches up to 0.4% in year 2. Smaller equilibrium production levels and lower prices result in an outsized negative impact on profits, which amounts to –8.7% in year 2. The large impact is also

likely to be the outcome of the negative reinforcement loop: the downward pressure on wages and employment related to worse profitability prospects, together with lower income from firm ownership implies that in year 2 aggregate disposable income declines by 1.4% and private consumption falls by 1.8%, which in turn has a negative effect on profits. On the other hand, there are several stabilising processes. Government spending remains quite resilient, at the cost of rising fiscal deficits and increasing government debt. Also, productivity falls less than wages, bringing down unit labour costs (ULC) and improving international competitiveness. In the face of contracting domestic demand and smaller ULC, economy relies more on net exports. As a result of the above discussed key economic developments, real output declines by 0.8% and 1.5% in the first and second year after the shock, respectively. When interest rates rise back to the baseline levels, the dampening impact on the economy vanishes in about one year. Private sector takes advantage of lower indebtedness and debt servicing costs and, also, labour costs remain lower for some time, which makes profits rebound quickly and even exceed baseline levels. This leads eventually to a slightly higher level of economic output, as compared to the baseline scenario.

If interest rates are raised in 2009 Q1, i.e. at the initial stage of the economic crisis, the system's reaction to the shock remains qualitatively similar but the overall magnitude of the impact is considerably larger (see Table C1 and Figure 6). For instance, real GDP and consumer prices decline, respectively, by up to 3.2% and 2.9%. Again, the main channels of the impact relate to investment and housing prices. The interest rate shock directly affects housing prices through increased interest burden and reduced borrowing and has indirect adverse effects due to declining salaries, employment and dividends. As a result, housing prices exhibit a significant 12.8% decline from the baseline scenario in the second year after the shock. The decline in the housing prices has a strong adverse impact on corporate profits[6]. Declines in investment, triggered by falling housing prices and deteriorating profits, also reach up to 10.6% in year 2. Labour market adjustment provides a crucial stabilisation channel: even though both supply and demand effects weigh down on real productivity, which declines by 2.3% from the baseline in year 3, wage declines are even larger (-6.1%), and this results in pronounced contraction of the ULC. Lower income and employment together with higher debt servicing costs lead to a strong consumption squeeze: private consumption deviates by 5.9% from the baseline in year 2. Finally, credit to firms and households drops broadly in line the overall economic activity, so their ratios to GDP reported in Table C1 show relatively little change.

Why does the shock impact during the crisis get amplified as compared to the impact of a similar shock at the beginning of boom years? The increased sensitivity of the economy to economic shocks is primarily related to higher financial leverage of households and firms. Note that the private nonfinancial sector's financial burden associated with a 1 percentage point increase in effective loan rates is much higher in the case of high aggregate indebtedness as compared to the case of low indebtedness. For instance, in the two-year period starting at the beginning of 2003, the 1% burden of outstanding credit to households constitutes on average 7 million litas per quarter, as compared to approximately 72 million litas per quarter during the crisis period. For firms, it stands at roughly 22 and 81 million litas per quarter in 2003-2004 and 2009-2010 episodes, respectively. When the debt servicing cost is high, a fractional increase in its size has a strong impact on household income and corporate earnings, which is not the case

[6] During the crisis corporate profits become negative, therefore the percentage changes from the baseline fluctuating around zero are not economically meaningful and are not reported in tables of Appendix C.

when the overall indebtedness of the private sector is low. Housing prices are directly affected by changes in household disposable income, and the financial accelerator linking housing prices and credit further amplifies the impact of the shock.

It has to be emphasised, however, that model regressions are mostly based on boom-period data, and this adds uncertainty to the system's behaviour during this severe economic and financial distress period. Thus, quantitative responses to the interest rate shock have to be taken with caution but such analysis helps to understand the role of the financial accelerator for recent economic developments. The above analysis also serves as an indication that interest rate increases in the financially over-stretched economy at the beginning of the crisis could have substantially contributed to the economy reaching the "tipping point". On the other hand, effective interest rates in fact declined by 2-3 percentage points during the crisis by end-2010, providing some cushion for the economy.

4.3. Permanent increase in banks' net foreign borrowing

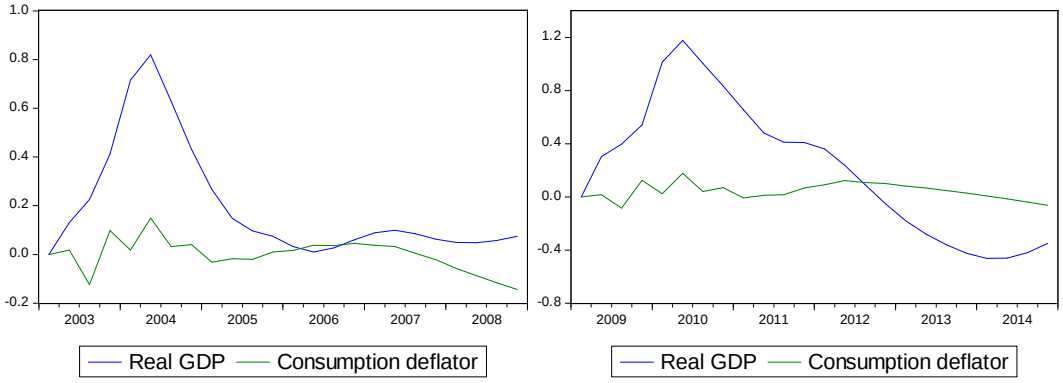
In this experiment we examine the system's response to a permanent 1 percentage point increase in banks' net foreign debt relative to baseline GDP (*BANKDEBT / Y*). The aim of the experiment is to find out how reliant on banks' access to foreign financial resources were economic developments during boom and bust episodes.

A permanent increase in banks' financing from abroad assumed at the beginning of the boom period has a temporary stimulating impact on the economy (see Table C2). The impact is concentrated on the demand side but is quickly propagated through the whole economy. Increased foreign financing changes the balance between supply and demand for credit and, as a result, credit to households rises by 0.6% in the second year following the shock. Credit-driven consumer demand is primarily directed towards acquisition of housing. As housing supply is sluggish, real estate prices exhibit an immediate strong increase of 2.4% in the following year but the increase is temporary. Demand for housing is accommodated by increasing investment (mainly non-manufacturing investment), which rises by 1.2% in year 2. Increased real estate market activity and, especially, higher housing prices have a strong positive impact on corporate profits, which exceed the baseline by 2.9% in year 2. Increased tension in the labour market leads to higher wages (by 0.6% in year 2) and higher employment (by 0.2% in year 2) but wages increase more than productivity leading to rising ULC. Higher household income leads to stronger consumption and higher imports. Increased imports dampen consumer price inflation but the GDP exhibits a moderate temporary increase of 0.2% in year 2. All in all, real credit-stimulated GDP accelerates by 0.6% in year 2 (see Figure 7) but the effect quickly dies out afterwards. Fiscal balances also improve on rising real activity and prices, and the ratio of government debt to GDP falls.

If we assume a similar shock to banks' net foreign debt at the beginning of economic contraction, we get quite similar results. However, a notable difference is that a temporary positive impact during the crisis is slightly stronger at first but in a few years it turns more negative than during the boom episode. The reason is that increased bank borrowing from abroad and the related rise in credit supply may help to stabilise the economy in the short term but the associated debt servicing cost gets relatively high in a contracting economy (the so-called "debt deflation"). Drawing an analogy with the actual bank lending behaviour in Lithuania, during the crisis there was a strong demand for bank credit as it could provide short-term relief (e.g. working capital for firms) but banks were reluctant to lend due to a lack of

viable business projects. Generally, further increase in indebtedness of the private sector is not a sustainable solution to the overborrowing crisis.

Figure 7. Percentage change in real GDP and consumer prices in response to banks' foreign borrowing shock



We can conclude that in general the system's response to the shock is in line with intuitive expectations. When assessing a possible overall impact of banks' external borrowing and the subsequent deleveraging on the economy, one also has to keep in mind that banks increased their foreign indebtedness by roughly 25 percentage points of GDP over the period of rapid credit expansion and by end-2010 banks' net foreign debt declined by some 11 percentage points from its peak reached in 2008 Q4. During the crisis foreign banks active in Lithuania withdrew very substantial amounts of funding, and given the economy's "addiction" to easy credit, banks' reluctance to provide credit probably had a negative short-term impact on the economy. However, the credit contraction was not only a consequence of banks' lending decisions, but rather it was determined by both supply and demand factors, as well as a very significant increase in perceived credit risks. It should be also noted that macroeconomic effects of deteriorating availability of credit in the model were alleviated by falling interest rates and by very sharply rising government debt.

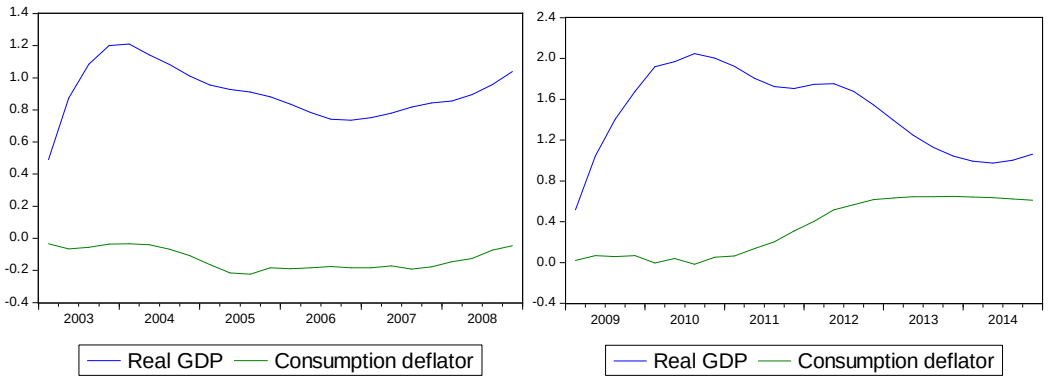
4.4. Permanent increase in foreign demand

In this experiment we examine the macroeconomic impact of a permanent 1% rise in the level of economic activity in foreign trading partner countries (*WDUR*). It definitely has a positive effect on the economy both in the economic boom and downturn episodes (see Table C3).

A permanent rise in foreign demand at the beginning of the boom period induces an immediate increase in manufacturing investment. As a result, real total investment rises by 2% from the baseline in the same year. This leads to a sustained increase in productivity, as the impact on employment and unemployment rate is quite low. Higher foreign demand has a strong impact on firms' profits, which initially rise by 5% but gradually level off in subsequent years. Wages exhibit a moderate increase of 0.7% in year 2 but the effect is long-lasting. As households' disposable income rises, private consumption shows a sustained increase of about 1% from the baseline. Interestingly, due to the relatively strong increase in imports of both investment and final consumption goods, the contribution of net exports remains negative. Firm credit to GDP ratio rises by 0.3% to accommodate increased demand for investment. Real GDP

exceeds the baseline by about 1.1% in year 2 (see Figure 8). Stronger economic activity improves fiscal balances, contributes to higher housing prices and a larger stock of loans to households.

Figure 8. Percentage change in real GDP and consumer prices in response to external demand shock



A foreign demand shock induced during the economic downturn produces a qualitatively very similar impact on the economy, which is again somewhat stronger. For instance, GDP rises by 2% in year 2. Also, the shock eventually induces an increase of 0.5-0.6% in consumer prices, which was not the case during the economic boom. The differences in system's responses to the shock relate to a large extent to increased sensitivity of housing prices to economic shocks. The stabilising impact on housing prices (of up to 5%) induced by export-related income gains encourages investment and, more generally, stimulates domestic demand and price growth. Note that actually foreign demand rose by 25% from 2003 to its peak at the end of 2007 and was lower by 7% in mid-2010 and quickly recovered afterwards.

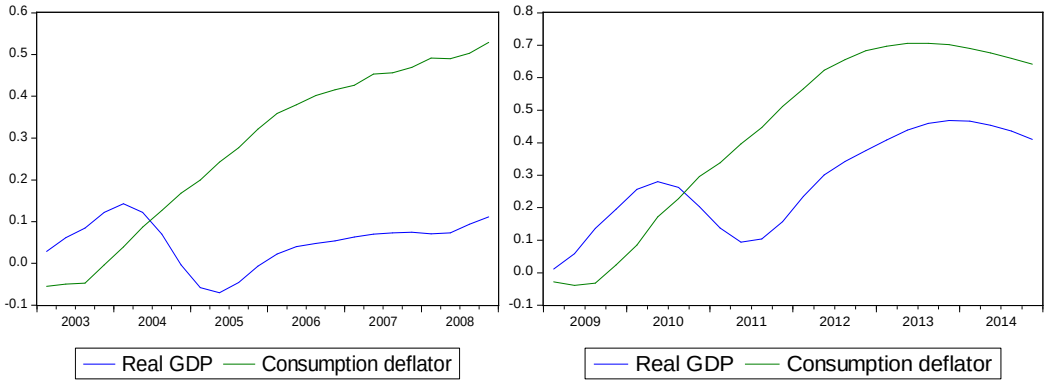
4.5. Permanent increase in nominal government consumption

The last type of shock that we consider is a permanent 1% increase in nominal government consumption (*GCONS*). In this case we make government consumption exogenous both during the boom and the downturn period. The impact of the shock is concentrated on the demand side (see Table C4). The effect of the increased government spending on the overall economic activity is negligible during the "good times", whereas fiscal policy has some potential for economic stabilisation during a deep structural crisis.

A permanent increase in government consumption at the beginning of the economic boom is associated with an immediate rise in the overall wage level both due to the direct effect of wage rises in the public sector and due to the indirect effect of competitive pressures in the private sector. Wages immediately exceed the baseline by 0.6% but eventually the gap grows to 1%. Labour productivity is only marginally affected, which leads to higher ULC. Inflation is initially subdued as stronger demand is to a significant extent accommodated by rising imports but moderate inflationary pressures gradually build up (see Figure 9). In this context the impact on profits is negative so they fall by 1.7% from the baseline in the first year following the shock. Wage rises and a moderate increase in employment offset the fall in income from firm ownership, leading to a moderate rise in household disposable income (0.8% larger than the baseline in year 6), though one has to keep in mind that with growing inflation the positive impact on real income is considerably smaller. Real household consumption gets 0.5% higher in

year 2. Housing prices gradually increase by up to 0.9% from the baseline, while financial variables are affected very little. It is important to note that in order to keep government spending permanently higher, government debt needs to grow. It gradually outpaces GDP growth, and by year 6 the debt to GDP ratio becomes 0.4 percentage point higher than the baseline. This indicates that in the longer term fiscal stimulation bears an economic cost and cannot be regarded as a "free lunch".

Figure 9. Percentage change in real GDP and consumer prices in response to government spending shock



The shock repeated at the initial stages of the economic downturn reveals that government spending can help stabilise the economy in the short and medium term. Again, the government consumption shock has an immediate impact on wages in the economy, and the effect eventually grows somewhat stronger than during the boom episode. Just as we saw in cases of other shocks, housing prices are more sensitive to shocks in a highly leveraged economy, and increases in household disposable income related to wage rises provide a sizeable stabilising impact (of up to 2.3% in year 5) on housing prices. This contributes to a pronounced rise in investment and productivity (even though wages grow faster than productivity, leading to an increase in ULC). As a result, real GDP increases from the baseline by up to 0.5% in year 5. The economic impact of the fiscal stimulus is also inflationary, as consumer prices rise by up to 0.9% from the baseline in year 5 (see Figure 9). It is interesting to note that, unlike during the boom episode, in response to permanently increased government consumption government debt to GDP ratio declines by 0.3 percentage points in year 5. This suggests that government spending helps to avoid the deflationary debt trap in the short and medium term by alleviating the vicious circle of contracting economy. This is in line with the popular among policy makers practice to respond crises by increasing government spending.

Let us put the results of this experiment in the actual context of the recent economic crisis in Lithuania. In 2008 and 2009, nominal government consumption declined, respectively, by 5% and 4%, after it grew at an exceptionally strong pace of 22% in 2008. Thus, some of the past excess was corrected during the crisis but nevertheless government consumption contracted considerably less than nominal GDP or government revenue. A relatively slow decline and the ensuing strong recovery of government spending indicate that fiscal policies were essentially accommodative during the crisis period. Such policies helped to alleviate the crisis, though it has to be emphasised that the model does not say anything about the long-term economic cost of sharply increasing government debt owing to the increasing gap between general government's expenditure and revenue. Model results only suggest that government spending can help to

temporarily stabilise economic situation but little can be said about reducing deep structural imbalances: it cannot be ruled out that balanced economic state is characterised by even lower housing prices and further diversion of capital and labour resources from procyclical sectors. In such case accommodating government spending must be promptly combined with deep structural reforms in order to achieve sustainable recovery and balanced economic development. Otherwise, clear short- and medium-term gains could be followed by even larger economic pain in the future.

5. Scenario analysis

We also conduct scenario analysis in an attempt to examine to what extent the recent economic boom can be attributed to the dynamics of four exogenous factors, namely, loan interest rates, banks' borrowing from abroad, external demand and government spending. For the purpose of including a proxy for government spending in the scenario analysis we make nominal government consumption (*GCONS*) and social transfers (*STRANFS*) variables exogenous, i.e. exclude equations (23)-(24) and (30)-(31) from the model. The ensuing analysis has some caveats related to government spending: it is not a genuinely exogenous policy variable, as it depends on the objective economic condition of the economy, which is in turn related to credit market conditions, external environment, etc. Thus, dependence of various economic processes on exogenous government consumption basically suggests that those processes can be to some extent affected by discretionary government policies. One should not forget that these policies are themselves dependent on the economic situation. We find that roughly a third of increase in government expenditure could be related to exports, whereas direct relation with credit market conditions is rather weak. The main reason why we made government expenditure exogenous in the scenario analysis was that this allows one to see which economic processes could be potentially influenced by discretionary fiscal policies[7].

This is an in-sample analysis, as we work with data from 2002 Q1 to 2009 Q2. Initially all of the abovementioned exogenous variables are fixed at their respective levels observed in 2002 Q1, and the resulting dynamics of endogenous variables is interpreted as driven by other structural economic variables. Then each of the analysed exogenous variables is alternately assumed to take its actual path in order to separate their individual contributions to the dynamics endogenous variables. The remaining differences between the sum of individual effects and the unconstrained model baseline dynamics are interpreted as synergy effects of simultaneous changes in the analysed exogenous factors. And finally, the difference between the actual dynamics of endogenous variables and the unconstrained model baseline is unexplained by the model (see figures in Appendix D). Interpreting figures in Appendix D also note that bold lines indicate the cumulative percentage change of endogenous variables from the level recorded at the beginning of the sample (i.e. the 2002 Q1) and the associated stacked columns show percentage contributions of exogenous variables to this change.

What were the main drivers behind real economic activity in Lithuania during the analysed period? As can be seen from the GDP figure in Appendix D, strong economic growth during the

[7] Another, technical reason for making government spending exogenous is that endogenous government spending in the model is not very sensitive to radical shifts in exogenous variables, so assuming subdued economic development government spending remains high implying very strong fiscal stimulus and rapidly rising public debt. This is not what we think would have happened in the absense of banks' access to foreign capital or flat foreign demand for exports.

boom period was mostly associated with strong foreign demand against the background of the global economic boom. However, the cumulative contribution of foreign demand lost momentum in the second half of 2007, and domestic factors gained relatively more importance at that time. Dynamics of banks' financing from abroad and interest rate dynamics contributed quite moderately to the overall GDP growth but there were episodes when financial conditions did have a very significant influence on GDP dynamics: one is the start of active involvement of foreign banks and declining interest rates around 2003-2004, and another one is the period of significant financial overheating from mid-2006 when the economy became overly reliant on foreign credit. It should be noted that the actual increase in banks' net foreign liabilities by around 30 billion litas during the analysed period had a direct cumulative positive impact on nominal GDP by some 21 billion litas over the eight and a half years (in real terms, it constitutes about 16% of the cumulative increase in real GDP). Another driver of real activity, namely government spending, gained importance from 2007 when government fiscal policies were becoming highly procyclical. Finally, other factors put together in a broad category that includes both fundamental factors, e.g. commodity prices, and technical factors, e.g. exogenous inventories, constitute another quite important driver behind real economic activity.

Analysis of contributions to employment dynamics shows that employment growth was, again, to a large extent determined by growing exports. Interestingly, credit expansion played a considerably more important role in determining the level of employment than in the case of real GDP dynamics, which is in line with known facts that during boom years the labour force was concentrating into highly procyclical and relatively less productive non-tradable sectors.

Turning to aggregate demand components and household consumption in particular, we find that direct contribution of exports to aggregate demand components is considerably smaller. Naturally, only a relatively small fraction of total population is employed in the exporting sector. We can see from the real household consumption graph in Appendix D that reallocation of financial resources through the public sector (i.e. compensation of public sector employees, pensions and other social transfers) was the crucially important determinant of household consumption expenditure. In this context, one should keep in mind that in Lithuania public sector workers make up a significant fraction – almost 40% – of the total number of employed persons.

Construction investment expenditure is another aggregate demand component, which is not very sensitive to exports. Though export performance was indeed very important in the first half of the past decade, starting from 2006 credit supply proxied by banks' net foreign indebtedness played the main role in determining real construction investment.

As the housing bubble was at the heart of the recent boom-and-bust cycle in Lithuania, it is crucially important to examine determinants of housing prices. It should be also noted that interpretation of the causes of the housing bubble by economic commentators is surrounded by considerable controversy, and there are many differing views. The current model's results suggest that the housing price bubble cannot be attributed to any one particular factor (see the housing prices figure in Appendix D). However, from around 2005, households' income growth linked to rising government expenditure was one of the main factors contributing to rapid housing price growth. Direct contributions of externally funded credit supply and buoyant exports were also quite significant, though lower than that of government expenditure. For instance, at the peak achieved in 2007 Q4, housing prices were at least 19% higher due to externally funded bank credit. In line with results of the shock analysis, loan interest rates positively contributed to housing price growth only in the first half of the decade, whereas the

contribution turned slightly negative in later stages of the boom. Notably, rising interest rates, declining exports and contracting foreign bank financing created strong negative accelerator effects that significantly contributed to sharp housing price declines during the crisis.

Interpreting model results with regard to housing price determinants, it is necessary to take into account some important aspects. As was mentioned above, general government spending is not an exogenous policy variable fully controlled by the government – rather, it depends on government revenue, level of economic activity, dynamics of exports markets, inflow of financial resources from abroad, etc. Since government spending is largely conditioned on actual economic processes and it is only to some extent determined by discretionary policies, it means that in fact government spending is less important, whereas exports and externally funded credit are commensurately more important, in determining housing prices than suggested by the figure in Appendix D. Also note in this context, that considerable share of credit was domestically funded, which further strengthens the impact of credit on housing prices. Moreover, the scenario analysis does not take into consideration major favourable changes in the interest rate environment that took place at the beginning of the decade (prior to the analysed sample), and in this light the importance of low interest rate environment for the formation of the housing bubble should not be overlooked.

During the analysed episode, rising consumer prices posed a significant problem for policy makers. Even though the current model is not designed for a specific and robust analysis of inflation, it may help shed some light on the drivers behind high inflation. As can be seen from the related graph in Appendix D, the contribution to inflation from exogenous structural factors, such as commodity prices, was quite significant throughout the whole episode. However, rising government expenditure and the associated broadly based rise in household incomes started to dominate among determinants of the consumer price deflator from end-2006. The model shows, quite surprisingly, that both externally funded credit and exports contributed negatively to consumer prices. Technically, this is related to the above-discussed result that both banks' active borrowing from abroad and rising exports lead to a relatively strong rise in imports, which dampens domestic price pressures. These results again have to be interpreted with caution because some inflationary pressures related with rising exports and with externally funded credit supply simply show up as a contribution from government spending (through reallocation of financial resources to broader population).

6. Conclusion

This study is one of the first attempts to develop a medium-sized macromodel of the Lithuanian economy that includes a simple but operational financial sector. The model is specifically designed to analyse the economic cycle of the past decade. Model simulation analysis is aimed at discerning the impact of the interest rate environment, foreign financial capital inflows, external trade conditions, fiscal policy decisions and other structural factors on recent cyclical economic developments. Transparent model structure and intuitive individual equations, which do not rely on strong theoretical assumptions, could be useful for a further and more detailed analysis of interesting areas of the economy. Further improved and extended, the model could also form a coherent framework for economic policy analysis and short-term forecasting.

The distinctive feature of the model is that financial sector variables are incorporated quite organically into the broader economy. It is maintained in the model that both stocks and flows

of credit have effects on the economy, and direct effects can also be amplified by accelerator effects. More specifically, on the demand side, the flow of credit fosters household spending and business investment. On the supply side, credit-fuelled business investment raises productive capacity of the economy but also alters the capital structure, as construction investment is found to rely on credit more than manufacturing investment. Private sector indebtedness (credit stock) and the associated debt servicing have a suppressing impact on corporate profits and disposable incomes of households. Credit also spurs economic dynamics through several feedback loops in the model: 1) strong credit flows to the private sector help to increase aggregate demand and boost profits and wages, which can potentially result in positive second-round effects in the short and medium term, 2) easily available credit positively affects real estate prices, which in turn raise perceived collateral value, stimulate construction activity and generally create additional demand for credit (financial accelerator effect), and 3) new credit raises the stock of deposits in the banking system and a fraction of these deposits again serve as a funding basis for further credit expansion (credit multiplier effect).

The overall dynamics of the model system is reasonably close to the actual economic developments over the model solution sample. Basic out-of-sample projections reveal that the model generally captures short-term trends quite well. The model correctly describes basic features of internal devaluation environment: downward nominal adjustment of wages, deflating housing bubble, deleveraging pressures and sharp real adjustment. Model results also suggest that without fiscal intervention and buoyant recovery of exports, the process of adjustment of past economic imbalances would have been considerably longer and more severe. In that case one could have expected a period of stagnation until 2015-2016 followed by gradual recovery. It should be emphasised, however, that if the natural balanced state of the economy is characterised by even lower housing prices and further diversion of capital and labour resources from procyclical sectors, then the current recovery may prove unsustainable. In this light, it is necessary to combine accommodating government expenditure with deep structural reforms in order to achieve sustainable recovery and balanced economic development.

Four types of standard shocks to the economy are analysed in the paper. Their timing is set at the beginning of the boom and at the beginning of the economic downturn in order to compare the economy's reaction to shocks in different phases of the economic cycle. We find that the model economy generally becomes more sensitive to shocks during the crisis. This is to a large extent related to the fact that in a highly leveraged economy housing prices become more sensitive to changes in household disposable income and financing conditions.

The shock analysis reveals that a temporary interest rate rise during the boom period has a moderate inhibiting effect on the economy, two most pronounced channels of the interest rate pass-through being related to investment demand and housing prices. If interest rates are raised at the initial stage of the economic crisis, the system's reaction to the shock remains qualitatively similar but the overall magnitude of the impact is considerably larger, which serves as an indication that interest rate increases in the financially over-stretched Lithuanian economy at the beginning of the crisis could have substantially contributed to the economy reaching the "tipping point".

A permanent increase in banks' financing from abroad assumed at the beginning of the boom period has a temporary stimulating impact on the economy, which is concentrated on the demand side but is quickly propagated through the whole economy. A notable difference is that a temporary positive impact during the crisis is slightly stronger at first but in a few years it turns more negative than during the boom episode due to rising debt servicing cost in a

contracting economy (the “debt deflation” phenomenon). This helps to explain the actual bank lending behaviour during the crisis in Lithuania – banks were quite reluctant to lend due to changed risk perceptions and due to lack of viable business projects. Model results provide some supporting evidence that further increase in indebtedness of the private sector may not be a sustainable solution to the balance-sheet, or overborrowing, crisis.

A permanent rise in the level of economic activity in foreign trading partner countries has a clearly positive effect on the economy both in the economic boom and downturn episodes via increased demand for exports, rising manufacturing investment and enhanced industrial productivity.

The impact of a permanent increase in government consumption is concentrated on the demand side. The impact on the overall economic activity is negligible during the “good times”, whereas fiscal policy has some potential for economic stabilisation during a deep structural crisis. Government spending helps to avoid the deflationary debt trap in the short and medium term by alleviating the vicious circle of contracting economy. This is in line with the popular among policy makers practice to respond crises by increasing government spending. Yet again, fiscal stimulus must be applied only in conjunction with deep structural reforms.

Scenario analysis implemented in the current paper helps to identify drivers behind the recent boom-and-bust episode. This analysis reveals that strong economic growth during the boom period was mostly associated with strong foreign demand against the background of the global economic boom. However, contribution of foreign demand to real economic growth lost momentum in the second half of 2007, and domestic factors gained relatively more importance at that time. Dynamics of banks’ financing from abroad and interest rate dynamics contributed quite moderately to the overall GDP growth but there were episodes when financial conditions did have a very significant influence on GDP dynamics: one is the start of active involvement of foreign banks and declining interest rates around 2003-2004, and another one is the period of significant financial overheating from mid-2006 when the economy became overly reliant on foreign credit.

Results of the scenario analysis suggest that the housing price bubble cannot be attributed to any one particular factor. From around 2005, households’ income growth linked to rising government expenditure was one of the main factors contributing to rapid housing price growth. Direct contributions of externally funded credit supply and buoyant exports are found to be also quite significant. Since government spending is largely conditioned on actual economic processes and it is only to some extent determined by discretionary policies, booming global economy and exceptionally easy credit conditions may in fact be very important determinants of the recent housing price bubble.

References

Benkovskis, K.; Stikuts, D. 2006. Latvia's Macroeconomic Model. Bank of Latvia Working Paper 2/2006.

Celov, D.; Vilkas E.; Grinderslev D.; Moller Andersen F. 2003. A Macro-Econometric Model for Lithuania (LITMOD). Ministry of Economy of the Republic of Lithuania, http://www.ukmin.lt/en/strat_prog/rd/doc/litmod2.pdf.

Kattai, R. 2005. EMMA – a Quarterly Model of the Estonian Economy. Working papers of Eesti Pank 15.

Kuodis, R.; Ramanauskas, T. 2009. From Boom to Bust: Lessons from Lithuania. *Monetary Studies (Pinigų studijos)* 1, 96-104.

Ramanauskas, T. 2005. Assessment of Bank Credit Growth from Macroeconomic Perspective (in Lithuanian). *Monetary Studies (Pinigų studijos)* 3, 78-97.

Ramanauskas, T. 2006. Blowing Bubbles, Enjoying Economic Growth. *Baltic Economic Trends*, 1.

Ramanauskas, T. Assessment of Credit Growth in Lithuania. Enoch, Ch.; Otker-Robe, I. (red.) *Rapid Credit Growth in Central and Eastern Europe*. Palgrave Macmillan, 2007.

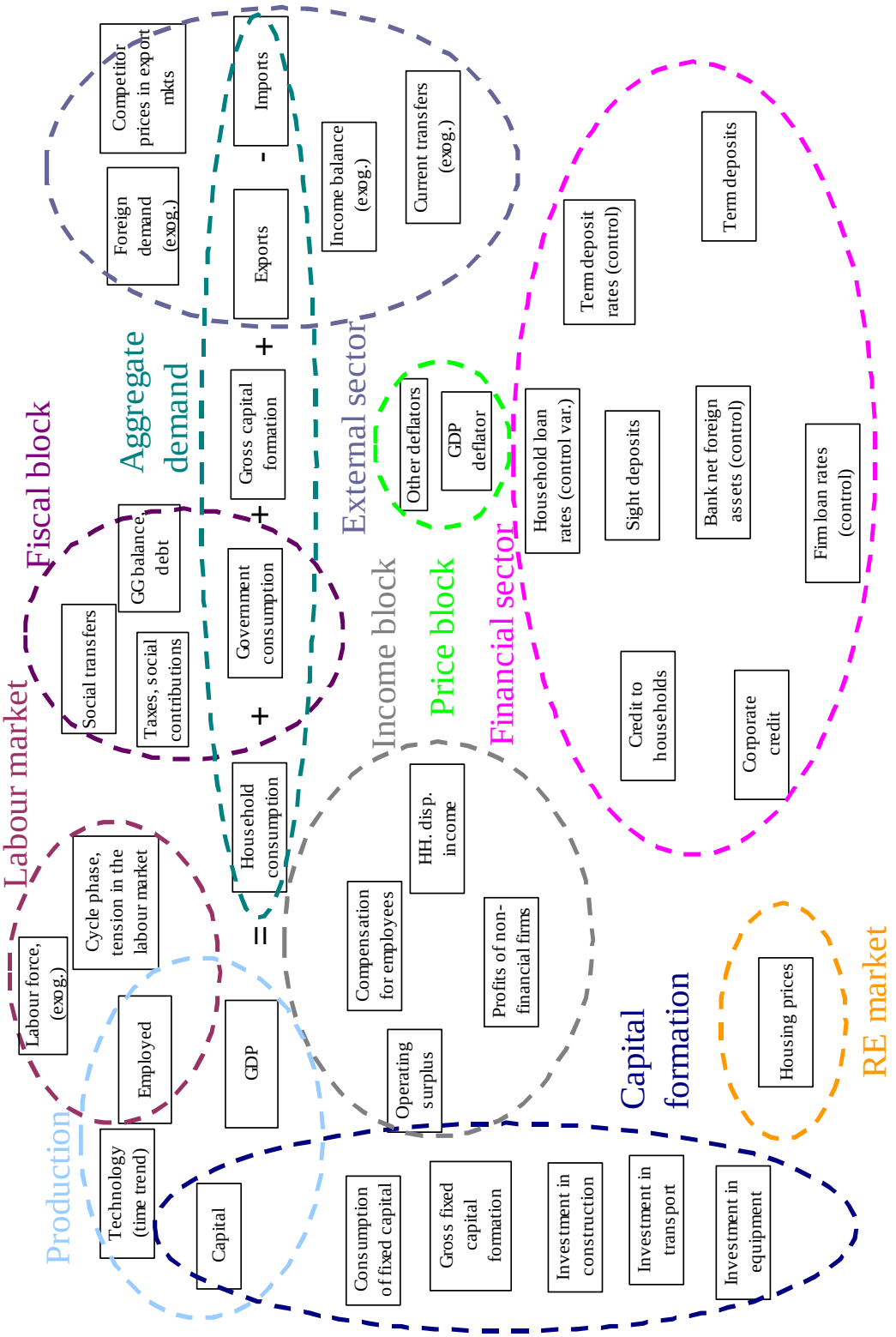
Ramanauskas, T.; Jakaitienė, A. 2007. Household Consumption Modelling (in Lithuanian). *Monetary Studies (Pinigų studijos)* 1, 25-44.

Rudzkis, R.; Kvedaras, V. 2005. A Small Macroeconometric Model of the Lithuanian Economy. *Austrian Journal of Statistics* 34(2), 185-197.

Vetlov, I. 2004. The Lithuanian block of the ECSB multi-country model. BOFIT Discussion papers 13.

Vetlov, I. 2005. Econometric Analysis of the Demand for Litas (in Lithuanian). *Monetary Studies (Pinigų studijos)* 4, 5-27.

APPENDIX A. Model's main building blocks



APPENDIX B. Model simulation results

Figure B1. Simulated in-sample dynamics of selected variables vs. actual values

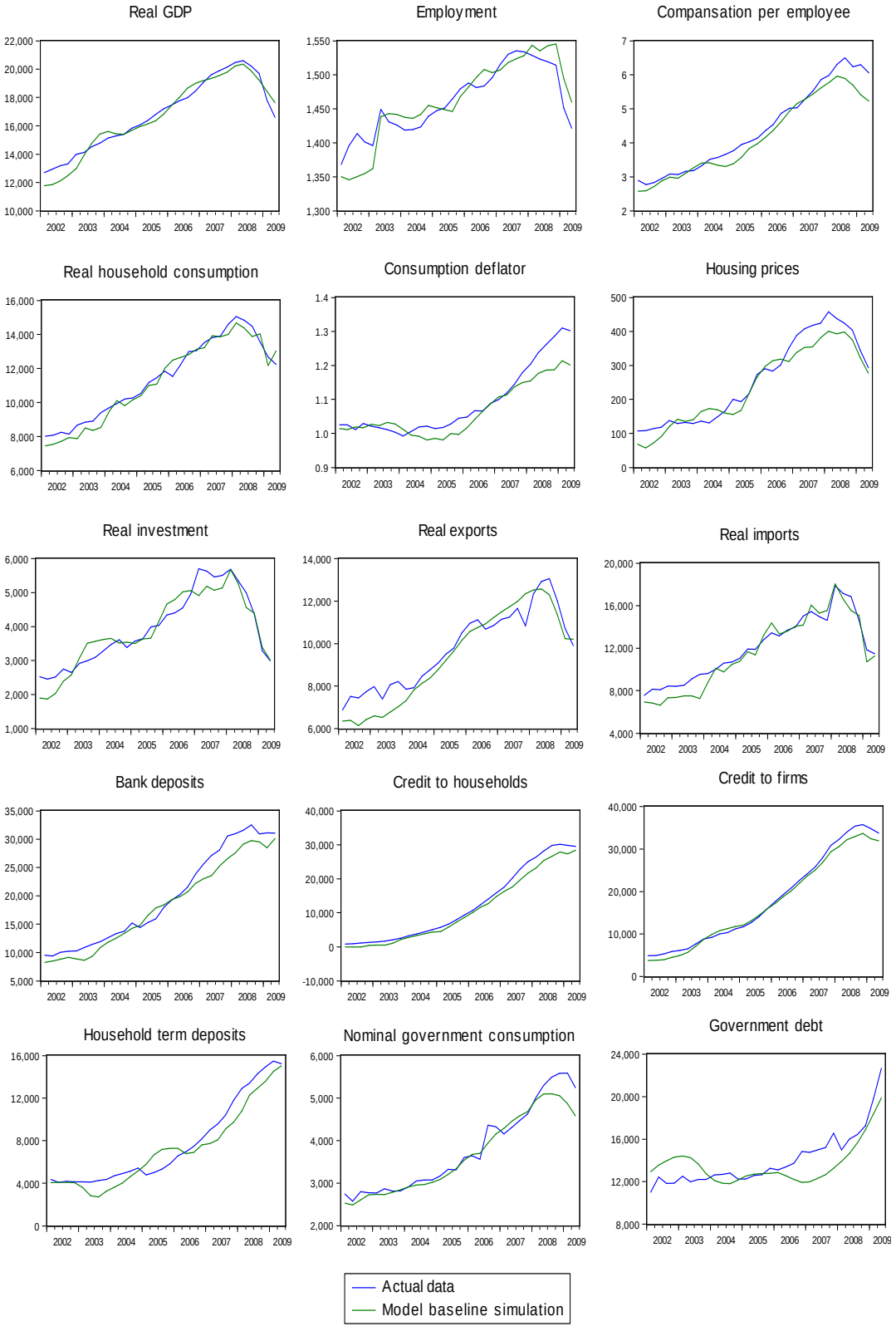
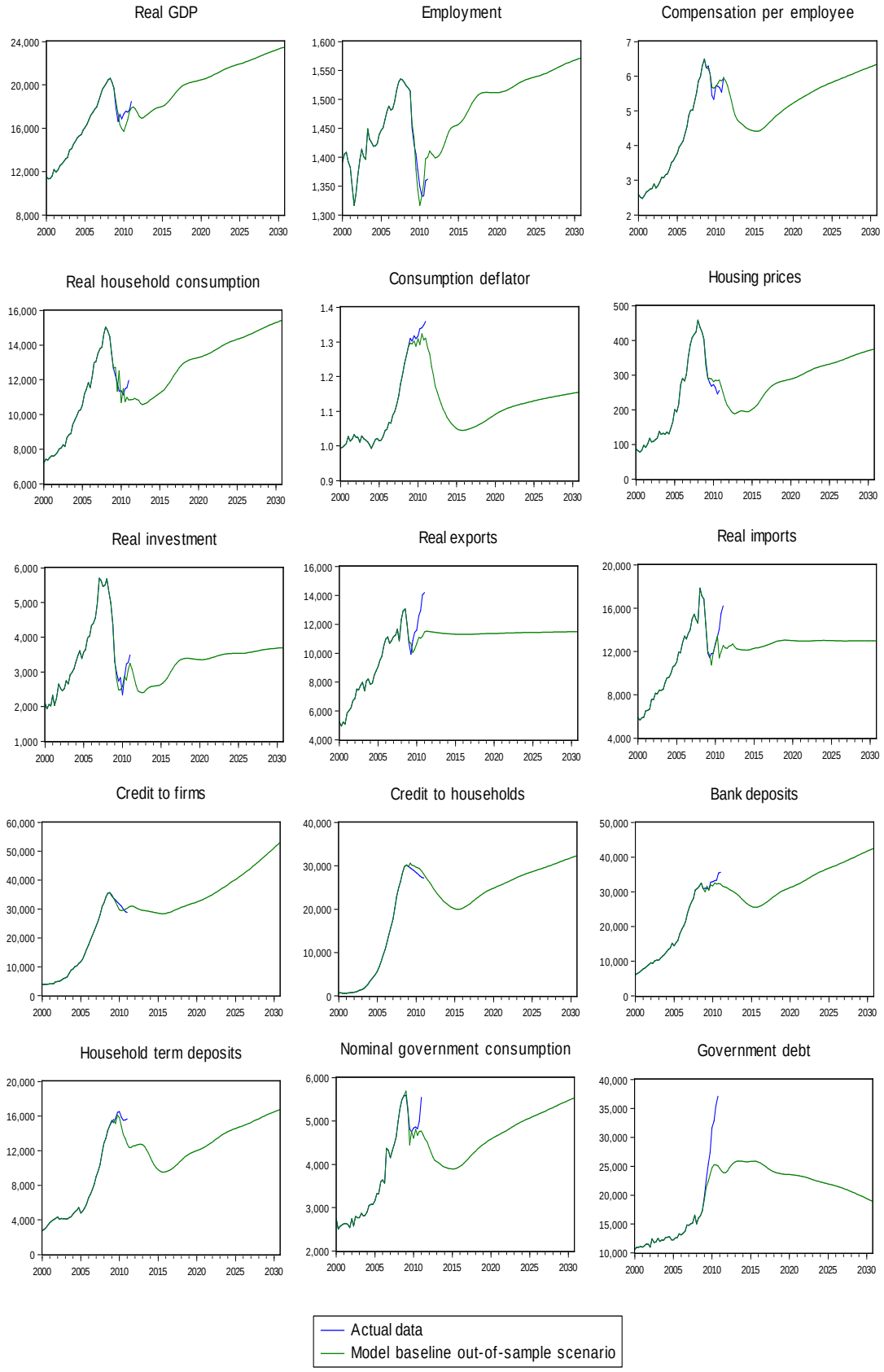


Figure B2. Model's out-of-sample solutions for selected variables vs. actual values



APPENDIX C. Shock responses of model economy

Table C1. Model response to temporary 1 p.p. increase in loan interest rates

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Prices	Deviations from baseline											
Consumption deflator	0.01	0.01	-0.10	-0.28	-0.32	-0.12	-0.25	-1.70	-2.89	-2.83	-2.09	-1.35
GDP deflator	-0.10	-0.37	-0.34	-0.29	-0.25	-0.10	-0.67	-2.12	-3.37	-3.33	-2.34	-1.34
ULC	0.20	-0.20	-0.70	-0.60	-0.30	-0.10	-0.14	-1.70	-3.87	-4.36	-3.46	-1.84
Compensation per employee	-0.40	-1.10	-1.00	-0.50	-0.30	-0.10	-0.92	-4.02	-6.11	-5.99	-3.60	-1.17
Productivity	-0.55	-0.92	-0.29	0.09	0.00	0.00	-0.78	-2.36	-2.33	-1.70	-0.15	0.69
Investment deflator	-0.25	-0.77	-0.55	0.11	0.14	0.04	-0.29	-2.83	-4.13	-2.52	-0.49	0.73
Export deflator	-0.01	-0.07	-0.11	-0.07	-0.04	-0.02	-0.03	-0.30	-0.61	-0.69	-0.51	-0.23
Import deflator	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
GDP and its components	Deviations from baseline											
GDP	-0.77	-1.46	-0.45	0.35	0.16	0.06	-1.15	-3.23	-2.73	-1.61	0.44	1.61
Private consumption	-0.70	-1.80	-1.00	0.20	0.50	0.20	-3.36	-5.92	-4.12	-2.47	-0.20	1.85
Government consumption	-0.05	-0.30	-0.65	-0.26	0.11	0.14	0.17	-0.52	-1.11	-1.00	-0.29	0.72
Investment	-2.40	-3.30	-0.30	1.10	0.60	0.30	-7.82	-10.6	-5.71	-2.10	2.27	3.90
Exports	-0.01	-0.05	-0.06	-0.04	-0.03	-0.01	-0.01	-0.09	-0.20	-0.28	-0.25	-0.16
Imports	-0.45	-1.10	-0.67	0.04	0.44	0.26	-3.41	-4.35	-2.26	-1.12	-0.37	0.71
Contributions to changes in GDP	As percentage of GDP, deviations from baseline											
Domestic demand (p.p.)	-1.04	-2.15	-0.89	0.41	0.51	0.30	-3.53	-6.37	-4.18	-2.25	0.35	2.19
Trade balance (p.p.)	0.27	0.69	0.44	-0.06	-0.35	-0.24	2.38	3.15	1.45	0.64	0.09	-0.58
Labour market	Deviations from baseline											
Employment	-0.22	-0.55	-0.16	0.26	0.16	0.06	-0.38	-0.88	-0.41	0.09	0.59	0.91
Unemployment rate (p.p.)	0.19	0.49	0.15	-0.24	-0.15	-0.05	0.32	0.73	0.36	-0.08	-0.52	-0.82
Household accounts	Deviations from baseline											
Disposable income	-0.57	-1.43	-1.05	-0.25	-0.01	0.02	-1.86	-4.75	-5.82	-4.97	-2.54	-0.22
Saving rate (p.p.)	0.10	0.40	0.00	-0.20	-0.20	-0.10	1.57	2.48	0.97	0.23	-0.22	-0.59
Fiscal ratios	As percentage of GDP, deviations from baseline											
Government revenue (p.p.)	0.00	-0.02	0.07	0.06	-0.01	0.00	0.08	0.35	0.51	0.47	0.25	0.07
Government expenditure (p.p.)	0.50	0.64	-0.27	-0.35	0.00	0.04	0.72	1.46	0.45	0.05	-0.70	-0.62
Government deficit (p.p.)	0.50	0.66	-0.34	-0.41	0.01	0.04	0.65	1.10	-0.05	-0.42	-0.95	-0.69
Government debt (p.p.)	0.60	1.30	0.70	0.20	0.20	0.20	0.90	2.90	3.10	3.00	1.30	0.10
Financial variables	As percentage of GDP, deviations from baseline											
Credit to households (p.p.)	-0.50	-0.80	-0.50	-0.30	-0.10	0.00	-0.04	-0.04	-0.35	-0.54	-0.69	-0.46
Credit to firms (p.p.)	-0.50	-0.90	-0.70	-0.50	-0.40	-0.40	-0.20	-0.50	-0.60	-1.20	-1.90	-2.10
Deposits (p.p.)	-0.26	-0.40	-0.39	-0.21	0.01	-0.03	-0.10	-0.10	-0.30	-0.50	-0.80	-0.60
Household term deposits (p.p.)	-0.01	-0.04	-0.18	-0.08	0.05	0.00	0.05	0.08	-0.13	-0.28	-0.51	-0.33
Other variables	Deviations from baseline											
Profits of non-fin. corporations	-6.00	-8.70	0.20	1.50	0.20	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Housing prices	-3.34	-4.81	-1.30	0.78	0.53	0.25	-4.10	-11.4	-12.8	-7.00	0.40	4.20

Note: Two temporary two-year shocks are assumed. A left hand side panel contains responses to a shock assumed in 2003 Q1. A right hand side panel contains responses to a shock assumed in 2009 Q1. Percentage deviations of corporate profits from the baseline are not reported if profits fluctuate around zero.

Table C2. Model response to permanent 1 p.p. increase in banks' foreign borrowing to GDP ratio

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Prices	Deviations from baseline											
Consumption deflator	0.00	0.06	-0.01	0.03	0.01	-0.10	0.01	0.08	0.02	0.11	0.06	-0.03
GDP deflator	0.05	0.21	0.09	0.05	0.02	-0.09	0.04	0.14	0.19	0.18	0.09	-0.03
ULC	-0.05	0.18	0.21	0.12	0.04	-0.10	-0.09	0.06	0.29	0.36	0.25	-0.03
Compensation per employee	0.06	0.59	0.28	0.15	0.09	-0.09	0.11	0.63	0.52	0.50	0.05	-0.30
Productivity	0.12	0.42	0.08	0.04	0.05	0.01	0.19	0.57	0.23	0.14	-0.19	-0.27
Investment deflator	0.09	0.42	0.22	0.02	0.05	0.01	0.09	0.76	0.59	0.19	-0.17	-0.33
Export deflator	0.00	0.03	0.04	0.02	0.01	0.00	0.00	0.04	0.07	0.06	0.03	-0.01
Import deflator	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
GDP and its components	Deviations from baseline											
GDP	0.19	0.65	0.15	0.03	0.08	0.06	0.31	1.01	0.49	0.16	-0.31	-0.42
Private consumption	0.31	0.52	0.35	-0.01	-0.11	-0.15	0.39	0.89	0.84	0.15	-0.42	-0.75
Government consumption	-0.03	0.11	0.26	0.16	0.09	0.09	0.03	0.47	0.48	0.32	0.04	-0.19
Investment	0.79	1.25	0.12	-0.03	-0.02	-0.10	1.87	2.14	0.73	-0.12	-1.01	-1.00
Exports	0.00	0.02	0.03	0.01	0.01	0.00	0.00	0.01	0.03	0.03	0.02	0.00
Imports	0.33	0.11	0.27	-0.02	-0.19	-0.22	0.35	0.24	0.45	-0.02	-0.24	-0.45
Contributions to changes in GDP	As percentage of GDP, deviations from baseline											
Domestic demand (p.p.)	0.39	0.71	0.32	0.01	-0.07	-0.12	0.54	1.17	0.79	0.13	-0.49	-0.73
Trade balance (p.p.)	-0.20	-0.06	-0.17	0.02	0.15	0.18	-0.22	-0.16	-0.30	0.03	0.18	0.31
Labour market	Deviations from baseline											
Employment	0.08	0.23	0.07	0.00	0.04	0.04	0.12	0.43	0.26	0.02	-0.12	-0.15
Unemployment rate (p.p.)	-0.07	-0.21	-0.06	0.00	-0.04	-0.04	-0.10	-0.36	-0.23	-0.01	0.10	0.14
Household accounts	Deviations from baseline											
Disposable income	0.14	0.55	0.37	0.09	0.03	-0.10	0.23	0.81	0.74	0.36	-0.10	-0.45
Saving rate (p.p.)	-0.15	-0.02	0.04	0.06	0.12	0.14	-0.14	-0.14	-0.10	0.09	0.22	0.28
Fiscal ratios	As percentage of GDP, deviations from baseline											
Government revenue (p.p.)	-0.01	0.02	-0.05	-0.01	0.00	-0.01	-0.01	-0.06	-0.08	-0.04	-0.01	0.03
Government expenditure (p.p.)	-0.11	-0.28	0.14	0.06	-0.01	0.01	-0.15	-0.33	0.06	0.10	0.22	0.12
Government deficit (p.p.)	-0.10	-0.30	0.19	0.08	-0.01	0.02	-0.13	-0.27	0.15	0.14	0.22	0.09
Government debt (p.p.)	-0.14	-0.49	-0.20	-0.09	-0.09	-0.06	-0.17	-0.62	-0.38	-0.24	0.11	0.27
Financial variables	As percentage of GDP, deviations from baseline											
Credit to households (p.p.)	0.43	0.59	0.63	0.56	0.50	0.56	0.31	0.37	0.61	0.75	0.82	0.81
Credit to firms (p.p.)	0.30	0.40	0.40	0.30	0.30	0.30	0.24	0.23	0.32	0.39	0.44	0.43
Deposits (p.p.)	0.18	0.15	0.26	0.18	0.06	0.06	0.04	0.06	0.21	0.14	0.12	0.11
Household term deposits (p.p.)	-0.01	-0.02	0.10	0.06	-0.02	0.00	-0.02	0.02	0.08	0.02	-0.02	-0.03
Other variables	Deviations from baseline											
Profits of non-fin. corporations	1.00	2.90	-0.40	-0.40	-0.20	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Housing prices	2.34	2.40	0.66	0.36	0.13	0.02	1.81	2.45	1.93	0.53	-1.07	-1.26

Note: Two permanent shocks are assumed. A left hand side panel contains responses to a shock assumed in 2003 Q1. A right hand side panel contains responses to a shock assumed in 2009 Q1. Percentage deviations of corporate profits from the baseline are not reported if profits fluctuate around zero.

Table C3. Model response to permanent 1% increase in external demand

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Prices	Deviations from baseline											
Consumption deflator	0.02	-0.18	-0.21	-0.10	-0.06	-0.07	0.05	0.02	0.18	0.53	0.64	0.63
GDP deflator	-0.04	-0.05	-0.16	-0.15	-0.15	-0.08	-0.04	0.22	0.50	0.80	0.85	0.78
ULC	-0.21	-0.03	0.04	0.03	-0.05	-0.06	-0.25	0.27	0.74	1.17	1.34	1.14
Compensation per employee	0.56	0.71	0.69	0.60	0.54	0.57	0.66	1.36	1.84	2.43	2.32	2.01
Productivity	0.77	0.74	0.64	0.57	0.58	0.63	0.92	1.09	1.09	1.24	0.97	0.87
Investment deflator	-0.22	-0.10	-0.27	-0.43	-0.54	-0.40	-0.38	0.40	0.58	0.45	0.08	-0.14
Export deflator	0.02	0.07	0.06	0.07	0.07	0.07	0.03	0.14	0.18	0.24	0.24	0.21
Import deflator	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
GDP and its components	Deviations from baseline											
GDP	0.91	1.11	0.92	0.77	0.80	0.94	1.16	1.98	1.79	1.68	1.20	1.01
Private consumption	0.33	1.17	1.12	0.81	0.71	0.88	0.73	2.32	2.59	2.14	1.68	1.27
Government consumption	0.24	0.54	0.94	0.88	0.82	0.77	0.45	1.12	1.37	1.26	1.02	0.81
Investment	2.03	1.87	1.57	1.21	1.19	1.26	3.70	4.18	3.17	2.73	1.66	1.45
Exports	1.74	1.81	1.66	1.54	1.48	1.42	1.37	1.45	1.47	1.52	1.55	1.55
Imports	1.30	1.89	1.95	1.61	1.40	1.32	1.18	2.25	2.58	2.15	2.05	1.84
Contributions to changes in GDP	As percentage of GDP, deviations from baseline											
Domestic demand (p.p.)	0.77	1.39	1.34	1.06	0.99	1.16	1.12	2.69	2.65	2.23	1.62	1.28
Trade balance (p.p.)	0.14	-0.28	-0.43	-0.29	-0.19	-0.22	0.04	-0.71	-0.86	-0.55	-0.42	-0.27
Labour market	Deviations from baseline											
Employment	0.15	0.37	0.27	0.21	0.21	0.30	0.24	0.89	0.69	0.43	0.23	0.14
Unemployment rate (p.p.)	-0.13	-0.33	-0.25	-0.19	-0.2	-0.29	-0.20	-0.73	-0.60	-0.37	-0.20	-0.13
Household accounts	Deviations from baseline											
Disposable income	0.55	0.95	0.91	0.73	0.72	0.87	0.92	1.94	2.41	2.49	2.25	1.91
Saving rate (p.p.)	0.19	-0.03	0.00	0.02	0.07	0.06	0.12	-0.34	-0.30	-0.15	-0.07	0.00
Fiscal ratios	As percentage of GDP, deviations from baseline											
Government revenue (p.p.)	0.03	0.03	-0.04	-0.01	-0.02	-0.02	-0.01	-0.10	-0.17	-0.18	-0.17	-0.16
Government expenditure (p.p.)	-0.44	-0.26	0.01	0.03	-0.04	-0.13	-0.45	-0.50	-0.14	-0.20	-0.01	-0.05
Government deficit (p.p.)	-0.47	-0.29	0.05	0.04	-0.02	-0.11	-0.44	-0.40	0.02	-0.02	0.16	0.11
Government debt (p.p.)	-0.57	-0.81	-0.66	-0.51	-0.48	-0.59	-0.60	-1.20	-1.20	-1.60	-1.40	-1.30
Financial variables	As percentage of GDP, deviations from baseline											
Credit to households (p.p.)	0.12	0.20	0.18	0.09	0.03	-0.02	-0.16	-0.12	0.07	0.07	0.16	0.19
Credit to firms (p.p.)	0.25	0.33	0.31	0.23	0.18	0.18	0.00	0.08	0.21	0.34	0.55	0.75
Deposits (p.p.)	0.14	0.27	0.31	0.16	0.09	0.08	0.02	0.16	0.27	0.11	0.19	0.30
Household term deposits (p.p.)	0.06	0.15	0.21	0.10	0.05	0.04	0.02	0.14	0.18	0.04	0.06	0.16
Other variables	Deviations from baseline											
Profits of non-fin. corporations	5.00	4.20	1.60	1.00	1.00	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Housing prices	1.67	2.08	1.50	0.74	0.69	1.06	1.71	4.37	5.12	4.54	3.07	2.64

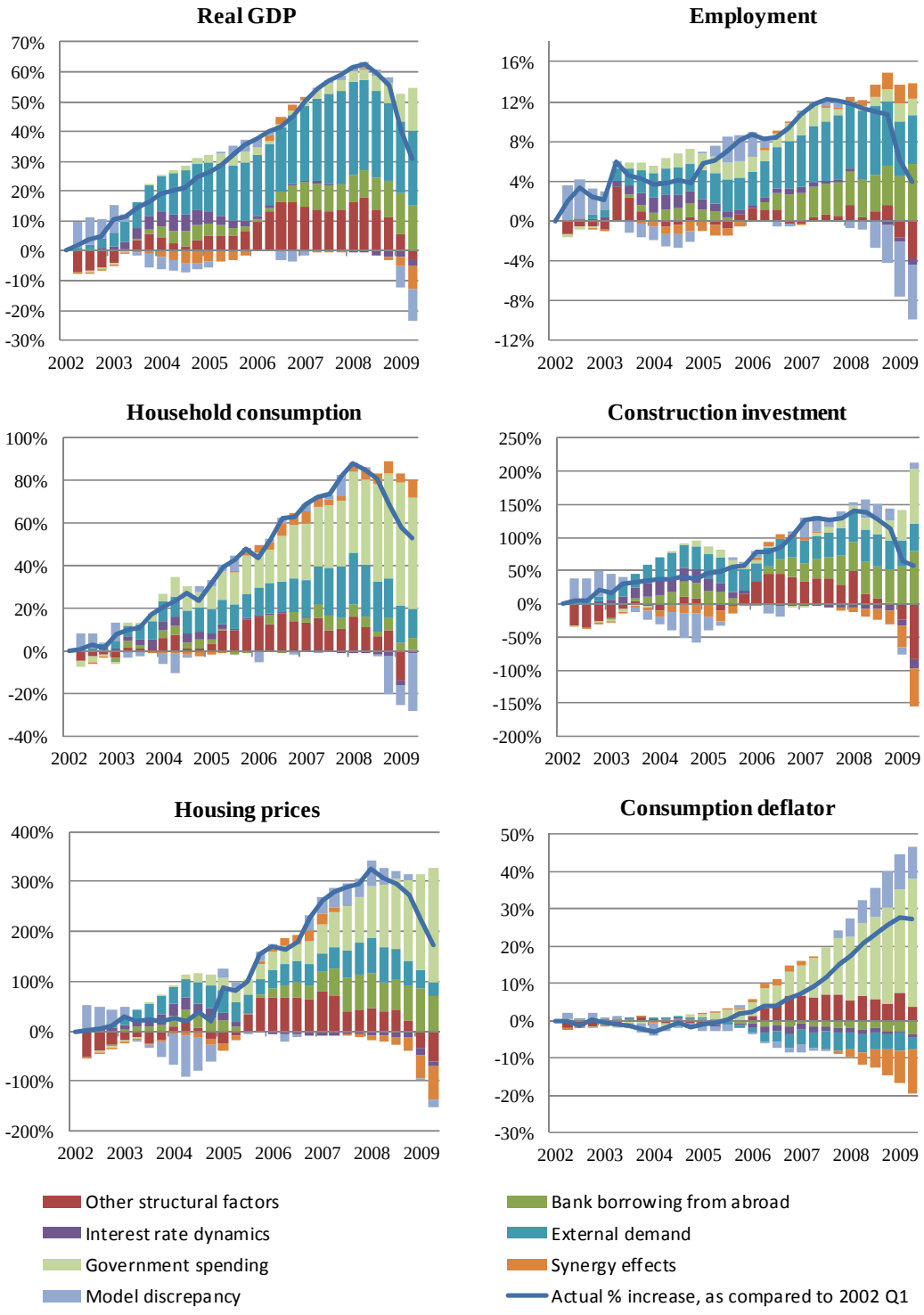
Note: Two permanent shocks are assumed. A left hand side panel contains responses to a shock assumed in 2003 Q1. A right hand side panel contains responses to a shock assumed in 2009 Q1. Percentage deviations of corporate profits from the baseline are not reported if profits fluctuate around zero.

Table C4. Model response to permanent 1% increase in nominal government consumption

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Prices	Deviations from baseline											
Consumption deflator	-0.04	0.11	0.26	0.39	0.45	0.50	0.01	0.27	0.48	0.67	0.71	0.65
GDP deflator	0.07	0.23	0.34	0.47	0.55	0.65	0.19	0.43	0.64	0.84	0.91	0.86
ULC	0.60	0.70	0.80	0.80	0.80	0.90	0.63	0.74	0.87	0.91	0.90	0.89
Compensation per employee	0.60	0.70	0.80	0.90	0.90	1.00	0.59	0.85	1.00	1.23	1.32	1.25
Productivity	-0.03	0.01	-0.02	0.04	0.06	0.07	-0.04	0.10	0.13	0.31	0.41	0.36
Investment deflator	0.08	0.14	0.14	0.19	0.28	0.30	0.11	0.31	0.41	0.52	0.64	0.59
Export deflator	0.02	0.06	0.07	0.08	0.10	0.11	0.04	0.09	0.12	0.14	0.16	0.16
Import deflator	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
GDP and its components	Deviations from baseline											
GDP	0.07	0.08	-0.05	0.04	0.07	0.09	0.13	0.23	0.13	0.35	0.47	0.42
Private consumption	0.40	0.50	0.30	0.30	0.30	0.40	0.54	0.63	0.55	0.55	0.64	0.62
Government consumption	0.90	0.70	0.60	0.40	0.30	0.20	0.77	0.49	0.24	-0.01	-0.10	-0.03
Investment	0.30	0.20	0.10	0.30	0.30	0.30	0.61	0.74	0.55	0.88	0.92	0.71
Exports	0.02	0.04	0.04	0.04	0.04	0.04	0.01	0.03	0.04	0.05	0.06	0.07
Imports	0.76	0.71	0.60	0.45	0.44	0.40	0.75	0.64	0.59	0.35	0.27	0.27
Contributions to changes in GDP	As percentage of GDP, deviations from baseline											
Domestic demand (p.p.)	0.49	0.51	0.40	0.35	0.38	0.41	0.65	0.70	0.56	0.60	0.65	0.60
Trade balance (p.p.)	-0.42	-0.43	-0.45	-0.31	-0.31	-0.32	-0.52	-0.47	-0.43	-0.25	-0.18	-0.18
Labour market	Deviations from baseline											
Employment	0.10	0.08	-0.03	0.00	0.01	0.01	0.17	0.12	0.00	0.04	0.07	0.07
Unemployment rate (p.p.)	-0.09	-0.07	0.02	0.00	-0.01	-0.01	-0.15	-0.10	0.00	-0.04	-0.06	-0.06
Household accounts	Deviations from baseline											
Disposable income	0.12	0.31	0.38	0.52	0.65	0.78	0.27	0.61	0.83	1.11	1.33	1.27
Saving rate (p.p.)	-0.30	-0.30	-0.20	-0.20	-0.10	-0.10	-0.25	-0.25	-0.19	-0.10	-0.02	0.00
Fiscal ratios	As percentage of GDP, deviations from baseline											
Government revenue (p.p.)	0.04	0.04	0.01	0.02	0.01	0.00	0.03	-0.01	-0.05	-0.07	-0.10	-0.10
Government expenditure (p.p.)	0.20	0.20	0.20	0.10	0.10	0.00	0.15	0.04	0.07	-0.15	-0.20	-0.13
Government deficit (p.p.)	0.20	0.10	0.20	0.10	0.10	0.00	0.12	0.06	0.12	-0.08	-0.10	-0.03
Government debt (p.p.)	0.10	0.18	0.34	0.33	0.34	0.37	0.03	0.00	0.07	-0.11	-0.26	-0.23
Financial variables	As percentage of GDP, deviations from baseline											
Credit to households (p.p.)	0.03	0.05	0.07	0.05	0.04	0.01	-0.03	-0.03	0.03	0.01	0.03	0.08
Credit to firms (p.p.)	-0.03	-0.08	-0.12	-0.13	-0.15	-0.15	-0.10	-0.15	-0.15	-0.15	-0.05	0.08
Deposits (p.p.)	-0.01	-0.04	0.00	0.01	0.04	0.06	-0.04	-0.04	0.03	0.01	0.07	0.16
Household term deposits (p.p.)	-0.01	-0.04	-0.01	0.01	0.05	0.05	-0.04	-0.03	0.01	0.01	0.06	0.13
Other variables	Deviations from baseline											
Profits of non-fin. corporations	-1.70	-0.80	-0.60	0.30	0.50	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Housing prices	0.58	0.51	0.60	0.78	0.88	0.95	0.62	1.21	1.61	2.21	2.28	1.97

Note: Two permanent shocks are assumed. A left hand side panel contains responses to a shock assumed in 2003 Q1. In both cases nominal government consumption is held exogenous. A right hand side panel contains responses to a shock assumed in 2009 Q1. Percentage deviations of corporate profits from the baseline are not reported if profits fluctuate around zero.

APPENDIX D. Selected graphs of scenario analysis



APPENDIX E. Variable list and explanations

Variable	Type	Description	Unit	Source
BANKDEBT	Ex.	Banks' net foreign assets	Million litas, current prices	Bank of Lithuania (BoL)
CAPDEPR	End.	Capital consumption	Million litas, current prices	Assumed 2% quarterly depreciation of real capital, on average equal to National Accounts (NA) data
CMD	Ex.	Competitors' import prices in domestic currency	Index 2000 = 1	BoL calculations
CXD	Ex.	Competitors' export prices in domestic currency	Index 2000 = 1	BoL calculations
DEFLCONS	End.	Private consumption deflator	Unit index	Ratio of nominal and real private consumption (from NA data)
DEFLCONSTR	End.	Construction investment deflator	Unit index	Ratio of nominal and real investment in construction (from NA data)
DEFLEX	End.	Export deflator	Unit index	Ratio of nominal and real exports (NA data)
DEFLG	End.	Government consumption deflator	Unit index	Ratio of nominal and real government consumption (NA data)
DEFLIM	End.	Import deflator	Unit index	Ratio of nominal and real imports (NA data)
DEFLM	End.	Machinery investment deflator	Unit index	Ratio of nominal and real investment in machinery (NA data)
DEFLTR	End.	Transport investment deflator	Unit index	Ratio of nominal and real investment in transport equipment (NA data)
DEFLY	End.	GDP deflator	Unit index	Ratio of nominal and real GDP (NA data)
DEPOSITS	End.	Residents' bank deposits	Million litas	BoL data
EX	End.	Exports of goods and services	Million litas	SL data
FCREDIT	End.	Portfolio of bank loans to firms	Million litas	BoL data
FLRATE	Ex.	Average bank rates on existing loans to firms	Percent (e.g. 0.05)	BoL data
GCONS	End./Ex.	Government consumption	Million litas	NA data
GROSSCOMP	End.	Compensation of employees (including social contributions)	Million litas	NA data
HCONS	End.	Aggregate household consumption	Million litas	NA data
HCREDIT	End.	Portfolio of bank loans to households	Million litas	BoL data
HLRATE	Ex.	Average bank rates on existing loans to households	Percent	BoL data
HPI	End.	Housing price index	Index; end-1998 = 100	National Registry
HTDEPOSITS	End.	Household term deposits	Million litas	BoL data
HTDRATE	Ex.	Rates on existing household term deposits	Percent	BoL data
IM	End.	Imports of goods and services	Million litas	NA data
INVC	End.	Construction investment	Million litas	Sum of investment in residential and non-residential construction (Statistics Lithuania data)

INVM	End.	Investment in manufacturing equipment	Million litas	Statistics Lithuania (SL) data
INVTR	End.	Investment in transport equipment	Million litas	SL data
K	End.	Capital stock	Million litas	Accumulated investment, assuming 2% real depreciation (calibrated with actual data on capital consumption); author's calculations based on NA data
L	End.	Employed labour	Thousands	SL data
LF	Ex.	Labour force	Thousands	SL data
NEER	Ex.	Nominal effective litas exchange rate	Index 1993.06 = 100	BoL data
NETCOMP	End.	Net compensation of employees (excluding social contributions)	Million litas	NA data
NFCPROFITS	End.	Net profits of nonfinancial corporations	Million litas	Balance-sheet statistics, SL data
PEI	Ex.	Price of imported energy and raw materials in domestic currency	Index, 2000 = 1	BoL calculations
PROFITS	End.	Operating surplus and mixed income	Million litas	NA data
SCONTR	End.	Social contributions	Million litas	NA data
SDEPOSITS	End.	Residents' sight deposits	Million litas	Approximated by difference between total deposits and household term deposits, BoL data
STRANSF	End.	Government social transfers	Million litas	Ministry of Finance (MoF) data
TAXINC	End.	Income and wealth taxes	Million litas	MoF data
TAXPROD	End.	Production taxes	Million litas	MoF data
TREND	Ex.	Time trend variable	Units	
WAGE	End.	Quarterly net compensation per employee	Thousand litas	Net compensation of employees divided by employed labour, NA data
WDUR	Ex.	External demand	Index, 2000 = 1	Weighted GDP index of trading partners, BoL calculations
YD	End.	Aggregate disposable income	Million litas	Calculated ad sum of personal disposable income and other disposable income, NA data
YDO	End.	Other disposable income	Million litas	Calculated as sum of operating surplus, net income balance and net current transfers from the Balance of Payments (BoP), SN and BoP data
YDP	Ex.	Personal disposable income	Million litas	Calculated as sum of net compensation of employees and social transfers, plus interest on deposits less debt servicing costs; NA, MoF, BoL data
Y	End.	Gross domestic product	Million litas	NA data

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