

# Re-estimation of the quarterly model of the Polish economy NECMOD 2010

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# 1 Introduction

The NECMOD model is an econometric model used at the National Bank of Poland for preparing inflation projections published in Inflation Reports. A detailed description of the model can be found in Budnik et al. (2009a, 2009b). The present document discusses changes introduced to the model following the re-estimation performed in May 2010. Model's parameters are estimated once a year, before the June forecasting round, and on this occasion some blocks of the model are also modified. In 2008, the most important changes included: the extension of the labour market component, the introduction of forward-looking expectations to the model, the disaggregation of investments and accounting for the impact of world market prices on domestic prices. In 2009, the most important modification implemented was the change in the specification of the foreign trade block. On the occasion of the last re-estimation, the scale of changes was relatively smaller and focused on modifications in the price equations. These changes are described in the second chapter in detail. The third chapter discusses the model's response to selected impulses.

## 2 Changes in the model

Current estimates of the parameters of the NECMOD model behavioural equations are presented in Annex 1. Annex 2 provides a description of the model's variables. Changes, as compared to the previous version of the model (Budnik et al. 2009b), result from the extension of the re-estimation sample (including the year 2009), as well as from the modifications introduced to certain blocks of the model. This chapter describes the most important changes that comprise the correction of the cointegrating equations for the gross value added deflator, components of the CPI deflator (core inflation, energy prices and food prices) and the corporate gross fixed capital formation. Furthermore, the definitions of capital used in the model have been changed and the consumption equation has been disaggregated.

**Deflators of gross value added and core inflation.** In the previous version of the model the deflators of gross value added and core inflation were determined, in the long term, by the weighted average of unit labour cost (ULC) and import prices, i.e.<sup>1</sup>

$$pva_t^* = \alpha_1 + \alpha_2 \cdot ulcna_t + (1 - \alpha_2) \cdot (pimp_t^c + \log(1 + GR\_TAR\_TR_t)) \quad (1)$$

In a simple model with the Cobb-Douglas production function, unit labour costs are proportionate to the marginal cost and the changes in costs result only from the adjustment of labour force supply to changes in the output level. Import prices have been included in the price equation for two reasons. On the one hand, the cost of imported goods is taken into account as a direct cost incurred in the production process. On the other hand, imports constitute competition to domestic goods and affect the level of profit margins.

In this version of the model, the block of prices is based on the concept used in the model of Banco de España (Estrada et al. 2004; Ortego et al. 2007). Current unit labour costs have been changed for unit labour costs determined for the level of employment adjusted to the current output level ( $EMP_t^*$ ). Total employment in the equilibrium is determined by inverting the production function, i.e.:

$$EMP_t^* = \frac{GDP_t^{1/0.67}}{K_t^{(1-0.67)/0.67} \cdot TFP\_TREND_t^{1/0.67}} \quad (2)$$

By substituting the equilibrium employment for the current employment in the equation (1), we obtain the long-run equation for prices in the form of:

$$pva_t^* = \alpha'_1 + \alpha'_2 \cdot (wage\_n_t - \frac{1}{0.67} tfp\_trend_t + (\frac{1}{0.67} - 1)(gdp_t - k_t)) + (1 - \alpha'_2) \cdot (pimp_t^c + \log(1 + GR\_TAR\_TR_t)) \quad (3)$$

Due to the fact that, in the long run, the employment is in the equilibrium ( $EMP_t = EMP_t^*$ ), both approaches, (1) and (3), produce the same long-term solution. However, the short-run behaviour of prices is different in these two equations. The changed cointegrating equation of prices can be obtained by completing the previous form with a gap between

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<sup>1</sup>This chapter describes the changes in the equation of the gross value added deflator without a separate description of core inflation, which is modelled in the same way.

the total employment adjusted to the current output level, and the current employment. The above gap constitutes an indicator of production capacity utilisation in the economy and of the demand pressure. Thus, the cointegrating equation for prices includes both cost and demand elements.

**Equation of corporate gross fixed capital formation.** In the previous version of the model, the optimal level of productive private capital was determined by equating the marginal product of capital with the cost of capital:

$$MPC_t = RUCC_t \quad (4)$$

where:

$$MPC_t = \frac{\delta GDP\_POT_t}{\delta KP_t} = 0.33 \cdot \frac{GDP\_POT_t}{K_t} \cdot 0.7^3 \cdot \left(\frac{K_t}{KP_t}\right)^3.$$

Currently, this relationship takes also into account the path of the other production factor – i.e. labour. In the new specification, the corporate investment demand increases if the ratio of the marginal product of capital to the marginal product of labour is higher than the corresponding relation of their real costs.

$$\frac{MPC'_t}{MPL_t} = \frac{RUCC_t}{RUCL_t} \quad (5)$$

where:

$$MPC'_t = \frac{\delta GDP_t}{\delta KP_t^*} = 0.33 \cdot \frac{GDP_t}{K_t} \cdot 0.7^3 \cdot \left(\frac{K_t}{KP_t^*}\right)^3,$$

$$MPL_t = \frac{\delta GDP_t}{\delta EMP_t^*} = 0.67 \cdot GDP_t^{(-0.33/0.67)} \cdot TFP\_TREND_t^{(1/0.67)} \cdot K_t^{(0.33/0.67)}.$$

In addition, the definition of the marginal product of capital was changed. Now, it is determined on the basis of current rather than potential GDP. Whereas, the marginal product of labour is determined accounting for the adjustment of the total employment to the current level of production.

The change in the specification of the private investment equation has induced its greater procyclicality. For example, a disruption involving population growth (e.g. due to a return wave of migration) increases potential output and contributes to the creation of a negative output gap. At the same time, such shock translates into an easing of wage pressure in the labour market and thus a decline of a real labour cost. This, according to the new specification of the equation, is reflected in the declining investment demand, which, in the longer term, lowers the level of potential output and contributes to the closure of the negative output gap. Such dependence did not exist in the previous specification of the model. The above-mentioned modifications, despite having contributed to a greater procyclicality of private investment, have not changed the long-run equilibrium.

**Equations of energy and food prices.** The domestic energy and food prices in the previous version of the model were, in the long term, a function of the world market's and domestic prices. The long-term energy equation<sup>2</sup> had the following form:

$$\begin{aligned} enerpci_t^* &= \beta_1 + \beta_2 \cdot (p\_ener_t + s\_usd\_pln_t^c + GR\_VAT\_TR_t) \\ &+ (1 - \beta_2) \cdot (corecpi_t - GR\_EXT\_REST\_TR_t) \\ &+ GR\_EXT\_ENER\_TR_t \end{aligned} \quad (6)$$

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<sup>2</sup>This chapter describes only the equation of energy prices, food prices are modelled analogically.

In the new version, the gross value added deflator is used as a measure of domestic prices, instead of core inflation, which is a narrower category.

$$\begin{aligned} enerpcpi_t^* &= \beta_1' + \beta_2' \cdot (p\_ener_t + s\_usd\_pln_t^e) \\ &\quad + (1 - \beta_2') \cdot pva_t + \log(1 + GR\_ENER\_TR_t) \end{aligned} \quad (7)$$

Because, after the accession to the EU, the energy prices were rising faster than it was expected from analyzing cost determinants (among others, due to the investments necessary to adapt the energy sector to EU standards), it was assumed that this equation saw a structural change in 2004 Q3, modelled with the use of a dummy variable.

**Changed definition of capital.** In the current version of the model the definition of capital has been changed from gross capital to net capital, what is consistent with national accounts. Currently, the quarterly rate of depreciation of capital is 2.3% (a liquidation rate of 0.8% was used before), which is consistent with the value adopted in other models (Pytlarczyk 2005; Grabek et al. 2007; Dam and Lina 2004, Boivin and Giannoni 2005). Net capital assumes lower values than gross capital, and therefore, investments more strongly affect the relative change in net capital than that in gross capital. Consequently, the new specification of the model displays a lower inertia of productive capital (and potential output) in the cycle, which has strengthened the mechanisms closing the demand gap after a disturbance.

**Disaggregation of consumption.** The purpose of disaggregation of consumption into three components: consumption of durable goods, residential services and other goods and services was to take into account determinants specific for each of these categories and to reinforce the impact of the interest rate on total consumption. In the previous version of the model the equation of consumption had the following form:

$$\begin{aligned} conp_t^* &= \gamma_1 + \gamma_2 \cdot yd_t + (1 - \gamma_2) \cdot wealth_t + \gamma_3 \cdot I\_3MR\_CPI_t \\ &\quad + \gamma_4 \cdot HH\_NET\_WEALTH\_RATIO_t \end{aligned} \quad (8)$$

Currently, each type of consumption is modelled separately. The equation of the consumption of durable goods has the following form:

$$conp\_dur_t^* = \gamma_1' + \gamma_2' \cdot yd_t + (1 - \gamma_2') \cdot wealth_t + \gamma_3' \cdot I\_3MR\_CPI_t. \quad (9)$$

The following equations were adopted, respectively, for the consumption of residential services and the consumption of other goods and services:

$$\begin{aligned} conp\_resid_t^* &= conp_t - \gamma_1'' + \gamma_2'' \cdot UNRATE_t \\ &\quad + \gamma_3'' \cdot (pgfcf\_h_t - cpi_t + rucc\_h_t), \end{aligned} \quad (10)$$

$$\begin{aligned} conp\_ndur_t^* &= \gamma_1''' + \gamma_2''' \cdot yd_t + (1 - \gamma_2''') \cdot wealth_t \\ &\quad + \gamma_3''' \cdot HH\_NET\_WEALTH\_RATIO_t. \end{aligned} \quad (11)$$

### **3 Impulse response analysis**

The behaviour of the model is presented based on the description of selected impulses. Unless otherwise indicated, changes are unexpected and the monetary rule is enabled (interest rates are formed according to the Taylor rule). Variables' responses to an impulse are presented in the horizon of 12 quarters (cf. Figures 1-6).

#### **3.1 Analysis of the effects of monetary shock**

A monetary impulse is defined as an unexpected increase in the short-term interest rates of 100 basis points for the period of four quarters. After the shock interest rates behave according to the Taylor rule, remaining temporarily above the baseline scenario as a result of the rule's mechanism smoothing the path of interest rates.

The increase in short-term interest rates, which in turn causes a hike in long-term rates, leads to an increase in costs of raising capital, and consequently, reduces both corporate and households' investment (residential investment).

In turn, lower residential investment leads to a drop in housing prices and, consequently, to the decline in household assets reducing consumer demand. Higher interest rates also curb individual consumption by shifting consumption in time, especially in the case of durable goods. On the other hand, individual consumption is increased by the appreciation of the national currency, which is improving Poland's net foreign asset position, and higher interest on public debt.

The appreciation of the Polish currency, through its impact on foreign trade prices, reduces export growth and increases the growth rate of imports. In consequence, the exchange rate channel is contributing to a reduction in net exports. As a result, GDP growth falls by about 0.12 percentage points, with the strongest decline coming three quarters after the monetary shock.

The effect of the interest rate rise on inflation is associated with a lower growth of import prices due to domestic currency appreciation and lower labour costs, resulting from the reduced growth rates of wages and employment in response to the slowdown in economic activity. Consequently, CPI inflation falls by about 0.1 percentage points six quarters after the increase in interest rate.

In response to the decline in GDP growth, as well as lower inflation, the monetary shock is followed by a monetary policy easing, in line with the Taylor rule. Lower interest rates leading to increased economic activity and faster price growth, bring the economy back to the baseline path.

#### **3.2 Analysis of the effects of changes in external prices**

The impulse has been defined as a sustained 10-percent increase in the prices of oil, gas and coal in the world markets (in the NECMOD model these prices are the components of the index of energy commodity prices).

The increase in energy commodity prices leads directly to a higher growth rate of import prices and energy prices in the domestic market. The trade balance deterioration, caused by less favourable terms of trade, translates into weakening of the equilibrium exchange rate and, consequently, lower current exchange rate. These factors contribute to inflation growth, with the highest inflation level (a shift of approx. 0.2 percentage points)

recorded in the fourth quarter after the impulse. The consequence of inflation growth is a monetary policy tightening.

Enterprises incur additional costs associated with rising energy prices and higher credit costs, which curbs their investments, and translates, with some delay, into decline of productive capital. This leads to a reduction in the level of potential output and wealth. Wealth is further reduced by the depreciation of the exchange rate, which affects the level of net foreign assets. The reduction in assets and real income of households (as a result of higher consumer prices) decreases consumer demand, which in combination with a decline in investment translates into lower growth in domestic demand and GDP. In the short term, a slight increase in GDP results from the effect of the zloty's depreciation on net exports.

### **3.3 Analysis of the effects of the economic slowdown abroad**

The economic slowdown abroad has been defined as a reduction in GDP growth rate in the global economy (i.e. the euro area, the United States and the United Kingdom) of 1 percentage point for one quarter. According to the model of the external environment, used in the simulation version of the NECMOD model, the growth of the world economy after the shock, remains lower than in the baseline scenario for four consecutive quarters. The slowdown in GDP growth is accompanied by a decline in the inflation rate abroad of approx. 0.4 percentage points in the first year after triggering the impulse. At the same time, in response to lower inflation and weaker GDP growth interest rates abroad fall by about 0.6 percentage points. Yet another consequence of the global economic slowdown is a lower growth rate of the energy commodities and agricultural products prices in the world markets (of approx. 2 and 0.1 percentage points, respectively).

The disturbances in the external environment result in a reduction in foreign trade. Lower external demand, combined with the appreciation of the national currency (due to lower interest rates abroad), translates into a slower pace of export growth. The growth of imports also slows down, albeit to a lesser extent, due to the large import intensity of exports. The shifts in trade volumes reduce the contribution of net exports to GDP growth.

In response to the economic downturn in the country, enterprises are cutting investment. This effect is only partially offset by lower prices of commodities in the world markets. While cutting their costs enterprises also reduce the employment and salaries of employees. As a result, the income and consumption of households are lessened. Individual consumption is also slowed down by the reduction in household's wealth associated with a lower level of productive capital.

As far as nominal economy is concerned, the slower rise in commodity prices in global markets translates into a lower growth rate of energy and food prices in the domestic market, which combined with the slowdown in the domestic growth is conducive to lower CPI inflation.

### **3.4 Analysis of the effects of exchange rate disturbances**

The impulse has been defined as unsustained 10-percent appreciation of the real (and nominal) exchange rate.

Exchange rate appreciation leads to a decline in import prices and thus in all the components of CPI inflation (core inflation, energy prices and food prices). The maximum reduction in CPI inflation (a drop of 1.5 percentage points) is observed four quarters after the shock occurs.

Along with the appreciation of the exchange rate domestic products become less competitive abroad, which leads to weakening exports with the concurrent rise in imports, and thus to a negative contribution of net exports to GDP growth. The strongest decline in GDP occurs in the third quarter after the impulse. Due to the weaker sales opportunities, enterprises reduce their investments. The economic slowdown also leads to a deterioration in the labour market situation and, consequently, to a reduction of disposable income of households and a consumption decline.

In response to dropping prices and lower economic growth, monetary policy is being relaxed, supporting the economy in its return to the equilibrium state.

### **3.5 Analysis of the effects of EU funds inflow**

The impulse is defined as an increase in the inflow of EU structural funds allocated for public investment of 1% of GDP for four quarters.

Higher public investment, due to its low import intensity, significantly increase the demand for domestic goods, which translates into faster GDP growth. On the other hand, the inflow of EU funds improves the current account balance, which leads to the strengthening of the zloty exchange rate. The stronger zloty reduces exports and increases imports, adversely affecting GDP growth, limiting the positive impact of higher public investment on GDP.

The growing demand increases corporate investment. Consumption also rises, primarily due to the improved labour market situation resulting from the economic recovery.

The impact of this impulse on prices in the economy is significantly smaller than on the GDP growth rate. In the short term, the inflow of EU funds raises demand in the economy, pushing CPI inflation up. The opposite influence is exerted by the appreciation of the exchange rate leading to a decline in import prices, including food prices expressed in domestic currency, which leads to the reduction in core inflation and food price inflation. This effect is further reinforced by the growing potential output in the economy.

In the longer horizon, as the demand impulse wears off, the inflation declines. Therefore the effects of domestic currency appreciation, potential growth and higher interest rates outweigh.

### **3.6 Analysis of the effects of fiscal shock**

The impulse is defined as a transitory (lasting for four quarters) unexpected decrease in intermediate consumption of 1% of GDP. Thus, the shock introduced to the model can be interpreted as a transitory fiscal tightening reducing domestic demand.

As the public sector curtail the purchases of goods and services, the GDP declines. This effect is amplified by the Keynesian multiplier effect and, due to the reduction of collective consumption by 1% of GDP, GDP falls by approx. 1.4%. The fastest and the strongest consequence of this drop is a decline of investment (which annual growth rate in the first year of simulation falls on average by 1.0 percentage points) and an increase

in inventories. In subsequent periods, after general government demand returns to its original path, investment and inventories rebuild. By contrast, the response of household consumption is weaker and delayed in time. The maximum effect materialises after three quarters at -0.4 percentage points, which is due to two factors. Firstly, the reduction of the purchases of goods and services by the public sector affects households through non-immediate adjustments in the labour market, resulting in a decline in disposable income. Secondly, households tend to smooth consumption over time and thus individual consumption responds to transient shocks only to a small extent.

Reduced demand influences the labour market situation with a delay. The level of employment adjusts slightly faster. Its annual growth rate reaches a maximum decrease after 3 quarters of the simulation, while the annual growth rate of wages drops to the lowest value one quarter later.

A negative demand shock leads to the opening of a gap between demand and supply, which together with the deterioration in the labour market contributes to inflation decline. An additional channel through which the fiscal policy can influence prices is the exchange rate channel. Cutting down expenditure and budget deficit is conducive to improving investors' perception of Poland, and consequently, the exchange rate appreciation (up to 2.1%, in this scenario, after three quarters of the simulation), leading indirectly to inflation reduction.

Fiscal tightening, resulting in a negative output gap and deflationary pressures, leads to monetary policy easing and the return of the economy to the equilibrium in the long term.

Figure 1. Analysis of the effects of monetary shock

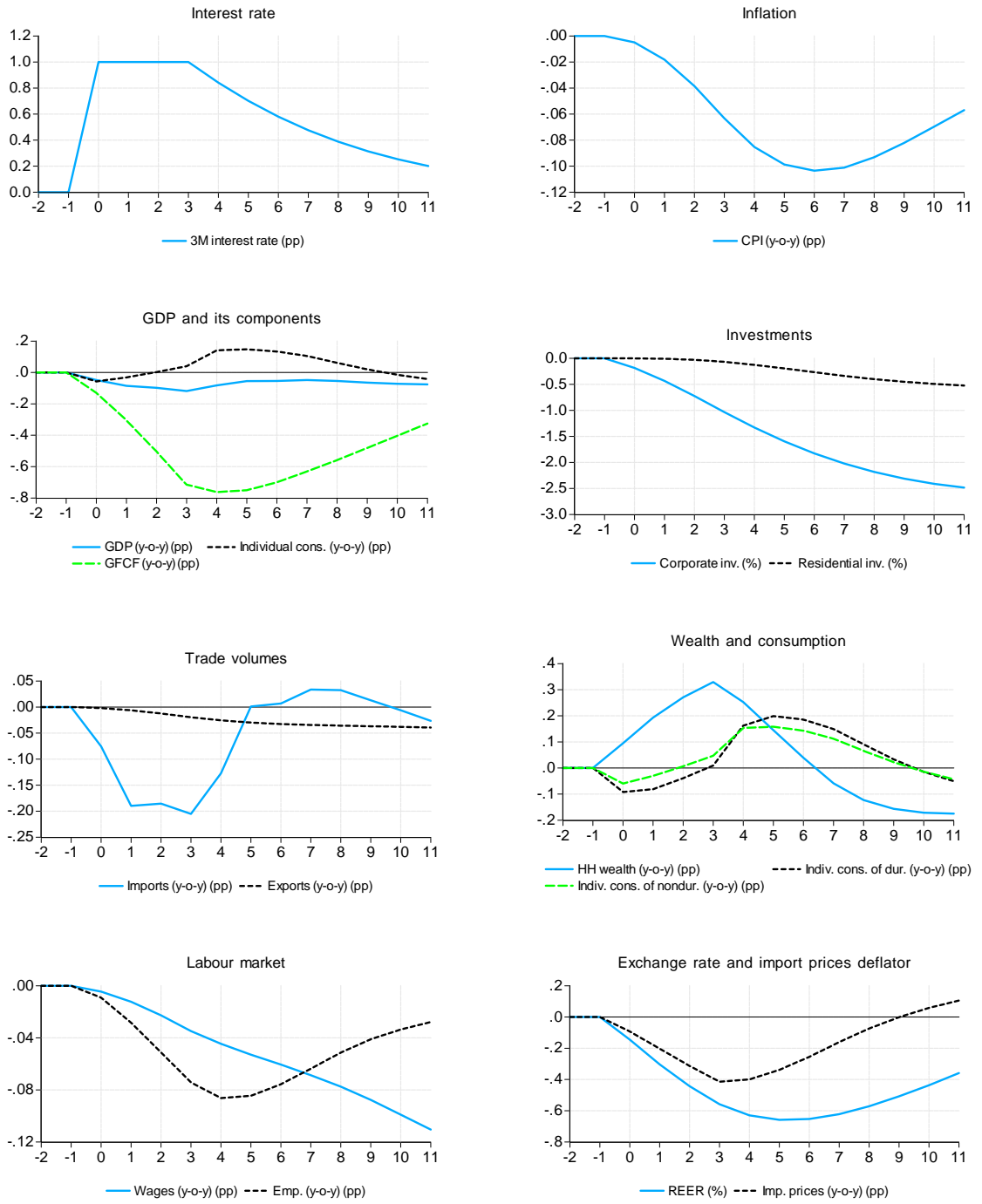


Figure 2. Analysis of the effects of changes in external prices

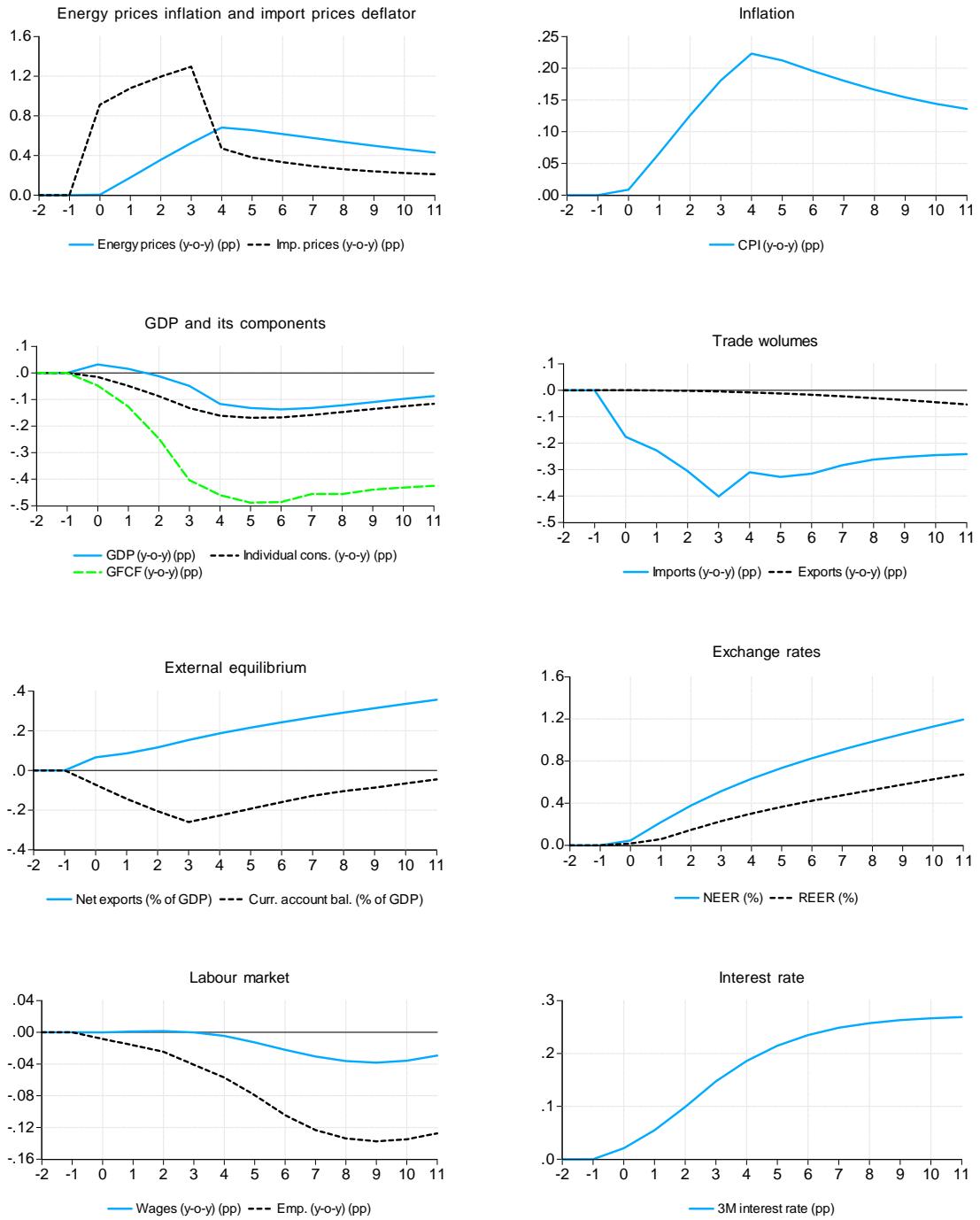


Figure 3. Analysis of the effects of the economic slowdown abroad

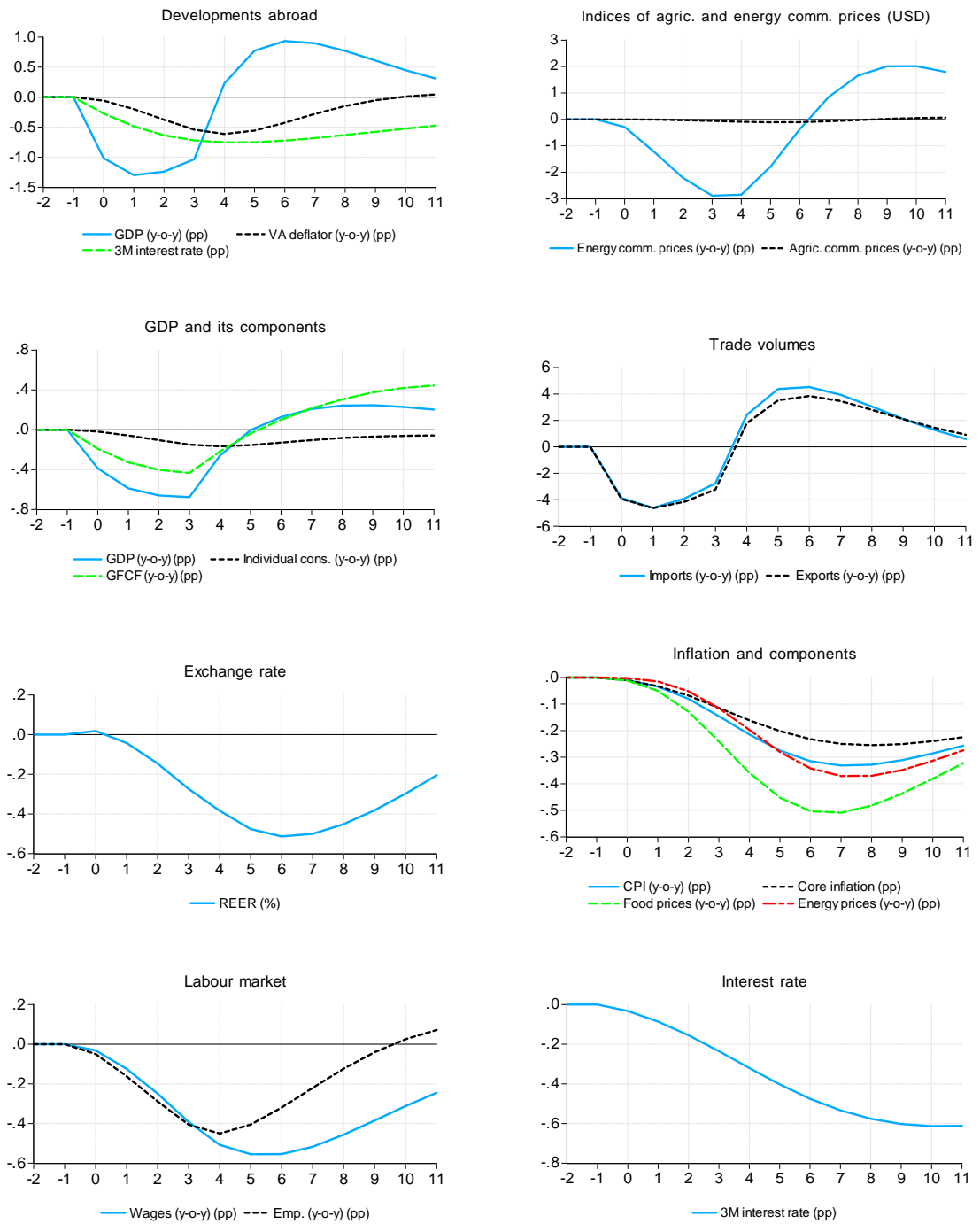


Figure 4. Analysis of the effects of exchange rate disturbances

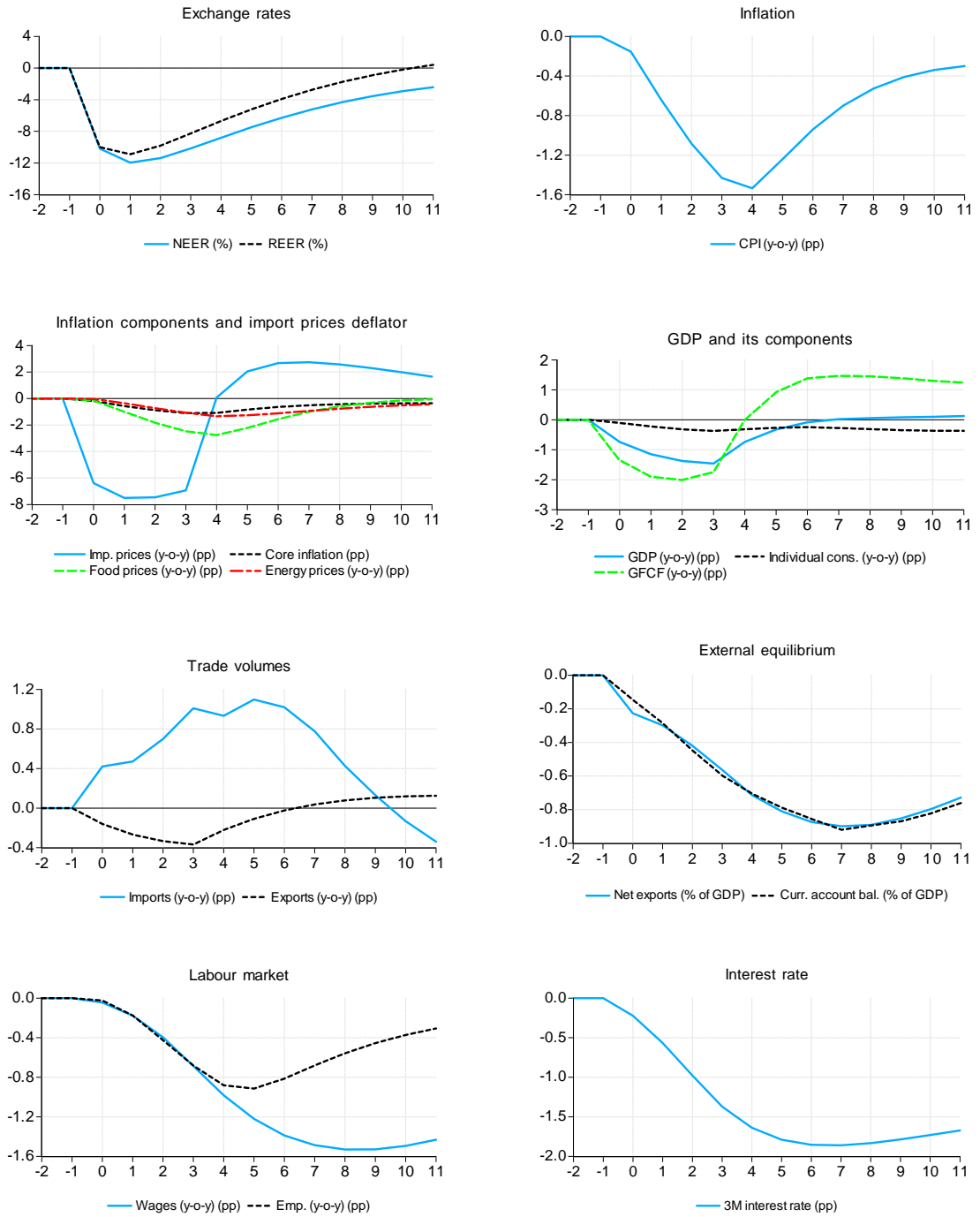


Figure 5. Analysis of the effects of EU funds inflow

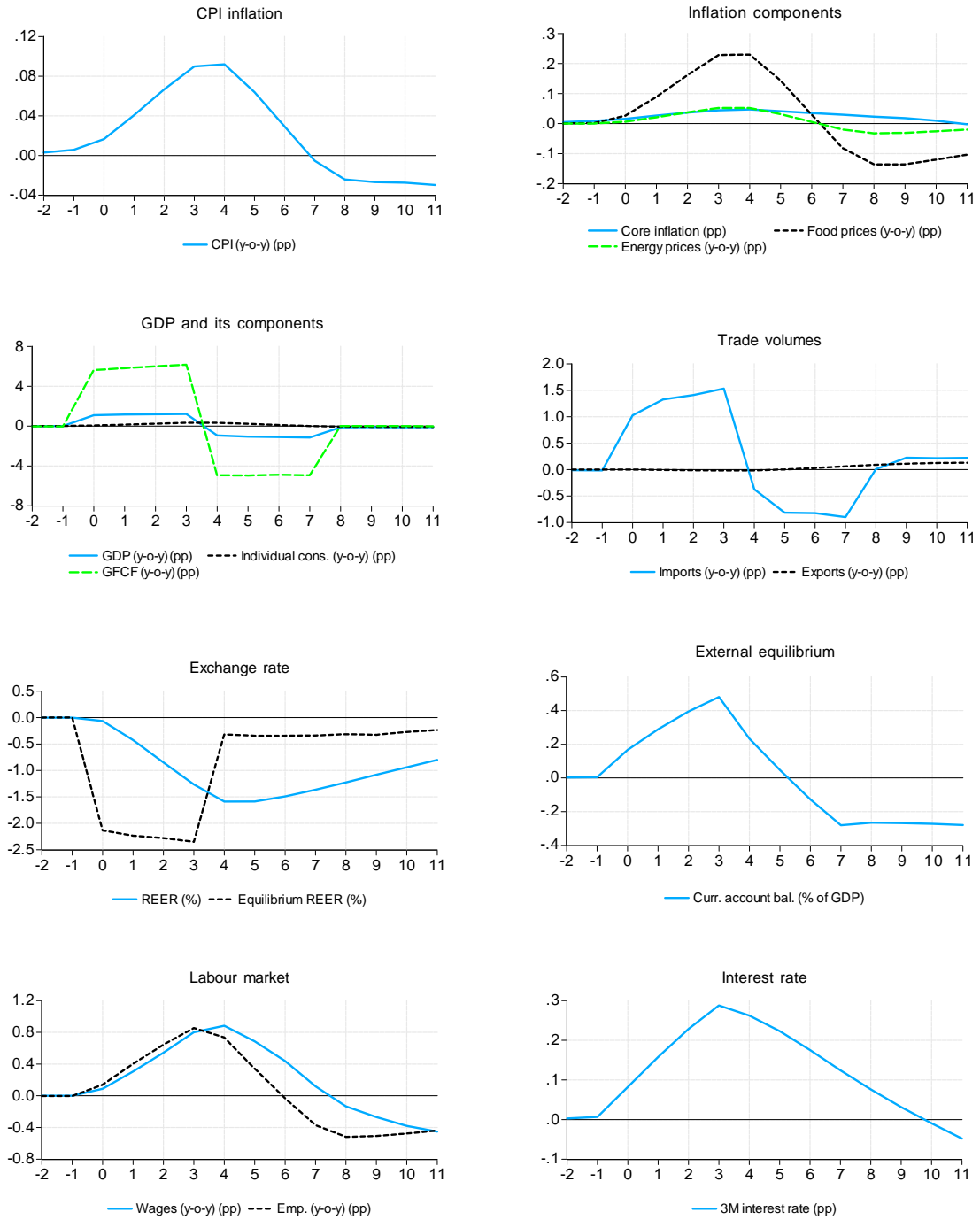
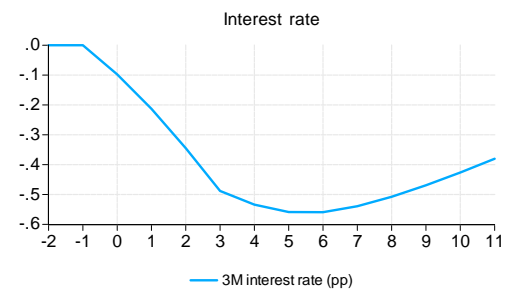
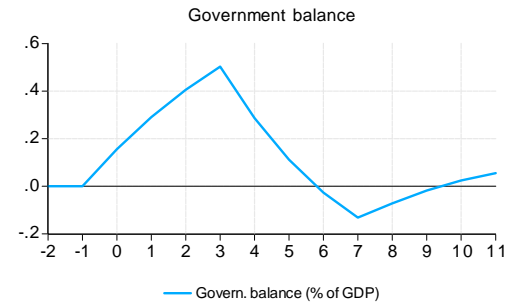
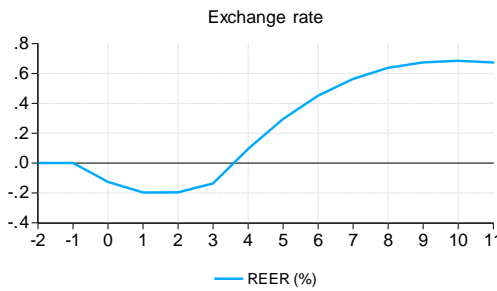
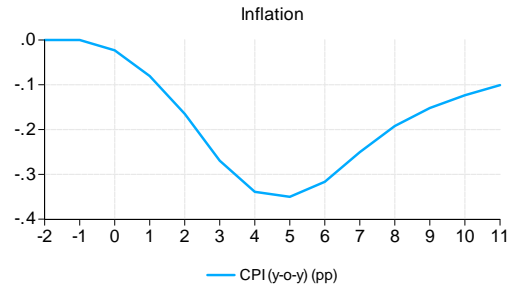
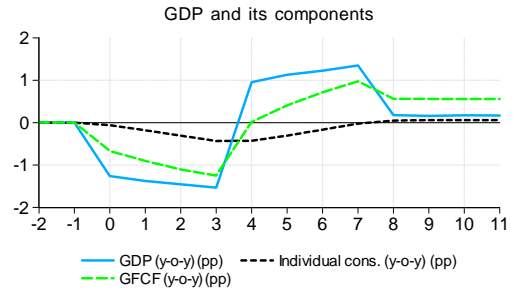
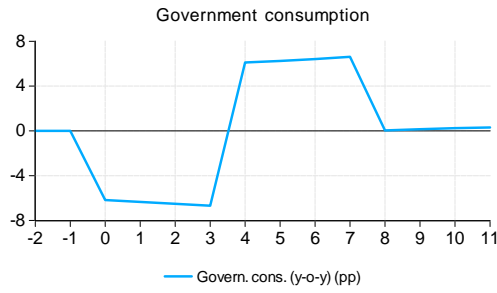


Figure 6. Analysis of the effects of fiscal shock



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## A NECMOD equations

Individual consumption of durable goods

$$\begin{aligned} \text{comp\_dur}_t^* &= -3.20 + 0.76 \cdot yd_t + (1 - 0.76) \cdot \text{wealth}_t \\ &\quad - 0.07 \cdot I\_3MR\_CPI_t \end{aligned} \quad (12)$$

$$\begin{aligned} \Delta \text{comp\_dur}_t &= \frac{0.69}{(0.12)} \cdot (\Delta \text{tfp\_trend}_t / 0.67) \\ &\quad + (1 - \frac{0.69}{(0.12)}) \cdot \Delta \text{comp\_dur}_{t-1} \\ &\quad - \frac{0.19}{(0.05)} \cdot (\text{comp\_dur}_{t-1} - \text{comp\_dur}_{t-1}^*) \\ &\quad - \frac{0.09}{(0.21)} \cdot \Delta I\_3MR\_CPI_t \end{aligned} \quad (13)$$

*Adjusted R*<sup>2</sup> = 0.22

*S. E. of equation* = 0.017

*LM test (p-value)* = 0.003

*Estimation period*: 1997q2 - 2009q4

Residential services consumption

$$\begin{aligned} \text{comp\_resid}_t^* &= \text{comp}_t - 5.05 - 2.97 \cdot UNRATE_t \\ &\quad - 0.7 \cdot (\text{pgfcf\_}h_t - \text{cpi}_t + \text{rucc\_}h_t) \end{aligned} \quad (14)$$

Individual consumption of non-durable goods and services

$$\begin{aligned} \text{comp\_ndur}_t^* &= -0.55 + 0.93 \cdot yd_t + (1 - 0.93) \cdot \text{wealth}_t \\ &\quad + 0.40 \cdot HH\_NET\_WEALTH\_RATIO_t \end{aligned} \quad (15)$$

$$\begin{aligned} \Delta \text{comp\_ndur}_t &= \frac{0.66}{(0.16)} \cdot (\Delta \text{tfp\_trend}_t / 0.67) \\ &\quad + \frac{0.18}{(0.11)} \cdot \Delta \text{comp\_ndur}_{t-1} - \frac{0.18^{3/2}}{(0.11)} \cdot \Delta \text{comp\_ndur}_{t-2} \\ &\quad + (1 - \frac{0.66}{(0.16)} - \frac{0.18}{(0.11)} - \frac{0.18^{3/2}}{(0.11)}) \cdot \Delta yd_t \\ &\quad - \frac{0.15}{(0.05)} \cdot (\text{comp\_ndur}_{t-1} - \text{comp\_ndur}_{t-1}^*) \\ &\quad - \frac{0.08}{(0.07)} \cdot \Delta I\_3MR\_CPI_t \end{aligned} \quad (16)$$

Adjusted  $R^2 = 0.20$

S. E. of equation = 0.006

LM test (p-value) = 0.35

Estimation period: 1997q2 - 2009q4

Gross fixed corporate capital formation

$$KP^* \text{ meets condition : } \frac{MPC_t}{MPL_t} = \frac{RUCC_t}{RUCL_t} \quad (17)$$

$$\begin{aligned} \Delta gfcf\_p_t &= \underset{(0.05)}{-0.09} \cdot (kp_t + 0.015 - kp_t^*) & (18) \\ &+ \underset{(0.07)}{0.29} \cdot \Delta gfcf\_p_{t-1} + \underset{(0.07)}{0.29^{3/2}} \cdot \Delta gfcf\_p_{t-2} \\ &+ (1 - \underset{(0.07)}{0.29} - \underset{(0.07)}{0.29^{3/2}}) \cdot \Delta gdp_t - \underset{(0.01)}{0.06} \cdot I09Q2 \\ &- \underset{(0.01)}{0.01} \cdot \Delta_4 (p\_ener_t + s\_usd\_pln_t^c - pva_t) \end{aligned}$$

Adjusted  $R^2 = 0.38$

S. E. of equation = 0.028

J statistic (p-value) = 0.30

Estimation period: 1998q3 - 2009q4

Gross fixed residential capital formation

$$\begin{aligned} (gfcf\_h_t - gdp\_pot_t)^* &= 0.24 \cdot (pgfcf\_h_t - pva_t) & (19) \\ &+ \log(1 - 0.32 \cdot GR\_VAT\_TR_t) - 3.49 \end{aligned}$$

$$\begin{aligned} \Delta gfcf\_h_t &= \underset{(0.12)}{1.06} \cdot \Delta gdp\_pot_t & (20) \\ &- \underset{(0.09)}{0.23} \cdot (gfcf\_h_{t-1} - gdp\_pot_{t-1} - (gfcf\_h_{t-1} - gdp\_pot_{t-1})^*) \\ &- \underset{(0.04)}{0.17} \cdot (I02Q3 - I02Q2) \\ &+ \underset{(0.19)}{0.35} \cdot \Delta (pgfcf\_h_{t-1} - pva_{t-1}) \\ &+ \log(1 - 0.3 \cdot GR\_VAT\_TR_{t-1}) \\ &+ (1 - \underset{(0.12)}{1.06}) \cdot \Delta gfcf\_h_{t-1} \end{aligned}$$

*Adjusted R*<sup>2</sup> = 0.39

*S. E. of equation* = 0.056

*LM test (p-value)* = 0.95

*Estimation period: 1995q4 - 2009q4*

Employment

$$emp_t^* = (1/0.67) \cdot gdp_t - (1/0.67) \cdot tfp\_trend_t - (0.33/0.67) \cdot k_t \quad (21)$$

$$\begin{aligned} \Delta emp_t = & \underset{(0.14)}{0.48} \cdot \Delta emp_{t-1} + \underset{(0.14)}{(1 - 0.48)} \cdot \Delta (lf_t + \log(1 - NAWRU_t)) \quad (22) \\ & - \underset{(0.02)}{0.10} \cdot (emp_{t-1} - emp_{t-1}^*) \\ & + \underset{(0.09)}{0.14} \cdot (\Delta gdp_t - \Delta tfp\_trend_t/0.67) \\ & - \underset{(0.04)}{0.05} \cdot (\Delta (wage\_n_{t-1} + \log(1 + GR\_CORP\_TR_{t-1}) - pva_{t-1}) \\ & - \Delta (gdp_{t-1} - emp\_na_{t-1})) \end{aligned}$$

*Adjusted R*<sup>2</sup> = 0.74

*S. E. of equation* = 0.004

*LM test (p-value)* = 0.04

*Estimation period: 1995q4 - 2009q4*

Inflation of energy prices

$$\begin{aligned} enerpci_t^* = & -0.42 + 0.18 \cdot (p\_ener_t + s\_usd\_pln_t^c) \quad (23) \\ & + (1 - 0.18) \cdot pva_t + \log(1 + GR\_ENER\_TR_t) \end{aligned}$$

$$\begin{aligned} \Delta enerpci_t = & \underset{(0.13)}{(1 - 0.09 - 0.13)} \cdot \underset{(0.08)}{((1 + INF\_TARGET_t)^{0.25} - 1)} \quad (24) \\ & + \underset{(0.13)}{0.09} \cdot \Delta enerpci_{t-1} + \underset{0.08}{0.13} \cdot (\Delta pva_t + \\ & \Delta \log(1 + GR\_ENER\_TR_t)) \\ & - \underset{(0.04)}{0.08} \cdot (enerpci_{t-1} - enerpci_{t-1}^*) \\ & + \underset{(0.003)}{0.0064} \cdot D04Q3 \end{aligned}$$

*Adjusted R*<sup>2</sup> = 0.31

*S. E. of equation* = 0.018

*LM test (p-value)* = 0.13

*Estimation period: 1995q4 - 2009q4*

Inflation of food prices

$$\begin{aligned} foodcpi_t^* &= -0.12 + 0.13 \cdot (p\_food_t + s\_usd\_pln_t^c) \\ &\quad + (1 - 0.13) \cdot pva_t + \log(1 + GR\_FOOD\_TR_t) \end{aligned} \quad (25)$$

$$\begin{aligned} \Delta foodcpi_t &= \underset{(0.09)}{0.36} \cdot \Delta foodcpi_{t-1} \\ &\quad + (1 - \underset{0.09}{0.36}) \cdot (\Delta pva_t + \Delta \log(1 + GR\_FOOD\_TR_t)) \\ &\quad - \underset{(0.03)}{0.08} \cdot (foodcpi_{t-1} - foodcpi_{t-1}^*) \end{aligned} \quad (26)$$

*Adjusted R*<sup>2</sup> = 0.66

*S. E. of equation* = 0.009

*LM test (p-value)* = 0.48

*Estimation period: 1995q4 - 2009q4*

Exports volume

$$\begin{aligned} gdp\_exp_t^* &= gdp\_ext_t - 19.59 + 1.67 \cdot gdp\_pot_t \\ &\quad - 0.42 \cdot (pexp_t - (pva\_ext_t + s\_neer_t)) \\ &\quad + 0.15 \cdot D04Q3 \end{aligned} \quad (27)$$

$$\begin{aligned} \Delta gdp\_exp_{t-1} &= \underset{(0.11)}{-0.04} \cdot \Delta (pexp_t^c - (pva\_ext_t + s\_neer_t)) \\ &\quad + \underset{(0.56)}{3.68} \cdot \Delta (gdp\_ext_t - tfp\_ext_t^{1/0.67}) \\ &\quad + \underset{(0.14)}{1.05} \cdot (2.36 \cdot \Delta tfp\_trend_{t-1} \\ &\quad + 1.62 \cdot \Delta tfp\_ext_{t-1}) + (1 - \underset{(0.14)}{1.05}) \cdot \Delta gdp\_exp_{t-1} \\ &\quad - \underset{(0.05)}{0.07} \cdot (gdp\_exp_{t-1} - gdp\_exp_{t-1}^*) \end{aligned} \quad (28)$$

*Adjusted R*<sup>2</sup> = 0.38

*S. E. of equation* = 0.025

*LM test (p-value)* = 0.42

*Estimation period: 1996q1 - 2009q4*

Imports volume

$$\begin{aligned} gdp\_imp_t^* &= gdp_t - 13.43 + 1.67 \cdot gdp\_ext\_pot_t & (29) \\ &\quad - 1.69 \cdot (pimp\_core_t + \log(1 + GR\_TAR\_TR_t) - pva_t) \\ &\quad - 0.02 \cdot D04Q3 \end{aligned}$$

$$\begin{aligned} \Delta gdp\_imp_t &= \underset{(0.08)}{-0.15} \cdot \Delta(pimp_t^c - pva_t + \log(1 + GR\_TAR\_TR_t)) & (30) \\ &\quad + \underset{(0.05)}{0.32} / OPEN_t \cdot \Delta(\log(0.4 \cdot GFCF\_P_t + 0.4 \cdot INV_t \\ &\quad + 0.2 \cdot CONP_t + 0.1 \cdot (CONGOV_t \\ &\quad + GFCF\_G_t + GFCF\_H_t)) - tfp\_trend^{1/0.67}) \\ &\quad + \underset{(0.09)}{0.85} \cdot \Delta(gdp\_exp_t - (2.3 \cdot tfp\_trend_t + 1.68 \cdot tfp\_ext_t)) \\ &\quad + \underset{(0.05)}{0.98} \cdot (2.3 \cdot \Delta tfp\_trend_{t-1} + 1.68 \cdot \Delta tfp\_ext_{t-1}) \\ &\quad + (1 - \underset{(0.05)}{0.98}) \cdot \Delta gdp\_imp_{t-1} \\ &\quad - \underset{(0.03)}{0.05} \cdot (gdp\_imp_{t-1} - gdp\_imp_{t-1}^*) \end{aligned}$$

*Adjusted R*<sup>2</sup> = 0.91

*S. E. of equation* = 0.012

*LM test (p-value)* = 0.15

*Estimation period: 1999q1 - 2009q4*

Yield on 5-year government bonds

$$\begin{aligned} I\_5Y_t &= \underset{(0.04)}{0.36} \cdot I\_5Y_{t-1} + (1 - \underset{(0.04)}{0.36}) \cdot (\frac{1}{17} \cdot I\_3M_t & (31) \\ &\quad + (1 - \frac{1}{17}) \cdot I\_5Y_{t+1} \\ &\quad - \underset{(0.01)}{0.0089} \cdot G\_BALANCE\_GDP_t) \end{aligned}$$

Adjusted  $R^2 = 0.97$   
*S. E. of equation* = 0.005  
*J statistic (p-value)* = 0.86  
*Estimation period: 2000q3 - 2009q4*

Inventories

$$\begin{aligned} \Delta(INV_t/SALES_t) = & \underset{(0.05)}{0.19} \cdot (\Delta sales_t - \Delta gdp\_pot_t) & (32) \\ & - \underset{(0.07)}{0.21} \cdot \Delta((STOCK_{t-1}/SALES_{t-1}) \\ & - (0.57 - 0.12 \cdot I\_3MR\_PVA_{t-1})) \\ & - \underset{(0.02)}{0.06} \cdot ((STOCK_{t-1}/SALES_{t-1}) \\ & - (0.57 - 0.12 \cdot I\_3MR\_PVA_{t-1})) \\ & - \underset{(0.12)}{0.25} \cdot \Delta(STOCK_{t-1}/SALES_{t-1}) \end{aligned}$$

Adjusted  $R^2 = 0.39$   
*S. E. of equation* = 0.003  
*LM test (p-value)* = 0.29  
*Estimation period: 1996q1 - 2009q4*

Younger labour force (15-24 years)

$$\begin{aligned} \left( \frac{LF\_Y_t}{POP\_Y_t} \right)^* = & 0.91 - 0.14 \cdot UNRATE_t - 0.02 \cdot (1 - D99Q1) & (33) \\ & + 0.01 \cdot (1 - D97Q1) \\ & - 0.3 \cdot (GR\_EMP\_TR_t + GR\_PIT\_TR_t + GR\_HC\_TR_t) \\ & - 0.3 \cdot (GR\_VAT\_TR_t + W\_CORE_t \cdot GR\_GAM\_TR_t \\ & + (W\_ENER_t + W\_CORE_t) \cdot GR\_EXT\_TR_t) \\ & - 1.5 \cdot STUDENT_t - 0.02 \cdot rr\_rem_t \\ & + 0.02 \cdot minw_t \end{aligned}$$

$$\begin{aligned} \Delta lf\_y_t = & \underset{(0.08)}{-0.14} \cdot \left( \frac{LF\_Y_{t-1}}{POP\_Y_{t-1}} - \left( \frac{LF\_Y_{t-1}}{POP\_Y_{t-1}} \right)^* \right) & (34) \\ & + \Delta pop\_y_t \\ & + \underset{(0.16)}{0.27} \cdot (\Delta(wage\_n_{t-1} - cpi_{t-1}) \\ & - \Delta tfp\_trend_{t-1}/0.67) + \underset{(0.12)}{0.20} \cdot \Delta minw_t \end{aligned}$$

*Adjusted R*<sup>2</sup> = 0.24

*S. E. of equation* = 0.01

*LM test (p-value)* = 0.008

*Estimation period: 1995q3 - 2009q4*

Middle-aged labour force (25-44 years)

$$\begin{aligned} \left( \frac{LF\_M_t}{POP\_M_t} \right)^* &= 0.87 + 0.07 \cdot \overline{UNRATESA}_t & (35) \\ &- 0.01 \cdot rr\_nlf\_m_t - 0.1 \cdot (GR\_EMP\_TR_t \\ &+ GR\_PIT\_TR_t + GR\_HC\_TR_t) \\ &- 0.1 \cdot (GR\_VAT\_TR_t + W\_CORE_t \cdot GR\_GAM\_TR_t \\ &+ (W\_CORE_t + W\_ENER_t) \cdot GR\_EXT\_TR_t) \\ &- 0.001 \cdot (1 - D99Q1) + 0.002 \cdot (1 - D97Q1) \end{aligned}$$

$$\begin{aligned} \Delta l f\_m_t &= -\frac{0.18}{(0.08)} \cdot \left( \frac{LF\_M_{t-1}}{POP\_M_{t-1}} - \left( \frac{LF\_M_{t-1}}{POP\_M_{t-1}} \right)^* \right) & (36) \\ &+ \frac{0.25}{(0.09)} \cdot \Delta l f\_m_{t-1} + \frac{0.25}{(0.09)} \cdot \Delta l f\_m_{t-2} \\ &+ \left( 1 - \frac{0.25}{(0.09)} - \frac{0.25}{(0.09)} \right) \cdot \Delta pop\_m_t \\ &- \frac{0.006}{(0.008)} \cdot \Delta rr\_nlf\_m_t \end{aligned}$$

*Adjusted R*<sup>2</sup> = 0.59

*S. E. of equation* = 0.002

*LM test (p-value)* = 0.0008

*Estimation period: 1996q1 - 2009q4*

Older labour force (45+ years)

$$\begin{aligned}
 \left( \frac{LF_{-}O_t}{POP_{-}O_t} \right)^* &= -1.10 - 0.10 \cdot \overline{UNRATESA}_t - 0.40 \cdot rr\_nlf\_o_t & (37) \\
 &- 0.3 \cdot (GR\_EMP\_TR_t + GR\_PIT\_TR_t + GR\_HC\_TR_t) \\
 &- 0.3 \cdot (GR\_VAT\_TR_t + W\_CORE_t \cdot GR\_GAM\_TR_t \\
 &+ (W\_CORE_t + W\_ENER_t) \cdot GR\_EXT\_TR_t) \\
 &+ WORK\_AGE_t \\
 &- 0.20 \cdot rr\_relief\_kind_t + 0.076 \cdot (1 - D97Q1)
 \end{aligned}$$

$$\begin{aligned}
 \Delta lf\_o_t &= \frac{-0.05}{(0.05)} \cdot \left( \frac{LF_{-}O_{t-1}}{POP_{-}O_{t-1}} - \left( \frac{LF_{-}O_{t-1}}{POP_{-}O_{t-1}} \right)^* \right) & (38) \\
 &+ \Delta pop\_o_t - \frac{0.03}{(0.02)} \cdot \Delta rr\_nlf\_o_t \\
 &- \frac{0.02}{(0.01)} \cdot \Delta rr\_relief\_kind_t \\
 &+ \Delta WORK\_AGE_t + \frac{0.03}{(0.13)} \cdot (\Delta(wage\_n_{t-1} - cpi_{t-1})) \\
 &- \Delta(tfp\_trend_{t-1})/0.67
 \end{aligned}$$

*Adjusted R*<sup>2</sup> = -0.05

*S. E. of equation* = 0.005

*LM test (p-value)* = 0.0005

*Estimation period:* 2001q1 - 2009q4

Deflator of imports

$$\begin{aligned} (pimp_t - pva_t)^* &= -3.10 + 0.50 \cdot s\_reer_t - 0.01 \cdot D04Q3 & (39) \\ &+ 0.06 \cdot (p\_oil_t + s\_usd\_pln_t - pva_t) \\ &+ 0.03 \cdot (p\_gas_t + s\_usd\_pln_t - pva_t) \end{aligned}$$

$$\begin{aligned} \Delta pimp\_core_t &= \underset{(0.1)}{-0.37} \cdot ((pimp_{t-1} - pva_{t-1}) - (pimp_{t-1} - pva_{t-1})^*) \\ &+ \underset{(0.08)}{1.09} \cdot \Delta pva_t + 0.50 \cdot \Delta s\_reer_t & (40) \\ &+ (1 - \underset{(0.08)}{1.09}) \cdot \Delta pimp\_core_{t-1} \end{aligned}$$

*Adjusted R*<sup>2</sup> = 0.48

*S. E. of equation* = 0.027

*Q test (p-value)* = 0.253

*Estimation period: 1995q3 - 2009q4*

Deflator of exports

$$\begin{aligned} (pexp_t - pva\_ext_t - s\_neer_t)^* &= -4.09 - 0.34 \cdot s\_reer_t & (41) \\ &+ 0.07 \cdot D04Q3 \end{aligned}$$

$$\begin{aligned} \Delta pexp_t &= \underset{(0.09)}{-0.48} \cdot ((pexp_{t-1} - pva\_ext_{t-1} - s\_neer_{t-1}) \\ &- (pexp_{t-1} - pva\_ext_{t-1} - s\_neer_{t-1})^*) & (42) \\ &+ \underset{(0.08)}{1.03} \cdot (\Delta(pva\_ext_t + s\_neer_t) - 0.34 \cdot \Delta s\_reer_t) \\ &+ (1 - \underset{(0.08)}{1.03}) \cdot \Delta pexp_{t-1} + \underset{(0.02)}{0.04} \cdot \Delta D04Q3 \end{aligned}$$

*Adjusted R*<sup>2</sup> = 0.34

*S. E. of equation* = 0.029

*Q test (p-value)* = 0.253

*Estimation period: 1995q3 - 2009q4*

Deflator of gross fixed residential capital formation

$$\begin{aligned}
 \Delta pgfcf\_h_t &= \frac{0.2}{(0.04)} \cdot \log(1 + INF\_TARGET_t)/4 & (43) \\
 &+ (1 - \frac{0.2}{(0.04)} + \frac{0.37}{(0.11)}) \cdot \Delta pgfcf\_h_{t-1} \\
 &- \frac{0.02}{(0.009)} \cdot (conp\_resid_{t-1} - conp\_resid_{t-1}^*) \\
 &- \frac{0.09}{(0.86)} \cdot \Delta RUCC\_H_t - \frac{0.87}{(0.32)} \cdot \Delta UNRATE_t \\
 &- 0.37 \cdot \Delta pgfcf\_h_{t-2}
 \end{aligned}$$

*Adjusted R<sup>2</sup> = 0.86*

*S. E. of equation = 0.013*

*LM test (p-value) = 0.28*

*Estimation period: 1995q2 - 2009q4*

WIBOR 3M quarterly average

$$\begin{aligned}
 I\_3M_t &= \frac{0.87}{(0.02)} \cdot I\_3M_t + (1 - \frac{0.87}{(0.02)}) \cdot (I\_3MR\_EQ_t + INF_{t+1}) & (44) \\
 &+ \frac{1.14}{(0.71)} \cdot (INF_{t+1} - \overline{INF\_TARGET}_{t+3}) + 0.5 \cdot GAP_t
 \end{aligned}$$

*Adjusted R<sup>2</sup> = 0.98*

*S. E. of equation = 0.006*

*J statistic (p-value) = 0.85*

*Estimation period: 2000q3 - 2009q4*

Wages

$$\begin{aligned}
 wage\_n_t^* &= 1.90 + tfp\_trend_t + (1 - 0.67) \cdot k_t & (45) \\
 &+ cpi_t - 0.78 \cdot UNRATE_t + 0.34 \cdot RR\_UNEMP_t \\
 &- 3.90 \cdot RR\_REM_t + 0.5 \cdot gr\_indir\_tr_t \\
 &- (1 - 0.5) \cdot gr\_dir\_tr_t \\
 &- 0.5 \cdot \log(1 + GR\_CORP\_TR_t) + 0.91 \cdot rucc_t
 \end{aligned}$$

$$\begin{aligned}
\Delta wage\_n_t = & \frac{-0.03}{(0.04)} \cdot (wage\_n_{t-1} - wage\_n_{t-1}^*) & (46) \\
& + \frac{0.45}{(0.1)} \cdot \Delta wage\_n_{t-1} + 0.45^2 \cdot \Delta wage\_n_{t-2} \\
& + (1 - 0.45 - 0.45^2) \cdot ((\log(1 + INF\_TARGET_t)/4 \\
& + \Delta tfp\_trend_t/0.67) + \frac{0.05}{(0.09)} \cdot (\Delta gdp_{t-1} \\
& - \Delta tfp\_trend_{t-1}/0.67) \\
& - \frac{0.3}{(0.11)} \cdot \Delta UNRATE_t + \frac{0.04}{(0.06)} \cdot GAP_t + \frac{0.001}{(0.002)} \cdot (I99Q1 + I99Q2)
\end{aligned}$$

*Adjusted R*<sup>2</sup> = 0.74

*S. E. of equation* = 0.004

*LM test (p-value)* = 0.04

*Estimation period: 1996q4 - 2009q4*

Real effective exchange rate

$$\begin{aligned}
s\_reer_t^* = & \frac{1}{(1 - 0.42) \cdot (-0.34) - (1 - 1.69/0.91) \cdot 0.50 + 0.91} & (47) \\
& \cdot \left( \frac{TCAB_t - CAB\_TRANS\_INC\_GDP_t}{OPEN_t} \right. \\
& - \left( -19.59 + 13.43 + (-0.42 + 1) \cdot (-4.09) \right. \\
& - (-1.69/0.91 + 1) \cdot (-3.10) \\
& + (1.67 - 1) \cdot (gdp\_pot_t - gdp\_ext\_pot_t) \\
& + (0.15 + 0.02 + (-0.42 + 1) \cdot 0.07 \\
& - (-1.69/0.91 + 1) \cdot (-0.01)) \cdot D04Q3 \\
& + 1.69 \cdot \log(1 + GR\_TAR\_TR_t) \\
& - 0.06 \cdot (p\_oil_t + s\_usd\_pln_t - pva\_ext_t - s\_neer_t) \\
& \left. \left. - 0.03 \cdot (p\_gas_t + s\_usd\_pln_t - pva\_ext_t - s\_neer_t) \right) \right)
\end{aligned}$$

$$\begin{aligned}
\Delta s\_reer_t = & \frac{-0.11}{(0.06)} \cdot (s\_reer_{t-1} - s\_reer_{t-1}^* + 0.03) & (48) \\
& \frac{-0.18}{(0.19)} \cdot (I\_3MR\_PVA_t - I\_3MR\_EXT_t) \\
& \frac{-0.23}{(0.42)} \cdot \left( \frac{G\_BALANCE\_N_t}{GDP\_N_t} \right) + \frac{0.25}{(0.15)} \cdot \Delta(s\_reer_{t-1}) \\
& \frac{-0.01}{(0.63)} \cdot (I\_5Y_t - INF\_TARGET_t - I\_5Y\_EUR_t + 0.02) \\
& + 0.7 \cdot \left( \Delta(pva\_ext_t - pva_t) - 0.005 + \frac{\log(1 + INF\_TARGET_t)}{4} \right)
\end{aligned}$$

*Adjusted R*<sup>2</sup> = 0.12

*S. E. of equation* = 0.045

*LM test (p-value)* = 0.22

*Estimation period:* 1996q4 - 2009q4

Deflator of value-added

$$\begin{aligned}
pva_t^* = & -3.15 + 0.62 \cdot (wage\_n_t + \log(1 + GR\_CORP\_TR_t)) \\
& + 0.62 \cdot (1/0.67 - 1) \cdot (gdp_t - k_t) & (49) \\
& - 0.62 \cdot 1/0.67 \cdot tfp\_trend_t \\
& + (1 - 0.62) \cdot (pimp_t^c + \log(1 + GR\_TAR\_TR_t))
\end{aligned}$$

$$\begin{aligned}
\Delta pva_t = & \log(1 + INF\_TARGET_t)/4 \cdot (1 - \frac{0.10}{(0.02)} - \frac{0.22}{(0.007)} - \frac{0.08}{(0.01)}) \\
& + \frac{0.10}{(0.02)} \cdot \Delta(pva_{t-1}) + \frac{0.22}{(0.007)} \cdot pva_{t+1} & (50) \\
& + \frac{0.08}{(0.01)} \cdot \Delta(pimp_{t-1}^c + \log(1 + GR\_TAR\_TR_{t-1})) \\
& - \frac{0.13}{(0.004)} \cdot (pva_{t-1} - pva_{t-1}^*)
\end{aligned}$$

*Adjusted R*<sup>2</sup> = 0.42

*S. E. of equation* = 0.008

*test J (p-value)* = 0.025

*Estimation period:* 1997q2 - 2009q4

Core inflation

$$\begin{aligned} corecpi_t^* = & -2.70 + 0.52 \cdot (wage\_n_t + \log(1 + GR\_CORP\_TR_t)) \quad (51) \\ & + 0.52 \cdot (1/0.67 - 1) \cdot (gdp_t - k_t) \\ & - 0.52 \cdot 1/0.67 \cdot tfp\_trend_t \\ & + (1 - 0.52) \cdot (pimp\_core_t^c + \log(1 + GR\_VAT\_TR_t)) \\ & + \log(1 + GR\_CORE\_TR_t) - 0.03 \cdot D04Q3 \end{aligned}$$

$$\begin{aligned} \Delta corecpi_t = & \log(1 + INF\_TARGET_t)/4 \cdot (1 - \frac{0.32}{(0.004)}) \quad (52) \\ & - \frac{0.48}{(0.01)} - \frac{0.02}{(0.002)} \\ & + \frac{0.32}{(0.004)} \cdot \Delta corecpi_{t-1} + \frac{0.48}{(0.01)} \cdot corecpi_{t+1} \\ & + \frac{0.02}{(0.002)} \cdot \Delta (pimp\_core_{t-1}^c + \log(1 + GR\_VAT\_TR_{t-1})) \\ & - \frac{0.01}{(0.001)} \cdot (corecpi_{t-1} - corecpi_{t-1}^*) \end{aligned}$$

*Adjusted R*<sup>2</sup> = 0.94

*S. E. of equation* = 0.003

*J statistic (p-value)* = 0.025

*Estimation period: 1997q2 - 2009q4*

## B NECMOD variables

Symbols in the brackets following the variable name stand for: EX – exogenous, EN – endogenous.

- CAB\_TRANS\_INC\_GDP (EN) – ratio of current account income and transfer balances to GDP
- CONGOV (EN) – collective consumption
- CONP (EN) – individual consumption
- CONP\_DUR (EN) – individual consumption of durable goods
- CONP\_NDUR (EN) – individual consumption of non-durable goods and services
- CONP\_RESID (EN) – residential services consumption
- CORECPI (EN) – core CPI index (CPI net of food and energy prices)

- CPI (EN) – consumer price index
- DxxQy (EX) – shift dummy variable where xx means year and y denotes quarter when the shift takes place
- EMP (EN) – total employment
- EMP\_NA (EN) – non-agricultural employment
- ENERCPI (EN) – index of consumer energy prices
- FOODCPI (EN) – index of consumer food prices
- G\_BALANCE\_GDP (EN) – General Government balance to GDP ratio
- G\_BALANCE\_N (EN) – General Government balance
- GAP (EN) – output gap
- GDP (EN) – gross domestic product
- GDP\_EXP (EN) – exports volume
- GDP\_EXT (EX) – foreign GDP (weighted average of the respective variables for euro area, the UK, and the USA)
- GDP\_EXT\_POT (EX) – foreign potential output (weighted average of the respective variables for euro area, the UK, and the USA)
- GDP\_IMP (EN) – imports volume
- GDP\_N (EN) – nominal gross domestic product
- GDP\_POT (EN) – domestic potential output
- GFCF\_G (EN) – gross fixed public capital formation
- GFCF\_H (EN) – gross fixed residential capital formation
- GFCF\_P (EN) – gross fixed corporate capital formation
- GR\_CORE\_TR (EN) – effective rate of taxes imposed on prices of goods and services which are in a core inflation basket
- GR\_CORP\_TR (EN) – effective rate of social security contributions paid by employers
- GR\_DIR\_TR (EN) – effective rate of direct taxes imposed on gross wages
- GR\_EMP\_TR (EN) – effective rate of social security contributions paid by employees
- GR\_ENER\_TR (EN) – effective rate of taxes imposed on energy prices

- GR\_EXT\_ENER\_TR (EN) – effective rate of excise duties imposed on energy commodities (fuels and gas)
- GR\_EXT\_TR (EN) – effective rate of excise duties
- GR\_EXT\_REST\_TR (EN) – effective rate of excise duties imposed on goods other than energy commodities
- GR\_FOOD\_TR (EN) – effective rate of taxes imposed on food
- GR\_GAM\_TR (EN) – effective rate of gambling taxes
- GR\_HC\_TR (EN) – effective rate of compulsory health care contribution
- GR\_INDIR\_TR (EN) – effective rate of indirect taxes
- GR\_PIT\_TR (EN) – effective rate of personal income tax
- GR\_TAR\_TR (EN) – effective rate of import duties
- GR\_VAT\_TR (EN) – effective rate of VAT
- HH\_NET\_WEALTH\_RATIO (EN) – control variable for changes in the households' portfolio structure; ratio of a difference of financial assets and liabilities of households to nominal value of wealth
- I\_3M (EN) – WIBOR 3M quarterly average
- I\_3MR\_CPI (EN) – real 3-month interest rate (deflated with CPI)
- I\_3MR\_EQ (EX) – equilibrium real interest rate
- I\_3MR\_EXT (EN) – real 3-month foreign interest rate deflated with foreign value-added deflator
- I\_3MR\_PVA (EN) – real 3-month interest rate deflated with the value-added deflator
- I\_5Y (EN) – yield on 5-year government bonds
- I\_5Y\_EUR (EX) – yield on 5-year Bunds
- INF (EN) – CPI inflation
- INF\_TARGET (EX) – inflation target
- $\overline{INF\_TARGET}$  (EX) – smoothed inflation target (four-quarter moving average)
- INV (EN) – change in inventories
- IxxQy (EX) – one period dummy variable, where xx denotes year and y stands for quarter
- K (EN) – productive capital

- KP (EN) – corporate productive capital
- LF (EN) – labour force supply
- LF\_M (EN) – middle-aged labour force (25-44 years)
- LF\_O (EN) – older labour force (45+ years)
- LF\_Y (EN) – younger labour force (15-24 years)
- MINW (EN) – relation of minimum wage to average gross wage in the economy
- MPC (EN) - marginal product of corporate capital
- MPL (EN) - marginal product of labour after adjusting for current GDP
- NAWRU (EN) – non-accelerating wage inflation rate of unemployment
- OPEN (EN) – measure of openness; ratio of imports and exports to GDP
- P\_ENER (EX) – index of energy commodity prices
- P\_FOOD (EX) – index of agricultural commodity prices
- P\_GAS (EX) – global gas prices (price of Russian gas per 1000 cubic meters)
- P\_OIL (EX) – price of BRENT oil
- PEXP (EN) – deflator of exports
- PEXP<sup>c</sup> (EN) – export prices corrected for equilibrium exchange rate fluctuations
- PGDP (EN) – deflator of GDP
- PGFCF\_H (EN) – deflator of gross fixed residential capital formation
- PIMP (EN) – deflator of imports
- PIMP<sup>c</sup> (EN) – imports prices corrected for equilibrium exchange rate fluctuations
- PIMP\_CORE (EN) – deflator of imports excluding prices of oil and gas
- PIMP\_CORE<sup>c</sup> (EN) – imports prices excluding prices of oil and gas corrected for equilibrium exchange rate fluctuations
- POP (EX) – total population
- POP\_M (EX) – middle-aged population (25-44 years)
- POP\_O (EX) – older population (45+ years)
- POP\_Y (EX) – younger population (15-24 years)
- PVA (EN) – deflator of value-added
- PVA\_EXT (EX) – deflator of foreign value-added

- RR\_NLF\_M (EN) – replacement rate for middle-aged labour force (including disability benefits, retirement benefits and social relief)
- RR\_NLF\_O (EN) – replacement rate for older labour force (including disability benefits, retirement benefits and social relief)
- RR\_REM (EN) – ratio of the average value of remittances per Polish resident to average gross wage
- RR\_RELIEF\_KIND (EN) – ratio of the average value of social transfers in kind per eligible household to average gross wage
- RR\_UNEMP (EN) – replacement rate for unemployed (including unemployment benefits and social relief)
- RUCC (EN) – real user cost of capital
- RUCC\_H (EN) – real user cost of residential capital
- RUCL (EN) - real cost of labour
- S\_NEER (EN) – nominal effective exchange rate
- S\_USD\_PLN (EN) – USD/PLN exchange rate
- S\_USD\_PLN<sup>c</sup> (EN) – USD/PLN exchange rate corrected for equilibrium exchange rate fluctuations
- S\_REER (EN) – real effective exchange rate
- SALES (EN) – level of sales; variable composed of the sum of private and government consumption, total investment and the volume of exports
- STOCK (EN) – level of inventories
- STUDENT (EX) – ratio of non-extramural students to total younger population
- TCAB (EN) – the equilibrium current account to GDP ratio
- TFP\_TREND (EN) – total factor productivity trend
- TFP\_EXT (EN) – total factor productivity abroad
- ULCNA (EN) – unit labour costs in non-agricultural sector
- UNRATE (EN) – unemployment rate
- $\overline{UNRATE}$  (EN) – the average unemployment rate in the previous year
- W\_CORE (EX) – weight of core inflation in CPI basket
- W\_ENER (EX) – weight of energy prices in CPI basket
- WAGE\_N (EN) – average nominal gross wage

- WEALTH (EN) – households' wealth
- WORK\_AGE (EX) – trend indicating the negative influence of gradual ageing of older population on its activity rate (the relation of population between 45+ and 65 years old to total 45+ population)
- YD (EN) – real disposable income of households