SLOPOL10: A MACROECONOMETRIC MODEL FOR SLOVENIA

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ABSTRACT: *This paper describes the SLOPOL10 model, a quarterly macroeconometric model of the Slovenian economy to be used for forecasting macroeconomic development and simulating alternative policy measures. The model is of the Cowles Commission type and is estimated using the cointegration approach, thus combining the long-run equilibrium and the short-run adjustment mechanism. It contains behavioural equations and identities for the goods market, the labour market, the foreign exchange market, the money market, and the government sector. Estimation of behavioural equations for Slovenian aggregates is based on data starting in 1995. The model combines Keynesian and neoclassical elements. The Keynesian elements determine the short and medium-run solutions in the sense that the model is demand-driven and persistent disequilibria in the goods and labour markets are possible. The supply side incorporates neoclassical features. Static and dynamic ex-post simulations show that the model can reasonably reproduce past development and is therefore suited for prediction and policy evaluation, especially for fiscal policy design and optimal control experiments.*

Keywords: *SLOPOL10 model, macroeconometric models, fiscal policy design, optimal control experiments, Slovenia*
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1. INTRODUCTION

This paper presents SLOPOL10, a medium-sized macroeconometric model for the small open economy of Slovenia. We document the theory behind the model blocks, the equations, and formal tests of the ability of the model to replicate the trajectories of the endogenous variables in an ex-post simulation.

The Slovenian economy, although small, is of interest for the following reasons: First, it was part of the Yugoslav economy, a centrally planned economy with a unique system of workers' self-management, until the dissolution of Yugoslavia. Second, Slovenia has developed towards a parliamentary democracy and a capitalist economy much faster than any other of the successor states of Yugoslavia. In particular, it became a member of the European Union in 2004 and, as the first former communist country, joined the Euro Area in 2007, which at the time was regarded as a major achievement. Third, the Slovenian economy is one of the small open economies within the Euro Area; hence its economic policy problems may also be of interest to other economies of that type. For example, difficulties resulting from the particular policy architecture of supranational monetary policy versus a national fiscal policy occur not only in Slovenia but also in several other members of the Euro Area. Finally, Slovenia was hit very hard by the Great Recession and the ensuing sovereign debt crisis but managed to return to satisfactory growth relatively fast recently, so it can be regarded as a model for dealing with business cycles.

If we want to explain economic developments in a country like Slovenia, and even more so if we want to design economic policies for such a country, a model of the Slovenian economy is required. Such a model shall serve as a tool for forecasting macroeconomic developments over the short and medium run and for evaluating alternative policies aimed at influencing the business cycle, stabilizing unemployment and inflation, and enhancing growth and employment in Slovenia. Several modelling strategies are available for building a macroeconomic model which can fulfil these requirements. If a model builder believes in neoclassical or New Keynesian macroeconomic theory, a Dynamic Stochastic General Equilibrium (DSGE) model will be his/her choice. If, on the other hand, theories are distrusted and a "data-only" approach is preferred, a vector autoregression (VAR) model will be chosen. Here we follow a more traditional modelling approach and opt for an econometric model of the Cowles Commission type. These models compromise between the theory-first and the empirics-first approaches; they must be based on sound theoretical foundations and estimated using real data of the economy under consideration. Several models of this type have been estimated before by members of the present team of authors (Verbič 2005, 2006, Weyerstrass et al. 2007); here we follow this tradition.

To build such a model, it is important to have available a data base with sufficiently long time series to provide reliable estimates. For former communist countries like Slovenia, this poses a problem: data before 1991, when the country gained independence, are based on communist accounting rules and are not comparable to those of later years. Even for the early years of the transition process many data (especially those from national income accounting) are of dubious quality. Therefore estimation of behavioural

equations for Slovenian aggregates has to be based on data starting in 1995 or later. In order to obtain estimations with sufficient degrees of freedom, an econometric model for Slovenia has to use quarterly or – where available – monthly or even higher-frequency data. Here we describe a quarterly macroeconometric model called SLOPOL10, which is a revised and updated version of a series of models which we have built since the late 1990s, with increasing degrees of sophistication and reliability. These models have been used for various purposes of forecasting and especially evaluating alternative policies, where simulation and optimization experiments were conducted to arrive at politically relevant insights and policy recommendations (see, e.g., Neck et al. 2011). Of particular importance with respect to Slovenia's position in the European Union are evaluations of its fiscal policies as the country has to fulfil the requirements of the EU Stability and Growth Pact (see Blueschke et al. 2016).

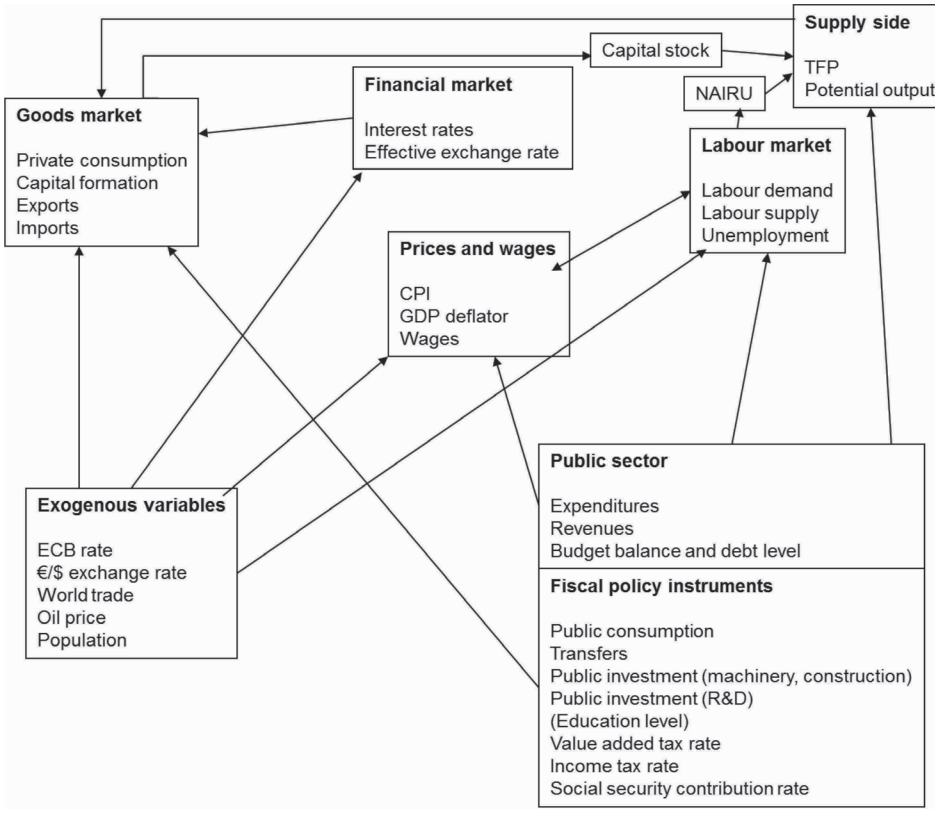
Like every structural econometric model, the SLOPOL10 model may be subject to the famous Lucas critique. Lucas (1976) argued that the relations between macroeconomic aggregates in an econometric model should differ according to the macroeconomic policy regime in place. In this case, the effects of a new policy regime cannot be predicted using an empirical model based on data from previous periods when that policy regime was not in place. Sargent (1981) argues that the Lucas critique is partly based on the notion that the parameters of an observed decision rule should not be viewed as structural. Instead, structural parameters in Sargent's conception are just "deep parameters", such as preferences and technologies. These parameters would be invariant, even under changing policy regimes. Providing for such "deep parameters" requires a different class of macroeconomic models, namely Computable General Equilibrium (CGE) or DSGE models. We take the Lucas critique into account to a certain extent by following the so-called London School of Economics tradition initiated by Sargan (1964). According to this approach, economic theory guides the determination of the underlying long-run specification while the dynamic adjustment process is derived from an analysis of the time series properties of the data series. Error correction models involving cointegrated variables combine the long-run equilibrium and the short-run adjustment mechanism.

2. MODEL DESCRIPTION

SLOPOL10 (SLOvenian economic POLicy model, version no. 10) is a medium-sized macroeconometric model of the Slovenian economy. In its current version, SLOPOL10 consists of 75 equations, 23 of which are behavioural equations and 52 identities. In addition to the 75 endogenous variables, the model contains 41 exogenous variables. A list of the variables used in the SLOPOL10 model can be found in Table A1 in the Appendix. The model is constructed in order to allow for forecasts and policy simulations over the near future. Statistical tests will be presented that show the performance of the model in the past. In our view, these tests show that the model exhibits acceptable quality for such uses. Improvements in the light of new data will be continually made when using the model for these purposes.

The behavioural equations were estimated with the software program EViews, using quarterly data for the period 1995q1 to 2015q4. Data for Slovenia and for Euro Area aggregates as well as the oil price were taken from the Eurostat database, and those for world trade came from the CPB Netherlands Bureau for Economic Policy Analyses. The model contains behavioural equations and identities for the goods market, the labour market, the foreign exchange market, the money market, and the government sector. Rigidities of wages and prices are taken into account. The model combines Keynesian and neoclassical elements, the former determining the short and medium-run solutions in the sense that the model is demand-driven and persistent disequilibria in the goods and labour markets are possible. In the following, the model equations are described verbally. A diagram of the building blocks of the model is given in Figure 1.

Figure 1: *SLOPOL10 – Building Blocks*



The supply side incorporates neoclassical features. In accordance with the approach applied by the European Commission for all EU Member States (Havik et al. 2014), potential output is determined by a Cobb-Douglas production function with constant returns to scale. It depends on trend employment, capital stock and autonomous technical

progress. Trend employment is defined as the labour force minus natural unemployment, the latter being defined via the non-accelerating inflation rate of unemployment (NAIRU). In line with the literature on production functions as well as international practice in macroeconometric modelling, the elasticities of labour and capital were set at 0.65 and 0.35 respectively. These elasticities correspond approximately to the shares of wages and profits respectively in national income. The NAIRU, which approximates structural unemployment, is estimated by applying the Hodrick-Prescott (HP) filter to the actual unemployment rate. For forecasts and simulations, the structural unemployment rate is then extrapolated with an autoregressive (AR) process. Capital stock enters the determination of potential GDP not with its trend level but with its actual one.

Several steps are required to determine technical progress. First, ex-post total factor productivity (TFP) is calculated as the Solow residual, i.e. that part of the change in GDP that is not attributable to change in the production factors of labour and capital, weighted with their corresponding production elasticities. In a second step, the trend of technical progress is then determined by applying the HP filter, in a procedure similar to the NAIRU. For simulations and forecasts, the trend of the TFP is explained in a behavioural equation. In accordance with the endogenous growth literature, technical progress is influenced by the share of people with tertiary education in the labour force. In addition, trend TFP is influenced by the real investment ratio, i.e. gross fixed capital formation over GDP. As a third factor, lagged real government spending on research and development (R&D) is included in the TFP equation.

On the demand side, the consumption of private households is explained by a combination of a Keynesian consumption function and a function in accordance with the permanent income hypothesis and the life cycle hypothesis. Thus, private consumption depends on current disposable income and on the long-term real interest rate, the latter entering the consumption equation with a negative sign. Real gross fixed capital formation is influenced by the change in real disposable income (more or less in accordance with the accelerator hypothesis) and by the user cost of capital, where the latter is defined as the real interest rate plus the depreciation rate of capital stock. Changes in inventories are treated as exogenous in the SLOPOL model, as in many macroeconomic models in use around the world.

Real exports of goods and services are a function of the real exchange rate and foreign demand for Slovenian goods and services. Foreign demand is approximated by the volume of world trade. The real exchange rate is meant to capture the competitiveness of Slovenian companies on the world market. Real imports of goods and services depend on domestic final demand and on the real exchange rate. A real appreciation of the Slovenian currency (the Slovenian tolar until the end of 2006 and the euro following Slovenia's entry into the Euro Area on 1 January 2007) makes Slovenian goods and services more expensive on the world markets. On the other hand, foreign products become relatively cheaper; hence domestic production is substituted by imports. Thus a real appreciation stimulates imports while having a negative effect on exports. Even when Slovenia is part of the Euro Area, its real exchange rate can, of course, still appreciate or depreciate, not only against

other currencies but also against other Euro Area countries due to inflation differentials. On the labour market, both labour demand and supply are divided into the main age group (15 to 64 years) and older people (65 years and above). The labour demand of companies (actual employment) is modelled via the employment rates of the two age groups, i.e. employment as a share of the relevant age group in the total population. Both equations were estimated as Tobit models, the employment rates being limited to lying between 0 and 0.9 (15 to 64 years) and between 0 and 0.5 (65 years and above). Both employment rates are influenced positively by real GDP and negatively by the real net wage and additionally by the wedge between the gross and the net wage. The idea behind the latter is that increases in the tax wedge are borne partly by employers and partly by employees. Rising income tax rates or social security contribution rates increase the production wage, to which employers react by reducing their employment demand. Labour supply is modelled via the share of the labour force of the two age groups in the total population. These equations have also been estimated as Tobit models, with the restrictions of being positive but below 0.9 and 0.5 respectively. Labour supply depends positively on the real net wage and, as employment, negatively on the wedge between the gross and the net wage.

In the wage-price system, gross wages, the consumer price index CPI (to be precise, the harmonised index of consumer prices HICP for Slovenia), and various deflators are determined. The gross wage rate depends on the price level, labour productivity and the unemployment rate. This equation is based on a bargaining model of the labour market, where the relative bargaining power of the employees (or the trade unions) is negatively affected by unemployment. The consumer price index is linked to the private consumption deflator. The latter depends on domestic and international factors. Domestic cost factors comprise unit labour costs and the capacity utilisation rate. The inclusion of the capacity utilisation rate in the price equation represents a channel for closing an output gap by increasing prices in the case of over-utilisation of capacities and by decreasing prices if actual production falls behind potential GDP. Foreign influences on Slovenian consumer prices are approximated by the import deflator. The public consumption deflator is linked to the most important cost factor of the public sector, which is public consumption. Public consumption includes purchases of goods and services and the wage costs of public employees. Similarly to consumer prices, both the investment and the export deflators are influenced by domestic and imported cost elements. The former are approximated by the unit labour costs while the latter are captured by the import deflator. Finally, the import deflator is influenced by the oil price in euro as a proxy for international raw material prices, which constitute an important determinant of the price level in a small open economy like Slovenia.

On the money market, the short-term interest rate is linked to its Euro Area counterpart so as to capture Slovenia's Euro Area membership and the resulting gradual adjustment of interest rates in Slovenia towards the Euro Area average. In the same vein, the long-term Euro Area interest rate is included in the equation determining the long-term interest rate in Slovenia. In addition, the long-term interest rate is linked to the short-term rate, representing the term structure of interest rates. Furthermore, the long-term interest rate is influenced by the debt to GDP ratio, representing a risk premium that rises with

the debt ratio. The foreign exchange market is modelled by the real effective exchange rate against a group of 41 countries. Due to Slovenia's membership of the Euro Area, the nominal exchange rate is exogenous for Slovenia. However, the real exchange rate is still endogenous, even for the Euro Area countries, since it also depends on domestic price developments. Furthermore, the real effective exchange rate is an important determinant of exports and imports. When determining the effective exchange rate for Slovenia, it has to be taken into account that the country has only been a Euro Area member state since 2007. As the time series on which the estimations of the behavioural equations are based include the period before Slovenia's Euro Area accession in 2007, the bilateral exchange rate between the Slovenian tolar and the euro is included as one of the explanatory variables in the real effective exchange rate equation. In addition, the exchange rate between the euro and the US dollar is considered. Furthermore, inflation in Slovenia is a regressor. To be theoretically consistent, the inflation differential between Slovenia and the group of countries forming the base for the real effective exchange rate should have been taken. However, this would have involved information about price developments in 41 countries, and for these exogenous variables assumptions had to be made for ex-post simulations.

In the government sector of the model, the most important expenditure and revenue items of the Slovenian budget are determined. Social security contributions by employees are calculated by multiplying the average social security contribution rate by the gross wage rate and the number of employees. In the same vein, income tax payments by employees are determined by multiplying the average income tax rate by the gross wage rate and the number of employees. In a behavioural equation, social security payments by companies are linked to social security contributions by employees. Profit tax payments by companies are explained by GDP as an indicator for the economic situation, taking account of the fact that profits and hence profit tax payments display a strongly pro-cyclical behaviour. Value added tax revenues depend on the value added tax rate and on private consumption. Other direct and indirect taxes are determined via their relation to nominal GDP, which is exogenous and has to be extrapolated in ex ante simulations, as for all other exogenous variables. Interest payments on public debt depend on the lagged debt level and on the long-term interest rate. Public consumption and transfer payments to private households as well as the remaining public expenditures and revenues are exogenous. By definition, the budget balance is given by the difference between total government revenues and expenditures. The public debt level is extrapolated using the budget balance equation. The model is closed by a number of identities and definition equations.

3. TESTS FOR STATIONARITY OF THE TIME SERIES

As can be seen from Table A2 in the Appendix, it turns out that most level variables are I(1). Only a few variables are stationary in levels. These are the output gap (be construction, this variable should be stationary), the real interest rate, the real GDP growth rate, the labour force and employment of older people (very small numbers), the user cost of capital, and changes in inventories (as expected). For the budget balance in relation to GDP, the stationarity tests are inconclusive, although in the longer term this

variable should be stationary. Also for the average real gross and net wage, the stationarity results are inconclusive, although one would expect these variables to increase over time. However, according to the data in our database, the average real wage per employee declined between 1996 and 2003, then rose until 2011, before decreasing again somewhat.

We also tested for cointegration between those time series where we suspected long-run relations to hold. In those cases where cointegration seemed to be present, we used error-correction models as dynamic specifications for these relations while estimations in levels or first differences were tried when tests indicated the absence of long-run relations between stationary or between I(1) variables. The tests support our suspicion of cointegration between the variables we included in the behavioural equations. The detailed results can be found in Table A3 in the Appendix.

4. MODEL EQUATIONS

In this section, the model equations are listed in detail, starting with the behavioural equations and then presenting the model identities.

4.1. Behavioural Equations

Hereinafter, R^2 is the adjusted coefficient of determination, BG(p) is the Breusch-Godfrey Lagrange Multiplier statistic, a test for serial correlation up to lag p; *, **, *** denote rejection of the null hypothesis of no serial correlation at the 10, 5, 1 percent significance level respectively; t-statistics are given in parentheses below coefficients.

Trend TFP

$$\begin{aligned}\text{LOG}(TRENDTFP) = {} & -4.588302 + 0.009127 * \text{LOG}(GERDR(-1)) + 0.384806 * \text{LOG}(LFTERSHARE) \\ & (-145.3956) \quad (3.105505) \qquad\qquad\qquad (28.58483) \\ & + 0.309750 * \text{LOG}(INVR/GDPR) \\ & (15.03015)\end{aligned}$$

Adj. $R^2 = 0.923320$ F-stat = 318.0849 BG(2) = 40.364***

Private Consumption

$$\begin{aligned}\text{LOG}(CR/CR(-4)) = {} & 0.321936 + 0.282529 * \text{LOG}(INCOMER/INCOMER(-4)) \\ & (1.108405) \quad (5.481512) \\ & - 0.121486 * \text{LOG}(CR(-4)) + 0.081661 * \text{LOG}(INCOMER(-4)) \\ & (-7.369967) \qquad\qquad (2.362665) \\ & - 0.006417 * GOV10YR - 0.062606\ D2013q1 \\ & (-5.068519) \qquad\quad (-3.531924)\end{aligned}$$

Adj. $R^2 = 0.612852$ F-stat = 24.74484 BG(2) = 6.503145**

Private Gross Fixed Capital Formation

$$\begin{aligned}\text{LOG}(PRINVR/PRINVR(-4)) = {} & -0.000824 + 0.542725 * \text{LOG}(PRINVR(-1)/PRINVR(-5)) \\ & (-0.106209) \quad (6.891356) \\ & + 0.404963 * \text{LOG}(INCOMER/INCOMER(-4)) \\ & (2.163258) \\ & - 0.018054 * (UCC(-1) - UCC(-5)) - 0.163850 * D2010\text{q}3 \\ & (-4.114459) \qquad\qquad (-2.41256) \\ & - 0.141658 * D2014\text{q}4 \\ & (-2.174659)\end{aligned}$$

Adj. $R^2 = 0.672624$ F-stat = 29.76431 BG(2) = 3.772958

Exports

$$\begin{aligned}\text{LOG}(EXR/EXR(-4)) = {} & 0.\ 549852 + 0.277227 * \text{LOG}(EXR(-1)/EXR(-5)) \\ & (4.119548) \quad (5.136417) \\ & + 0.\ 815406 * \text{LOG}(WTRADE/WTRADE(-4)) \\ & (13.78450) \\ & - 0.321950 * \text{LOG}(REER(-4)/REER(-8)) - 0.287643 * \text{LOG}(EXR(-4)) \\ & (-3.401803) \qquad\qquad (-4.888083) \\ & + 0.411336 * \text{LOG}(WTRADE(-4)) + 0.033620\ \text{D2007} - 0.026177\ (D2013+D2013) \\ & (4.991134) \qquad\qquad (2.831993) \qquad (-2.808663)\end{aligned}$$

Adj. $R^2 = 0.917547$ F-stat = 120.2305 BG(2) = 3.249562

Imports

$$\begin{aligned}\text{LOG}(IMPR/IMPR(-4)) = {} & -5.038052 + 1.315281 * \text{LOG}(DEMAND(-1)/DEMAND(-5)) \\ & (-3.\ 231196) \quad (9.747473) \\ & + 0.801468 * \text{LOG}(REER(-2)/REER(-6)) \\ & (2.011144) \\ & - 0.831232 * \text{LOG}(REER(-3)/REER(-7)) - 0.480082 * \text{LOG}(IMPR(-4)) \\ & (-2.024690) \qquad\qquad (-2.652671) \\ & + 0.649493 * \text{LOG}(DEMAND(-4)) + 0.642609 * \text{LOG}(REER(-4)) \\ & (2.294327) \qquad\qquad (1.909966) \\ & + 0.090691 * D1998\text{q}1 - 0.200624 * D2009\text{q}1 \\ & (1.739119) \qquad (-4.110804)\end{aligned}$$

Adj. $R^2 = 0.684522$ F-stat = 21.61303 BG(2) = 1.195105

Employment 15 to 64

$$\begin{aligned}EMP1564/POP1564 = {} & -0.617752 + 0.473440 * EMP1564(-4)/POP1564(-4) + 0.200109 * \text{LOG}(GDPR) \\ & (-3.013194) \quad (5.660659) \qquad\qquad (7.137335) \\ & - 0.044223 * \text{LOG}(NETWAGER) - 0.071028 * \text{LOG}(WEDGE) \\ & (-1.931810) \qquad\qquad (-5.892452)\end{aligned}$$

Employment 65+

$$EMP65PLUS/POP65PLUS = -0.088596 + 0.601889 * EMP65PLUS(-1)/POP65PLUS(-1) + 0.057105 * \text{LOG}(GDPR) - 0.048881 * \text{LOG}(NETWAGEN+WEDGE)$$

(–0.684680) (6.271412) (1.928939) (–2.436480)

Labour Supply 15 to 64

$$LF1564/POP1564 = 0.216732 + 0.694325 * LF1564(-4)/POP1564(-4) + 0.145252 * \text{LOG}(NETWAGER/NETWAGER(-4))$$

(4.602100) (10.31312) (4.829452)

Labour Supply 65+

$$LF65PLUS/POP65PLUS = -0.170715 + 0.380958 * LF65PLUS(-1)/POP65PLUS(-1) + 0.036490 * \text{LOG}(NETWAGER) - 0.018406\ D2015 - 0.010935 * \text{LOG}(WEDGE) - 0.011630 * (D2012+D2013)$$

(–1.207595) (3.843020) (2.213463) (–3.537480) (–2.216665) (–2.812858)

Average Gross Wage

$$\text{LOG}(AGWN/AGWN(-4)) = 0.238652 + 0.599927 * \text{LOG}(AGWN(-1)/AGWN(-5)) + 0.133776 * \text{LOG}(CPI/CPI(-4)) + 0.114755 * \text{LOG}(PROD/PROD(-4)) - 0.003440 * UR - 0.055291 * \text{LOG}(AGWN(-4)/CPI(-4)) - 0.030158 * D2012q2$$

(2.517697) (7.324412) (2.223294) (2.480250) (–2.503514) (–2.175832) (–2.402247)

Adj. R^2 = 0.828677 F-stat = 61.46166 BG(2) = 2.439687

CPI

$$\text{LOG}(CPI/CPI(-4)) = -0.000764 + 0.860254 * \text{LOG}(CPI(-1)/CPI(-5)) + 0.119368 * \text{LOG}(CDEF/CDEF(-4)) - 0.024320 * \text{LOG}(CPI(-4))\text{-LOG}(CDEF(-4)) - 0.024477 * D2008q4$$

(–0.520422) (16.41307) (2.347029) (–2.247985) (–3.425420)

Adj. R^2 = 0.942442 F-stat = 303.9159 BG(2) = 7.259309**

Private Consumption Deflator

$$\begin{aligned}\text{LOG}(CDEF/CDEF(-4)) = {} & -0.635911 + 0.270101 * \text{LOG}(AGWN/AGWN(-4)) \\ & (-2.801746) \quad (2.994393) \\ & + 0.129630 * \text{LOG}(IMPDEF(-6)/IMPDEF(-10)) \\ & (2.534036) \\ & - 0.268560 * \text{LOG}(CDEF(-4)) + 0.101022 * \text{LOG}(AGWN(-4)) \\ & (-3.637782) \qquad\qquad (3.249838) \\ & + 0.133540 * \text{LOG}(UTIL(-1)) + 0.091529 * \text{LOG}(IMPDEF(-4)) \\ & (2.641737) \qquad\qquad (1.854469)\end{aligned}$$

Adj. $R^2 = 0.571235$ F-stat = 17.20944 BG(2) = 16.17359***

Public Consumption Deflator

$$\begin{aligned}\text{LOG}(GDEF/GDEF(-4)) = {} & 0.119450 + 0.544327 * \text{LOG}(GDEF(-1)/GDEF(-5)) \\ & (1.851414) \quad (6.264521) \\ & + 0.090745 * \text{LOG}(GNFIN/GNFIN(-4)) - 0.086096 * \text{LOG}(GDEF(-4)) \\ & (2.283731) \qquad\qquad (-3.041525) \\ & + 0.038165 * \text{LOG}(GNFIN(-4)) \\ & (3.062869)\end{aligned}$$

Adj. $R^2 = 0.680608$ F-stat = 42.55355 BG(2) = 1.793151

Investment Deflator

$$\begin{aligned}\text{LOG}(INVDEF/INVDEF(-4)) = {} & 0.010428 + 0.216076 * \text{LOG}(ULC/ULC(-4)) \\ & (5.262049) \quad (4.098676) \\ & + 0.141856 * \text{LOG}(IMPDEF/IMPDEF(-4)) \\ & (2.601534) \\ & + 0.042883 * D1997q1 + 0.046206 * D1998q4 \\ & (2.655108) \qquad\qquad (2.855100) \\ & - 0.052778 * D2000q4 \\ & (-3.160315)\end{aligned}$$

Adj. $R^2 = 0.342428$ F-stat = 9.227795 BG(2) = 31.20401

Export Deflator

$$\begin{aligned}\text{LOG}(EXPDEF/EXPDEF(-4)) = {} & 0.691182 + 0.477104 * \text{LOG}(IMPDEF/IMPDEF(-4)) \\ & (5.368551) \quad (13.53162) \\ & - 0.636126 * \text{LOG}(EXPDEF(-4)) + 0.403268 * \text{LOG}(IMPDEF(-4)) \\ & (-6.693435) \qquad\qquad (6.843747) \\ & + 0.046780 \text{ LOG}(AGWN(-4)) \\ & (3.329078)\end{aligned}$$

Adj. $R^2 = 0.785893$ F-stat = 73.49374 BG(2) = 10.24065***

Import Deflator

LOG(*IMPDEF*/*IMPDEF*(–4)) = 1.688217 + 0.064189 * LOG(*OILEUR*/*OILEUR*(–4))
(6.514300) (8.883464)

– 0.427363 * LOG(*IMPDEF*(–4)) + 0.070433 * LOG(*OILEUR*(–4))
(–6.675438) (7.561347)

– 0.040262 * *D2009* + 0.028375 * *D2010*
(–3.950683) (2.861353)

Adj. R^2 = 0.698642 F-stat = 37.62936 BG(2) = 28.40523***

Short-term Interest Rate

SITBOR3M–*SITBOR3M*(–4) = 0.072921 + 0.583728 * (*SITBOR3M*(–1) –*SITBOR3M*(–5))
(1.110144) (10.69963)

+ 0.510182 * (*EUR3M*–*EUR3M*(–4))
(7.271125)

– 0.453068 * (*SITBOR3M*(–4) –*EUR3M*(–4))
(–6.395199)

Adj. R^2 = 0.859096 F-stat = 159.5222 BG(2) = 23.92325***

Long-term Interest Rate

GOV10Y–*GOV10Y*(–4) =–0.116529 + 0.218874 * (*SITBOR3M*–SITBOR3M(–4))
(–0.780286) (2.522239)

+ 2.021775 * (*EUR10Y*–*EUR10Y*(–4))
(10.71268)

+ 1.694831 * LOG(*DEBTGDP*/*DEBTGDP*(-4)) – 1.856888 * *D2004*
(1.704599) (–3.693687)

+ 1.992136 * *D2012* + 1.624226 * *D2013*
(4.029161) (3.083994)

Adj. R^2 = 0.679935 F-stat = 23.30579 BG(2) = 17.72585***

Real Effective Exchange Rate

LOG(*REER*/*REER*(–4)) = –0.007941 + 0.084268 * LOG(*EURUSD*/*EURUSD*(–4))
(–2.789133) (4.503065)

+ 0.280321 * LOG(*SITEUR*/*SITEUR*(–4))
(4.729566)

+ 0.678165 * LOG(*GDPDEF*/*GDPDEF*(–4)) + 0.037226 * *D1998*
(6.623438) (4.447943)

+ 0.031405 * *D1999*
(3.946994)

Adj. R^2 = 0.701605 F-stat = 38.14987 BG(2) = 31.90596***

Employers' Social Security Contributions

$$\begin{aligned}\text{LOG}(SOCCOMP/SOCCOMP(-4)) = {} & -0.418600 + 0.941308 * \text{LOG}(SOCEMP/SOCEMP(-4)) \\ & (-7.290584)\ \ (14.45902) \\ & - 0.646844 * \text{LOG}(SOCCOMP(-4)) \\ & (-17.69022) \\ & + 0.682561 * \text{LOG}(SOCEMP(-4)) \\ & (19.67186)\end{aligned}$$

Adj. $R^2 = 0.888454$ F-stat = 210.7419 BG(2) = 3.277950

Corporate Income Tax Payments

$$\begin{aligned}INCTAXCORP - INCTAXCORP(-4) = {} & -1717.275 + 1168.325 * \text{LOG}(GDPR/GDPR(-4)) \\ & (-3.778722)\ \ \ (5.918436) \\ & - 0.341519 * INCTAXCORP(-4) + 193.6532 * \text{LOG}(GDPR(-4)) \\ & (-4.077339) \qquad\qquad (3.780993)\end{aligned}$$

Adj. $R^2 = 0.421035$ F-stat = 20.15009 BG(2) = 0.591128

Value Added Tax Revenues

$$\begin{aligned}\text{LOG}(VAT) = {} & -5.491826 + \ 1.054549 * \text{LOG}(CN) \ + 1.054032 * \text{LOG}(VATAXRATE) \\ & (-7.238066)\ \ (19.42491) \qquad\qquad (4.267224) \\ & - 0.336750 * D2000q1 - 0.630827\ D2001q1 - 0.926044\ D2002q1 \\ & (-2.658629) \qquad\qquad (-4.981327) \qquad\qquad (-7.337844)\end{aligned}$$

Adj. $R^2 = 0.883668$ F-stat = 127.0950 BG(2) = 4.614928*

Interest Payments on Public Debt

$$\begin{aligned}\text{LOG}(INTEREST) = {} & -1.966945 + 0.832199 * \text{LOG}(INTEREST(-4)) \\ & (-1.894332)\ (17.18193) \\ & + 0.242440 * \text{LOG}(DEBT(-4) * GOV10Y) \\ & (2.378300) \\ & + 1.454346 * (D2010q2 + D2010q3) + 0.2866858 * q1 \\ & (5.976520) \qquad\qquad (3.071885)\end{aligned}$$

Adj. $R^2 = 0.859831$ F-stat = 122.1512 BG(2) = 1.288664

4.2. Identities

AGWR = *AGWN* / *CPI* * 100
BALANCE = *TGRN* − *TGEN*
BALANCEGDP = *BALANCE* / *GDPN* * 100
CAGDP = *CAN* / *GDPN* * 100
CAN = *EXR* * *EXPDEF* / 100 − *IMPR* * *IMPDEF* / 100
CAPR = (1 − *DEPR* / 100) * *CAPR*(−1) + *INVR*
CN = *CR* * *CDEF* / 100
DEBT = *DEBT*(−1) − *BALANCE* + *BANKCAP* + *DEBTADJ*
DEBTGDP = *DEBT* / (*GDPN* + *GDPN*(−1) + *GDPN*(−2) + *GDPN*(−3)) * 100
DEMAND = *INVR* + *CR* + *GR* + *EXR*
EMP = *EMP1564* + *EMP65PLUS*
GAP = (*GDPR* − *YPOT*) / *YPOT* * 100
GDPDEF = *GDPN* / *GDPR* * 100
GDPN = *CN* + *GN* + (*INVR* + *INVENTR*) * *INVDEF* / 100 + *CAN*
GDPR = *CR* + *GR* + *INVR* + *INVENTR* + *EXR* − *IMPR*
GERDR = *GERD* / *INVDEF* * 100
GINVR = *GINVN* / *INVDEF* * 100
GN = *GNFIN* + *GN_REST*
GOV10YR = *GOV10Y* − *INFL*
GR = *GN* / *GDEF* * 100
GRGDPR = *GDPR* / *GDPR*(−4) * 100 − 100
GRYPOT = (*YPOT* / *YPOT*(−4) − 1) * 100
INCOME = *GDPN*+*TRANSFERSN*−*SOCTOTAL*−*INCTAX*−*VAT*−*TAXDIRREST*−*TAXINDIRREST*
INCOMER = *INCOME* / *CPI* * 100
INCTAX = *INCTAXPERS* + *INCTAXCORP*
INCTAXPERS = *INCTAXRATE* * (*AGWN* * *EMP* / 1000) / 1000
INFL = (*CPI* / *CPI*(−4) − 1) * 100
INVN = *INVR* * *INVDEF* / 100
INVR = *PRINVR* + *GINVR* + *GERDR*
LF = *LF1564* + *LF65PLUS*
LOG(YPOT) = 0.65 * *LOG*(*TRENDEMP*) + (1 - 0.65) * *LOG*(*CAPR*) + *LOG(TRENDTFP)*
NETWAGEN = *AGWN* − *WEDGE*
NETWAGER = *NETWAGEN* / *CPI* * 100
OILEUR = *OIL* / *EURUSD*
PRIMBALANCE = *BALANCE* + *INTEREST*
PRIMBALANCEGDP = *PRIMBALANCE* / *GDPN* * 100
PROD = *GDPR* / *EMP* * 100
SOCEMP = *SOCEMPRATE* * (*AGWN* * *EMP* / 1000) / 1000
SOCTOTAL = *SOCCOMP* + *SOCEMP*
TAXDIRREST = *TAXDIRRATE* * *GDPN* / 100
TAXINDIRREST = *TAXINDIRRATE* * *GDPN* / 100

TGEN = *GNFIN* + *GINVN* + *TRANSFERSN* + *INTEREST* + *EXPREST*
TGRN = *VAT* + *SOCTOTAL* + *INCTAX* + *TAXDIRREST* + *TAXINDIRREST* + *REVREST*
TRENDEMP = *LF* * (1 − *NAIRU_EU* / 100)
UCC = *GOV10YR* + *DEPR*
ULC = *AGWN* / *PROD*
UN = *LF* − *EMP*
UN1564 = *LF1564* − *EMP1564*
UR = *UN* / *LF* * 100
UR1564 = *UN1564* / *LF1564* * 100
UTIL = *GDPR* / *YPOT* * 100
WEDGE = *AGWN* * (*INCTAXRATE* + *SOCEMPRATE*)

5. EX-POST SIMULATION

Figures A1–A12 in the Appendix show the results of a dynamic ex-post simulation of the model over the period 1999 to 2015 for the key macroeconomic variables. In addition to the visual inspection, we tested the quality of the ex-post forecasting performance of the model formally. As quality criteria we chose the root mean squared error (RMSE) or the root mean squared percent error (RMSPE), the mean absolute percent error (MAPE) or the mean absolute error (MAE), and Theil's inequality coefficient (THEIL).

Regarding the Theil coefficient, we chose the U2 coefficient, defined by the following formula:

$$\text{THEIL} = \frac{\sqrt{\sum_{i=1}^{n}(F_i - A_i)^2}}{\sqrt{\sum_{i=1}^{n} A_i{}^2}}$$

where A_i and F_i denote the actual realisations and forecasts of changes in the underlying variables. The benchmark is the no-change forecast. In this case, THEIL will take the value 1. Values below 1 show an improvement over the simple no-change forecast (Theil 1966).

The RMSE, the RMSPE, the MAE and the MAPE are defined as follows (Shcherbakov et al., 2013):

$$\text{RMSE} = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(F_i - A_i)^2}$$

$$\text{RMSPE} = \sqrt{\frac{1}{n}\sum_{i=1}^{n}\left[100 * \left(\frac{(F_i - A_i)}{A_i}\right)^2\right]}$$

$$\text{MAE} = \frac{1}{n}\sum_{i=1}^{n} |F_i - A_i|$$

$$\text{MAPE} = \frac{1}{n}\sum_{i=1}^{n} 100 * \frac{|F_i - A_i|}{F_i}$$

We took the RMSE and the MAE for interest rates, ratios (net exports, budget balance and public debt in relation to GDP), growth rates, interest rates, the inflation rate and the unemployment rate, and the RMSPE and the MAPE for all other variables.

The results of these tests ascertaining the quality of the ex-post simulation are shown in Table A4 in the Appendix. Overall, the results are quite promising. The high values of the error statistics for the budget balance and net exports can be explained by the fact that in some cases the simulation misses the correct sign, leading to large errors. Among the demand components, for investment and imports the model simulation is worse than for the other GDP components. Employment and unemployment are in general tracked satisfactorily, with the exception of the labour market indicators of the older people, which is due to the very small absolute numbers of these variables.

6. CONCLUDING REMARKS

The SLOPOL10 model as described above was obtained after a series of steps, following the general-to-specific methodology initiated by David Hendry and associates (see, e.g., Hendry 1995). We also conducted simulations of the model (both static and dynamic) with historical values of (non-controllable and policy) exogenous variables over the period of estimation and found reasonable tracking quality for most variables with respect to trends and turning points. This encourages us to use the model for policy analysis. Among these, policy simulations for fiscal policy design and optimal control experiments for determining optimal budgetary policies will be prominent.

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Appendix

Table A1: *List of Variables*

Endogenous Variables

AGWN	Average gross wage, euro per employee
AGWR	Average gross wage real
BALANCE	Budget balance
BALANCEGDP	Budget balance in relation to GDP
CAGDP	Current account balance in percent of GDP
CAN	Current account balance
CAPR	Real capital stock
CDEF	Private consumption deflator
CN	Private consumption, nominal
CPI	Consumer price index
CR	Private consumption, real
DEBT	Public debt stock
DEBTGDP	Debt level in relation to GDP
DEMAND	Final demand, real
EMP	Total number of employees
EMP1564	Employment, 15 to 64 years
EMP65PLUS	Employment, 65 years or older
EXPDEF	Export deflator
EXR	Exports of goods and services, real
GAP	Output gap in percent of potential GDP
GDEF	Public consumption deflator
GDPDEF	GDP deflator
GDPN	Nominal GDP
GDPR	Real GDP
GERDR	Real government R&D expenditures
GINVR	Real government investment
GN	Public consumption, national accounts, nominal
GOV10Y	10 year government bond yield
GOV10YR	Real government bond yield
GR	Public consumption, real
GRGDPR	Real GDP growth rate
GRYPOT	Growth rate of potential GDP
IMPDEF	Import deflator
IMPR	Imports of goods and services, real
INCOME	Disposable income of private households, nominal
INCOMER	Disposable income of private households, real
INCTAX	Total income tax revenues
INCTAXCORP	Corporate income tax revenues
INCTAXPERS	Personal income tax revenues
INFL	Inflation rate

INTEREST	Interest payments on public debt
INVDEF	Investment deflator
INVN	Gross fixed capital formation, nominal
INVR	Gross fixed capital formation, real
LF	Total labour force
LF1564	Labour force, 15 to 64 years
LF65PLUS	Labour force, 65 years or older
NETWAGEN	Net wage, nominal
NETWAGER	Average net wage, real
OILEUR	Oil price in euro
PRIMBALANCE	Primary budget balance
PRIMBALANCEGDP	Primary budget balance in relation to GDP
PRINVR	Real private investment
PROD	Labour productivity
REER	Real effective exchange rate (deflator: consumer price indices, 42 trading partners)
SITBOR3M	3 month interest rate before 2007, EURIBOR from 2007 onwards
SOCCOMP	Social security contributions by employers
SOCEMP	Social security contributions by employees
SOCTOTAL	Total social security contributions
TAXDIRECT	Other direct taxes
TAXINDIRECT	Other indirect taxes
TGEN	Total government expenditures
TGRN	Total government revenues
TRENDEMP	Trend of employment
TRENDTFP	Trend of total factor productivity
UCC	User cost of capital
ULC	Unit labour cost
UN	Total number of unemployed persons
UN1564	Unemployment, 15 to 64 years
UR	Unemployment rate
UR1564	Unemployment rate, 15 to 64 years
UTIL	Capacity utilisation rate
VAT	Value added tax revenues
WEDGE	Tax wedge on gross wages
YPOT	Potential output

Exogenous Variables not Controllable by Slovenian Policy Makers

BANKCAP	Capital injections into the banking sector, mill. euro
D1997	Dummy, 1 in 1997, 0 else
D1998	Dummy, 1 in 1998, 0 else
D1999	Dummy, 1 in 1999, 0 else
D2000	Dummy, 1 in 2000, 0 else
D2001	Dummy, 1 in 2001, 0 else

D2002	Dummy, 1 in 2002, 0 else
D2003	Dummy, 1 in 2003, 0 else
D2004	Dummy, 1 in 2004, 0 else
D2005	Dummy, 1 in 2005, 0 else
D2008	Dummy, 1 in 2008, 0 else
D2009	Dummy, 1 in 2009, 0 else
D2010	Dummy, 1 in 2010, 0 else
D2012	Dummy, 1 in 2012, 0 else
D2013	Dummy, 1 in 2013, 0 else
D2014	Dummy, 1 in 2014, 0 else
D199xQi	Dummy, 1 in quarter *i* of year 199*x*, 0 else
D200xQi	Dummy, 1 in quarter *i* of year 200*x*, 0 else
DEBTADJ	Change in debt level, not due to budget balance or bank capitalisation
DEPR	Capital stock depreciation rate
EUR10Y	10 year government bond yield, Euro Area average
EUR3M	3-month EURIBOR
EURUSD	Exchange rate, US dollar per euro
EXPREST	Remaining government expenditures
GN_REST	Public consumption, diff. between national account and fiscal stat.
INVENTR	Real changes in inventories
OIL	Oil price, USD per barrel Brent
NAIRU_EU	Non-accelerating inflation rate of unemployment, published by the EU Commission
POP1564	Population, 15 to 64 years
POP65PLUS	Population, 65 years or older
q1	Dummy, 1 in the first quarter of each year, 0 else
REVREST	Remaining government revenues
SITEUR	Exchange rate, euro per Slovenian tolar
TAXDIRRATE	Other direct taxes in relation to nominal GDP
TAXINDIRRATE	Other indirect taxes in relation to nominal GDP
WTRADE	World trade, CPB

Policy Instruments

GERD	Public expenditures, Research & Development
GINVN	Public investment, nominal
GNFIN	Public consumption according to fiscal statistics, nominal
INCTAXRATE	Average personal income tax rate
LFTERSHARE	Active working population with tertiary education, % of total
SOCEMPRATE	Average social security contribution rate
TRANSFERSN	Transfers to individuals and households
VATAXRATE	Value added tax rate

The following table shows the detailed results of the stationarity tests. We report the results of Augmented Dickey-Fuller tests (ADF), Phillips-Perron tests (PP) and Kwiatkowski-Phillips-Schmidt-Shin tests (KPSS) for stationarity. The decision on lag length was based on the Schwarz information criterion (SIC). The bandwidth was automatically selected using the Newey-West (1994) approach. We used the test model with a constant and without a deterministic trend. *, **, *** denote rejection of the null hypothesis of a unit root at the 10, 5, 1 percent level of significance respectively. +, ++, +++ denote rejection of the null hypothesis of no unit root at the 10, 5, 1 percent level of significance respectively.

Table A2: *Results of Tests for Stationarity*

Levels

Variable	ADF	Lags	PP	Bandwidth	KPSS	Bandwidth
AGWN	-1.773	4	-1.406	13	1.127+++	7
AGWR	-3.043**	4	-5.638***	2	0.174	6
BALANCE	-1.499	3	-5.872***	2	0.789+++	6
BALANCEGDP	-1.734	3	-6.893***	3	0.782+++	5
CAGDP	0.899	3	-2.588*	7	0.949+++	6
CAN	2.07	3	-2.632*	23	0.873+++	6
CAPR	-1.547	5	-1.463	6	1.115+++	7
CDEF	-1.358	4	-1.237	15	1.134+++	7
CN	-1.173	4	-1.598	14	1.121+++	7
CPI	-2.596*	5	-3.661***	8	1.218+++	6
CR	-1.747	8	-2.995*	19	1.199+++	6
DEBT	3.494	0	3.778	1	0.971+++	7
DEBTGDP	2.321	0	2.086	3	0.927+++	6
DEMAND	-1.437	5	-1.404	16	1.079+++	7
EMP	-1.656	4	-2.915*	16	0.348+	6
EMP1564	-2.134	4	-2.111	21	0.367+	6
EMP65PLUS	-3.523***	0	-3.573***	1	0.418+	5
EXPDEF	-0.651	4	-0.887	6	1.115+++	7
EXR	-0.446	5	-0.134	14	1.128+++	7
GAP	-5.023***	4	-8.500***	2	0.134	3
GDEF	-1.808	4	-1.259	14	1.127+++	7
GDPDEF	-1.286	4	-1.36	16	1.138+++	7
GDPN	-1.146	6	-1.281	14	1.113+++	7
GDPR	-1.645	6	-1.762	16	1.041+++	7
GERDR	-1.581	3	-8.808***	20	0.474++	10
GINVR	0.121	3	-7.910***	2	1.882+++	0
GN	-1.183	8	-1.097	14	1.112+++	7
GOV10Y	-1.384	1	-3.932***	3	1.014+++	6
GOV10YR	-4.225***	1	-3.109**	2	0.224	5
GR	-1.970	4	-1.625	14	1.063+++	7
GRGDPR	-3.556***	2	-2.789*	4	0.428+	6
GRYPOT	-2.189	0	-2.172	2	0.846+++	6
IMPDEF	-0.7	0	-0.78	3	1.051+++	7

Variable	ADF	Lags	PP	Bandwidth	KPSS	Bandwidth
IMPR	-1.314	4	-1.006	59	1.072+++	7
INCOME	-1.318	5	-1.3	14	1.127+++	7
INCOMER	-2.268	5	-4.746***	5	0.231	6
INCTAX	-1.636	3	-4.629***	22	1.04+++	6
INCTAXCORP	-1.52	3	-4.783***	2	0.616++	6
INCTAXPERS	-2.021	3	-5.053***	29	1.196+++	6
INFL	-0.944	4	-1.205	3	1.032+++	6
INTEREST	0.21	11	-7.885***	1	1.338+++	4
INVDEF	0.35	2	-0.343	21	1.125+++	7
INVN	-2.369	4	-2.098	82	0.74+++	6
INVR	-2.381	4	-2.181	82	0.433+	6
LF	-1.427	4	-2.934**	17	0.716++	6
LF1564	-1.396	2	-1.903	26	0.752+++	6
LF65PLUS	-3.523***	0	-3.573***	1	0.418+	5
NETWAGEN	-1.533	5	-1.479	14	1.113+++	7
NETWAGER	-2.988**	4	-3.233**	49	0.458+	6
OILEUR	-1.505	0	-1.505	0	0.977+++	7
PRIMBALANCE	-1.912	3	-5.552***	3	0.549++	6
PRIMBALANCEGDP	-2.03	3	-6.633***	3	0.557++	5
PRINVR	-2.124	4	-2.041	60	0.332	6
PROD	-2.189	7	-2.083	16	1.241+++	6
REER	-1.949	0	-2.121	1	0.741+++	6
SITBOR3M	-2.687*	1	-2.103	4	0.86+++	6
SOCCOMP	-0.961	4	-1.017	15	1.107+++	7
SOCEMP	-1.721	4	-1.415	14	1.119+++	7
SOCTOTAL	-1.378	4	-1.221	14	1.116+++	7
TAXDIRREST	-2.534	4	-2.988**	20	0.629++	6
TAXINDIRREST	-1.138	3	-1.752	26	1.134+++	7
TGEN	-1.692	5	-1.343	14	1.125+++	7
TGRN	-1.822	4	-1.786	15	1.114+++	7
TRENDEMP	-1.568	4	-3.151**	13	0.575++	6
TRENDTFP	-1.877	8	-5.521***	6	1.009+++	7
UCC	-4.266***	1	-3.154**	2	0.216	5
ULC	-1.500	4	-1.549	19	1.033+++	7
UN	-2.472	8	-1.639	5	0.483++	7
UN1564	-2.306	8	-1.505	5	0.553++	6
UR	-2.406	8	-1.717	7	0.408+	7
UR1564	-2.472	8	-1.611	6	0.464++	6
UTIL	-5.023***	4	-8.500***	2	0.134	3
VAT	-1.399	3	-4.813***	12	1.251+++	6
WEDGE	-2.666*	3	-2.025	16	1.127+++	7
YPOT	-2.068	4	-2.094	14	1.085+++	7
DEBTADJ	-13.689***	0	-13.711***	3	0.147	0
DEPR	-0.415	4	-0.319	85	0.449+	6
EUR10Y	-2.193	1	-2.336	4	1.067+++	6

Variable	ADF	Lags	PP	Bandwidth	KPSS	Bandwidth
EUR3M	-2.414	1	-1.855	4	0.988+++	6
EURUSD	-2.035	1	-1.624	2	0.382+	6
EXPREST	-0.89	4	-2.477	19	1.147+++	7
GERD	-1.504	3	-8.284***	7	1.362+++	0
GINVN	0.469	3	-7.201***	0	1.552+++	3
GN_REST	-0.316	3	-4.877***	4	0.565++	6
GNFIN	-2.125	4	-1.784	15	1.09+++	7
INCTAXRATE	-3.075**	3	-7.214***	1	0.942+++	5
INVENTR	-3.137**	4	-5.843***	1	0.228	5
LFTERSHARE	2.803	4	3.037	4	1.123+++	6
NAIRU_EU	-0.733	9	-0.807	4	1.164+++	7
OIL	-1.557	2	-1.616	3	0.863+++	7
POP1564	-0.521	5	-0.133	4	0.287	6
POP65PLUS	0.112	1	2.799	30	1.189+++	6
REVREST	-0.709	3	-4.133***	13	1.336+++	6
SITEUR	-2.689*	8	-7.179***	9	0.901+++	7
SOCEMPRATE	-3.082**	4	-5.357***	42	1.108+++	6
TAXDIRRATE	-1.929	4	-2.733**	36	0.249	6
TAXINDIRRATE	-1.487	3	-3.223**	8	0.954+++	6
TRANSFERSN	-2.19	4	-1.663	14	1.175+++	7
VATAXRATE	-1.729	3	-11.539***	2	0.656+++	27
WTRADE	-1.029	2	-0.938	1	1.185+++	7
YPOT	-2.068	4	-2.094	14	1.085+++	7

First Differences

Variable	ADF	Lags	PP	Bandwidth	KPSS	Bandwidth
AGWN	-2.312	3	-33.323***	47	0.254	13
AGWR	-2.334	3	-31.946***	28	0.096	13
BALANCE	-13.39***	2	-28.624***	17	0.109	15
BALANCEGDP	-14.273***	2	-30.893***	16	0.104	15
CAGDP	-11.625***	2	-22.159***	19	0.303	18
CAN	-5.417***	3	-15.823***	17	0.338	16
CAPR	-1.864	4	-2.287	51	0.398+	6
CDEF	-3.172**	3	-11.877***	14	0.192	14
CN	-2.898**	3	-21.676***	13	0.142	13
CPI	-0.838	3	-8.512***	2	1.28+++	2
CR	-2.123	7	-28.605***	14	0.218	13
DEBT	-4.499***	1	-8.642***	4	0.709++	5
DEBTGDP	-4.478***	1	-8.394***	4	0.495++	5
DEMAND	-3.641***	4	-21.409***	42	0.185	15
EMP	-3.816***	3	-10.045***	26	0.128	25
EMP1564	-3.727***	3	-9.087***	27	0.165	29
EMP65PLUS	-9.544***	0	-12.997***	14	0.157	17

Variable	ADF	Lags	PP	Bandwidth	KPSS	Bandwidth
EXPDEF	-3.273**	3	-9.309***	7	0.072	7
EXR	-4.754***	4	-9.687***	12	0.098	15
GAP	-5.356***	6	-42.042***	23	0.128	13
GDEF	-2.872*	3	-21.594***	27	0.176	14
GDPDEF	-3.353**	3	-13.965***	17	0.221	15
GDPN	-3.437**	5	-17.76***	16	0.148	13
GDPR	-4.001***	5	-19.49***	33	0.216	14
GERDR	-28.757***	2	-20.675***	13	0.091	12
GINVR	-40.618***	2	-24.808***	13	0.16	13
GN	-1.841	7	-27.178***	4	0.151	13
GOV10Y	-2.888*	10	-12.684***	3	0.333	8
GOV10YR	-7.119***	0	-7.091***	3	0.089	3
GR	-2.279	3	-29.073***	2	0.195	14
GRGDPR	-5.946***	3	-8.009***	3	0.037	3
GRYPOT	-9.439***	0	-9.449***	2	0.037	2
IMPDEF	-8.791***	0	-8.840***	3	0.084	3
IMPR	-3.214**	3	-13.062***	10	0.23	37
INCOME	-2.802*	4	-14.353***	14	0.14	13
INCOMER	-2.717**	4	-14.622***	14	0.079	14
INCTAX	-12.354***	2	-31.134***	19	0.165	13
INCTAXCORP	-13.754***	2	-25.119***	16	0.113	14
INCTAXPERS	-15.093***	2	-44.113***	17	0.175	13
INFL	-6.092***	3	-6.855***	3	0.036	3
INTEREST	-3.058**	10	-29.74***	13	0.101	13
INVDEF	-12.284***	1	-9.487***	27	0.11	20
INVN	-2.602*	3	-12.377***	18	0.246	23
INVR	-2.753*	3	-13.303***	46	0.272	19
LF	-11.16***	1	-10.608***	26	0.15	25
LF1564	-10.165***	1	-10.062***	27	0.164	29
LF65PLUS	-9.544***	0	-12.997***	14	0.157	17
NETWAGEN	-2.883*	4	-20.567***	14	0.156	13
NETWAGER	-3.306**	3	-16.111***	14	0.124	13
OILEUR	-7.438***	0	-7.351***	3	0.179	0
PRIMBALANCE	-10.064***	2	-37.165***	40	0.149	20
PRIMBALANCEGDP	-11.229***	2	-35.294***	25	0.131	18
PRINVR	-2.938**	3	-10.627***	19	0.358+	18
PROD	-5.074***	6	-24.469***	25	0.287	14
REER	-7.864***	0	-7.904***	1	0.047	1
SITBOR3M	-6.426***	0	-6.414***	1	0.083	4
SOCCOMP	-4.44***	3	-22.854***	26	0.124	14
SOCEMP	-2.726	4	-23.800***	23	0.199	13
SOCTOTAL	-3.8	3	-23.724***	23	0.169	13
TAXDIRREST	-3.387	3	-14.619***	15	0.328	14

Variable	ADF	Lags	PP	Bandwidth	KPSS	Bandwidth
TAXINDIRREST	-15.542	2	-29.294***	17	0.19	15
TGEN	-2.794	4	-33.417***	14	0.116	13
TGRN	-5.585	3	-41.022***	15	0.166	13
TRENDEMP	-11.161	1	-10.692***	26	0.15	25
TRENDTFP	-1.712***	7	-1.668	6	0.767+++	7
UCC	-7.164***	0	-7.137***	3	0.085	3
ULC	-2.849*	3	-17.118***	32	0.163	15
UN	-1.853	7	-9.096***	9	0.082	10
UN1564	-2.713*	3	-8.385***	8	0.11	9
UR	-2.029	7	-9.325***	12	0.086	14
UR1564	-1.572	7	-8.359***	11	0.112	13
UTIL	-5.356***	6	-42.042***	23	0.128	13
VAT	-19.866***	2	-42.366***	14	0.094	13
WEDGE	-5.984***	3	-42.232***	15	0.197	13
YPOT	-2.609*	3	-8.314***	8	0.555++	6
DEBTADJ	-8.254	5	-36.099***	5	0.114	17
DEPR	-9.447	3	-9.466***	26	0.361+	19
EUR10Y	-6.358	0	-6.291***	2	0.207	4
EUR3M	-5.024	0	-5.099***	1	0.063	4
EURUSD	-6.762	1	-6.323***	8	0.131	3
EXPREST	-6.328	3	-25.289***	13	0.084	13
GERD	-28.241	2	-21.678***	13	0.063	13
GINVN	-44.566	2	-27.355***	13	0.175	13
GN_REST	-22.335	2	-24.487***	14	0.237	13
GNFIN	-2.573	3	-29.785***	55	0.213	13
INCTAXRATE	-22.203	2	-37.677***	14	0.187	13
INVENTR	-4.443	3	-24.159***	22	0.108	15
LFTERSHARE	-2.365	3	-7.962***	1	0.909+++	3
NAIRU_EU	-3.005	8	-4.262***	2	0.062	4
OIL	-7.291	1	-6.852***	9	0.159	4
POP1564	-2.873	4	-8.365***	4	0.508++	4
POP65PLUS	-13.868	0	-14.307***	8	0.489++	47
REVREST	-17.644	2	-38.455***	14	0.082	14
SITEUR	-2.372	7	-6.142***	4	1.02+++	5
SOCEMPRATE	-3.622	3	-25.702***	13	0.252	13
TAXDIRRATE	-2.925	3	-10.84***	28	0.277	18
TAXINDIRRATE	-14.309	2	-27.146***	20	0.131	15
TRANSFERSN	-3.346	4	-26.334***	17	0.346	13
VATAXRATE	-19.501	2	-50.457***	14	0.098	13
WTRADE	-5.956	1	-4.453***	9	0.061	1

The following table shows the results of the cointegration tests for the behavioural equations finally adopted. *, **, *** means that the null hypothesis (ADF and Phillips-Perron: no stationarity of the residuals; KPSS: stationarity of the residuals) can be rejected at the 10, 5, 1 percent level of significance respectively. Similarly to the tests for stationarity, we chose the models with a constant, but without a trend. As before, the decision on lag length was based on the Schwarz information criterion. The bandwidth was selected automatically using the Newey-West (1994) approach.

Table A3: *Tests for Cointegration – Tests for Stationarity of Residuals of the Equations*

Equation	**ADF**	**Lags**	**PP**	**Bandwidth**	**KPSS**	**Bandwidth**
Trend TFP	-2.012	4	-3.872***	5	0.176	6
Consumption	-6.536***	0	-6.546***	3	0.065	2
Investment	-7.636***	0	-7.913***	5	0.195	5
Exports	-7.243***	0	-7.267***	1	0.092	1
Imports	-9.165***	0	-9.156***	4	0.124	4
Employment 15-64	-4.250***	0	-4.250***	0	0.184	4
Employment 65+	-7.983***	0	-7.984***	1	0.109	2
Labour supply 15-64	-5.241***	0	-5.260***	1	0.264	3
Labour supply 65+	-7.965***	0	-7.965***	1	0.098	1
Wage rate	-8.002***	0	-7.999***	1	0.060	0
CPI	-6.739***	0	-6.806***	2	0.048	3
Cons. Deflator	-5.007***	0	-5.039***	2	0.082	3
Gov. cons. deflator	-8.062***	0	-8.062***	0	0.093	1
Investment deflator	-4.739***	0	-4.739***	0	0.217	4
Export deflator	-6.105***	1	-6.288***	4	0.074	2
Import deflator	-5.127***	3	-4.563***	5	0.124	5
Short-term int. rate	-5.080***	0	-5.080***	0	0.086	4
Long-term int. rate	-3.865***	5	-4.357***	4	0.205	4
Real eff. exch. rate	-4.592***	0	-4.550***	2	0.131	5
Soc. sec. revenues	-7.798***	0	-7.869***	3	0.130	4
Company taxes	-9.062***	0	-9.161***	5	0.105	5
VAT revenues	-2.920**	3	-8.474***	8	0.175	3
Interest payments	-9.239***	0	-9.244***	2	0.216	2

Table A4: *Results of Ex-post Model Evaluation*

Variables in levels

Variable	RMSPE	Theil	MAPE	Variable	RMSPE	Theil	MAPE
AGWN	4.1	0.359	3.6	INTEREST	9,463.4	0.660	18.1
AGWR	2.0	0.516	1.8	INVDEF	1.8	0.459	1.2
BALANCE	247.8	0.689	293.7	INVN	10.6	0.814	8.6
CAN	467.9	1.062	447.9	INVR	11.0	0.838	9.2
CAPR	7.2	0.373	6.5	LF	0.9	0.767	0.7
CDEF	2.0	0.570	1.5	LF1564	0.9	0.795	0.6
CN	5.1	0.543	4.2	LF65PLUS	9.4	0.726	7.2
CPI	4.4	0.436	3.3	NETWAGEN	4.1	0.369	3.6
CR	3.2	0.557	2.7	NETWAGER	2.0	0.381	1.8
DEBT	22.8	0.160	21.1	OILEUR	0.0	0.000	0.0
DEMAND	2.0	0.328	1.6	PRIMBALANCE	9,081.8	0.679	339.0
EMP	1.4	0.787	1.3	PRINVR	12.3	0.854	10.4
EMP1564	1.3	0.778	1.2	PROD	2.0	0.610	1.7
EMP65PLUS	16.2	1.034	12.2	REER	2.2	0.697	1.9
EXPDEF	0.8	0.484	0.7	SOCCOMP	5.2	0.430	4.6
EXR	2.1	0.197	1.7	SOCEMP	4.5	0.387	3.9
GDEF	2.0	0.431	1.7	SOCTOTAL	4.8	0.392	4.2
GDPDEF	8.2	0.366	0.8	TAXDIRREST	2.9	0.257	2.5
GDPN	2.8	0.513	2.4	TAXINDIRREST	3.0	0.366	2.6
GDPR	2.3	0.525	1.9	TGEN	0.5	0.056	0.4
GERDR	1.6	0.054	1.2	TGRN	3.8	0.458	3.0
GINVR	1.8	0.080	1.4	TRENDEMP	0.9	0.759	0.7
GN	0.0	0.000	0.0	TRENDTFP	3.8	1.164	0.0
GR	1.9	0.532	1.6	UCC	49.4	1.134	40.9
IMPDEF	1.7	0.451	1.5	ULC	3.6	0.682	3.0
IMPR	4.4	0.418	3.8	UN	18.7	1.044	15.9
INCOME	2.5	0.463	2.1	UN1564	17.1	0.896	14.9
INCOMER	5.2	0.621	3.8	VAT	7.2	0.653	5.7
INCTAX	8.8	0.699	7.4	WEDGE	4.1	0.250	3.6
INCTAXCORP	32.4	0.955	27.0	YPOT	5.8	0.639	5.5
INCTAXPERS	4.6	0.296	4.0				

Variables in percent

Variable	RMSE	Theil	MAE
BALANCEGDP	1.4	0.777	1.0
CAGDP	1.7	1.121	1.4
DEBTGDP	7.8	0.324	7.3
GAP	5.7	0.971	4.9
GOV10Y	0.6	0.471	0.5
GOV10YR	1.8	1.140	1.5
GRGDPR	2.1	0.695	1.6
GRYPOT	1.9	1.706	1.5
INFL	1.9	0.862	1.6
PRIMBALANCEGDP	1.5	0.758	1.2
SITBOR3M	1.0	0.828	0.7
UR	1.3	1.030	1.1
UR1564	1.2	0.892	1.0
UTIL	5.7	0.969	4.9

Figure A1: *Real GDP*

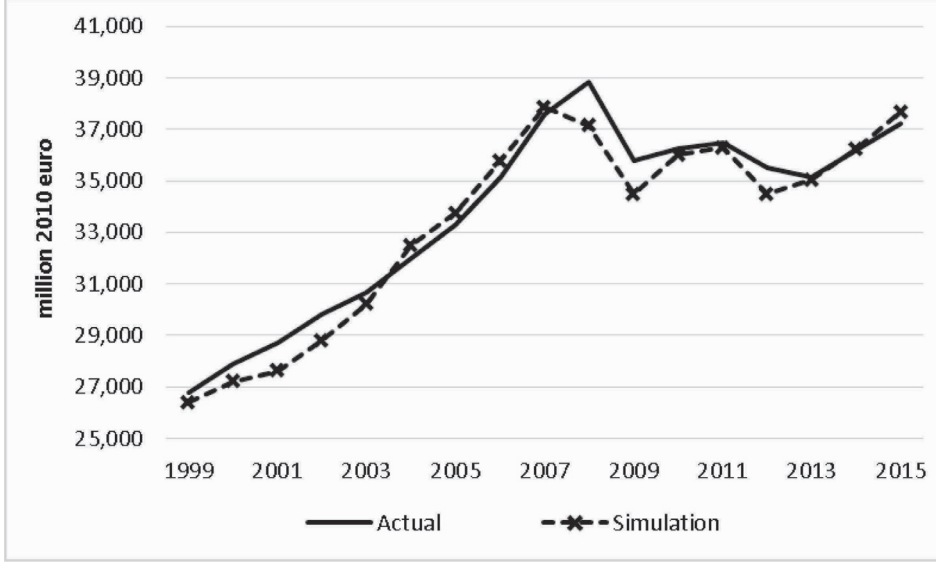

Figure A2: *Potential GDP*

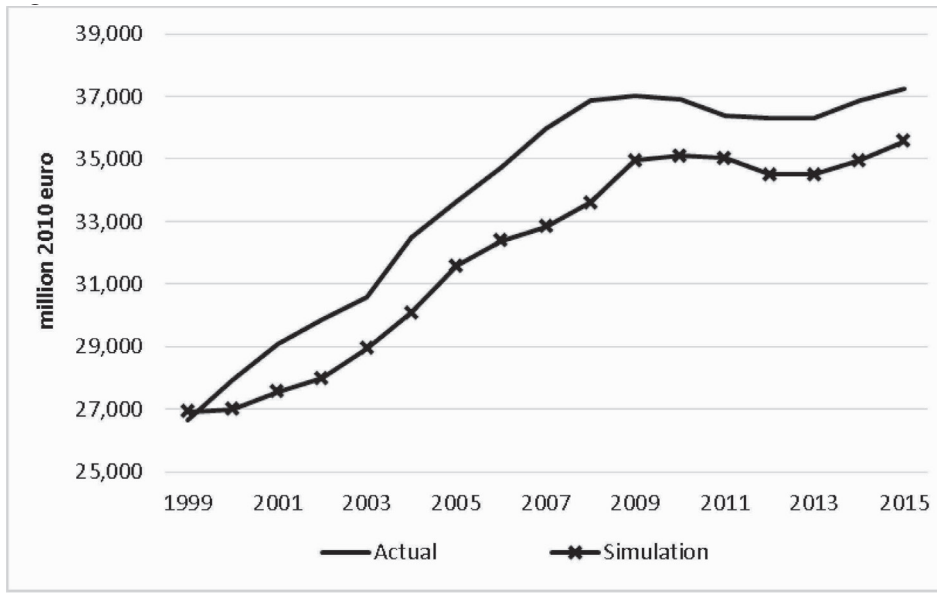

Figure A3: *Real GDP Growth*

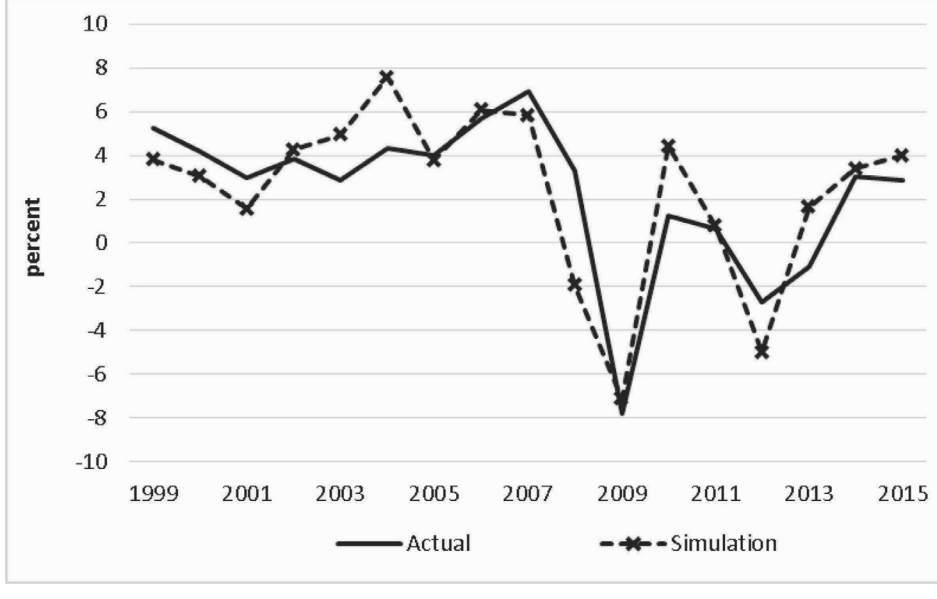

Figure A4: *Real private consumption*

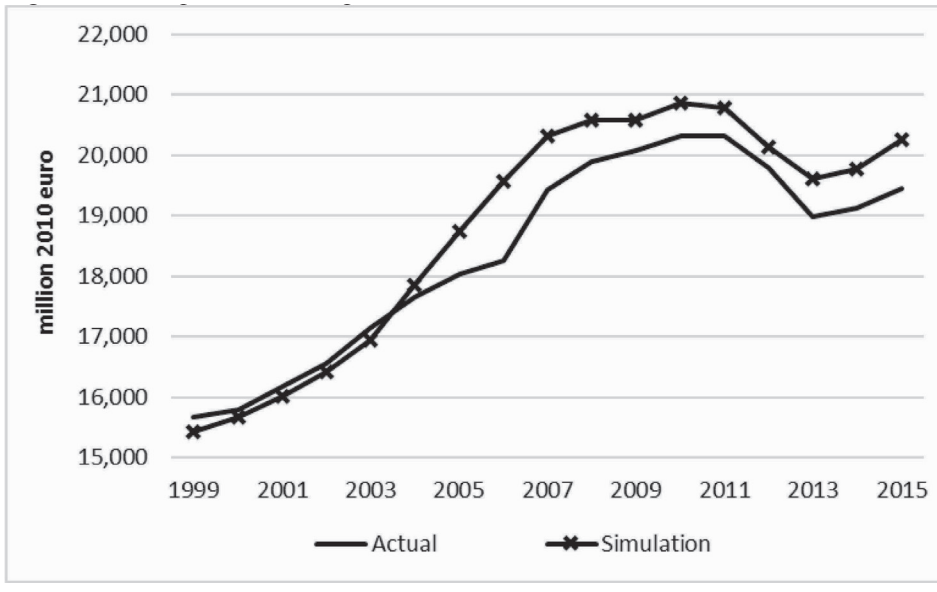

Figure A5: *Real investment*

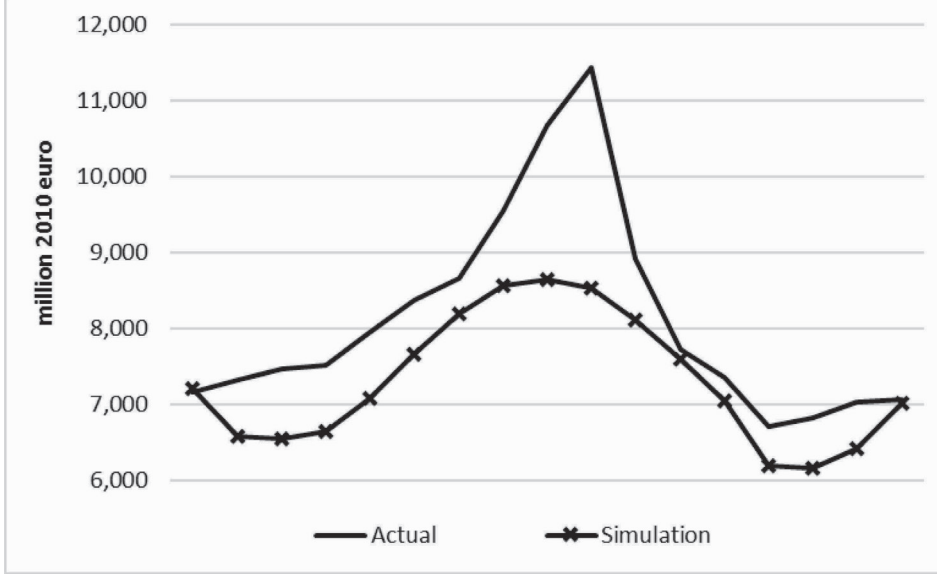

Figure A6: *Consumer Price Index*

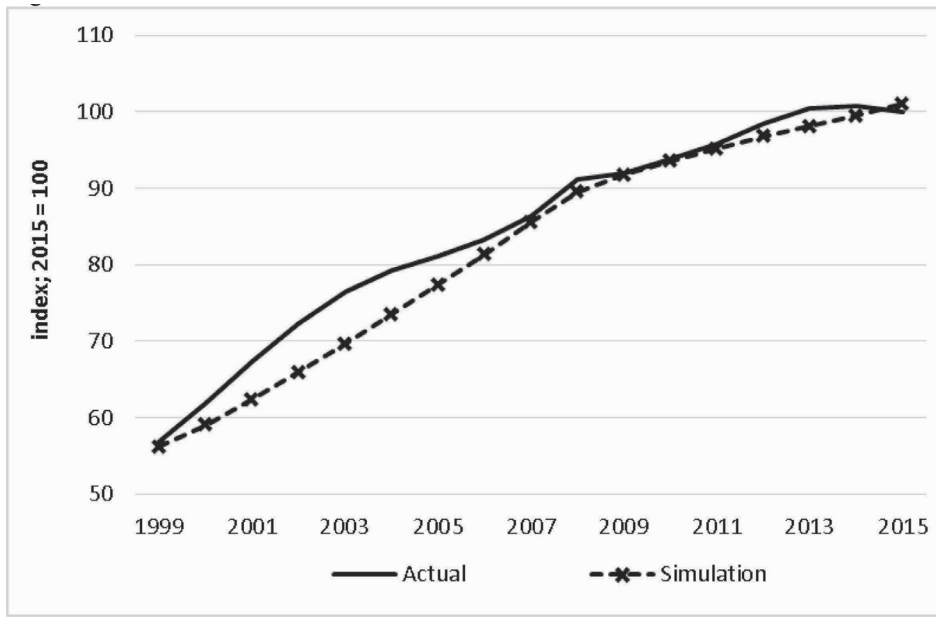

Figure A7: *Inflation Rate*

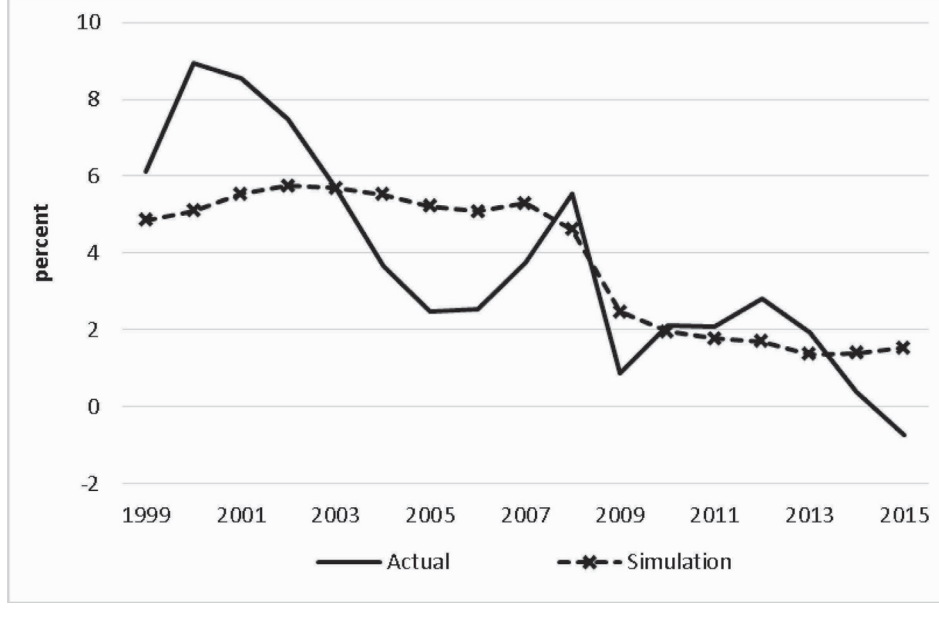

Figure A8: *Employment*

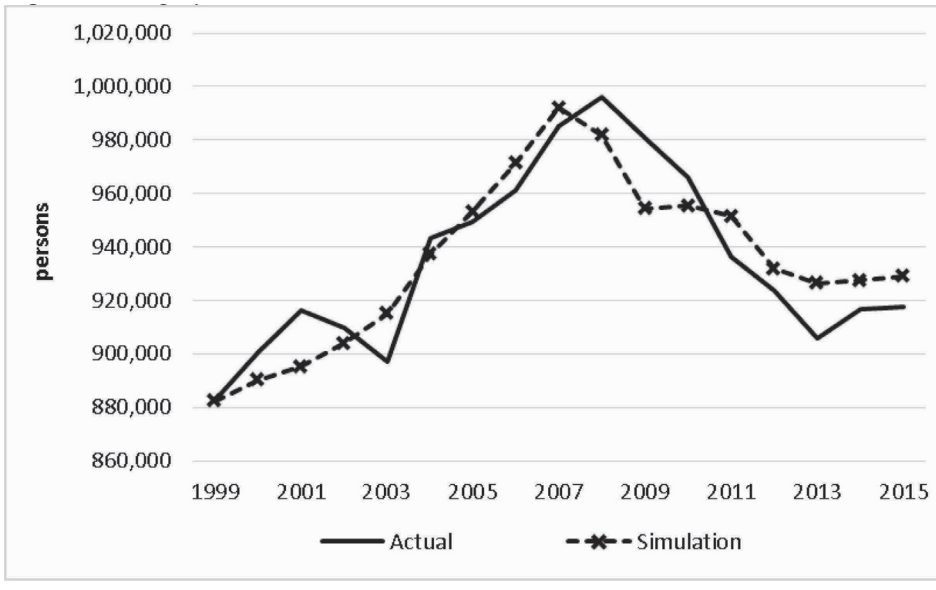

Figure A9: *Unemployment Rate*

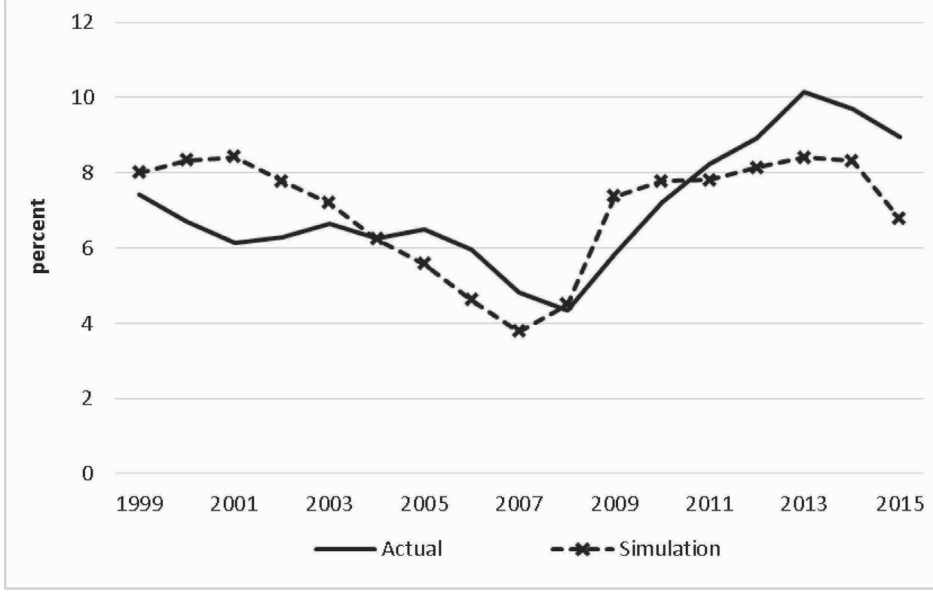

Figure A10: *Public Debt in relation to Nominal GDP*

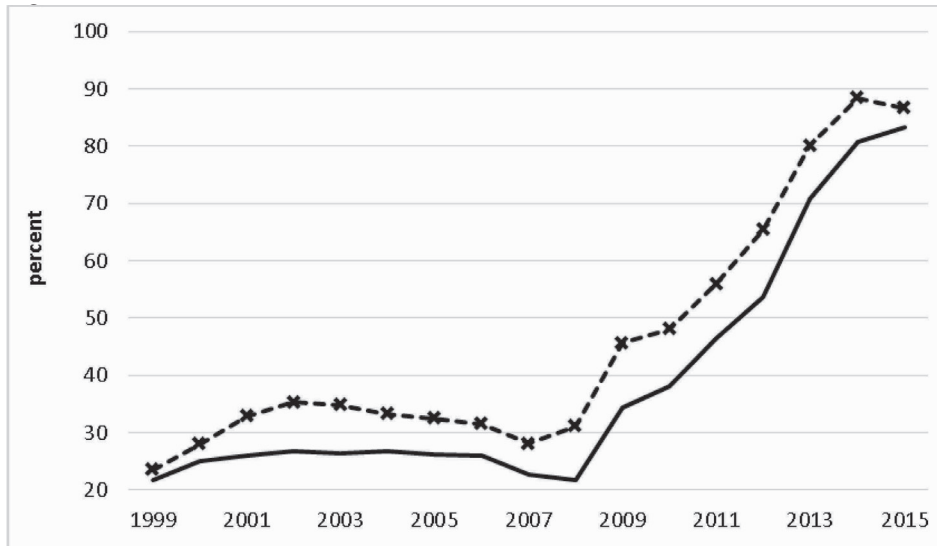

Figure A11: *Budget balance in relation to Nominal GDP*

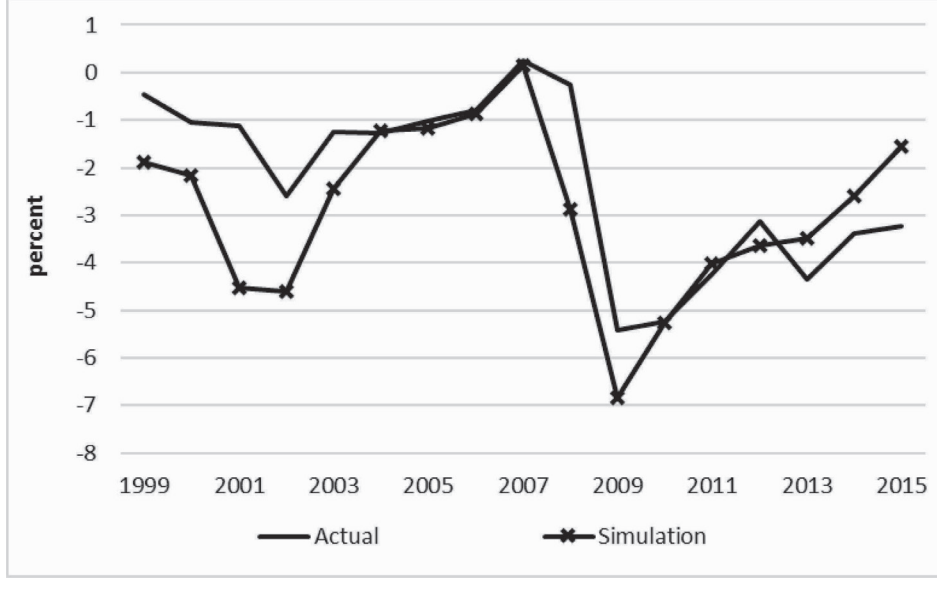

Figure A12: *Net Exports in relation to Nominal GDP*