

# **A Macroeconometric Model for Serbia**

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## Abstract

This paper describes and evaluates a quarterly macroeconometric model for Serbia. Due to the economic restructuring and transformation in Serbia which followed the major geographical, economic, and institutional disruptions in the former Yugoslavia in the first half of the 1990s, reliable macroeconomic time series for Serbia are available only from about 1997 onwards. Hence, quarterly data have been used to estimate the behavioral equations of the model. However, for some aggregates only annual data are available. In these cases, quarterly data have been derived by recurring to related series. Notwithstanding these data limitations, the macroeconometric model is able to replicate the endogenous variables reasonably well in an ex post simulation.

JEL classification codes: **C51, C53, E17**

Keywords: **Econometric modelling, Serbia, Model evaluation**

## 1. Introduction

Macroeconomic policy-making is confronted with an increasingly complex environment. Furthermore, external shocks such as sudden exchange rate movements or raw material prices impact on the domestic economy. Besides external shocks, in the case of Serbia its intensifying European economic integration has important macroeconomic consequences. Existing trade barriers are removed, thus international trade is gradually re-oriented towards EU markets. In addition, the increasing macroeconomic and political stabilisation can be expected to raise the attractiveness of the Serbian economy for foreign investors. Growing foreign direct investment (FDI) will bring about a faster increase and renewal of the capital stock. In addition, the accompanying knowledge transfer raises total factor productivity (TFP). Both effects, a larger and modernised capital stock and a faster TFP growth, will augment Serbia's growth potential, enabling a higher GDP growth and lower inflation. While the qualitative effects of these events as well as of monetary and fiscal policy measures can often be derived from economic theory, their quantification requires a mathematical representation of the economy. Here, macroeconometric models, containing the most important macroeconomic aggregates and markets, have established a long tradition. With the aim of quantifying the sketched effects of the intensifying European integration of Serbia, as well as generating macroeconomic forecasts, in an international cooperation a macroeconometric model for Serbia was developed. This model is regularly updated and applied for simulations and for forecasting. Work on this model originated in the project "Strategic Partnership in Support of the Integrated Regional Development Plan (IRDP) of the Autonomous Province of Vojvodina", financed by the Austrian Development Agency ADA. The project was jointly carried out by the Institute for Advanced Studies, Vienna, and ECONOMICA Institute of Economic Research, Vienna, in close cooperation with the Centre for Strategic Economic Studies "Vojvodina CESS", Novi Sad, Serbia. A detailed description of the first model version can be found in Berrer et al. (2009). The model for Serbia has a structure and theoretical underpinning similar to a model for Slovenia developed by one of the authors within an earlier cooperation (Weyerstrass and Neck 2007; Weyerstrass, Neck and Haber 2001).

This paper describes the macroeconometric model for Serbia. First, in the next section data issues are elaborated. In particular, the availability of time series on macroeconomic aggregates

for Serbia and necessary data transformations are addressed. Furthermore, the time series properties of the variables are investigated. In section 3, the behavioural equations are described. A full list of the equations is provided in the appendix. Finally, in section 4 the ability of the model to replicate the endogenous variables is evaluated on the basis of an ex post simulation.

## **2. Data issues**

In this section, the data used for the model and data transformations are described in detail. At the time of writing this paper (i.e. at the beginning of 2012), available reliable macroeconomic data for Serbia covers at best the period 1997 to the first half of 2011. For many aggregates, the time series even start only in 1999 or 2000. Hence, it was decided to base the econometric estimation of the behavioural equations of the macroeconomic model for Serbia on a higher than an annual frequency. For some aggregates such as wages, prices, labour market indicators and interest rates, monthly data are available. However, for GDP only annual and quarterly data are available. Therefore, it was decided to use quarterly data.

In particular, data for GDP, the capital stock and public finances are scarce. For the expenditure components of GDP, only annual data at current prices are available for Serbia. Quarterly data are published for total real GDP, but not for the expenditure components. Hence, these data had to be constructed by reverting to related macroeconomic aggregates that are available at least at a quarterly frequency. In addition, a time series of the capital stock had to be constructed by generating an initial capital stock in a base year and then applying the Perpetual Inventory Method (PIM). The initial capital stock in 1997 was determined by reverting to a capital-output ratio found for Macedonia. This initial value of the capital stock was then extrapolated by adding gross investment and subtracting depreciation, in accordance with the PIM.

### ***Data Transformations***

In Serbia, data on quarterly GDP as published by the Statistical office presently covers total GDP at constant prices, starting in 1997. Data on the GDP expenditure components at current prices are available at an annual frequency, also starting in 1997. However, the annual figures are published with a considerable time lag of about three quarters. No data are published on the expenditure aggregates at constant prices. In order to derive a quarterly series for total GDP at current prices, it was assumed that GDP at current prices follows the same quarterly pattern as GDP at constant prices.

For quarterly data on the GDP expenditure components at current prices, the following computations have been performed:

- Exports and imports: the National Bank of Serbia publishes quarterly balance of payments data in euro and in US dollar. The quarterly profile of these data on exports and imports of goods and services have been assigned to exports and imports in Serbian dinar (RSD) according to the national accounts statistics.
- Public consumption: for the quarterly division of public consumption according to national accounts statistics, public finance data have been resorted to. The Serbian Ministry of Finance publishes monthly figures on a detailed breakdown of revenues and expenditures. The sum of the items “expenditures for employees” and “purchases of goods and services” was taken as an approximation for government consumption. The quarterly profile of the sum of these public expenditures has been used to derive government consumption according to national accounts statistics.
- Consumption of private households: as an indicator for the expenditures of private households, revenues from value added tax (VAT) have been used. These figures were

taken from the “Bulletin Public Finances” of the Serbian Ministry of Finances. Using annual data on VAT revenues and private household consumption, a behavioural equation was estimated, with private consumption as the dependent variable and VAT revenues as the explanatory variable. By dividing the constant by four, adding quarterly VAT revenues, multiplied by the respective coefficient, and adding the residuals of the estimation, a quarterly series for private consumption, adding up to the actual annual figures, was calculated.

- Gross fixed capital formation: as an indicator for the sub-annual development of fixed investment is lacking, the same quarterly profile as for total GDP has been taken.
- Changes in inventories: for the period 1997 to 2002, quarterly changes in inventories have been determined as the residual between total GDP and the final demand components. For the years since 2004, changes in inventories and a series for the statistical discrepancy are published; before 2004, the statistical discrepancy was included in the changes in inventories. Hence, for the period since 2004 the annual changes in inventories have been divided by quarters by resorting to the same quarterly shares as in the cases of total GDP and fixed investment, and the residual was assigned to the statistical discrepancy.

#### *Real GDP by expenditure*

Annual data for nominal and real GDP are officially published. No data are available for the expenditure components at constant prices, nor for quarterly GDP at current prices. In order to derive real GDP by expenditure, some assumptions and calculations had to be made. A series of the total GDP deflator could be calculated. For the annual GDP deflator, actually published data could be used, while the calculation of the quarterly deflator was based on official data for real GDP and the calculated series of quarterly GDP at current prices. It was assumed that the same deflator as for total GDP also pertains to each expenditure component; this assumption is problematic, since consumer prices, export prices and prices for investment goods are known to develop quite differently. However, since no further information on the various deflators was available, this approximation can be justified. These calculations resulted in quarterly series for the GDP expenditure components at constant prices.

#### *Capital stock*

For Serbia, no official data on the capital stock are available. Hence, a capital stock series was constructed based on the Perpetual Inventory Method (PIM). According to the PIM, the net capital stock at the end of the current year ( $K_t$ ) is equal to the capital stock at the end of the previous year ( $K_{t-1}$ ) plus gross fixed capital formation in the current year ( $I_t$ ) minus depreciation in the current year ( $DEP_t$ ):

$$K_t = K_{t-1} + I_t - DEP_t \quad (1)$$

The application of the Perpetual Inventory Method requires the determination of an initial value of the capital stock in the starting year  $t_0$ . One option would be to assume that at the beginning of the economic transformation process at the end of the 1990s the capital stock in Serbia was totally outdated, implying an initial value of zero in 1997. However, it seems reasonable to assume that not the entire capital stock was outdated. Therefore, it was decided to base the starting year value of the capital stock on international data. For Macedonia, capital stock estimates exist (Roberts 2002). Since Macedonia is also a successor state of the former Yugoslavia, it is particularly suited as a benchmark for Serbia. Hence, it was decided to determine the starting value of the capital stock in Serbia at the beginning of 1997 on the basis of the capital-output ratio of 1.6 as found by Roberts (2002) for Macedonia. This value refers to the net capital stock, i.e. cumulative gross investment net of depreciation. Capital stock data refer to the stock at a certain point in time, while GDP and investment data are flows during a

certain period. The first year for which GDP data for Serbia is available is 1997; hence the starting value of the capital stock was determined by multiplying the annual GDP figure for 1997 by the assumed capital-output ratio of 1.6. This figure was then taken as the initial value of the capital stock at the end of 1996 or the beginning of 1997, respectively. From the first quarter of 1997 onwards, the capital stock was then extrapolated by applying the Perpetual Inventory Method, i.e. by adding quarterly gross fixed capital formation and subtracting depreciation. Depreciation could take different patterns. With straight-line depreciation, the market value of an asset in constant prices is assumed to decline by the same amount each period. This amount is equal to  $1/T$ th of the initial value of the asset, where  $T$  is the service life of that particular asset. With geometric depreciation, the market value in constant prices is assumed to decline at a constant rate in each period (e.g. OECD 2001). The latter will normally be a good approximation of the former; hence a constant depreciation rate was assumed. The above equation for the calculation of the capital stock can thus be rewritten as:

$$K_t = (1-\delta) K_{t-1} + I_t \quad (2)$$

with  $\delta$  as the depreciation rate.

For Serbia, no income account of GDP is published. Hence, no official data on depreciation is available. Even if it were available, depreciation, according to national accounts statistics, deviates from the consumption of fixed capital. The physical depletion of the capital stock is not necessarily identical to the economic depreciation as accounted for in the national accounts statistics. Were capital stock data available, depreciation could be calculated by re-arranging the above equation for the PIM accordingly. As already mentioned, capital stock data are not available for Serbia, hence the depreciation rate could not be derived in this way.

Since no information on depreciation of the capital stock in Serbia is available, the depreciation rate for the calculation of the capital stock according to the Perpetual Inventory Method was based on data for other countries. The OECD publishes data on the gross and net capital stocks, gross fixed capital formation, and consumption of fixed capital (depreciation) for 14 countries (OECD 1997). Since for some countries some of these aggregates are missing, all relevant data are available for ten countries. The unweighted average of the depreciation rate (current year consumption of fixed capital as a percentage of the capital stock at the end of the previous year) amounts to 5 percent. The value ranges between 2.7 percent in Greece and 8.7 percent in Canada. However, these extreme values are outliers; the majority of the depreciation rate lies between 4.6 percent and 5.7 percent. Hence, at least for developed industrialised countries a depreciation rate of about 5 to 6 percent per year seems a reasonable assumption.

Applying the perpetual inventory method to Serbia with an annual depreciation rate of 6 percent (1.47 percent per quarter), the capital-output ratio rises from 1.6 in 1997 to about 1.8 in 2010. Due to the legacy of the former Yugoslav era, physical capital in Serbia needs to be considerably rebuilt and modernised. Hence, a rising capital-output ratio should also be expected in the future. In the OECD countries, this value lies in the range of about 2.5 to 3.

### **3. The Model**

#### **3.1. Modelling Approach**

The macroeconomic model for Serbia comprises all important macroeconomic markets, i.e. the labour, goods, monetary and foreign exchange markets. Hence, the model contains equations for GDP and its expenditure components, prices, wages, employment, unemployment, interest rates, and exchange rates. In addition, the government sector is modelled in some detail. The latter

model bloc contains the most important revenue and expenditure items of the consolidated general government, i.e. the Republic of Serbia (the central government), the Autonomous Province of Vojvodina, the municipalities and cities, as well as the Social Security Organisations.

Unit root tests identify most variables as integrated of order one (see TABLE 2 in the appendix for details), i.e. the variables are non-stationary in levels, but the first differences are stationary.<sup>1</sup> Hence, for almost all behavioural equations error correction models (ECM) were chosen as the most appropriate modelling technique. An ECM combines the long-run, cointegrating relationship between the levels of the included variables and the short-run relationship between the first differences of the variables. An error correction model has the following form:

$$\Delta y_t = \alpha \Delta y_{t-1} + \sum_{i=0}^p (\beta_1 \Delta x_{1,t-i} + \dots + \beta_r \Delta x_{r,t-i}) + \gamma [y_{t-1} - c - \delta_1 x_{1,t-1} - \dots - \delta_r x_{r,t-1}] + \varepsilon_t \quad (3)$$

In this specification,  $y$  is the endogenous variable  $x_r$  are the  $r$  explanatory variables, and  $\varepsilon$  denotes the error term in period  $t$ . The term in square brackets comprises the cointegrating relationship. As the specification shows, the short-run dynamic of the endogenous variable is driven by short-run movements of the exogenous variables and by past deviations from the long-run equilibrium.

Most equations have been specified in logarithmic differences, i.e. the endogenous variables are defined as growth rates. In addition to the explanatory variables derived from economic theory, many equations contain dummy variables. These account either for outliers in certain periods or for seasonal effects.

### 3.2. Description of Model Equations

In this section, the behavioural model equations are briefly described. A list of the model equations is provided in the appendix, together with a description of the model variables in TABLE 1.

For modelling *consumption of private households*, the Keynesian consumption theory and the permanent income hypothesis are combined. According to the Keynesian view, consumption of private households depends on current disposable income. The permanent income hypothesis stipulates that is the present value of expected future income rather than current disposable income which is relevant for consumption decisions. Taking both strands of consumption theory together, private household consumption depends both on current disposable income and on wealth. Wealth effects are approximated by the real long-term interest rate. The interest rate as a determinant of consumption accounts both for the fact that some households finance part of their consumption via bank credits, and for the intertemporal decision on the allocation of income to consumption in the present period and in the future. The higher the interest rate, the higher are the opportunity costs of spending income for current consumption. Gross fixed capital formation is undertaken to renew the capital stock, and to adjust it to changes in final demand. Hence, the accelerator theory stipulates that changes in demand determine fixed capital formation. Since it takes time to purchase and install new capital goods, it is expected rather than actual demand that has to be considered. However, in the case of adaptive expectations, as is assumed here, expectations are based on past observations. Therefore, in the investment equation actual demand is included as approximation for expected future demand. According to

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<sup>1</sup> In many cases, the results of the unit root tests are inconclusive. These problems are caused by the shortness of the time series and by the fact that some quarterly time series had to be derived from the respective annual values.

theories focussing on the profitability of investment projects, the value of the capital stock equals the discounted future income that can be generated by employing the capital stock. Therefore, the interest rate, which is used to discount future income, is crucial for the profitability of an investment project. The market interest rate is formed on the basis of the time preferences of the individual investors. According to this strand of theories, investment is only a function of the real interest rate. The relation between the present value of the discounted future revenues that can be generated by an additional unit of the capital stock and the price for this additional unit of capital is called marginal  $q$ . This theory was introduced by Keynes (1936) and further elaborated by Brainard and Tobin (1968) and by Tobin (1969, 1978). In empirical studies the problem arises that the marginal  $q$  is unobservable and has to be approximated by observable variables. A possible candidate that may be used to approximate the present value of future revenues of a selected number of firms is the stock index. However, this is only justified under the condition that the stock market correctly reflects economic fundamentals of the firms and is not biased by speculative bubbles or over-pessimistic expectations. The neoclassical theory of investment combines the investment determinants according to the accelerator hypothesis and profitability considerations (see, e.g., Jorgensen 1963). In this case, the investment function is derived from profit maximisation of companies, based on a neoclassical production function with the input factor capital and a positive but diminishing marginal product. The optimal capital stock equalises the marginal revenue product of capital and the user cost of capital. The latter consist of the depreciation rate, the real interest rate, and the growth rate of the prices for capital goods. If the price for capital goods rises, this diminishes the user cost of capital, since in this case it is more profitable to invest in the current period instead of postponing investment to the following period. Besides these variables, the user cost of capital is influenced by taxation. Tax allowances lower the user cost of capital whereas taxation of profits reduces the profitability of investment projects. In empirical estimations, however, the inclusion of these variables is often limited by data availability. In the model for Serbia, due to data availability as well as significance and sign of the estimated coefficients, the user cost of capital are approximated solely by the real long-term interest rate. In addition to the user cost of capital, investment is influenced by (the change in) total final demand. *Exports* of Serbian goods and services depend on international demand and on the relative price of Serbian exports on the world market. Worldwide demand is approximated by world trade, while the real effective exchange rate accounts for price effects. *Imports of goods and services* depend on total demand in Serbia and on relative prices. Total demand is approximated by real GDP. As in the case of exports, relative prices are approximated by the real effective exchange rate of the Serbian dinar.

*Labour demand by companies* (i.e. actual employment) is influenced by the production level and by labour costs. In the model, production is approximated by real GDP, while labour costs consist of the average gross wage per employee. In the model, labour supply by private households is exogenous.

The *consumer price index* (CPI) is related to internal and external determinants. The most important internal cost-push factor is wages. In addition, rising capacity utilisation exerts upward pressure on prices. As an important external cost factor, the oil price in dinar enters the consumer price equation. The *GDP deflator* is simply linked to the development of the consumer price index. In an *extended Phillips curve equation*, the *wage rate* is negatively influenced by the difference between the actual unemployment rate and the non-accelerating inflation rate of unemployment, or the NAIRU. In addition, wages are positively influenced by consumer prices and by labour productivity.

On the financial market, interest rates and exchange rates are determined. Since the National Bank of Serbia (NBS) runs an independent monetary policy, the *NBS interest rate for open market operations* has been included in the model as the relevant monetary policy instrument. In

model simulations and forecasts, this short-term interest rate which is determined by the National Bank of Serbia might either be exogenous or endogenous. In the first case, the forecaster has to determine the expected future path of monetary policy and hence of the NBS interest rate. In this case, the model equation determining the NBS interest rate has to be switched off in forecasts. For the case of a model-based monetary policy path, the model contains a Taylor rule (Taylor 1993) type equation determining the short-term interest rate, i.e. the NBS interest rate. In this equation, the NBS interest rate for open market operations depends positively on the inflation rate and on the output gap in Serbia. This approach implies that the National Bank of Serbia follows both inflation and an output target. In this case, monetary policy becomes more restrictive, i.e. the interest rate is raised if inflation rises and/or actual output exceeds potential output. In the latter case, i.e. if resources are fully or even over-employed, inflationary pressure arises since employees' associations have more power to claim higher wage increases, and as machines run at full capacity, costs for maintenance and repairs rise. In a term structure equation, the *long-term interest rate* depends on the short-term interest rate. The *nominal effective exchange rate* of the Serbian dinar is determined by important bilateral exchange rates. Since the countries of the euro area are Serbia's most important trading partners, the nominal effective exchange rate of the Serbian dinar is mainly determined by the exchange rate vis-à-vis the euro. When including both the euro and the US dollar, the latter has to wrong sign. Hence, only the euro is considered as determinant of the nominal effective exchange rate of the dinar in the Serbia model. The *real effective exchange rate* is influenced by the nominal effective exchange rate and by price developments. In the model, the latter are approximated by the inflation rate in Serbia. In theory, it is the inflation differential rather than exclusively inflation in Serbia that matters. However, it would have been difficult to construct an international inflation rate consistent with the regional pattern of Serbia's external trade as reflected in the effective exchange rate. Therefore, in the real effective exchange rate equation only inflation in Serbia has been included in addition to the nominal effective exchange rate.

In the *supply block*, potential GDP is determined. The calculation of potential output is based on a Cobb-Douglas production function with constant returns to scale and with the production factors labour, capital and autonomous technical progress. Since potential GDP is a measure of the long-run production possibilities of an economy, it is the long-run trends rather than the actual realisations of the production factors that enter the production function. An exception is the capital stock where it is assumed that it is normally fully utilised. Autonomous technical progress is defined as total factor productivity (TFP). Under these assumptions, trend employment, the capital stock and trend total factor productivity determine potential output. The production function has the following form:

$$\log(\text{YPOT}) = 0.7 \log(\text{TRENDEMP}) + 0.3 \log(\text{CAPR}) + \text{TRENDTFP} \quad (4)$$

In this equation, YPOT is potential GDP, TRENDEMP is the labour force adjusted for structural unemployment, CAPR is the real capital stock, and TRENDTFP is the long-run trend of total factor productivity (TFP). Since for the time being no income data of the national account exist for Serbia, the production elasticities of the production factors employment (0.7) and capital (0.3) were based on international empirical evidence.

Before calculating potential GDP according to the above equation, trend employment and trend total factor productivity have to be determined. Trend employment is calculated by subtracting natural or structural unemployment from the labour force. Since structural unemployment is non-observable, this variable has to be approximated. In the model for Serbia, this is done by applying a Hodrick-Prescott (HP) filter to the actual unemployment rate in order to extract the trend. Structural unemployment is then defined as the long-run trend in actual unemployment. In order to endogenise the NAIRU, it is modelled as a moving average (MA) process.



In a growth accounting exercise, total factor productivity (TFP) is calculated as that part of (the change in) real GDP that is not due to (increased) labour and capital input, where both production factors are weighted with their production elasticities, i.e. 0.3 for the capital stock and 0.7 for labour, respectively. For the production possibilities, the long-run trend rather than the current level of total factor productivity is relevant. Therefore, the actual TFP series is smoothed by applying the Hodrick-Prescott filter so as to remove short-run fluctuations that are caused by the business cycle or by any short-run shocks.

In the *public sector* block, the model contains behavioural equations for the most important revenue and expenditure items of the consolidated general government, i.e. the Republic of Serbia (i.e. the central government), the Autonomous Province of Vojvodina, the municipalities and cities, and the Social Security Organisations (i.e. the Pension Fund, the Health Fund, and the National Employment Agency). In a fiscal rule, *public expenditures on goods and services* are inversely related to the past change in the debt level. This rule prevents public debt from ever increasing, since a rise in the debt level is in the next period counteracted by a spending restraint. In order to account for differences between national accounts and public finance data, the model includes a behavioural equation relating government consumption according to national accounts to government *consumption according to public finance statistics*. *Interest payments* on outstanding public debt are determined by the debt level and by the long-term interest rate. *Subsidies* to the corporate sector are positively related to the general economic situation, which is approximated by GDP at current prices. *Social security benefits* are determined by the average gross wage. The *remaining government expenditures* are explained by the economic situation as measured by nominal GDP. *Income tax revenues* are linked to the number of employees, multiplied by the average income tax rate and the gross wage rate. In a similar vein, revenues from *corporate income taxes* are explained by GDP as a proxy for company profits, multiplied by the average corporate income tax rate. *Value added tax (VAT) revenues* are determined by private consumption expenditures, multiplied by the value added tax rate. *Social security contributions* by employees and employers are linked to the number of employees, multiplied by the average gross wage and the average social security contribution rate. As in the case of government expenditures, the *remaining government revenues* are positively related to the economic situation, which is measured by nominal GDP.

#### 4. Model evaluation

The ability of the model to replicate the endogenous variables is based on an ex post simulation for the period 2005 to 2009. The following two commonly applied statistical measures will be used to evaluate the model:

- a) The mean absolute percent error (MAPE) is the average absolute percent error. To arrive at the MAPE one must take the sum of the ratios between the forecast error and the actual realization of the respective variable times 100 (to get the percentage) and divide by the number of forecasting periods. The MAPE is defined by the following formula:

$$MAPE = \frac{1}{N} \sum_{t=1}^N \left| \frac{\hat{x}_t - x_t}{x_t} \right| \cdot 100 \quad (5)$$

- b) Theil's inequality coefficient U2. Theil's inequality coefficient U2 compares the forecast with a naïve no-change forecast. In the case of five-year averages this means that the average of the past five years is taken as the benchmark forecast for the outcome in the following five-year period. The U2 statistic will take the value 1 under the naïve forecasting method. Values less than 1 indicate greater forecasting accuracy

than the naïve forecasts, values above 1 indicate the opposite. Theil's U2 statistic is defined by the following formula:

$$\sqrt{\frac{\sum_{t=1}^{N-1} \left( \frac{\hat{x}_{t+1} - x_{t+1}}{x_t} \right)^2}{\sum_{t=1}^{N-1} \left( \frac{x_{t+1} - x_t}{x_t} \right)^2}} \quad (6)$$

In both equations,  $x$  and  $\hat{x}$  denote the actual and the forecast value, respectively, of the variable,  $t$  is the time period, and  $N$  denotes the number of periods. In the ex post simulation, the number of forecasting periods  $N$  was equal to 40 quarters, but for the calculation of the MAPE and of Theil's inequality coefficient, the quarterly time series had been aggregated to annual data, hence in this case  $N$  was equal to 5 years (2005 to 2009).

The results in TABLE 3 in the appendix show that in half of the cases Theil's inequality coefficient takes values below 1, implying that for these variables the macroeconomic model beats the naive no-change forecast. For the important variables real GDP growth and inflation, Theil's U2 is only slightly above unity, and for the labour market indicators employment, unemployment and the unemployment rate it is clearly below 1. Nominal values of the GDP expenditure components can be better traced by the model than the respective real variables. The model contains behavioural equations for the real GDP components (private and public consumption, gross fixed capital formation, exports and imports), as well as for prices (CPI and the GDP deflator). As can be seen from TABLE 3, the price levels can be replicated very well, and better than the real variables. Hence, when calculating the nominal values by multiplying the real values with the deflator, relatively high and low values of Theil's inequality coefficient are combined, reducing the inequality coefficients of the GDP expenditure components. Regarding the mean absolute percent error (MAPE), again prices, wages and the labour market indicators exhibit low values. On the other hand, the effective exchange rates and some fiscal variables cannot be tracked so well by the model.

For some important variables, the actual and forecast values are visualised in the figures in the appendix. Overall, the ability of the macroeconomic model for Serbia to replicate the endogenous variables can be regarded as satisfactory, in particular taking the shortness of the available time series into account. The results of the forecast evaluation give reason for optimism regarding the reliability of the model when it is used for forecasting and simulations.

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## Appendix

In the following, t-statistics are provided in parentheses below the estimated coefficients. The adjusted R<sup>2</sup> is the coefficient of determination, adjusted for the degrees of freedom. LM denotes the Breusch-Godfrey test for serial correlation. Unlike the Durbin-Watson statistic for AR(1) errors, the LM test may be used to test for higher order ARMA errors and is applicable whether or not there are lagged dependent variables. The null hypothesis of the LM test is that there is no serial correlation up to lag order p. The local alternative is ARMA(r,q) errors, where the number of lag terms  $p = \max(r,q)$ . In all equations, p was determined as 2. \*, \*\*, \*\*\* means that the null hypothesis of no serial correlation has to be rejected at the 10, 5, 1 percent level of significance, respectively.

## Model equations

### Behavioural equations

#### Consumption of private households

$$\begin{aligned} \log(\text{CONSR}/\text{CONSR}_{-4}) = & -1.111 + 0.326*\log(\text{CONSR}/\text{CONSR}_{-4}) + 0.721*\log(\text{YDR}/\text{YDR}_{-4}) \\ & (1.117) \quad (2.450) \quad (3.647) \\ & - 0.535*\log(\text{CONSR}_{-4}) + 0.4185*\log(\text{YDR}_{-4}) - 0.006*(\text{ILEND}-\text{INFL}) + 0.094*\text{DUM061}_{-1} \\ & (3.775) \quad (2.606) \quad (2.666) \quad (2.468) \\ R^2 = 0.712 \quad & \text{LM}(2) = 1.558 \end{aligned}$$

#### Gross fixed capital formation

$$\begin{aligned} \log(\text{GFCFR}/\text{GFCFR}_{-4}) = & -1.124 + 0.524*\log(\text{GFCFR}_{-1}/\text{GFCFR}_{-5}) + 0.734*\log(\text{GDPR}/\text{GDPR}_{-4}) \\ & (0.671) \quad (6.415) \quad (4.099) \\ & - 0.241*(\log(\text{GFCFR}_{-4}) + 0.305*\log(\text{DEMANDR}_{-4}) - 0.003 \text{ ILEND} \\ & (3.530) \quad (1.678) \quad (3.864) \\ R^2 = 0.751 \quad & \text{LM}(2) = 5.623^* \end{aligned}$$

#### Exports of goods and services

$$\begin{aligned} \log(\text{EXR}/\text{EXR}_{-4}) = & -0.452 + 0.751*\log(\text{WTRADE}_{-1}/\text{WTRADE}_{-5}) \\ & (0.402) \quad (3.067) \\ & - 0.107*\log(\text{REER}/\text{REER}_{-4}) - 0.629*\log(\text{EXR}_{-4}) + 1.071*\log(\text{WTRADE}_{-4}) \\ & (2.557) \quad (7.666) \quad (7.350) \\ & - 0.161*\log(\text{REER}_{-4}) - 0.857*\text{DUM99} - 0.815*\text{DUM00} - 0.420*\text{DUM021} \\ & (3.704) \quad (12.659) \quad (10.432) \quad (3.652) \\ R^2 = 0.924 \quad & \text{LM}(2) = 13.197^{***} \end{aligned}$$

### Imports of goods and services

$$\begin{aligned} \log(\text{IMR}/\text{IMR}_{.4}) &= -6.889 + 0.348*\log(\text{IMR}_{.1}/\text{IMR}_{.5}) + 1.721*\log(\text{GDPR}/\text{GDPR}_{.4}) \\ &\quad (1.725) \quad (3.149) \quad (3.274) \\ &+ 0.244*\log(\text{REER}/\text{REER}_{.4}) - 0.975*(\log(\text{IMR}_{.4}) + 1.341*\log(\text{GDPR}_{.4})) \\ &\quad (2.839) \quad (5.098) \quad (3.467) \\ &+ 0.376*\log(\text{REER}_{.4}) \\ &\quad (2.707) \\ R^2 &= 0.667 \quad \text{LM}(2) = 2.447 \end{aligned}$$

### Employment

$$\begin{aligned} \log(\text{EMP}/\text{EMP}_{.4}) &= -0.010 + 0.498*\log(\text{EMP}_{.1}/\text{EMP}_{.5}) + 0.134*\log(\text{GDPR}/\text{GDPR}_{.4}) \\ &\quad (2.156) \quad (5.938) \quad (2.916) \\ &- 0.043*\log(\text{ULC}_{.1}/\text{ULC}_{.5}) - 0.081*\text{DUM02} \\ &\quad (2.672) \quad (6.258) \\ R^2 &= 0.737 \quad \text{LM}(2) = 2.517 \end{aligned}$$

### Gross wage

$$\begin{aligned} \log(\text{GWAGE}/\text{GWAGE}_{.4}) &= 3.805 + 0.562*\log(\text{CPI}/\text{CPI}_{.4}) + 0.889*\log(\text{PROD}/\text{PROD}_{.4}) \\ &\quad (5.297) \quad (5.661) \quad (4.614) \\ &- 0.021*(\text{UR}-\text{NAIRU}) - 0.676*(\log(\text{GWAGE}_{.4}) + 0.811*\log(\text{CPI}_{.4})) + 0.305*\log(\text{PROD}_{.4}) \\ &\quad (1.649) \quad (8.038) \quad (6.490) \quad (1.902) \\ R^2 &= 0.926 \quad \text{LM}(2) = 13.799^{***} \end{aligned}$$

### Consumer price index

$$\begin{aligned} \log(\text{CPI}/\text{CPI}_{.4}) &= 0.039 + 0.101*\log(\text{OILDIN}/\text{OILDIN}_{.4}) + 0.302*\log(\text{GWAGE}/\text{GWAGE}_{.4}) \\ &\quad (2.446) \quad (5.697) \quad (4.562) \\ &+ 0.598*\log(\text{UTIL}_{.2}/\text{UTIL}_{.6}) + 0.524*\text{DUM01} - 0.402*\text{DUM014} \\ &\quad (3.729) \quad (10.157) \quad (5.781) \\ R^2 &= 0.928 \quad \text{LM}(2) = 8.247^* \end{aligned}$$

### GDP deflator

$$\begin{aligned} \log(\text{PGDP}/\text{PGDP}_{.4}) &= -0.003 + 0.923*\log(\text{PGDP}_{.1}/\text{PGDP}_{.5}) + 0.085*\log(\text{CPI}/\text{CPI}_{.4}) \\ &\quad (0.631) \quad (19.590) \quad (2.116) \\ &+ 0.217*\text{DUM001} - 0.401*\text{DUM021} \\ &\quad (10.849) \quad (15.844) \\ R^2 &= 0.990 \quad \text{LM}(2) = 2.211 \end{aligned}$$

### Short-term interest rate (Taylor rule)

$$\begin{aligned} \text{NBSRATE} &= 0.501*\text{NBSRATE}_{.1} + 0.057*\text{INFL} + 0.050*\text{UTIL} + 6.777*\text{DUM061} \\ &\quad (5.166) \quad (2.367) \quad (4.489) \quad (2.673) \\ R^2 &= 0.832 \quad \text{LM}(2) = 9.524^{***} \end{aligned}$$

### Long-term interest rate (term structure of interest rates)

$$\begin{aligned} \text{ILEND-ILEND}_{.4} &= -0.149 + 0.603*(\text{ILEND}_{.1}-\text{ILEND}_{.5}) + 0.376*(\text{NBSRATE}-\text{NBSRATE}_{.4}) \\ &\quad (0.446) \quad (17.123) \quad (6.782) \\ &- 20.540*\text{DUM014} \\ &\quad (9.947) \\ R^2 &= 0.976 \quad \text{LM}(2) = 1.621 \end{aligned}$$

### Nominal effective exchange rate

$$\begin{aligned} \log(\text{NEER}/\text{NEER}_{.4}) &= -0.030 + 0.919*\log(\text{NEER}_{.1}/\text{NEER}_{.5}) \\ &\quad (1.137) \quad (14.822) \\ &- 1.006*\log(\text{DINEUR}/\text{DINEUR}_{.4}) + 0.927*\log(\text{DINEUR}_{.1}/\text{DINEUR}_{.5}) \\ &\quad (16.180) \quad (10.893) \\ R^2 &= 0.931 \quad \text{LM}(2) = 32.998^{***} \end{aligned}$$

### Real effective exchange rate

$$\begin{aligned} \log(\text{REER}/\text{REER}_{.4}) &= 0.010 + 0.844*\log(\text{REER}_{.1}/\text{REER}_{.5}) + 0.654*\log(\text{NEER}/\text{NEER}_{.4}) \\ &\quad (0.203) \quad (15.554) \quad (10.304) \\ &- 0.490*\log(\text{NEER}_{.1}/\text{NEER}_{.5}) + 0.369*\log(\text{CPI}/\text{CPI}_{.4}) + 0.802*\text{DUM014} \\ &\quad (6.553) \quad (3.184) \quad (5.240) \\ R^2 &= 0.948 \quad \text{LM}(2) = 7.787^{**} \end{aligned}$$

### Trend TFP extrapolation

$$\begin{aligned} \log(\text{TRENDTFP}/\text{TRENDTFP}_{.4}) &= 0.031 + 3.614*\text{AR}(1) - 5.436*\text{AR}(2) + 4.778*\text{AR}(3) \\ &\quad (29.741) \quad (31.929) \quad (12.855) \quad (6.591) \\ &- 3.610*\text{AR}(4) + 3.591*\text{AR}(5) - 3.587*\text{AR}(6) + 2.258*\text{AR}(7) - 0.611*\text{AR}(8) \\ &\quad (4.242) \quad (4.271) \quad (5.204) \quad (5.906) \quad (6.229) \\ R^2 &= 0.999 \quad \text{LM}(2) = 5.814^* \end{aligned}$$

### NAIRU extrapolation

$$\begin{aligned} \log(\text{NAIRU}/\text{NAIRU}_{.4}) &= 0.001 + 3.581*\text{AR}(1) - 4.901*\text{AR}(2) + 2.913*\text{AR}(3) \\ &\quad (0.067) \quad (27.019) \quad (11.520) \quad (6.404) \\ &- 1.334*\text{AR}(5) + 1.026*\text{AR}(6) - 0.285*\text{AR}(7) \\ &\quad (2.860) \quad (2.238) \quad (1.861) \\ R^2 &= 0.999 \quad \text{LM}(2) = 2.435 \end{aligned}$$

### Value added tax (VAT) revenues

$$\begin{aligned} \log(\text{VAT}/\text{VAT}_{.4}) &= -1.698 \\ &\quad (2.634) \\ &+ 1.107*\log((\text{CONS}*\text{VATR}/100)/(\text{CONS}_{.4}*\text{VATR}_{.4}/100)) \\ &\quad (7.360) \\ &- 0.861*(\log(\text{CONS}_{.4}*\text{VATR}_{.4}/100)) + 0.221*\text{DUM05} \\ &\quad (6.007) \quad (8.714) \\ R^2 &= 0.945 \quad \text{LM}(2) = 4.382 \end{aligned}$$

### Social security contributions

$$\begin{aligned} \log(\text{SOCCONTR}/\text{SOCCONTR}_{.4}) &= -3.503 + 0.597*\log(\text{SOCCONTR}_{.1}/\text{SOCCONTR}_{.5}) \\ &\quad (3.154) \quad (7.0400) \\ &+ 0.600 \log(\text{SOCCONTR}_{.1}/\text{SOCCONTR}_{.5}) \\ &\quad (1.734) \\ &+ 0.165*\log((\text{EMP}*GWAGE*\text{SOCCONTRATE}/100)/(\text{EMP}_{.4}*GWAGE_{.4}*\text{SOCCONTRATE}_{.4}/100)) \\ &\quad (1.734) \\ &- 0.633*(\log(\text{SOCCONTR}_{.4}) + 0.453*(\log(\text{EMP}_{.4}*GWAGE_{.4}*\text{SOCCONTRATE}_{.1}/100))) \\ &\quad (5.261) \quad (4.639) \\ &- 0.247*\text{DUM051} - 0.088*\text{DUM062} - 0.106*\text{DUM071} \\ &\quad (6.520) \quad (2.435) \quad (2.928) \\ R^2 &= 0.905 \quad \text{LM}(2) = 5.497^* \end{aligned}$$

### Personal income tax revenues

$$\begin{aligned} \log(\text{TAXINC}/\text{TAXINC}_{.4}) &= -6.147 + 0.153*\text{DUM07} \\ &\quad (4.835) \quad (5.312) \\ &+ 0.951*\log((\text{EMP}*GWAGE*\text{PINCTRATE}/100)/(\text{EMP}_{.4}*GWAGE_{.4}*\text{PINCTRATE}_{.4}/100)) \\ &\quad (2.674) \\ &- 0.520*(\log(\text{TAXINC}_{.4}) + 0.503*(\log(\text{EMP}_{.4}*GWAGE_{.4}*\text{PINCTRATE}_{.4}/100))) \\ &\quad (4.268) \quad (3.561) \\ R^2 &= 0.737 \quad \text{LM}(2) = 2.713 \end{aligned}$$

### Corporate income tax revenues

$$\begin{aligned} \log(\text{TAXCORP}/\text{TAXCORP}_{.4}) &= -0.034 + 0.524*\log(\text{TAXCORP}_{.2}/\text{TAXCORP}_{.6}) \\ &\quad (0.375) \quad (3.875) \\ &- 0.575*\text{DUM0912} + 1.321*\log((\text{GDP}_{.2}*\text{CORPTRATE}_{.2})/(\text{GDP}_{.6}*\text{CORPTRATE}_{.6})) \\ &\quad (5.334) \quad (2.038) \\ R^2 &= 0.765 \quad \text{LM}(2) = 2.621 \end{aligned}$$

### Remaining government revenues

$$\begin{aligned} \log(\text{REVREST}/\text{REVREST}_{.4}) &= -0.014 + 1.172*\log(\text{GDP}/\text{GDP}_{.4}) + 0.430*\text{DUM04} \\ &\quad (0.342) \quad (4.568) \quad (5.245) \\ &+ 0.345*\text{DUM061} \\ &\quad (4.232) \\ R^2 &= 0.744 \quad \text{LM}(2) = 6.357^{**} \end{aligned}$$

### Government consumption

$$\begin{aligned} \log(\text{G}/\text{G}_{.4}) &= 0.058 + 0.196*\log(\text{G}_{.1}/\text{G}_{.5}) - 0.468*\log(\text{DEBT}_{.1}/\text{DEBT}_{.5}) + 0.604*\text{DUM03} \\ &\quad (1.766) \quad (2.037) \quad (1.927) \quad (6.324) \\ R^2 &= 0.715 \quad \text{LM}(2) = 21.432^{***} \end{aligned}$$

### Government consumption (public finance statistics)

$$\begin{aligned} \log(\text{GOVCONS}/\text{GOVCONS}_{.4}) &= -0.092 + 0.132*\log(\text{GOVCONS}_{.1}/\text{GOVCONS}_{.5}) \\ &\quad (2.292) \quad (2.278) \\ &+ 0.961*\log(\text{G}/\text{G}_{.4}) - 0.451*\log(\text{GOVCONS}_{.4}/\text{G}_{.4}) \\ &\quad (4.320) \quad (4.203) \\ R^2 &= 0.720 \quad \text{LM}(2) = 6.184^{**} \end{aligned}$$

### Social benefits

$$\begin{aligned} \log(\text{SOCBENEFIT}/\text{SOCBENEFIT}_{.4}) &= 0.038 + 0.517*\log(\text{SOCBENEFIT}/\text{SOCBENEFIT}_{.4}) \\ &\quad (1.313) (2.916) \\ &+ 0.282*\log(\text{GWAGE}/\text{GWAGE}_{.4}) \\ &\quad (2.195) \\ R^2 &= 0.508 \quad LM(2) = 0.974 \end{aligned}$$

### Subsidies

$$\begin{aligned} \log(\text{SUBSIDIES}/\text{SUBSIDIES}_{.4}) &= -6.692 + 3.844*\log(\text{GDP}/\text{GDP}_{.4}) - 0.590*\log(\text{SUBSIDIES}_{.4}) \\ &\quad (2.660) (4.153) \quad (3.926) \\ &+ 0.909*\log(\text{GDP}_{.4}) - 0.454*\text{DUM071} - 0.441*\text{DUM072} - 0.512*\text{DUM083} \\ &\quad (3.937) \quad (2.477) \quad (2.400) \quad (2.653) \\ R^2 &= 0.627 \quad LM(2) = 4.043 \end{aligned}$$

### Interest payments on outstanding public debt

$$\begin{aligned} \log(\text{INTEREST}/\text{INTEREST}_{.4}) &= -4.558 + 0.756*\log(\text{INTEREST}_{.1}/\text{INTEREST}_{.5}) \\ &\quad (2.282) (4.399) \\ &+ 0.836*\log(\text{DEBT}* \text{ILEND}/\text{DEBT}_{.4}* \text{ILEND}_{.4}) + 0.979*\text{DUM081} \\ &\quad (2.273) \quad (2.793) \\ R^2 &= 0.603 \quad LM(2) = 0.494 \end{aligned}$$

### Remaining government expenditures

$$\begin{aligned} \log(\text{EXPREST}/\text{EXPREST}_{.4}) &= -0.765*(\log(\text{EXPREST}_{.4}) + 0.601*\log(\text{GDP}_{.4})) - 1.160*\text{DUM053} \\ &\quad (5.977) \quad (6.144) \quad (3.582) \\ R^2 &= 0.627 \quad LM(2) = 2.071 \end{aligned}$$

### Identities

oilain = oilusd \* dinusd  
gwager = gwage / cpi \* 100  
infl = (cpi / cpi<sub>.4</sub> - 1) \* 100  
ucc = ilend - ((pgdp / pgdp<sub>.4</sub> - 1) \* 100) + deprate  
prod = gdpr / emp  
ulc = gwage / prod  
un = lforce - emp  
ur = un / lforce \* 100  
gdpr = consr + gr + gfcfr + inventr + exr - imr  
grgdpr = (gdpr / gdpr<sub>.4</sub> - 1) \* 100  
gdp = gdpr \* pgdp / 100  
yd = gdp - taxinc - vat - soccontr + socbenefit  
ydr = yd / cpi \* 100  
cons = consr \* pgdp / 100  
gr = g / pgdp \* 100  
demandr = consr + gr + gfcfr + inventr + exr  
balance = taxinc + taxcorp + vat + soccontr + revrest - socbenefit - subsidies - govcons  
- interest - exprest  
balanceratio = (balance + balance<sub>.1</sub> + balance<sub>.2</sub> + balance<sub>.3</sub>) / (gdp + gdp<sub>.1</sub> + gdp<sub>.2</sub> + gdp<sub>.3</sub>) \* 100  
debt = debt(-1) - balance + deltadebt  
debratio = debt / (gdp + gdp<sub>.1</sub> + gdp<sub>.2</sub> + gdp<sub>.3</sub>) \* 100  
capr = capr(-1) \* (1 - deprate / 100) + gfcfr  
trendcapr = trendcapr(-1) \* (1 + @pc(capr) / 100)

$\text{trendemp} = \text{lforce} * (1 - \text{nairu} / 100)$   
 $\log(\text{ypot}) = 0.7 * \log(\text{trendemp}) + 0.3 * \log(\text{trendcapr}) + \log(\text{trendtfp})$   
 $\text{util} = \text{gdpr} / \text{ypot} * 100$

**TABLE 1**  
**List of Variables**

<b>Endogenous variables</b>	
BALANCE	General budget balance
ALANCERATIO	Budget balance as percentage of GDP
CAPR	Real capital Stock [mill. RSD]
CONS	Cons. of households and NPISHs, nom.
CONSR	Cons. of households and NPISHs, real
CPI	Consumer price index
DEBT	Public debt [mill. Din.] (end of period)
DEBRATIO	Public debt as percentage of GDP
DEMANDR	Total real demand
EMP	Persons in employment
EXPREST	Remaining, unspecified government expenditures
EXR	Exports of goods and services, real
G	Public consumption, nom.
GDP	GDP, nominal [mill. RSD]
GDPR	GDP, const. 2002 prices [mill. RSD]
GFCFR	Gross fixed capital formation, real
GOVCONS	Public consumption (fiscal statistics)
GR	Public consumption, real
GRGDPR	Real GDP growth rate
GWAGE	Average gross wage [dinar]
GWAGER	Gross real wage rate
IEND	Total lending interest rate
IMR	Imports of goods and services, real
INFL	Inflation rate
INTEREST	Interest payment
NAIRU	Non-accelerating inflation rate of unemployment
NBSRATE	NBS interest rate -Open market operations
NEER	Nominal effective ex. rate
OILDIN	Oil price in dinar
PGDP	GDP deflator
PROD	Labour productivity
REER	Real effective ex. rate
REVEST	Remaining, unspecified government revenues
SOCBENEFIT	Social insurance benefits



SOCCONTR	Social contributions
SUBSIDIES	Subsidies
TAXCORP	Corporate income tax
TAXINC	Personal income tax
TRENDCAPR	Trend of capital stock
TRENDEMP	Trend of employment
TRENDTFP	Trend of total factor productivity
UCC	User cost of capital
ULC	Unit labour costs
UN	Unemployed persons
UR	Unemployment rate
UTIL	Capacity utilisation rate
VAT	Value added tax revenues
YD	Personal disposable income
YDR	Real personal disposable income
YPOT	Potential output

**Exogenous variables**

CORPTRATE	Corporate income tax rate
DELTADEBT	Diff. between change in debt level and budget balance
DEPRATE	Quarterly depreciation rate of capital stock (7 % p.a.)
DINEUR	Exchange Rate Dinar / Euro
DINUSD	Exchange Rate Dinar / US Dollar
DUM00	Dummy variable, 1 in 2000
DUM001	Dummy variable, 1 in 2000q1
DUM01	Dummy variable, 1 in 2001
DUM014	Dummy variable, 1 in 2001q4
DUM02	Dummy variable, 1 in 2002
DUM021	Dummy variable, 1 in the 1st quarter of 2002
DUM03	Dummy variable, 1 in 2003
DUM041	Dummy variable, 1 in 2004q1
DUM05	Dummy variable, 1 in 2005
DUM051	Dummy variable, 1 in 2005q1
DUM054	Dummy variable, 1 in 2005q4
DUM061	Dummy variable, 1 in 2006q1
DUM062	Dummy variable, 1 in 2006q2
DUM07	Dummy variable, 1 in 2007
DUM071	Dummy variable, 1 in 2007q1
DUM072	Dummy variable, 1 in 2007q2
DUM081	Dummy variable, 1 in 2008q1
DUM083	Dummy variable, 1 in 2008q3
DUM0912	Dummy variable, 1 in 2009q1 and 2009q2

DUM99	Dummy variable, 1 in 1999
INVENTR	Changes in inventories, real
LFORCE	Labour force
OILUSD	Oil price [USD] per barrel Brent
PINCTRATE	Personal income tax rate
SOCCONTRATE	Social security contribution rate
VATRATE	Value added tax rate
WTRADE	World trade in goods and services; OECD Main Economic Indicators

**TABLE 2**  
**Results of Unit Root Tests**

<i>Variable</i>	<i>Level</i>			<i>First difference</i>			<i>Order of integration</i>
	<b>ADF</b>	<b>PP</b>	<b>KPSS</b>	<b>ADF</b>	<b>PP</b>	<b>KPSS</b>	
BALANCE	-4.833***	-7.951***	0.500***	-4.556***	-24.843***	0.074	1
BALANCERATIO	-3.284*	-3.308*	0.066	-4.505***	-5.713***	0.125	1
CAPR	-1.164	0.211	0.241***	-2.521	-3.112	0.117	-
CONS	-2.846	-3.643**	0.129*	11.978***	-11.618***	0.250	1
CONSR	-3.048	25.145***	0.114	-3.009**	-25.651***	0.290	1
CPI	-2.212	-1.760	0.126*	-4.651***	-4.686***	0.056	1
DEBT	-4.734**	-1.748	0.061	-4.030***	-3.986***	0.096	1
DEBRATIO	-11.055***	-7.694***	0.185**	-5.105***	-5.712***	0.597**	0
DEMANDR	-2.577	-4.219**	0.125**	-1.784	-16.193***	0.500**	1
EMP	-2.357	-2.147	0.166**	-6.266***	-6.266***	0.119*	1
EXPREST	-6.452***	6.861***	0.337***	-7.861***	-18.931***	0.500***	-
EXR	-3.860**	-3.755**	0.103	-6.627***	-21.597***	0.198**	1
G	-3.071	-4.941***	0.214**	-4.748***	-17.834***	0.372*	1
GDP	-2.866	-3.064***	0.210**	-2.526	-9.085***	0.363*	1
GDPR	-4.156**	-4.900***	0.208**	-2.077*	-15.344***	0.146	1
GFCFR	-2.596	-2.432	0.185**	-2.261	-9.747***	0.271	1
GOVCONS	-1.645	-5.617***	0.500***	-8.596***	-24.507***	0.144*	1
GR	-3.431*	-5.219***	0.186**	-5.021***	-22.407***	0.140*	1
GRGDPR	-1.749*	-3.913***	0.217	-5.791***	-9.043***	0.065	1
GWAGE	-2.340	-2.635	0.204**	-1.556	-10.316***	0.280	1
GWAGER	-1.800	-2.857	0.119**	-1.565	-12.241***	0.255	1
IEND	-1.779	-1.758	0.741***	-4.263***	-4.292***	0.145	1
IMR	-3.818**	-3.818**	0.098	-6.285***	-13.220***	0.207	1

<i>Variable</i>	<i>Level</i>			<i>First difference</i>			<i>Order of integration</i>
	<i>ADF</i>	<i>PP</i>	<i>KPSS</i>	<i>ADF</i>	<i>PP</i>	<i>KPSS</i>	
INFL	-2.301	-1.682	0.452*	-3.690***	-3.700***	0.057	1
INTEREST	-3.272*	-3.290*	0.117	-7.472***	-14.257***	0.209	1
NAIRU	-2.913*	-2.840*	0.726**	-0.684	-0.018	0.709**	> 1
NBSRATE	-2.179	-4.786***	0.438*	-6.517***	-6.517***	0.274	1
NEER	-3.002**	-7.295***	0.722**	-1.559	-7.454***	0.474**	1
OILDIN	-4.102**	-3.068	0.069	-5.282***	-5.045***	0.046	1
PGDP	-3.376*	-4.316***	0.082	-2.374	-11.572***	0.121**	1
PROD	-3.130	-6.382***	0.222***	-2.496	-19.048***	0.217***	1
REER	-4.422***	-2.111	0.088	-1.919	-3.959**	0.093	1
REVREST	-1.557	-4.967***	0.188**	-9.675***	-15.365***	0.166**	1
SOCBENEFIT	-1.967	-4.730***	0.106	-2.200	-18.828***	0.154*	1
SOCCONTR	-2.024	-4.244**	0.132*	-1.811	-13.898***	0.139*	1
SUBSIDIES	-6.482***	-6.511***	0.142*	-7.440***	-26.697***	0.182**	1
TAXCORP	-2.099	-5.124***	0.106	-2.005	-11.505***	0.138**	1
TAXINC	-2.169	-4.691***	0.153**	-5.532***	-23.982***	0.168**	1
TRENDCAPR	-	-0.134	0.250***	-5.522***	-1.634	0.127*	1
TRENDEMP	-2.191	-1.998	0.142**	-6.722***	-6.716***	0.104	> 1
TRENDTFP	-3.877**	-1.958	0.129*	-3.775**	-0.711	0.240***	> 1
UCC	-3.169***	-3.066***	0.139	-7.538***	-7.890***	0.228	0
ULC	-2.358	-0.550	0.822***	-0.424**	-6.508***	0.155	1
UN	-2.198	-1.384	0.555**	-2.146	-5.983***	0.426*	1
UR	-1.844	-1.833	0.740***	-5.861***	-5.822***	0.338	1
UTIL	-3.244**	-9.255***	0.500**	-2.936***	-20.387***	0.258	0
VAT	-3.196	-3.246*	0.154*	-7.541***	-7.517***	0.049	1
YD	-1.877	-4.300**	0.120*	-1.707	-18.439***	0.500**	1
YDR	-4.206**	-4.134**	0.088	-7.005***	-14.199***	0.434**	1
YPOT	-2.628	-2.523	0.171**	-5.463***	-5.462***	0.367*	1
DELTADEBT	-4.699***	-4.696***	0.176	-6.123***	-24.596***	0.500**	0
DINEUR	-1.400	-1.382	0.859***	-7.102***	-7.117***	0.116	1
DINUSD	-1.936	-1.938	0.588**	-6.770***	-6.766***	0.165	1
INVENTR	-5.310***	-5.363***	0.171	-7.902***	-20.062***	0.352*	0
LFORCE	-1.406	-1.434	0.119*	-6.340***	-6.324***	0.051	1
OILUSD	-4.237***	-2.693	0.126*	-6.198***	-6.496***	0.056	1
WTRADE	-3.384*	-1.605	0.088	-4.698***	-3.307**	0.112	1

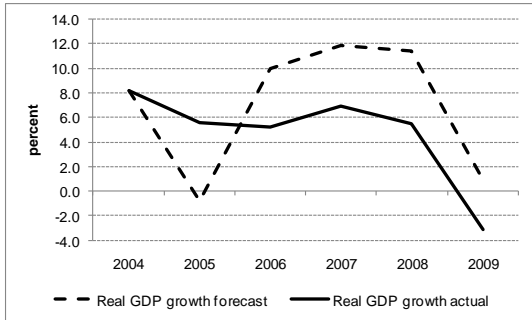
Notes: ADF: Augmented Dickey-Fuller test; PP: Phillips-Perron test; KPSS: Kwiatkowski, Phillips, Schmidt, and Shin test. \*, \*\*, \*\*\* means that the null hypothesis (ADF and Phillips-Perron: no stationarity of the series; KPSS: stationarity of the series) can be rejected at the 10, 5, 1 percent level of significance, respectively. In the final column, the order of integration is indicated; the variables are classified as I(0) or I(1), respectively if this is indicated by at least two of the unit root tests.

**TABLE 3**  
**Forecast Evaluation**

	<b>MAPE</b>	<b>Theil's U2</b>		<b>MAPE</b>	<b>Theil's U2</b>
BALANCE	167.452	1.352	INFL	47.396	1.483
BALANCERATIO	168.261	1.389	INTEREST	61.802	1.895
CAPR	1.506	0.303	NBSRATE	24.219	0.506
CONS	12.316	1.087	NEER	36.670	0.807
CONSR	11.946	2.362	PGDP	2.261	0.302
CPI	7.555	0.906	PROD	5.429	1.142
DEBT	16.864	1.736	REER	54.016	2.156
DEBTRATIO	21.487	1.729	REVREST	12.197	0.752
DEMANDR	7.081	1.143	SOCBENEFIT	6.752	0.492
EMP	1.693	0.791	SOCCONTR	8.749	0.799
EXPREST	14.825	0.768	SUBSIDIES	32.271	1.570
EXR	20.743	2.036	TAXCORP	18.332	0.594
G	20.000	1.416	TAXINC	16.693	1.154
GDP	8.801	0.709	UCC	94.344	0.632
GDPR	6.463	1.423	ULC	8.992	0.787
GFCFR	8.583	0.882	UN	4.002	0.656
GOVCONS	24.990	0.979	UR	3.956	0.918
GR	20.517	3.031	UTIL	6.140	2.405
GRGDPR	102.775	1.142	VAT	14.617	0.807
GWAGE	12.945	0.823	YD	14.376	1.156
GWAGER	9.149	0.964	YDR	18.902	3.135
IEND	14.906	0.963	YPOT	0.362	0.120
IMR	17.050	1.638			

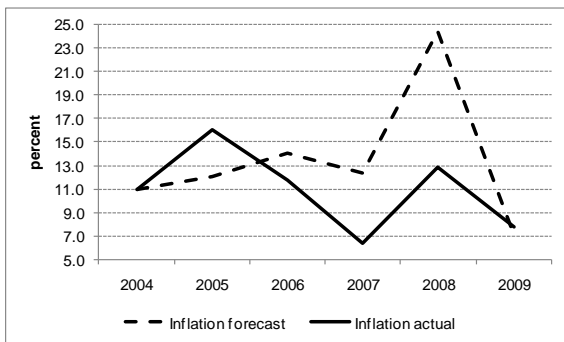
Notes: MAPE: Mean absolute percent error. Theil's U: Theil inequality coefficient. Values above 1 indicate that the model forecast is worse than the naive forecast.

**FIGURE 1**  
Real GDP growth rate



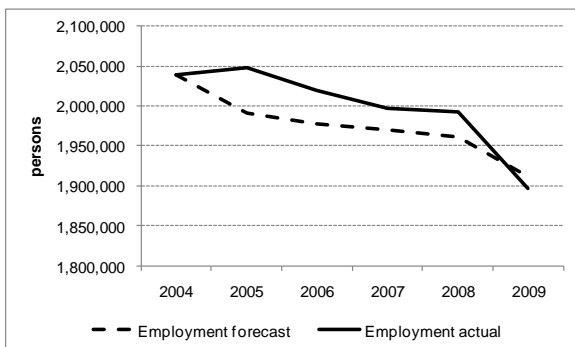
Source: Authors' illustration

**FIGURE 2**  
Inflation rate



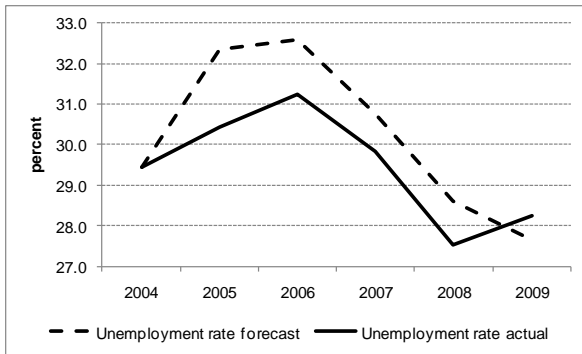
Source: Authors' illustration

**FIGURE 3**  
Employment



Source: Authors' illustration

**FIGURE 4**  
**Unemployment rate**



*Source:* Authors' illustration