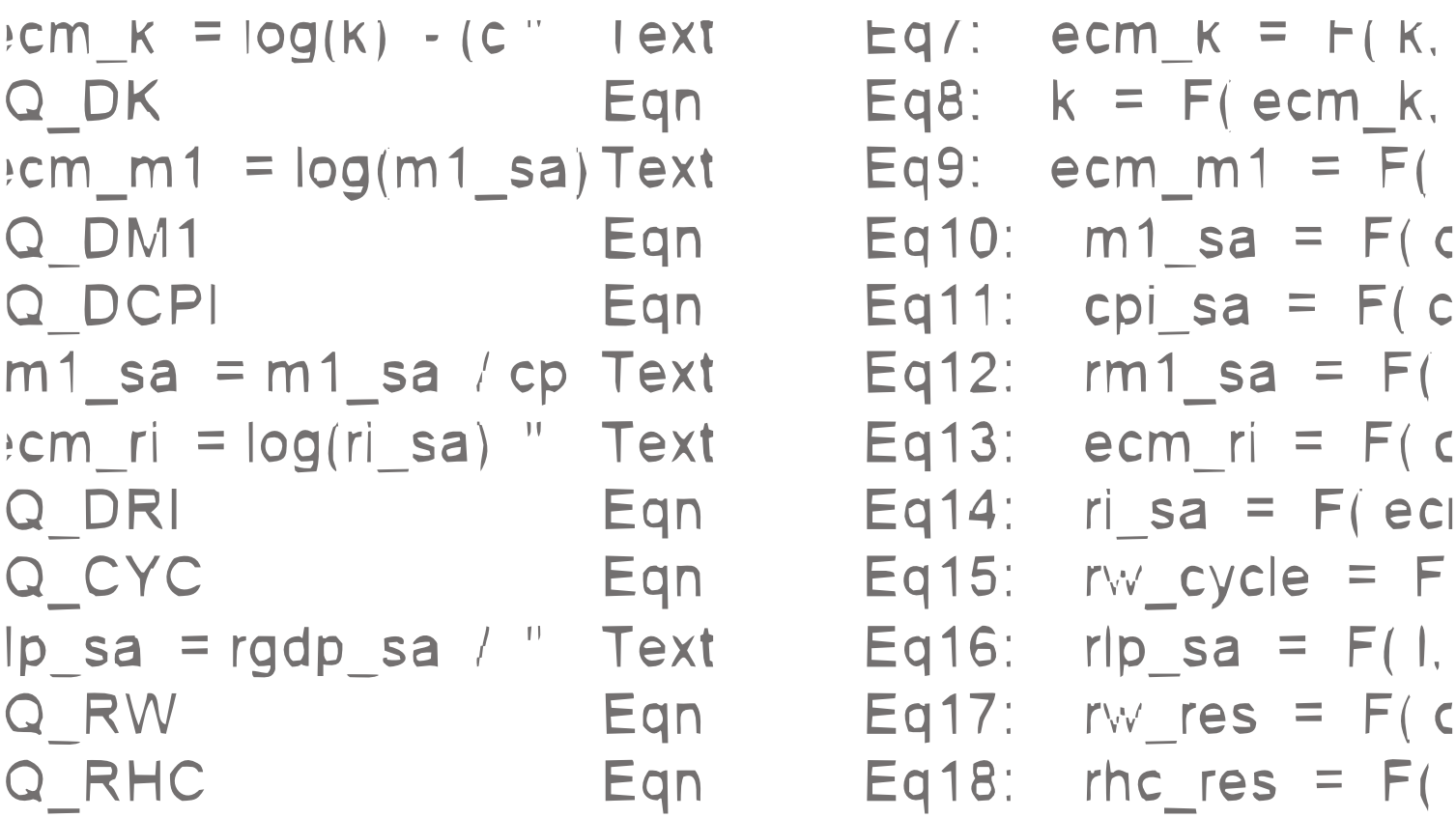
MAJOR MACROECONOMIC RELATIONSHIPS IN BELARUSIAN ECONOMY:

the results of econometric modelling



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MAJOR MACROECONOMIC RELATIONSHIPS IN BELARUSIAN ECONOMY: the results of econometric modelling

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The publication analyses major macroeconomic relationships on the basis of original macroeconometric model built by the authors. The model is based on the traditional theoretical assumptions and takes into account specific features of the Belarusian economy. It includes the four sectors of the economy: real, state, monetary and external ones, and describes behaviour of the respective economic actors. Correct specification of the model equations has been ensured by the study of dynamic properties of the data. Long-run relationships have been studied on the basis of cointegration analysis (two-step Engle-Granger cointegration test), while analysis of the short-run relationships has been made on the basis of error-correction models (in case of cointegration between variables). The model has allowed to make retrospective estimates of some hypothetical shocks of variables characteristic of the sectors dealt with in the model.

Contents

1. THEORETICAL FOUNDATIONS OF ECONOMIC MODELLING

1.1. Economic agents in macroeconomic models

One of the macroeconomic problems is proper aggregation and grouping of homogenous economic agents representing corresponding sectors of economy. Usually, the following classification is suggested:
- Households;
- Firms;
- State (government);
- External sector.

Each of the above-mentioned sectors performs certain economic functions defined inn turn by a 'patterned' behaviour of economic agents at a microlevel. These functions can be described as follows:

Households

In this sector, agents maximise utility function given budget constraints. Households perform the following functions:
- Consumption of goods and services;
- Demand for real money balances;
- Supply of factors of production and receipt of factor returns that allow to demand goods and services;
- Supply of credit and capital[1];
- Investment (in housing construction) and demand for credit and capital.

Firms

The major aim of this sector is profit maximisation given limited resources (factors of production). Chief functions are as follows:
- Supply of goods and services;
- Demand for factors of production supplied by households;
- Investment in fixed assets;
- Investment in inventories;
- Demand for real money balances;
- Demand for credit and capital for investment purposes.

[1] The notion of capital is interpreted as capital as a factor of production and long-term financial resources.

State

This agent is principally motivated by maximisation of public welfare and prevention of market failures. In order to achieve these aims, the following functions are performed:

- Redistribution of goods through state budget by using taxes and subsidies;
- Demand for or supply of credit and capital in order to perform redistribution function in an efficient way;
- Consumption of goods and services via state budget;
- Investment in fixed capital.

External sector

This sector consists of economic agents located outside national economy. In order to maximise profits or utility, these agents perform the following functions:

- Demand and/or supply at goods and services (exports and imports) market;
- Demand and/or supply at factor markets;
- Demand for and/or supply of credit and capital.

It is also possible to consider monetary authorities and commercial banks as separate sectors of economy. The chief aim of monetary authorities is to maintain internal and external stability of domestic currency, while the function is emission of national currency. In case a relatively simple model is considered (i.e. a four-sector one), this aim and function are transferred to state sector.

Banks

If banks are considered to be a separate sector, then their primary function is profit maximisation when providing financial intermediation. Banks are then treated as a part of national financial system. Financial flows channelled through or by banks are indirect ones, and through stock market – direct ones. Accordingly, functions of banks in economy are similar to functions of a financial system and financial markets in general:

- Demand and supply at money market;
- Demand and supply at capital market (financial market);
- Estimation of investment opportunities of the real sector of economy, execution of corporate control, and ensuring of efficient resource distribution.

These agents interact at four market markets: market for finished products (goods and services); factor markets; money market and capital market (long-term credit). This interaction is show at Figure 1.1.

Given the axiom of balanced incomes and expenditures in economic system, their circulation in national economy can be described in the form of the following identity (1.1) that describes incomes and expenditures of each of the four above-mentioned sectors:

$$C + I + G + X = C + S + T + M \,. \tag{1.1}$$

1.2. Theoretical approaches to macroeconomic dynamics and equilibrium

In a macroeconomic model, the reproduction of interaction among economic actors has to reflect the mechanics of functioning of economic system in the conditions of equilibrium/disequilibrium as well as the ways to reach that equilibrium. Also, structural macroeconomic models are used to address theoretical problems of microeconomic models, which do not explain mechanisms of general price increase (inflation) and the nature of economic cycle/fluctuations, and how economy functions in conditions of underemployment[2].

Next step in model-building is the mathematical description of behaviour of each group of the economic agents. For that purpose, interaction at each of the markets is introduced (Figure 1.1). The major indicator describing functioning of economy, that is, gross income, is defined by changes at market for goods and services (aggregate demand and aggregate supply). Aggregate demand is equal to expenditures of all economic agents at a given market. In other words, it is a sum of consumption of finished products, government consumption, NPISHs' consumption[3], investment demand, and net exports. Aggregate demand is defined by a production function of the real sector of economy and interaction among economic agents at factor markets. Behaviour of economic actors at other markets can impact their behaviour at market for finished products, or at functions of aggregate demand and supply. Therefore, the task of a theory is to choose proper functions of aggregate supply and aggregate supply and to describe equilibration mechanism at market for goods and services.

[2] Since microeconomic models do not consider the use of money, but functioning of the real sector of the economy. Accordingly, these models can not be used to explain inflation. Also, microeconomic equilibrium assumes full employment given the equilibrium at all markets and the absence of cycles in national economy.

[3] Non-profit (non-state) institutions serving households.

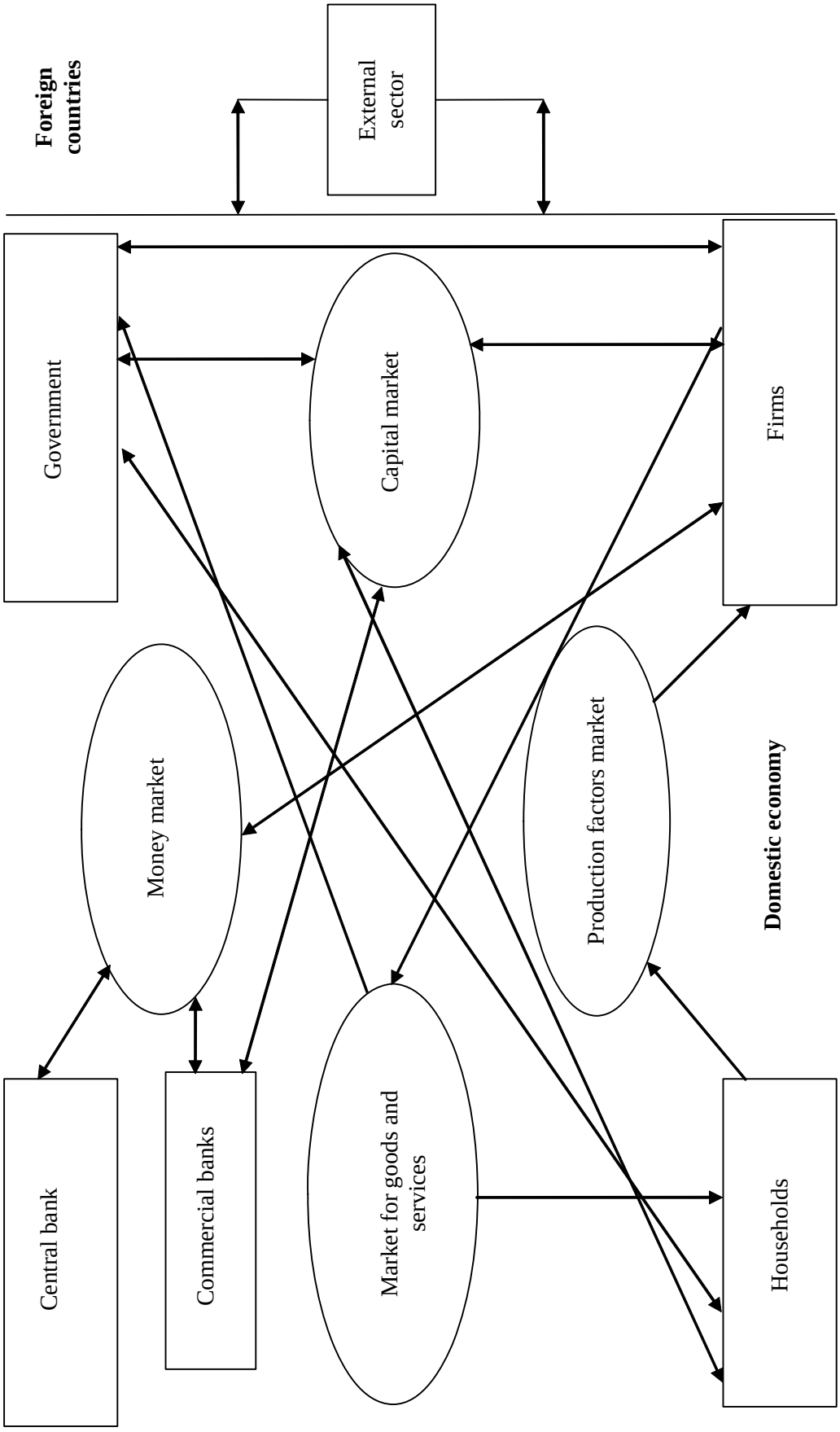


Figure 1.1. Interaction among Economic Agents in a 'Benchmark' Model

There are two schools – Neoclassical and Keynesian – that offer different approaches to equilibration, nature of inflation and economic cycles. These schools differ in their assumptions about degree of price flexibility and the speed of their adjustment to changes of market conditions and about the functioning of labour market. Neoclassical theory is based on the principle of classical dichotomy (relative independence of real and nominal sectors of economy), or 'money neutrality'. The latter suggests absolute price flexibility, and this informs equilibrium at a labour market having stable real wages and given full employment. Besides that, neoclassical theory treats interest rate as a return on factor. Its volume is established at a capital market. All these assumptions provide the background for a vertical curve of aggregate supply. This shape of the curve suggests that potential output is predetermined by the level of aggregate supply and its independence from the price level.

In contrast, traditional Keynesian theory is based on the assumptions of relative price rigidity and inflexibility of nominal wages. Consequently, there could be underemployment at an equilibrated labour market. As a result, aggregate supply curve can have a positive slope. Also, according to a Keynesian theory, interest rate is set up at a money market and determines the level of investment and savings in economy and thus the level of aggregate demand.

Each of these two theories contains different instruments to model economy. Neoclassical theory is more appropriate to describe long-term equilibrium and behaviour of economic agents over the long term. In this case, gross income is determined by aggregate supply (technologies available and stock of labour and capital). Keynesian theory is better suited to describe behaviour of and reaction to shocks of economic agents in the short term. These factors define fluctuations of aggregate demand and, hence, short-run fluctuations of real output.

The majority of contemporary macroeconomic models are grounded in neoclassical synthesis. This approach includes the description of long-run equilibrium in neoclassical terms (i.e. depends on the levels of capital, labour, and technology available). But the level of long-term output is unrelated to nominal variables (price dynamics). In the short run, fluctuations of aggregate demand are possible and its deviation from a long-term GDP trend as defined by aggregate supply. Apart from fluctuations of national income caused by economic shocks, there are changes in behaviour of economic agents at other markets. The dynamics of factor markets determine the level of capacity utilisation needed for output and returns to factors. Therefore, the interaction of economic agents at a given market can influ-

ence the volume of aggregate supply (in the short run) and the volume of aggregate demand.

The interaction of economic agents at financial markets (money market and capital market) defines the level of interest rate. The latter, in turn, can impact investment decisions made by firm and intertemporal choice made by households. As a result, interest rate can change the volume of aggregate demand. Change in investment affects the volume of capital stock, thus influencing the economy from a supply side. It follows that economic system is adjusted to shocks and macroeconomic equilibrium is restored at these markets. Their proper functioning largely conditions the correspondence between real functioning of national economy and theoretical expectations.

1.3. Theoretical foundation of contemporary structural macromodels

Assumptions

In contemporary structural macromodels, long-term equilibrium is typically set up by neoclassical theory. Accordingly, there are following theoretical assumptions introduced in a model to describe long-term period:

1. Real sector equilibrium is defined by production function (level of technological development achieved and stock of labour and capital used);
2. Long-term equilibrium does not depend on price level (nominal neutrality);
3. Long-run equilibrium levels of output and employment do not depend on the rate of inflation (inflation neutrality);
4. Nominal equilibrium is determined by controlled indicators of financial sector (money supply, price level, in some cases exchange rate) and reaction function of monetary authorities to economic shocks[4];
5. Response rate of nominal and real variables to economic shocks is defined by degree of flexibility and structural rigidity/inertia of factor markets (labour market in the first place) and financial markets.

Long-term equilibrium

In structural macromodels, long-term equilibrium can be described by functions of aggregate demand and supply. From a supply side, the necessary variables to include are output, labour, capital, and real wages. A rou-

[4] In this case, the dependent variable (in a function of reaction of monetary authorities) is interest rate adjusting to shocks to achieve the denoted level of a controlled nominal indicator.

tine way to define an equilibrium level of output is by using the Cobb-Douglas production function:

$$y_y = a_t^Y + \alpha l_t + \beta k_t \text{ [5]}, \quad (1.2)$$

where y, l и k – output, labour, and capital, respectively, and α and β – factor elasticity of output, a_t^y – constant describing the level of technological development. It follows from (1.2) and a profit maximisation assumption that firms make choices between factors of production on the basis of a rule defining a relationship of marginal product of these factors to their prices:

$$y_t - l_t = a_t^L + w_t - p_t, \quad (1.3)$$

$$y_t - k_t = a_t^K - rc_t, \quad (1.4)$$

where w – nominal wage, p – GDP deflator, rc – real value of capital, and variables a_t^L и a_t^K are used to characterise the level of technological development.

In equilibrium, productivity of each of the factors is related to the real price of a given factor of production. The use of the Cobb-Douglas function suggests a constant elasticity of output on each of the factors. In this case, the equation (1.2) can be rewritten to define demand for labour in economy. The equation (1.3) can also be used to specify labour demand function. Alternatively, it can be used to describe price dynamics by treating GDP deflator over the long run as a mark-up to the real value of a unit of labour. As a rule, the equation (1.4) is used to define demand for capital. It appears a supply side is fully described by the equations (1.1) – (1.4).

Further, aggregate demand is presented as a sum of household consumption, NPISHs and state, investment in fixed capital, investment in inventories, and net exports. In the long-run, aggregate demand is equal to potential aggregate supply. This is achieved due to real exchange rate. The latter is deducted from uncovered real interest rates parity (1.5):

$$e_t = e_{t+1} + r_t - r_t^* - p_t, \quad (1.5)$$

where e_t – real exchange rate, e_{t+1} – expected real exchange rate, r_t и r_t^* – domestic and foreign interest rate, respectively, and p_t – level of domestic prices.

[5] Linear function is used for natural logarithms of variables. In passim, the latter are denoted by lower case characters.

The equations (1.1) – (1.5) show that a long-term equilibrium is defined by the level of aggregate supply and dependent on real indicators only. This is compatible with the assumptions (1) – (3).

Price dynamics

Price dynamics in macroeconomic models is conditioned upon the assumption on monetary rules, i.e. specification of response function of central banks to deviation of a controlled variable or indicators related to it, from their target rate(s). In the majority of models that give monetary authorities an active role in economy, this rule is defined in relation to nominal short-term interest rate (it is assumed that central bank mainly reacts to adverse tendencies and send signals by using its responsibility to set up short-term interest rate at a money market). In theory, such a response function is based on a famous Taylor rule. The latter can be modified in accordance with nominal anchor (a controlled variable of the 'nominal' sector) chosen by monetary authorities. The equations (1.6) and (1.7) describe functions of central bank for inflation targeting and money supply targeting:

$$i_t = \pi_t + \overline{r_t} + \lambda^{\pi}(\pi_t - \pi_t^*), \quad (1.6)$$

$$i_t = \pi_t + \overline{r_t} + \lambda^{m}(m_t - m_t^*), \quad (1.7)$$

where i_t – nominal interest rate set up by central bank, π_t – actual level of inflation, r_t – actual level of real interest rate, m_t – actual money supply, π_t^*, m_t^* – central bank targets (inflation and money supply, respectively), λ^{π} и λ^{m} – equation coefficients characterising deviation of controlled indicators from their targeted levels.

The Taylor rule can be adjusted to other monetary policy regimes. In the most general case (1.8), monetary rule accounts for deviation of real sector dynamics from its long-term trend defined by aggregate supply. This deviation changes behaviour of economic agents and, hence, produces an impact on nominal variables:

$$i_t = \pi_t + \overline{r_t} + \lambda_1(\pi_t - \pi_t^*) + \lambda_2(y - y^*) \quad (1.8)$$

where $(y - y^*)$ – the deviation of actual output from its potential level (output gap) due so short-run disequilibrium

Short-run disequilibrium

In the short run, aggregate demand can deviate from its potential level. In theory, this is a product of real and nominal rigidity of economic processes. Real rigidity assumes the existence of certain expenses when firms change demand for capital and labour. Accordingly, equilibrium can not be immediately restored. Nominal rigidity assumes costs related to changes of nominal indicators (e.g. 'menu costs' caused by inflation). Another example of nominal rigidity can be a Keynesian assumption on nominal wage inflexibility, which is a product of contractual relationships between trade unions and employers. Contracts are usually concluded for a definite time span (e.g. a year). It appears that when shocks meet rigidities in the short run, aggregate demand deviates from its long-term equilibrium level, but nevertheless seeks to reach it. In this case, short-term economic dynamics can be described by using error correction models.

Deviation of actual output from its long-term level is usually measured by output gap and deviation of unemployment rate from its natural level. In this case, there are good reasons to use these indicators as determinants of inflation in macromodels. It can also be assumed that when actual output exceeds its potential level, then excess demand pushes price level up. In similar fashion, there is an interrelationship between inflation and unemployment (within the framework of short-run Phillips Curve).

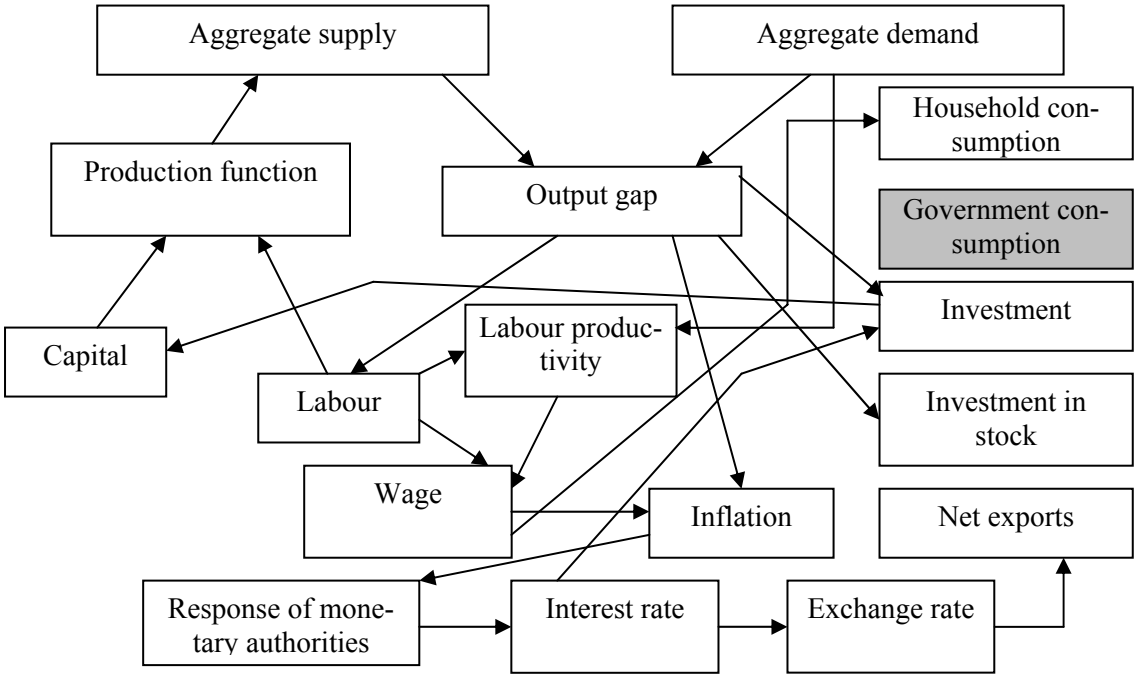


Figure 1.2. Economic structure of an elementary macromodel

However, in the literature there is a criticism of the approaches described above (see, for instance Stock, Watson (1999)). The indicators mentioned, and, in the first instance, output gap, can not – strictly speaking – be treated as causes of fluctuations. Accordingly, it is improper to consider output gap as a direct cause of acceleration of inflation. However, this indicator is still a good proxy to describe changes in behaviour of economic agents, including information about market conditions, also in monetary sphere. In this situation, it is far from problematic to use output gap in structural macromodel as a variable to denote economic agents' reaction to shocks. Still, in strict economic sense, the relationship between inflation and output gap is not well-defined.

It follows that the mechanism described above can be presented in the form of an elementary macromodel. This mechanism is based on the theoretical assumptions of short-run fluctuations around the long-term trend given the conditions of functioning of all agents and markets. This model can be solved for four independent blocks (Figure 1.2).

Block 1. Recursive equations

- Inflation. Relationship to output gap in the previous period.
- Investment in stock. Relationship to output gap in the previous period.
- Labour. Relationship to output gap in the previous period.
- Wages. Relationship to employment and productivity in the previous period.

Block 2. Simultaneous equations

- Interest rate. Relationship to equation.
- Exchange rate. Relationship to interest rate.

Block 3. Simultaneous equations

- Net exports. Relationship to exchange rate.
- Investment. Relationship to output gap in the previous period and exchange rate.
- Household consumption. Relationship to wages.
- Government consumption. Exogenous variable.
- Aggregate demand (GDP). Identity.
- Capital. Relationship to investment.

Block 4. Simultaneous equations

- Potential GDP. Relationship to labour and capital.
- Labour productivity.
- Output gap.

1.4. Potential and limitations of contemporary macromodels

The approach to building structural models described above is relatively widespread. Similar theoretical assumptions are introduced in the majority of models. Multi-dimensional models aimed at fuller depiction of interactions among agents in national economy are in fact based on an extended version of the flow-block shown above. Among such models are ones used by the Bank of England (Bank of England (1999), Harisson et al. (2005)), and an aggregated model built for the European Union (Barnai, Carlucci (2001)).

These models are helpful in making forecasts of economic development. Their precision is influenced by degree of detailed elaboration provided and methods selected to estimated model's equations. However, in structural models, forecasting is not always appropriate exercise from a quality perspective. This is because these models are still a simplification of economy. Economic dynamics can not be fully captured by using even sophisticated quantitative equations. At the same time, the major advantage of these models is their ability to reveal trajectory of reaction of economic agents to shocks and to delineate changes of market informed by this trajectory. It is therefore of crucial importance to build models on assumptions compatible with economic theory.

It has become a standard endeavour in this type of models to estimate supply side of economy in order to define long-term development trend. However, available data and/or specificity of economic mechanisms (especially in post-soviet countries) can make such an estimate a complicated enterprise (Ganev et al. (2002)). In this situation, it is possible to make assumptions different from the ones made above. Still, new assumptions have to allow modelling a supply side without resorting to the use of production function. These assumptions have to account for main behavioural characteristics of economic over the long run.

One of these approaches is an assumption about targeted levels of capital and employment as guidelines for the real sector given the current level of aggregate demand (for instance, this approach is used in Brillet (2006)). In addition, this approach opens up an opportunity of prospective estimate of productivity of labour and capital. On the basis of these esti-

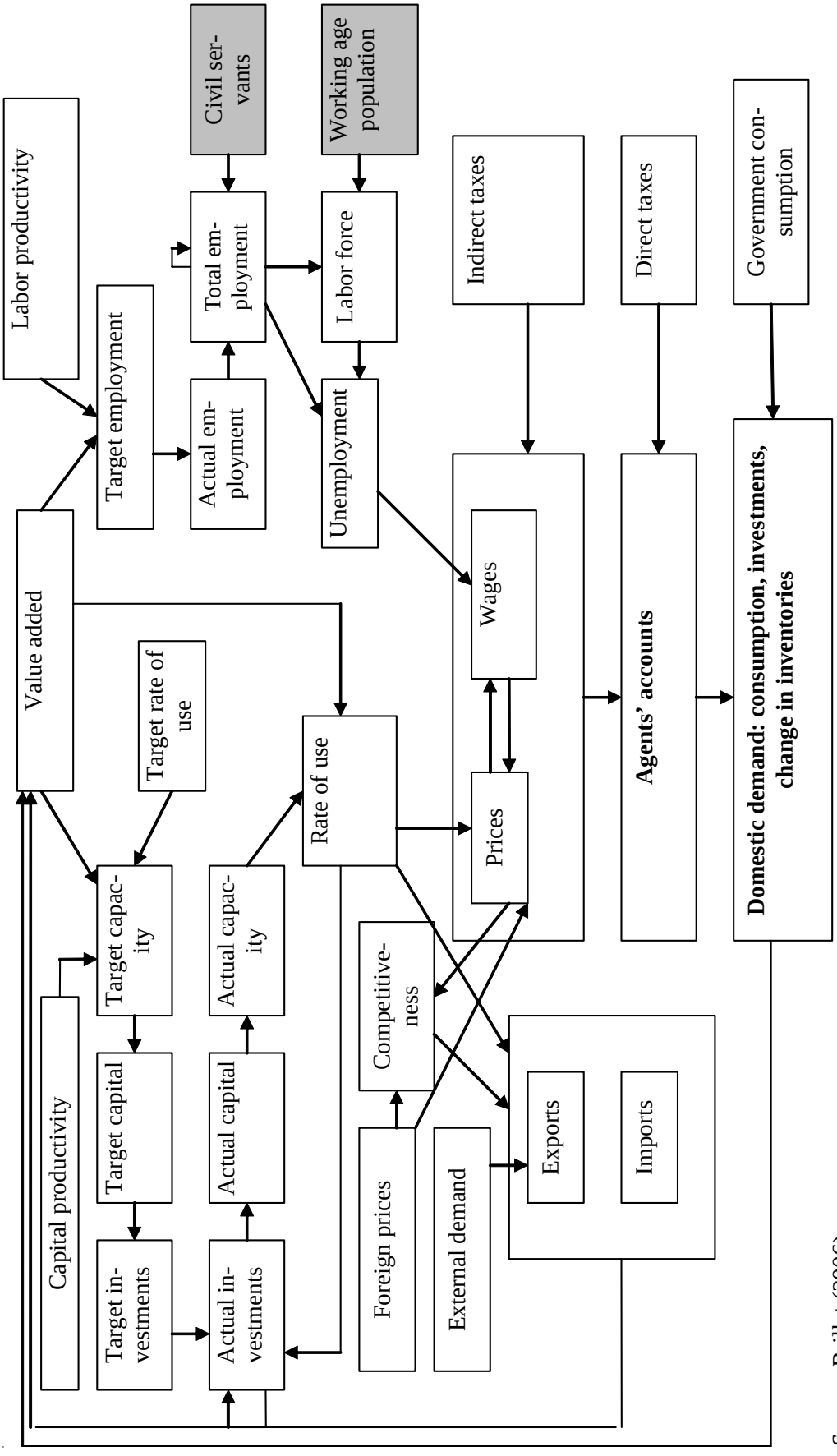


Figure 1.3. Economic Structure of the Model without Explicit Long-term Trend

Source: Brillet (2006).

mates and the level of aggregate demand, firms identify certain levels of labour and capital as appropriate (target). Accordingly, they demand them at a labour market and make necessary investment. In this case, aggregate demand is estimated in a way similar to a previous one. This estimate conditions behaviour of economic agents upon current market conditions. In general, this approach preserves the major characteristic of structural models, namely tendency of given aggregate supply to reach long-term equilibrium in the long run and the recognition of possibility of fluctuations around that equilibrium level in the short run. Economic structure of this model is shown below (Figure 1.3).

Therefore, a necessary condition of consistency of structural macromodel is its compatibility to economic theory. At the same time, a number of structural disparities characteristic of economy, have to be accounted for in a model. For this purpose, assumptions different from the ones postulated for an elementary model shown at Figure 1.2, have to be made. These assumptions can reflect, for instance, poor functioning of some markets and/or deviant behaviour of economic agents caused by regulation different from a 'benchmark' one, direct state intervention, or structural disparities in economy.

2. ASSUMPTIONS AND STRUCTURE OF THE MODEL

2.1. Sectors in the Belarusian economy

This chapter deals with major sector existing in the economy of Belarus, goals of economic agents and functions implied by them, and compare with the goals and functions of economic agents that have been discussed in the previous chapter. This comparison is helpful in adjusting the basic structure of macromodel to the characteristics of the Belarusian economy.

Households

Households in the Belarusian economy behave in the same way as predicted by theory. Their behaviour is motivated by maximization of utility given budget constraint. Accordingly, the majority of functions that the Belarusian households perform can be found at any other economy. At the same time, within these functions, there are some specific characteristics (Table 2.1).

Table 2.1

Households in the Belarusian economy: specific features

Function	Characteristic
Consumption of goods and services	A relatively high share of household expenditures is used to consume essential commodities, such as foodstuff and payment for public utilities[6]. So it is reasonable to assume that consumption has significant inertia.
Investment in housing construction and demand for credit and capital	A substantial fraction of investment in housing construction taken place due to cross-subsidisation. For instance, between the 1st and the 3rd quarters of 2006, it is only 44% of investment in housing construction was covered by the own resources of households. The rest was financed by preferential credits of banks, state subsidies, and housing and investment funds along with innovation funds of enterprises. So it is problematic to reveal the relationship between this function and incomes of consumers.
Demand for real money balances	No significant differences are registered.
Supply of credit and capital	Relatively short-term household deposits are dominant among all other forms of savings. Also, there is low share of 'long money' at credit and deposit market.

[6] Household survey conducted in the 3rd quarter of 2006 shows that expenditure on foodstuff occupied 41.5% of household expenditure, while payments for public utilities accounted for 7.1%.

Function	Characteristic
Supply of factors of production and receipt of factors returns	A low share of returns on labour in GDP (about 47% in the 2nd quarter of 2006), and a relatively low share of wages in total incomes of households (58% in 2005). Accordingly, there is a relatively high degree of social transfers (21.6%) and other incomes (18.8%) alongside with a low share of property incomes. Possibly, this structure of household incomes leads to a high inertia of consumption.

Firms

There are two relatively autonomous sectors in the Belarusian economy. The first one is the dominant state sector (enterprises owned by the state in either way). This sector includes the largest enterprises and a majority of exporters. It also incorporates the most profitable enterprises (by the volume of profit earned) alongside with those ones that perform mainly 'social' functions. This state segment is assigned a number of priority tasks of equal importance. These are to maintain certain rates of output growth and level of employment, to make 'socially important' investment, and to earn the maximum volume of profit in the framework defined by the existing economic model. This environment can be most property characterized as a market one, but there is a greater number of policy instruments available to provide soft budget constraints for enterprises of the state sector. The degree of softness (or hardness) of budget constraints varies depending on the situation in the real sector of the economy (defined, in turn, by general macroeconomic trends) and in a particular branch, its financial performance and a degree of priority assigned to it by the state.

Another important characteristic of the state segment of the real sector is a high degree of concentration of industry. In Belarus there is a special category of enterprises labelled 'bulk enterprises' or 'core enterprises'[7]. Accordingly, dynamics of the majority of macroeconomic indicators tend to be proportional to the dynamics of similar indicators displayed by these 'core' enterprises. Accordingly, for the government, the task of reaching both economic and non-economic performance targets becomes less complicated as soon as soft budget constraints are secured for a relatively small number of enterprises.

The second block of the real sector is a private sector, where mainly small and medium enterprises operate. In this sector, hard budget constraints dominate, while non-economic considerations are of much lesser importance than in the state sector. The branch structure of the private sec-

[7] According to the data provided by the Ministry of Statistics and Analysis, output produced by 114 'bulk enterprises' (of 11,000) accounts for about 60% of total output.

tor is probably close to the one of sectors of small enterprises[8]. Therefore, private sector is mainly serving the domestic market and consisting of industries with relatively small shares in value-added, profits and employment[9].

Also, in the Belarusian economy the interaction between large and small enterprises is rather weak in contrast to, for instance, Slovak or Hungarian economies. In these countries a certain number of small enterprises are the 'satellites' of a large one. They serve the bigger company in supplies and/or sales. Interaction provides economic system with necessary integrity, so that segments of the different scale and size work together rather smoothly. As a result, enterprises can play on a single 'economic field', competing for resource attraction. In Belarus, a low intensity of such interaction between large and small enterprises implies that state and private segments of the real sector operate in a more or less autonomous fashion. Nevertheless, this does mean the absence of linkages between the two segments of the real sector. It also suggests that there is a little room to apply the concept of 'dual track system' to the case of Belarus. This concept claims that the interpenetration of the public and the private sectors and softening of the budget constraints for the public sector help to achieve macroeconomic stabilization first and then to increase the efficiency of the economy on the basis of the private sector development (Che (2000)).

Given characteristics of legal and economic status of enterprises of the real sector, it is possible to delineate the following functions performed by enterprises.

Table 2.1

Specific features of the real sector of the Belarusian economy

Function	Characteristic
Supply of goods and services	Output volume is artificially predetermined by the production and employment targets set up by the government. Nevertheless, like in any other economy, aggregate supply is determined by the levels of technological development, employment and capital stock. Further, Belarusian economy is to a great extent export-oriented. This implies that its administrative regulation can only be efficient in the short run. Such a combination of specific features of the Belarusian economy and economic fundamentals can significantly impact the model specification.

[8]This proposition is compatible with the experience of a majority of countries at early stages of transformation prior to privatization of large enterprises. In the case of Belarus, there has been no privatization of large enterprises. Moreover, a substantial share of private sector is occupied by newly created enterprises. The majority of them can be defined as small. In 2005, about 95% of small enterprises were private ones.

[9] Small enterprises are concentrated mostly in trade and catering: about 45% the total number of small enterprises in the economy operates in this industry.

Function	Characteristic
Demand for factors of production	A stable demand for factors of production, mainly labour, is one of the major specific features of the Belarusian economy. This is required from the state-owned enterprises, and is fully compatible with the above-mentioned predetermination of output. Therefore, change in demand for labour as a way to adjust to economic shock is rather limited. Change in demand for capital is possible, but it assumes a substantial degree of rigidity since the only channel here is change in investment activity. It is probably only in the private sector dynamics of the factors of production are close to a 'benchmark' one.
Investment in fixed assets	Investment function is also tightly controlled by the state. However, this indicator is much less controlled directly. It is therefore possible to assume a relationship close to a 'benchmark' one. But 'administrative-regulatory' fraction of investment would, most likely, strengthen the relationship between investment and output dynamics.
Investment in inventories	Given the above-mentioned specific characteristic features of the Belarusian enterprises, it seems possible to assume a high degree of volatility of this indicator. This is because in the given conditions, enterprises can only react to a gap between demand and output by change in inventories.
Demand for credit	Market for credit and capital is also characterized by a high degree of state intervention. The state is using this market for cross-subsidization. As a result, a significant share of credit is distributed in accordance with either direct or indirect instructions issued by the government (Kruk (2006a), Kruk, Daneyko (2005)). State-owned enterprises of the real sector of the economy have been provided a preferential access to capital on 'special' terms. (Kruk, von Cramon-Taubadel (2004)).

State

In a 'benchmark' model, state maximizes public welfare. In the case of Belarus, there are no substantial differences in how standard role of state in economy is realized. State redistributes incomes in economy. For Belarus, this function is rather important (the share of the general government revenues is about 50% of GDP). Large-scale income redistribution can in certain extent change the behaviour of firms and households. Similar developments are observed in case of borrowing, investment and consumption made by the state. In order to implement these functions, the state mainly relies on standard economic mechanisms. Accordingly, this does not lead to changes in economic structure, but only impacts behavioural reactions of other economic agents.

At the same time, the state in Belarus performs a number of additional functions not observed in a 'benchmark' economy. These are, first of all, a high share of state ownership in the real and financial sectors of the economy, and a direct regulation of activity of enterprises and banks. In many areas of the economy, there are direct controls executed so that the functions of other agents and markets are substantially affected. All these conditions inform the above-mentioned specific features displayed by enter-

prises of the real sector. Additionally, they define a number of other distortions discussed below.

External sector

By definition, there are peculiar characteristics in the functioning of the external sector of Belarus that can produce a significant impact on the behaviour of the Belarusian economic agents. However, there are a number of specific features registered in the course of interaction between national economic agents and an external world:

- There is a high degree of dependency of the Belarusian economy on foreign trade (the volume of foreign trade turnover exceed GDP by 30–50%). At the same time, trade deficit is not financed by inflow of resources on financial and capital account of the balance of payments. First, in order to increase exports an adequate growth of intermediate imports is required. As for consumer and investment imports, policy of import substitution is implementing to a greater or lesser extent. Second, increase in imports requires a proper growth of exports. The inability to obtain resources inflow on finance and capital accounts of the balance of payments forces imports to adjust to shrinking exports. The latter is defined by the external demand and competitiveness (including a price one) of Belarusian companies abroad and, and, in certain sense, also a 'pre-determined' variable. This makes imports a variable responsible for balancing foreign trade.
- The European Union and Russia are the major geographical destination of Belarusian exports. As for the EU, oil products are the major export item. Accordingly, exports to the EU are neither dependent on the EU's output nor exchange rate. At the same time, exports to Russia are largely determined by the dynamics of demand and exchange rate.

Monetary sector

In a 'benchmark' model, there is central bank that emits money and commercial banks that perform financial intermediation function. Emission function is observed in any economy so that the sector and its function are intrinsic part of our model. Also, in a 'benchmark' model it has been assumed that central bank sets up short-term interest rate and is among the agents responsible for interest rate determination. As for the Belarusian economy, it has been shown that interest rate can not be used to equilibrate money market (Kruk (2006a), Kruk (2006b)). This is because of the soft budget constraints that enterprises of the real sector enjoy because of 'do-

nor' activity of the banking sector. The National Bank of Belarus and the state are, in their turn, 'donate' the baking sector. These factors inform specific characteristics of interactions among economic agents taking place at the money market, produce structural distortions, and contain opportunities of the money market for equilibration via interest rate (Kruk (2006a), Kruk, Daneyko (2005)):

- The narrow channel of bank lending is dominant in the NBB's activity. Competition occurs through volume of resources, but not their price;
- Interest rate preferences are provided for banks that perform donor functions in the system of soft budget constraints. This weakens the relationship between interest rate of the money market and the one of the credit market;
- Redistributive function of the state is also executed in the banking system. 'Alternative' money supply to banks is observed (e.g., by enlarging statutory funds of banks at the expense of the resources of the state budget);
- Interest rate is directly regulated at the credit and deposit market. This regulation distorts the relationship between interest rate at this market and the one at the money market.

In the Belarusian economy, the functions of the commercial banks are also substantially distorted. Regulation of the money market leads to a substantial distortion of a 'transmission' role of the commercial banks, i.e. their ability of transmitting impulses from the money market to the credit and capital market. Also, the existence of a range of regulatory measures implies that supply and demand at the capital market are not balanced. This is because the banking sector is unable to perform its function of investment projects evaluation efficiently so there is no improvement in the quality of corporate controls. These regulatory measures are as follows:

- Credit for the quasi-fiscal banks is provided following the direct and indirect instructions issued by the government;
- There are implicit state guarantees provided for population savings in the quasi-fiscal banks;
- The means of the state budget are used to increase statutory funds of the quasi-fiscal banks;
- Reserve requirements are not fulfilled by a number of banks;
- There is a gap between reserve requirements on bad debts and actual volume of reserves created;
- Interest rate spread is reduced artificially.

It follows that the modelling of the Belarusian economy requires consideration of central bank as performing its first function, namely emission

of a national currency. Also, it operates at the money market through volume, and not price, of resources. As for commercial banks, in Belarus these do not perform their 'benchmark' functions and do not canalise impulses of central bank to economy. So their role is rather minor, implying the unproblematic exclusion of these economic agents when building the Belarusian macromodel.

Given the behaviour of economic agents in the Belarusian economy, it is possible to point out to the specificity of functioning of different markets.

Market for goods and services

At this market, supply is exogenous due to the peculiar features of the real sector described above. Still, a given volume of supply is balanced against a given volume of demand. Domestic demand can fluctuate following shocks originating from household consumption, government consumption, and NPISHs consumption. External demand can be volatile because of the shocks related to the functioning of either world or the Russian market. In this case, equilibrium is established via the following variables: from a demand side, it is investment in inventories, while from a supply side, it is imports (intermediate imports dominate).

Labour market

This market is the most tightly regulated by the state that resorts to the following set of measures (Haiduk et al. (2006)):

- Administrative controls over employment alongside the use or permission of various forms of employment (including informal ones);
- Support of loss-making enterprises;
- Direct regulation of wages, including establishment of average wage level and target levels of deviation from it;
- Preservation of wage grid (used in wage-setting) in the real sector;
- Restrictions on labour mobility.

Money market

At this market, the state and the central bank both establish and implement direct and indirect regulation. The latter weakens the equilibrating role of this market. This is manifested in that interest rate does not fulfil its balancing role in the economy. Accordingly, interest rate is not used in the model as a variable adjusting the behaviour of economic agents.

Market for credit and capital

Neither interest rate nor the other factors do play their role in resource distribution at this market. This is because of the measures distorting bank behaviour and additional measures employed to regulate this market both directly and indirectly. In fact, it is the state that substitutes the fully-fledged functioning of market for credit and capital by the means of administrative redistribution of resources. With this in mind, this market has been excluded from the model. Moreover, such a role for the state at this 'market' enables to treat investment in fixed assets as a variable defined by some state policy measures, and by the outcome of interaction among economic agents acting at this market.

2.2. Suggested relationships among sectors

On the basis of the detailed characteristics of interaction among different economic agents outlined above, it is possible to construct the following flow chart (Figure 2.1). Firm lines reflect interactions among the economic agents at the different markets. Dashed lines show the influence of the state on certain sectors of the economy and regulatory measures (intervention into functioning of certain markets). In contrast to a 'benchmark' model, commercial banks and market for credit and capital are excluded from the model. Also, it is assumed that behaviour of economic agents is subject to state regulation. Moreover, regulation is extended to factor markets (labour market in particular), money market, and supply at market for goods and services, and interaction of economic agents of national economy with foreign ones. On the basis of this flow chart, it is plausible to expect the following specification of the model equations:

1. GDP. It is calculated by using production function, i.e. a long-term relationship to labour and capital. Given the low-quality data on fixed capital assets, the equation can include such indicators as proxies of technical progress, learning effects, and so on.
2. Capital. Relationship to volume of investment.
3. Labour. Relationship to demographic factors. This is because nearly full employment situation determines the unresponsiveness of demand for labour to economic factors.
4. Wages. Weak relationship to labour productivity and strong relationship to a cyclical component (Chubrik (2005b), Chubrik, Giucci (2006)).

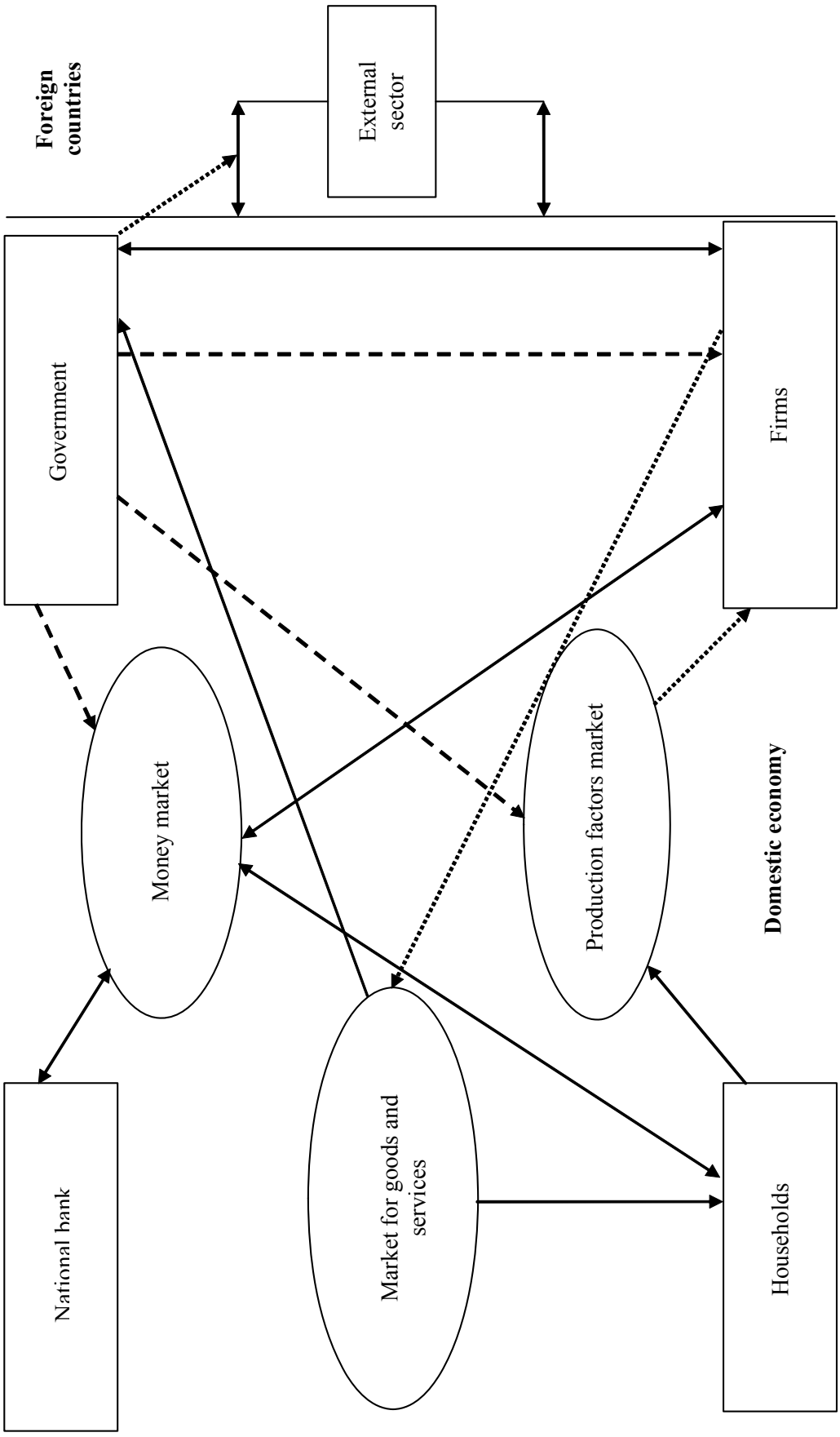


Figure 2.1. Interaction of Economic Agents in the Belarusian Economy

5. Money (aggregate *M*1). Relationship to GDP as an income indicator, to inflation as inertia indicator, to nominal exchange rate as an indicator balancing domestic money market and exchange rate market.
6. Inflation. Relationship to money supply.
7. Household consumption. Relationship to wages as an indicator of income and to inflation as an indicator of intertemporal choice (given the absence of interest rate).
8. Investment. Relationship to government consumption. It is assumed that as soon as a bigger volume of income is redistributed through the state budget and, hence, the volume of government consumption grows, possibilities for indirect administrative resource redistribution (that substitutes the functions of market for credit and capital) are shrinking. Also, there is crowding-out effect in this relationship (given the absence of interest rate). In addition, it can be expected that there is a relationship of investment to GDP dynamics as an indicator of market conditions.
9. Consumption of NPISHs. Possibly, it would demonstrate the dynamics similar to the one of government consumption.
10. Exports. Relationship of real exchange rate and a proxy of external demand (e.g. GDP in Russia as a major trading partner).
11. Investment in inventories. It balances domestic demand by relationship of a given output to the volumes of domestic and foreign demand. There is a likely relationship of investment in inventories to net exports and also some indicator reflecting domestic market activity.
12. Net exports. It balances demand and supply (difference between a supply-side GDP estimation and domestic demand).
13. Imports. It balances foreign trade balance. The model assumes its specification as a sum of exports and trade balance (net exports).

3. DYNAMIC PROPERTIES OF THE DATA

3.1. Sources and Methodology

The model is estimated on the basis of quarterly data between for the period 1995:1–2006:1 (45 observations). All indicators are presented below (table 3.1).

Table 3.1

Data used in the model

	Label	Indicator (in real terms, BYR bn, in constant prices of 2000)	Data source
1.	*RGDP*	GDP	Ministry of Statistics and Analysis
2.	*RHC*	Household consumption	Ministry of Statistics and Analysis
3.	*RGC*	Government consumption	Ministry of Statistics and Analysis
4.	*RNGC*	NPISHs consumption	Ministry of Statistics and Analysis
5.	*RI*	Gross fixed capital formation	Ministry of Statistics and Analysis
6.	*RCI*	Change in inventories	Ministry of Statistics and Analysis
7.	*RX*	Exports of goods and services	Ministry of Statistics and Analysis
8.	*RM*	Imports of goods and services	Ministry of Statistics and Analysis
9.	*RNX*	Net exports of goods and services	Ministry of Statistics and Analysis
10.	*RDD*	Domestic demand	Ministry of Statistics and Analysis
11.	*RW*	Average monthly wage (BYR, in constant prices of 2000)	Ministry of Statistics and Analysis
12.	*CPI*	Consumer price index, 2000 = 1	Ministry of Statistics and Analysis
13.	*NER*	Nominal exchange rate BYR/USD (index, 2000 = 1)	Authors' calculations[3]
14.	*RER*	Real exchange rate BYR/USD (index, 2000 = 1)	Authors' calculations[4]
15.	*CPIUS*	Consumer price index, USD-denominated (index, 2000=1)	International Financial Statistics
16.	*RGDPRUS*	Russia's GDP	International Financial Statistics
17.	*RLP*	Labour productivity (BYR thousand, in constant prices of 2000)	Authors' calculations
18.	*RD*	Depreciation of capital	Authors' calculations
19.	*M*1	Monetary aggregate *M*1, BYR bn (given denomination of 2000)	National Bank
20.	*RM*1	Monetary aggregate *M*1 in real term	Authors' calculations
21.	*L*	Employment, thousand people (beginning of period)	Ministry of Statistics and Analysis[5]
22.	*K*	Capital assets (beginning of period)	Ministry of Statistics and Analysis[6]

Notes

[1] Sum of net exports of goods and services and statistical discrepancy.

[2] Sum of household consumption, government consumption, NPISHs consumption, gross fixed capital formation and change in inventories.

[3] 1996–2000 – market exchange rate (data of the IPM Research Centre), 2001–2006 – weighted average (National Bank data).

[4] Exchange rate BYR/USD: 1996–2000 – market exchange rate (data of the IPM Research Center), 2001–2006 – weighted average (data of the National Bank); inflation in Belarus – data are

taken from the Ministry of Statistics and Analysis, U.S. inflation – data are taken from IMF International Financial Statistics.

[5] Estimates are made in the basis of annual data of Household Survey.

[6] Estimates are made on the basis of annual data on the yearly rate of growth of capital assets in comparable prices.

In order to reveal the dynamic properties of the data and to build a model, natural logarithms of the data and their first differences have been calculated. For testing of seasonality a combined test for the presence of identifiable seasonality[1] is implemented. In the case of seasonality in the data, the seasonally adjusted series have been used.

GDP and its demand factors

For the period 1995–2000, GDP and its components had been calculated in constant prices of 1995, while for the period 2000–2005 constant prices of 2000 is used. In order to obtain a comparable series, the following approach has been used. First, contribution of different factors to the increase of GDP has been calculated for a period of 1995–2000. Second, on the basis of GDP data for 2000, GDP components have been recalculated over the period 1995–1999.

A statistical discrepancy term is one of the GDP components which evidently should not be estimated in the model. The volumes of exports and imports have been adjusted in such a way that a sum of demand components without statistical discrepancy term has become equal to the volume of GDP. For this purpose, ½ of the statistical discrepancy term has been added to the volume of exports and deducted from the volume of imports. Net exports of goods and services have been calculated as difference between exports and imports.

In order to perform unit root tests and to build a model, logarithms of all variables have been used. It has been necessary to obtain cumulative series of change in inventories, because the logarithms of available series can not be calculated due to negative observations. The adjusted series have been obtained on the basis of an assumption that in the 4th quarter of 1994, the volume of inventories was BYR 450 bn, or about 30% of GDP (in constant prices of 2000). This step has permitted to construct the series without negative observations over the entire period studied.

[1] Seasonality has been tested by using the U.S. Census Bureau's X12 seasonal adjustment program in EViews 5.1 (X12ARIMA estimation).

Wages and productivity

Labour productivity has been calculated on the basis of the following formula:

(3.1) $$RLP_t = RGDP_t / L_t .$$

In order to make calculations, seasonally adjusted GDP has been used and employment measured in million people. Quarterly data on wages have been obtained on the basis of monthly data published by the Ministry of Statistics and Analysis.

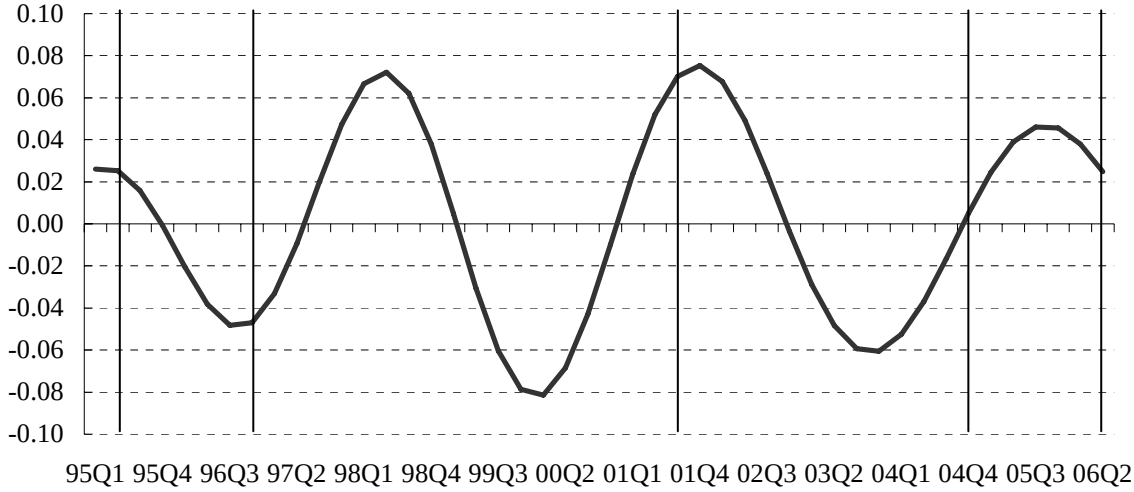
The dynamics of wages in Belarus has its specific features largely determined by a political-business cycle. The latter is manifested in wage increases prior to the important political events. In Belarus, in 1995–2006, there have been at least five such events: three constitutional referenda (1995, 1996, and 2004) and two presidential campaigns (2001 and 2006) (table 3.2).

Table 3.2

Political Business Cycle in Belarus

	USD-denominated average wage		Wage arrears
	rates of growth	target	
Referendum on May 14, 1995 (change of national symbols, integration with Russia, and land reform)	160% yoy – May 1995, 188% yoy – June 1995	--	--
Referendum on November 24, 1996 (extension of President's authority)	Wage decrease after a month after the referendum	--	September 1996 – 24% of total wage fund (WF), October 1996 – 6.5% of total WF
Presidential elections on September 9, 2001	-36% yoy – 1999, 44% yoy – 2000, 58% yoy – January-August 2001	USD 100 by September 2001	August 2000. – 17% of total WF, September 2000 – August 2001 – 2.4% of total WF (August 2001 – 0.5% of total WF). After the elections were over, increased by 15 times
Referendum on October 17, 2004 (lifting up the limits on the number of President's terms for one person)	28.6, 40.5 and 43.5% yoy – October, November, and December 2004, respectively	USD 200 by the end of 2004, USD 250 by the end of 2005	Since October 2003 there are virtually no wage arrears
Presidential Elections on March 19, 2006	No reduction below 30% yoy over two years	USD 300 by the end of 2006	

Source: Haiduk et al. (2006).



Note. Logarithmic scale; vertical lines (from left to right): referendum (May 1995), referendum (November 1996), presidential elections (September 20001), referendum (October 2004), and presidential elections (March 2006).
Source: author's calculations.

Figure 3.1. A Cyclical Component of Wages

With this in mind, a cyclical component[2] has been detected on the basis of a real wage series and then used to model behaviour of wages. Besides important political events, the cycle reflects market conditions, both favourable (growth of exports to Russia in 1997 and price increases on oil products and growth of their exports in 2004–2005) and unfavourable ones (Russian crisis of 1998). These conditions have influenced the wage dynamics in Belarus as well (figure 3.1).

Prices, money and exchange rates

In the model, consumer price index has been used to describe price dynamics, while money supply has been approximated by a monetary aggregate *M*1. Both indicators have been obtained on the basis of the monthly data (period average).

Over the time span analyzed, there had been multiple exchange rates regime (1996–2001). Accordingly, a market exchange rate has been used in the model obtained on the basis of monthly data (source – IPM Research Centre). Since 2002, a weighted average exchange rate (BYR/USD) has been used (source: National Bank). This rate is used by the Ministry of Sta-

[2] A cyclical component has been calculated in EViews 5.1 by employing the Christiano-Fitzgerald asymmetric full sample filter (Christiano, Fitzgerald, 2003)). Specification: min/max number of periods is equal to 10/20 quarters, lag length is equal to 12; trend component is removed; stationarity assumption of a series.

tistics and Analysis to compute volume of exports and imports in national currency.

Real exchange rate index has been calculated by using the following formula:

$$RER_t = (1/NER_t) \cdot (CPI_t / CPIUS_t), \quad (3.2)$$

where CPI and CPI are in the US used without seasonal adjustment.

Labour and capital

Data on capital (or capital assets) and labour (employment) are published annually (beginning of period) so quarterly series have been built. In order to obtain quarterly employment series, a program INTERPOL for WinRATS 6.1[3] has been used. The use of this interpolation method allows to leave a value of a variable unchanged at the end of each year.

Quarterly capital series has been built by using the formula below (3.3). Since there are not only annual data on capital assets at the beginning of the year (capital stock) available, but also quarterly data on gross fixed capital formation and quarterly data on depreciation, it is possible to calculate quarterly series of capital stock:

$$K_t = K_{t-1} + RI_t - RD_t. \quad (3.3)$$

However, quarterly data on capital depreciation are not publicly available. Accordingly, an assumption has been made that the quarterly distribution of capital depreciation is equal to investment. Real depreciation (*RD*) series has thus been calculated by using the following set of formulas:

$$RD_t = RI_t - (K_t - K_{t-1}), \quad (3.4)$$

$$RD_y = \sum_{q=1}^{4} RD_q, \quad (3.5)$$

$$RI_y = \sum_{q=1}^{4} RI_q, \quad (3.6)$$

$$RD_q / RD_y = RI_q / RI_y, \quad (3.7)$$

[3] Specification is *RWAR*1, i.e. it follows from the assumption that quarterly employment series is the random walk process containing first order autoregression (see Estima (2006)).

where q is an index denoting quarterly data, y is an index denoting annual data. On the basis of this series, a quarterly capital stock series has been calculated on the basis of series obtained from (3.4).

3.2. Order of integration of the variables

In order to analyse the order of integration of the variables, the Augmented Dickey-Fuller (*ADF*) unit root test has been employed. It is based on the following regression:

$$\Delta y_t = \mu + \delta T + \alpha y_{t-1} + \sum_{i=1}^{n} \beta_i \Delta y_{t-i} + \varepsilon_t , \quad (3.8)$$

where Δ is difference operator, $\mu, \delta, \alpha, \beta$ are regression coefficients, T is trend, ε_t is residuals. The following null hypothesis is tested: $H_0 : \alpha = 0$. When this hypothesis cannot be rejected, then the series is non-stationary (an alternative hypothesis is that the series is stationary). The null hypothesis is tested by comparing *t*-statistic of coefficient α to its critical value (Dickey, Fuller (1979)).

In case the Dickey-Fuller test leads to ambiguous results, the Kwiatkowski-Phillips-Schmidt-Shin test (*KPSS*) (Kwiatkowski et al. (1992)) has been used instead. If the null hypothesis cannot be rejected, then the series is stationary. In addition, in some cases, the Elliot-Rothenberg-Stock *DF-GLS* test (Elliot et al. (1996)) has been used[4].

Table 3.3

Unit Root Test

Variables[1]	Levels			First differences		
	t-ADF	Specification[2]	*F-LM* (lag length)	*t-ADF*	Specification	*F-LM* (lag length)
rgdp_sa	6.739	--	0.546 (0)	-6.147**	*C*	0.393 (0)
rhc_sa	-5.089**	*C, T*	0.713 (0)	--	--	--
rgc_sa	-1.984	*C*	0.115 (0)	-8.226**	*C*	0.824 (0)
rngc_sa	2.831	--	0.626 (0)	-6.365**	--	0.996 (0)
ri_sa	-1.420	*C, T*	0.443 (0)	-8.569**	*C, T*	0.152 (0)
rci_sa[4]	2.499	--	0.249 (0)	-4.727**	--	0.782 (0)
*rx*0_*sa*[5]	-3.430	*C, T*	0.942 (0)	--	--	--
*rm*0_*sa*[6]	-2.950	*C, T*	0.736 (0)	--	--	--
*rnx*0_*sa*	-5.033**	*C, T*	0.641 (0)	--	--	--
rdd_sa[7]	-3.220	*C, T*	0.877 (0)	-4.602**	*C*	0.114 (2)
rw_sa[8]	-3.895*	*C, T*	0.888 (1)	--	--	--

[4] All these tests are implemented in EViews 5.1.

Variables[1]	Levels			First differences		
	t-ADF	Specification[2]	*F-LM* (lag length)	*t-ADF*	Specification	*F-LM* (lag length)
cpi_sa	-0.973	--	0.771 (1)	-2.330*	--	0.776 (0)
ner[9]	-2.377*	--	0.075 (1)	-2.621**	--	0.165 (0)
rer[10]	-2.088*	--	0.254 (1)	--	--	--
cpius_sa	1.070	*C*	0.312 (0)	-4.673**	*C*	0.613 (0)
rgdprus_sa	-2.106	*C, T*	0.476 (0)	-3.801**	--	0.848 (0)
rd_sa	-2.691	*C, T*	0.426 (0)	-8.027**	--	0.185 (0)
rlp_sa	1.170	*C*	0.781 (0)	-6.356**	*C*	0.510 (0)
*m*1_*sa*	-2.143	*C*	0.340 (3)	-4.341**	*C*	0.061 (0)
*rm*1_*sa*	1.738	--	0.471 (1)	-3.156**	--	0.403 (0)
l	1.962	--	0.379(6)	-4.713**	--	0.313 (5)
k[11]	2.217	*C*	0.716 (1)	0.314	--	0.999 (0)

Notes.
[1] Natural logs of the variables have been tested. *_sa* index denotes that a variable is seasonally adjusted.
[2] *C* is constant, *T* is trend.
[3] *LM*-test for serial correlation of first – third orders (H_0: there is no serial correlation of the first – third order in the residuals).
[4] The volume of inventories is the cumulative sum of change in inventories (the volume of inventories in the 4th quarter of 1994 is taken as BYR 450 bn in constant prices of 2000, which is approximately 30% of GDP).
[5] The hypothesis of a unit root is rejected at 10%-level of significance. *KPSS* test-statistic (H_0: levels are stationary): *LM*=0.088 (*C*, *T*).
[6] *KPSS* test-statistic (H_0: levels are stationary): *LM*=0.105 (*C*, *T*).
[7] Hypothesis of unit root is rejected at 10%-level of significance. Additional tests: *KPSS* test-statistic (H_0: levels are stationary): *LM*=0.166* (*C*, *T*); *DF-GLS* test-statistic (H_0: levels contain unit root): *t-DF-GLS*=-2.882 (*C*, *T*).
[8] *KPSS* test-statistic (H_0: levels are stationary): *LM*=0.054 (*C*, *T*).
[9] *KPSS* test-statistic (H_0: levels are stationary): *LM*=0.288** (*C*, *T*).
[10] *KPSS* test-statistic (H_0 levels are stationary): *LM*=0.252 (*C*).
[11] *KPSS* test-statistic (H_0: levels are stationary): *LM*=0.166* (*C*, *T*); *DF-GLS* test-statistics (H_0: levels contain unit root): *t-DF-GLS*=-1.679 (*C*, *T*). Despite the results obtained, variable *K* is used as *I*(1). This is because this series contain several structural breaks not captured by the tests.

The following algorithm has been used to test the order of integration by using the *ADF*-test. First, regression equations have been used (3.8) excluding a component $\sum_{i=1}^{n} \beta_i \Delta y_{t-i}$ with constant and trend, with constant (no trend), and, finally, without both constant and trend. Second, the residuals of the equation have been tested for presence of serial correlation of the first – third orders by using the *LM*-test (H_0: there is no serial correlation of the first – third order in the residuals). If this hypothesis is rejected, then lags of the dependent variable have been added into the regression equa-

tions until the serial correlation is removed[5]. Third, when trend coefficient is insignificant, an equation with constant has been used, and when both constant and trend have insignificant coefficients, *t*-statistic of the *ADF*-test has been estimated by using regression equation without constant and trend. The results of the test are reported in table 3.3.

The *ADF*-test shows that the levels of six variables are stationary: household consumption (*rhc_sa*), net exports (*rnx*0*_sa*), wages (*rw_sa*), and real exchange rate (*rer*). The use of the *ADF*-test allows to reject a hypothesis of unit root in the level of the latter two variables at 5%-level of significance. However, the use of the *KPSS*-test shows that stationarity hypothesis cannot be rejected in both cases.

As for the index of nominal exchange rate (*ner*), the results of the *ADF*-test suggest the absence of unit root (at 5%-level of significance). At the same time, the use of *KPSS*-test allows to reject a stationarity hypothesis of this series at 1%-level of significance. Accordingly, the levels of nominal exchange rate index have been treated as a non-stationary variable.

Further, the use of the Dickey-Fuller test shows non-stationarity of the levels of exports (*rx*0*_sa*) and imports (*rm*0*_sa*). However, values of *t*-statistic of this test are negative and large (for exports, the hypothesis of unit root is rejected at 10%-level of significance). In this regard, additional tests of the levels of these variables have been performed by using the *KPSS*-test. The latter has not permitted to reject the hypothesis of stationary of levels of these series.

In similar fashion, the hypothesis that domestic demand contains unit root cannot be rejected at both 1 and 5%-levels of significance (the *ADF*-test has been used). Nevertheless, since this hypothesis has been already rejected at 10%-level of significance, additional tests have been performed. The use of the *KPSS*-test has led to rejecting the stationarity hypothesis at 5%-level of significance, while the use of the *GLS*-test has not allowed to reject the non-stationarity of domestic demand. These seemingly contradictory results can be explained by the inclusion of stationary variables such as household consumption and change in inventories in the series. At the same time, the levels of three other components of domestic demand are non-stationary. Given the results of the *KPSS* and the *GLS* tests, domestic demand is treated as a non-stationary variable.

First order differences of capital stock have been the most serious problem of testing. The use of all three above-mentioned tests has displayed non-stationarity of the series. However, its specificity (most likely,

[5] Since the inclusion of additional lags into unit root test equation is aimed at elimination of serial correlation in the residuals, the general to specific approach has been used for choosing the lag length (Pelipas (2003)).

the series contains several structural breaks, Figure A.22, Annex A) has suggested inclusion of two dummies into the *ADF* -test regression equation when analyzing order of integration. The dummies are *D*1=1 for a period between the 1st quarter of 1995 and the 4th quarter of 2001 (*D*1=0 for other periods), and *D*2=1 for a period between the 1st quarter of 1999 and the 4th quarter of 2002 (*D*2=0 for other periods). The value of *t*-statistic (-10.268) is significantly higher (in absolute value) than a critical value at 1%-level of significance for specification of the *ADF*-test with constant and trend (-4.186). As for the other variables, they are stationary in their first order differences (i.e. they are *I*(1) variables).

4. THE MODEL

4.1. Methodology of equations estimation

Since the majority of the variables are non-stationary ($I(1)$), there could exist the long-run relationship among them. In this case, analysis of short-run relationships between the variables should be implemented taking into account an error correction mechanisms.

In this paper, the long-run relationships have been analysed by using the two-step Engle-Granger method (Engle, Granger (1987)). This model has been chosen because of the sample size (no more than 46 observations have been available), and its relative simplicity. First, the following equation has been estimated:

$$y_t = \mu + \delta T + \sum_{j=1}^{k} \beta_j x_t^j + u_t, \quad (4.1)$$

where μ, δ, β are regression coefficients, T is time trend, u_t is error term. Second, residuals from the equation (4.1) have been tested with the Dickey-Fuller test[15] (in (3.8) specification without trend, intercept, and lag structure). This is a test for the long-run relationship (cointegration) (H_0: there is no cointegration exists). If the null hypothesis is rejected, i.e. variables y and x^j are cointegrated, then the short-run dynamics of the dependent variable should be analysed within the error-correction model. The error-correction mechanism (ECM_t) is equal to the residuals of the equation (4.1):

$$ECM_t = u_t = y_t - (\mu + \delta T + \sum_{j=1}^{k} \beta_j x_t^j). \quad (4.2)$$

An error-correction model is as follows:

$$\Delta y_t = \alpha + \sum_{i=1}^{n} \varphi_i \Delta y_{t-i} + \sum_{i=0}^{n} \sum_{j=1}^{k} b_{ij} \Delta x_{t-i}^j + \gamma ECM_{t-1} + \varepsilon_t, \quad (4.3)$$

where $\alpha, \varphi, b, \gamma$ are regression coefficients, ε_t are regression residuals. In this paper, the 'general-to-specific' approach has been used for error-correction models estimation, i.e. general specification (4.3) has been

[15] In this test, special McKinnon critical values for cointegration tests (McKinnon (1991)) are used.

gradually reduced to the parsimonious version. Reduction of the model specification has been implemented in PcGets 1 module of PcGive 10.3 package (Hendry, Krolzig (2001)). The lag length in initial specification of equations was equal to 4 ($n = 4$).

4.2. Equations of the model: results of econometric analysis

The initial specification of the equations of model has been set on the basis of theoretical expectations formulated in Section 2.2. In case the empirical analysis revels that these expectations did not prove to be true, additional assumptions of the equation specification are made.

At the initial stage of model estimation, 13 variables had been considered as exogenous. This followed from theoretical expectations about the specification of the corresponding behavioral equations. Additionally, the government consumption and a cyclical component of the wage are included in the model as endogenous variables estimated by the means of autoregression.[16] In addition to domestic demand variables, real exchange rate, real money supply and labor productivity are treated as endogenous variables estimated in the model on the basis of identities. Thus, there appears to be 19 endogenous variables in the model. In the case of existence of long-run relationships between levels of nonstationary variables and when variables stationary around deterministic trend are de-trended, appropriate equations for error correction mechanisms and de-trended variables have been also included in the model. Finally, there are foure exogenous variables in the model: labour, nominal exchange rate index, US inflation, and Russia's GDP.

Nominal money supply (M1)

Long-term equation:
Number of observations: 45.
Test for long-term relationship[17]: *t-DF* = –5.184*.

$$m1\_sa_t = \underset{(28.211)}{3.491} rgdp\_sa_t + \underset{(24.623)}{0.844} cpi\_sa_t - \underset{(-2.870)}{0.077} ner_t +$$
$$- \underset{(-21.885)}{21.126} - \underset{(-7.284)}{0.367} D1 + u_t,$$

[16] Government consumption in Belarus is inertial process. In fact, it could be set exogenously as a cyclical component of wages.
[17] H_0: absence of cointegration (long-term relationship).

where *D*1 is a dummy equal to 1 during 1st and 2nd quarters of 1995 and equal to 0 in other periods[18].

Error correction model[19]:
Number of observations: 41.
Tests:
Serial correlation of 1 – 3 order (*LM*-test)[20]: $F = 0.436$;
Test on autoregressive conditional heteroskedasticity (*LM*-test)[21]: $F = 0.639$;
Residuals normality test[22]: 0.815.

$$d(m1\_sa_t) = \underset{(2.525)}{0.324}\, d(m1\_sa_{t-1}) + \underset{(2.739)}{0.094}\, d(ner_{t-2}) - \underset{(2.356)}{0.559}\, d(rgdp\_sa_{t-4}) +$$
$$+ \underset{(6.910)}{0.467}\, d(cpi\_sa_t) - \underset{(-2.408)}{0.219}\, d(cpi\_sa_{t-1}) - \underset{(-3.721)}{0.296}\, ecm\_m1_{t-1} + \underset{(5.330)}{0.071} + \varepsilon_t.$$

Variable estimation has led to confirmation of the theoretical assumptions. The only deviation with the assumptions is the negative sign of the nominal exchange rate in the long-run equation. But in the long run this coefficient can denote the substitution effect of national currency by a foreign one in case the former is depreciated (Pelipas (1999)). This is because the aggregate *M*1 has been taken as a dependent variable. It does not include foreign currency component. In turn, the short-term equation denotes the positive dynamics between these indicators, which mirrors a range of accommodation effects in short-term money demand.

Inflation

Error correction model:
Number of observations: 43.
Tests:
Serial correlation of 1 – 3 order (*LM*-test): $F = 0.079$;
Test on autoregressive conditional heteroskedasticity (*LM*-test): $F = 0.499$;
Residuals normality test: 0.153.

$$d(cpi\_sa_t) = \underset{(7.421)}{0.382}\, d(cpi\_sa_{t-1}) + \underset{(4.526)}{0.140}\, d(ner_t) + \underset{(5.976)}{0.213}\, d(ner_{t-1}) +$$
$$+ \underset{(3.039)}{0.421}\, d(m1\_sa_t) + \underset{(4.612)}{0.393}\, ecm\_m1_{t-1} - \underset{(-2.752)}{0.038} + \varepsilon_t.$$

[18] In 1995 National bank began to implement the stabilization program, but the growth rates of money supply substantially decreased only in the second half of 1995.
[19] According to the equation (4.2), error correction term is equal to the residuals obtained from the long-term equation u_t.
[20] H_0: absence of serial correlation of 1-3 orders.
[21] H_0: absence of *ARCH*-effect.
[22] H_0: the residuals are normally distributed.

The inflation equation is also compatible with theoretical assumptions, but it also denotes a stronger dependence of domestic prices on the currency market stance than a predicted one

Wages

Error correction model:
Number of observations: 42.
Tests:
Serial correlation of 1 – 3 order (*LM*-test): $F = 0.609$;
Test on autoregressive conditional heteroskedasticity (*LM*-test): $F = 0.985$;
Residuals normality test: 0.096.

$$rw\_res_t = \underset{(4.685)}{0.460}\, rw\_res_{t-1} - \underset{(-3.679)}{0.260}\, rw\_res_{t-3} + \underset{(7.184)}{0.958}\, rw\_cycle_{t-1} +$$
$$+ \underset{(2.559)}{0.855}\, d(rlp\_sa_{t-1}) + \underset{(3.076)}{1.025}\, d(rlp\_sa_{t-1}) - \underset{(-4.584)}{0.214}\, d(cpi\_sa_t) +$$
$$+ \underset{(5.024)}{0.211}\, d(cpi\_sa_{t-2}) - \underset{(-2.837)}{0.036} + \varepsilon_t.$$

As expected, the wages equation displays a strong dependence on the cyclical component and on the labor productivity. At the same time, the connection between real wages dynamics and labor productivity in Belarus had not been identified earlier (Chubrik (2005 b)). This has been explained by difficulties of modeling of political and business cycle, as well as by policies aimed at lowering wage differentials across branches of the economy[23].

Household consumption

Error correction model:
Number of observations: 41.
Tests:
Serial correlation of 1 – 3 order (*LM*-test): $F = 0.814$;
Test on autoregressive conditional heteroskedasticity (*LM*-test): $F = 0.638$;
Residuals normality test: 0.523.

$$rhc\_res_t = \underset{(-1.961)}{-0.193}\, rhc\_res_{t-2} + \underset{(4.830)}{0.475}\, rhc\_res_{t-4} + \underset{(4.396)}{0.407}\, rw\_res_{t-1} +$$
$$+ \underset{(2.491)}{0.357}\, rw\_res_{t-2}) - \underset{(-4.036)}{0.432}\, rw\_res_{t-3} + \underset{(3.666)}{0.138}\, d(cpi\_sa_{t-2}) - \underset{(-2.624)}{0.015} + \varepsilon_t.$$

[23] The analysis has been made on the basis of the panel data on 22 sectors of economy during 9 years.

In this equation strong inertia is compatible with the initial assumption made on the basis of a relative large share of social transfers in household incomes. In the latter, a significant share is spent to consume essential goods and services. Furthermore, the consumption equation indirectly contains (through inflation) intertemporal substitution effect. The latter implies increase of consumption in the current period as a response to price increase.

Exports

Error correction model:
Number of observations: 42.
Tests:
Serial correlation of 1 – 3 order (*LM*-test): $F = 0.906$;
Test on autoregressive conditional heteroskedasticity (*LM*-test): $F = 0.839$;
Residuals normality test: 0.318.

$$rx\_res_t = \underset{(5.474)}{0.570}\, rx\_res_{t-1} + \underset{(3.520)}{1.237}\, d(rgdprus\_sa_t) +$$
$$+ \underset{(3.733)}{0.065}\, rer\_sa_{t-3} - \underset{(3.351)}{0.031} + \underset{(4.095)}{0.111} D1 + \varepsilon_t,$$

where $D1$ is a dummy equal to 1 in the 4th quarter of 2004, and -1 in the 1st quarter of 2005, and 0 in other periods[24].

The positive sign of the variable of the real exchange rate can be explained by the use of nominal exchange rate as an exogenous variable in the model. Export-related hard currency revenues facilitate appreciation of the national currency. The latter determines reduction in inflation and appreciation of real exchange rate. Given this relationship between the variables, a positive impact of exports on the real exchange rate can be expected, but in the model real exchange rate is on the right side of the equation with lag 3. This can be interpreted by the specificity of the export dynamics. As a rule, the growth of physical volumes follows the periods of increase in the total volume of exports caused by favorable price dynamics. It provides the inflow of hard currency and then leads to the appreciation of national currency. The effect is similar to the equation specification.

[24] The dummy denotes the adoption of a new country-of-destination principle of VAT payment in trade with Russia (since January 1st, 2005). Before this change in the mode of VAT payment exports and imports both exhibited substantial growth, but after the introduction of a new mode drastically declined.

Change in inventories

Long-term equation:
Number of observations: 45.
Test for long-term relationship: *t-DF* = –3.571*.

$$rci\_cml\_sa_t = \underset{(23.933)}{0.883} rm1\_sa_t + \underset{(5.407)}{1.216} + u_t.$$

Error correction model:
Number of observations: 43.
Tests:
Serial correlation of 1 – 3 order (*LM*-test): *F* = 0.413;
Test on autoregressive conditional heteroskedasticity (*LM*-test): *F* = 0.625;
Residuals normality test: 0.889.

$$d(rci\_cml\_sa_t) = \underset{(-3.762)}{-0.587}(rx0\_sa_t - rm0\_sa_t) +$$
$$+ \underset{(2.486)}{0.451}(rx0\_sa_{t-2} - rm0\_sa_{t-2}) + \underset{(3.490)}{0.436} d(rm1\_sa_{t-4}) +$$
$$- \underset{(-3.345)}{0.380} ecm\_rci\_cml_{t-1} + \varepsilon_t.$$

Real money balances appears to be an indicator of the domestic business cycle. This indicator is informative for enterprises from a point of view of market conditions. It both displays situation in the real and the nominal sector. Accordingly, in the long run it turns to be a major guideline to make decisions about volume of inventories. At the same time, since in the short run change in inventories equilibrates demand and supply, its relationship to foreign trade dynamics (net export) seems to be justified.

Investment in fixed capital

Long-term equation:
Number of observations: 45.
Test for long-term relationship: *t-DF* = –7.419**.

$$ri\_sa_t = \underset{(9.416)}{3.008} rgdp\_sa_t - \underset{(-4.210)}{0.892} rgdp\_sa_t - \underset{(-3.611)}{10.967} - \underset{(-3.962)}{0.023} T + u_t,$$

where *T* is time trend.

Error correction model:
Number of observations: 43.
Tests:
Serial correlation of 1 – 3 order (*LM*-test): *F* = 0.820;

Test on autoregressive conditional heteroskedasticity (*LM*-test): $F = 0.233$;
Residuals normality test: 0.807.

$$d(ri\_sa_t) = \underset{(5.520)}{1.768}\, d(rgdp\_sa_t) - \underset{(-3.029)}{1.089}\, d(rgc\_sa_{t-1}) - \underset{(-4.651)}{0.695}\, ecm\_ri_{t-1} + \varepsilon_t.$$

The specification chosen supports the assumption about the role government in resource allocation the existing of crowding-out effect. Accordingly, GDP level can be used as an indicator reflecting market conditions. This level and government consumption becomes major factors determining both short-term and long-term investment levels.

Capital

Long-term equation:
Number of observations: 45.
Test for long-term relationship: *t-DF* = –6.459**.

$$k_t = \underset{(9.416)}{0.067}\, ri\_sa_t + \underset{(679.048)}{9.849} - \underset{(-4.910)}{0.006}\, D1 + u_t,$$

where *D*1 is a dummy equal to 1 between the 1st quarter of 1997 and the 1st quarter of 2004 (0 in other periods).

Error correction model:
Number of observations: 41.
Tests:
Serial correlation of 1 – 3 order (*LM*-test): $F = 0.915$;
Test on autoregressive conditional heteroskedasticity (*LM*-test): $F = 0.268$;
Residuals normality test: 0.066.

$$d(k_t) = \underset{(17.853)}{0.935}\, d(k_{t-1}) + \underset{(2.816)}{0.004}\, d(rci\_cml\_sa_t) +$$
$$+ \underset{(2.265)}{0.003}\, d(rci\_cml\_sa_{t-3}) - \underset{(-2.024)}{0.066}\, ecm\_k_t + \varepsilon_t.$$

The long-term interrelationship between capital and investment is rather clear, since as soon as depreciation is considered in the model, the identity can be used to denote this relationship.[25]. Dependence of the

[25] The dynamic of capital depreciation in Belarus can not be modeled. Fixed capital accumulated in the Soviet Union becomes obsolete as soon as enterprises find an opportunity to make new investment. More or less intensive renewal of capital (unrelated to 'socialist' legacies) is observed only recently. As a result, capital stock is growing faster. Such specificity of capital investment can explain the necessity to include trend into production function. This is because the increase of quality of fixed assets is not reflected in national accounts.

change in capital on the dynamics of change in inventories (that is the variable balancing demand and supply and correspondently denoting the measure of disequilibrium) in the short-term witnesses that firms may react on the gap between actual and potential output by changing capital investments[26].

GDP

Long-term equation:
Number of observations: 45.
Test for long-term relationship (excluding dummies/including dummies[27]): *t-DF* = –2.986/-6.099**.

$$rgdp\_sa_t = \underset{(4.711)}{1.723}k_t + \underset{(2.575)}{0.566}l_t - \underset{(-5.524)}{18.956} + \underset{(28.508)}{0.013}T + u_t.$$ [28]

Error correction model:
Number of observations: 41.
Tests:
Serial correlation of 1 – 3 order (*LM*-test): $F = 0.847$;
Test on autoregressive conditional heteroskedasticity (*LM*-test): $F = 0.523$;
Residuals normality test: 0.266.

$$d(rgdp\_sa_t) = \underset{(2.682)}{0.327}d(rgdp\_sa_{t-3}) + \underset{(2.694)}{0.325}d(rgdp\_sa_{t-4}) +$$
$$+ \underset{(3.754)}{2.825}d(l_{t-2}) - \underset{(-4.346)}{3.185}d(l_{t-3}) - \underset{(-2.538)}{0.646}ecm\_rgdp_{t-1} + \underset{(28.508)}{0.008} + \varepsilon_t.$$

The equations of the production function are compatible with our theoretical assumptions. Moreover, the trend has been included in the long-term equation. This implies that quarterly GDP growth 'by default' is equal

[26] This relationship is rather weak since coefficients of change in inventories in this equation are close to zero.
[27] Since the sample is rather small and the data on employment and fixed capital are generated artificially on the basis of annual data, an additional test has been performed on the long-term relationship with dummies included in *DF*-test: D1 (equals to 1 between the 2nd quarter of 1995 and the 2nd quarter of 1996, and 0 in other periods) and D2 (equals to 1 between the 2nd quarter of 1997 and the 2nd quarter of 1998, 0 – other periods). The first dummy reflects the period of the last year of the adaptation recession. During that period of time, in some branches growth had been observed, while GDP declined irrespective of the dynamics of labor and capital. The second dummy reflects the period of the fast growth of exports to Russia impacted by exchange rate policies and creation of the customs union. GDP growth had been growing faster than it can be expected on the basis of dynamics of labor and capital.
[28] The sum of coefficients of labor and capital is more than unity. Hence an assumption of constant returns to scale of the Cobb-Douglas production function could not be accepted, since it would lead to incorrect specification of the equation (Chubrik (2002)).

to 1.3%. This phenomenon can be explained by inferior quality of GDP statistics and of the data on capital dynamics. In particular, the quality of GDP statistics is influenced by the existence of target indicators of output growth for the majority of enterprises, including some private ones. As for the level of technological development, over the last 11 years there has been no relationship to the dynamics of capital stock. During that period, it has increased by 7%,

In the short run the dynamics of GDP is determined by the fluctuations of employment and inertia of GDP dynamics. The latter is influenced by target indicators of output increase. However, in the model employment has been treated as an exogenous variable. This is related to the specificity of the employment series and the absence of relationship between employment dynamics and total population. By considering employment as an exogenous variable, there is a need for additional estimation of the labor market reaction to shocks and corresponding changes in the exogenous level of employment.

Other model equations

Government consumption (autoregression):

$$rgc\_sa_t = \underset{(49.456)}{0.901} rgc\_sa_{t-1} - \underset{(-9.907)}{0.126} D1 + \underset{(5.511)}{0.607} + \varepsilon_t,$$

where $D1 = 1$ in the 1st quarter of 1996 (0 in other periods).

The consumption of NPISHs:

$$rngc\_sa_t = \underset{(32.193)}{0.685} rgc\_sa_{t-1} - \underset{(-4.974)}{0.073} D1 + \underset{(6.729)}{0.098} D2 - \underset{(-2.626)}{0.338} + \varepsilon_t,$$

where $D1$ is dummy, $D1 = 1$ in the 1st quarter of 1996 (0 in other periods), $D2 = 1$ in the 1st quarter of 2006 (0 in other periods).

Cyclical component of wages (autoregression):

$$rw\_cycle_t = \underset{(180.942)}{3.537} rw\_cycle_{t-1} - \underset{(-95.961)}{5.073} rw\_cycle_{t-2} +$$
$$+ \underset{(65.889)}{3.447} rw\_cycle_{t-3} - \underset{(-50.311)}{0.951} rw\_cycle_{t-4} + \varepsilon_t.$$

4.3. Economic Structure of the Belarusian Economy Macromodel

Econometric estimate of the behavioral equations allows to depict the Belarusian macromodel in its final version (Figure 4.1). Basically, there are four relatively independent groups of macroeconomic indicators. The first group represents the production side (aggregate supply), which sets the long-term trend of development for the economy as a whole (potential output) and also the short-term dynamics of GDP. Regulation of labor market and investments both constrain the fluctuations of aggregate supply. But the inverse dependence of investments on government consumption makes both long-term and short-term dynamics of output sensitive to its fluctuations. This is because crowding-out effect informs reduction of growth rate or of volume of capital stock, which, in turn, lead to negative dynamics of GDP.

In the framework of the model, functional supply-side relationship can only change in case the government deregulates labor market. As a result, employment could be treated as an endogenous variable. At present, the reaction of aggregate supply to changes in employment can be considered only exogenously. Change in technologies, changes in prices of raw materials and other factors not considered in the model can be suggested as additional aggregate supply shocks.

The second group consists of the indicators of aggregate demand. The majority of them are affected by the government aimed at achieving target values of aggregate demand. These components are government consumption (and, hence, consumption of NPISHs) and investment in fixed capital. In addition, household consumption can be included. This is because this consumption is to a great extent determined by wages in turn informed by the existence of the political business cycle in Belarus. Household consumption is stationary around the trend like wages (both indicators grow 'by default' by 3% per quarter). This can be explained by specific wage policies conducted in Belarus. As for the final element of domestic demand, change in inventories, its role is to balance supply and both domestic and external demand.

A fraction of the Belarusian GDP is demanded by the external sector (the third group). Exports are determined by external demand and competitiveness of Belarusian goods at foreign markets, while imports balance foreign trade. Growth of domestic demand drives volume of production output up and, hence, requires an additional volume of intermediate goods imports. The latter is however limited by the ability to attract capital on finance and capital accounts of balance of payments. In similar fashion, decrease of domestic or external demand (i.e. exports) causes imports to decline.

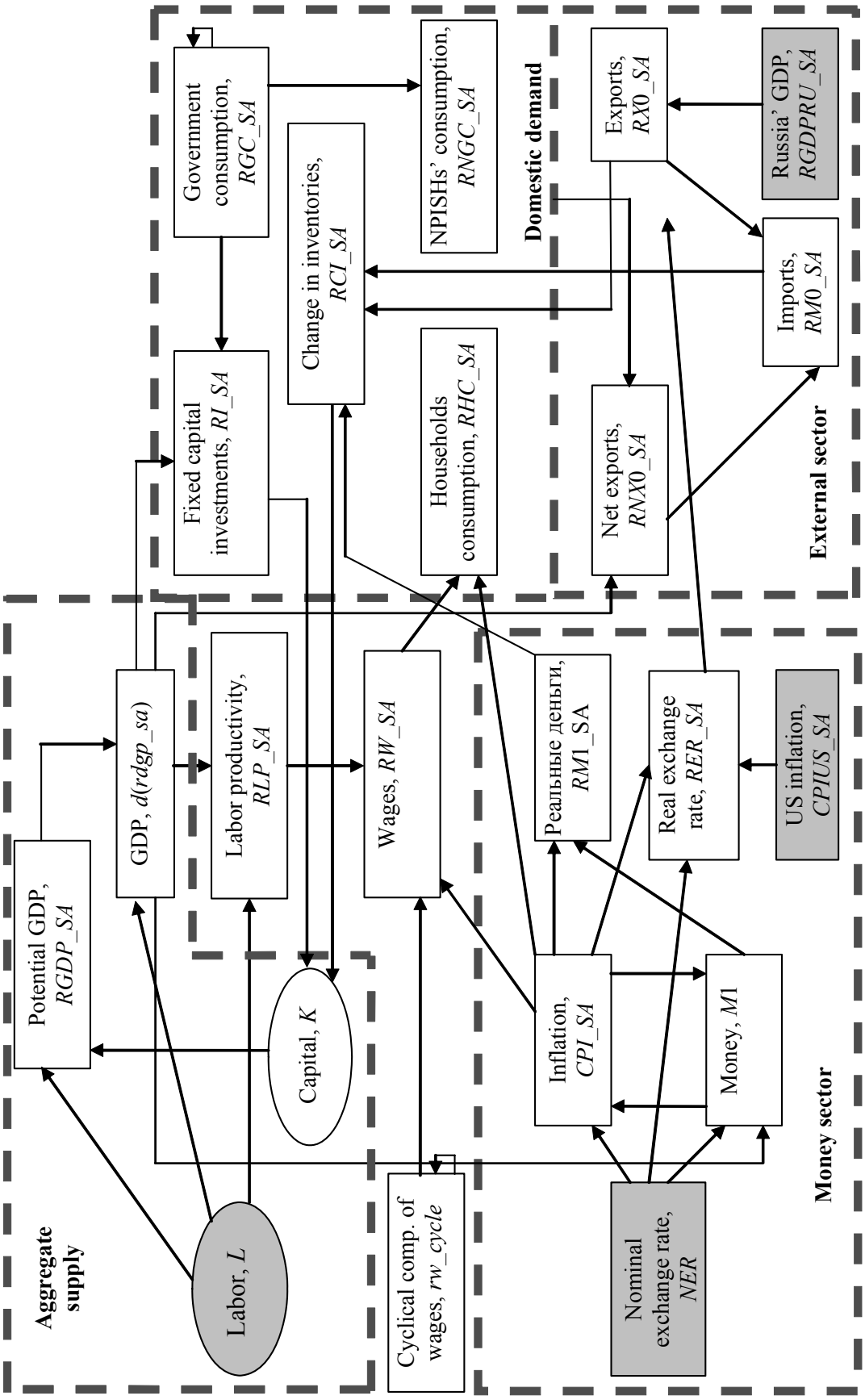


Figure 4.1. Economic Structure of the Model

The fourth group includes the monetary sector variables that affect the real sector situation through inflation. The channels are change in real wages and intertemporal effect of substitution. The real sector demands real money balances. Excessive money supply and/or shocks on the currency market transmitted through the nominal exchange rate accelerate inflation. There is also a mechanism of nominal sector influence on the real indicators related to price competitiveness of exports.

In the model, equilibrium (of aggregate supply set by the production function and aggregate demand) is established because of two variables: imports and change in inventories. The structure of the model substantially differs from a 'benchmark' one. Aggregate demand and its components are allowed to fluctuate in the model. However, the nature of these fluctuations and equilibrating mechanisms also substantially differ from a 'benchmark' one.

5. MODEL CONSISTENCY AND CHARACTERISTICS

5.1. Model solution

In order to check theoretical structure of a model for its consistency, it is first necessary to perform a convergence check, i.e. whether model solution exists. More generally, this solution can be written as the following vector function:

$$f = (y_t, y_{t-i,} x_{t,} a) = 0, \tag{5.1}$$

where y is vector of endogenous variables, x is vector of exogenous variables, and a is vector of model parameters.

Model convergence mainly depends on model structure, i.e. on how (specification of equations) and in what order variables are determined either recursively or simultaneously. In a more general case, it is assumed that model cannot be fully recursive. As a minimum, model should contain an identity that incomes are equal to expenditures. In other words, 'production creates demand, while demand has to be produced' (Brillet (2006)). Therefore, economic model should necessarily include one (or more) block(s) of simultaneous equations. In case model variables are all determined in a certain period, there is no solution to model or, alternatively an economically inconsistent algebraic solution. Therefore, the simulation of economic dynamics and the logical order of determination of variables are important conditions of model consistency. The latter also depends on a solver chosen.

In our case, the Gauss-Seidel solver[29] has been used. First, previous values are considered (e.g. retrospective values or last calculated values) and, second, all equations are computed in a sequential order. As a result, a new value of the variable is obtained. The process is repeated by using the last calculated values of those variables that explain an endogenous one. Variables of one period are calculated until the difference between the last two values turns to be sufficiently small and thus can be ignored. So solution is finally obtained (Brillet (2006)).

It follows that apart from economic structure of the model, it is possible to consider the order of estimation of model equations and identities. Division into blocks provides with a better understanding of the mechanics of cycles and model equilibration. A recursive block consists of a number of equations that use variables with defined values. One iteration is required to

[29] The model has been built and solved in EViews 5.1.

solve the recursive block. A simultaneous block includes the variables whose values are obtained after solving a system of simultaneous equations. A block structure of the Belarusian model is shown at Figure 5.1.

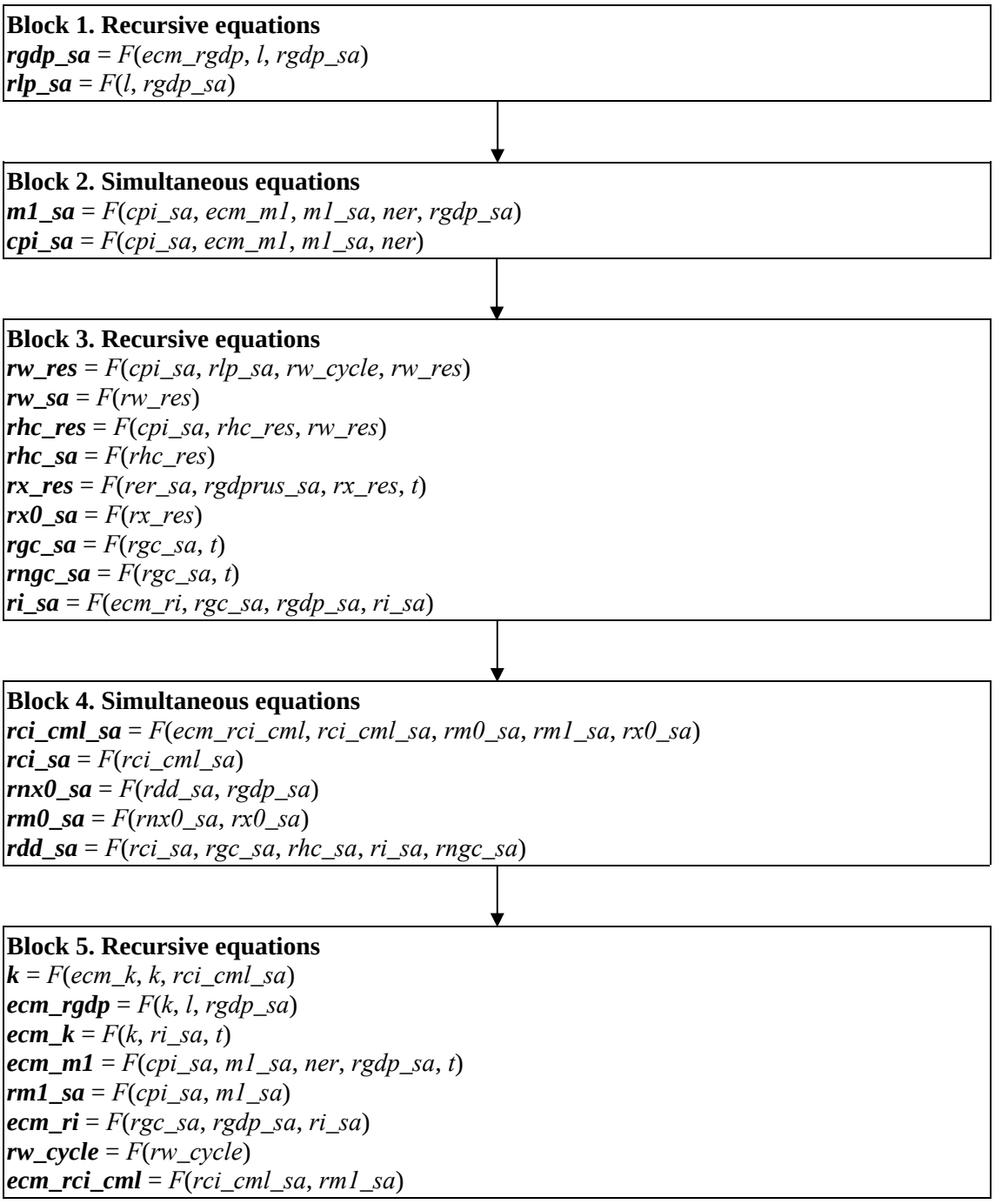


Figure 5.1: Flow chart of model solution

The structure of the first block reflects the major specific feature of the model built, namely that aggregate output is determined by a supply side.

At this stage, values of GDP and corresponding values of labour productivity are calculated on the basis of the values of corresponding variables of previous periods and exogenous variables (in this case, level of employment). From a point of view of economic structure of the model, the following process is observed: first, impulse is transmitted into economy from a supply side; second, economic agents take the gross income indicator as pre-given when planning their behaviour.

In the second block, values of the monetary sector variables are obtained. In this sector demand for money balances are determined by the level of income. Next, money supply depends on the current inflation rate (thus reflecting accommodation effects and, to some extent, speculative incentives of demand for money). Money supply, in its turn, determines inflation rate. Solution of this simultaneous system of equations provides us with value of price level in the current period. This level is taken into consideration by economic agents when they make decisions about their behaviour within the framework of their functions performed by them.

In the third block, the outcomes of decisions made by economic agents are obtained. Having information from the previous periods along with the current values of income level, as well as monetary indicators (inflation and real exchange rate are calculated on the basis of inflation and exogenous variables), households define their consumption level, while foreign economic sector decide about the volume of demand for Belarusian goods and services. In addition, at this stage the volume of government consumption is obtained. This volume – along with economic information available – in turn determines the current volume of investment in fixed assets and consumption of NPISHs.

Equilibrium of supply and demand of the current period is determined in a fourth block of simultaneous equations. Investment in inventories (decisions about their volume are made by firms on the basis of information available) and trade balance are the equilibrating variables. Next, the volume of imports is determined as soon as there is information about the volume of domestic demand (including investment in inventories) and exports. The outcome of these simultaneous decisions is equilibrium of demand and supply in the domestic economy in the current period.

From a point of view of model solution, a recursive fifths block can be called ‘an epilogue’ to the model. In this block, it is those values of the variables are calculated which then used as information for the similar order of solutions and for determination of values of the variables in the next period. Economically, the fifths block defines the level of long-run equilibrium in the current period that would determine the behaviour of agents in the next period. For instance, the volume of capital used in the current pe-

riod is obtained on the basis of information taken from the fifths block. In turn, this volume defines the level of potential GDP, i.e. long-equilibrium level. Deviation of the actual level of GDP[30] from its potential level is, in turn, used as an explanatory variable for determination of GDP volume in the next period.

5.2. Check for model consistency

Besides its algebraic convergence, the model has to be tested for its economic consistency. In other words, it is necessary to find out a quality of description of the interrelationships existing in the economic system modelled.

EViews 5.1 package allows deterministic solution of the model with three solve options (types of dynamics): model fit, static solution and dynamic solution. Model fit means that it is solved by using values of endogenous variables of the current period. In addition, for each of the endogenous variables, its explanatory variables (which are endogenous in the model) are taken as exogenous ones. This means that their actual values are used to solve the model. Therefore, the use of 'model fit' option allows to eliminate relationship among model equations and thus to make model 'consistent'. The latter means model ability to explain variation of corresponding endogenous variable by using given specification for each of the equations. Sizeable differences between obtained and real values of any of variables imply that dynamic solution would generate error term among all variables related to a given one. 'Model fit' option can only be used to make a retrospective estimate on the basis of actual values of the endogenous variables.

Model fit

Results of model solution by using 'model fit' option are shown in the Appendix B. Given the parameters of this option, it appears that the variables whose values are obtained on the basis of identities would be fully consistent with the actual values. Accordingly, the analysis of results of model fit considers only those variables whose values are obtained from behavioural equations. These variables are as follows: inflation (*cpi_sa*), money supply

[30] Since in our the volume of GDP is determined by a supply side not only in the long run, but also in the short run, the difference between actual and potential volumes of GDP is not fully compatible with a traditional notion of output gap in the strict sense. In fact, this difference is used in our model as error correction mechanism, (*ecm_rgdp*). The notion of output gap is about measuring the margin between potential GDP and its actual volume informed by volatility of aggregate demand. In our case, actual GDP is determined by a supply, not a demand side.

(*m1_sa*), capital (*k*), cumulative investment in inventories (*rci_cml_sa*), government consumption (*rgc_sa*), NPISHs consumption (*rngc_sa*), household consumption (*rhc_res*), investment in fixed assets (*ri_sa*), exports (*rx_res*), GDP (*rgdp_sa*), and wages (*rw_res*).

The best fit has been obtained for such variables as inflation, money supply, capital, GDP and wages. A relatively good fit has been obtained in the equations containing a number of aggregate demand components, namely government consumption, investment in fixed assets, and cumulative investment in inventories. For household consumption there is a difference between fitted and actual values at the end of the sample. This can suggest that there are changes in consumption function over the last years (specifically, a reduced inertia in contrast to the specification of the equation).

For the NPISHs equation, fit is not very good. This can be explained by the equation specification. However, NPISHs share in the aggregate demand is rather small, there is no substantial influence of the error that the component generates on the final modelling outcomes.

As for the exports equation, there are relatively large deviations between fitted and actual values registered in some periods of the sample. These deviations are related to a big number of short-run factors of a random nature. These factors can exert influence on external demand over a certain time span. They can be accounted for only by inclusion of a large number of dummies into regression equation. As such, this is not the best strategy.

To summarize, it is possible to claim that the model built is consistent and that it provides a proper description of major relationships among the sectors of the Belarusian economy.

Static solution

The next option used to solve the model is a ‘static solution’. This option employs actual values of endogenous variables until a period previous to a current one. Variables fitted by the model are then used to obtain values of endogenous variables in the current period. By its nature, static approach provides an opportunity to explain economic dynamics for one period ahead by using actual values up to the current period. Model can then be solved for the entire sample since actual data on the previous values of variables are available. However, static solution does not provide an opportunity to make a retrospective forecast more then for one period forward.

The results of the static solution of our model are shown in the Appendix C. In comparison with model fit, this solution has not substantially

altered conclusions about the model consistency related to its ability to show structural relationships existing in the Belarusian economy. In addition, model values of equilibrating indicators (imports and net exports) have displayed a relatively high quality of forecast. Estimate quality is also relatively high for the capital series, error correction mechanism from the capital equation (*ecm_k*), and GDP. So a hypothesis that output (both in the long run and the short run) is determined by a supply side can not be rejected. Moreover, quality of one-period forecast for these series suggest that equilibrating mechanism of supply and demand, where imports and investment play a crucial role, is close to the real one that exists in the Belarusian economy.

At this stage of estimation, some drawbacks of the model can be shown. For instance, there is a relatively sizeable deviation between actual and fitted values of error correction mechanisms used for investment in fixed assets and investment in inventories. Besides specification shortcomings, additional equilibrating variables are missing in the model. These are interest rate and the function of interaction among economic agents at market for credit and capital. Therefore, the quality of the model is informed by a number of assumptions that simplify the functional structure of the Belarusian economy. However, these assumptions are made on the basis of some of characteristic features of the economy of Belarus.

Dynamic solution

A dynamic model solution in a current period requires us to use the values of endogenous variables computed by the model for previous periods. This option illustrates how far model is appropriate to make forecasts (e.g. on the basis of quality of retrospective forecast). The results of the dynamic model solution and corresponding retrospective forecast are shown in the Appendix D.

There is however some deviation registered when GDP series have been estimated. This deviation is likely to be caused by growing discrepancies in the capital series and corresponding error correction mechanism (*ecm_k*). Discrepancies are caused, in turn, by differences between estimated and actual values of volume of investment in fixed assets. Ultimately, the underlying cause is simplified assumptions made due to institutional imperfections of the Belarusian economy.

Yet, the model allows to forecast the value of the major equilibrating element, that is, imports. In the end, it is possible to conclude that the functional structure of the model properly reflects interrelationships among and interactions across the sectors of the Belarusian economy. Also, predeter-

mination of aggregate demand by a supply side in the short run and the functioning of equilibrating mechanism seem to be very close to the reality.

However, the dynamic solution of the model displays a growing difference between real and predicted value of several variables. The main 'problematic' variable, that plays a significant role in the model, is investment in inventories. As it can be seen from the Appendix D, predicted values of this variable are located at the centre of fluctuations of the real values. The dynamics of the series are intact, while its variation is not properly reflected. Nevertheless, there are strong reasons to suggest that the role of this variable in the economic model is denoted correctly. At the same time, there is a need to improve specification of the corresponding equation that deals with a long-run relationship.

Similar situation is observed when indicators of the monetary sector are considered. These are money supply, inflation, and real exchange rate. Their dynamics do not only reflect structural distortions existing in the Belarusian economy and impossibility of modelling of some functions, but also suggest ways to improve specification of the equations that contain these variables[31]. If there were possibilities to add market for credit and capital (in accordance with the available data and on the basis of sound theoretical assumptions) into our model, then monetary aggregates $M2$ and $M3$ and their relationship to $M1$ could be modelled.

Since there has been no possibility to include capital, labour, and some other markets, whose functioning is distorted by the government interference, the model can not be used to predict a number of indicators determined at these markets. However, the model properly reflects the functional interrelationships existing in the Belarusian economy. In order to improve the quality of the model forecast, exogenous variables of the model can be changed according to expected changes in the variables not included in the model. For instance, instead of an assumption that a shock is likely to cause employment reduction, a corresponding change in the level of employment can be specified.

5.3. Imitation modelling and properties of the model

In order to illustrate model properties, response of the variables to various shocks has been studied. Shocks of one variable have been considered to simplify analytical endeavour. Since forecasting properties of the model are far from being perfect (as well as possibilities to compare results), within-the-sample shocks have been modelled. These shocks are as follows: nomi-

[31] For instance, functions performed by market for credit and capital are not included into the model and distorted in the reality. Also, interest rate has lost its indicative role.

nal exchange rate shock (e.g. caused by currency market deficit), government consumption shock, exports shock (e.g. caused by reduction of exports), and imports shock (e.g. caused by growing demand for imports), money supply shock (e.g. caused by increase in money supply by the National Bank). Also, labour market/employment shock has been analyzed (exogenous reduction of employment) that can accompany other shocks.

For illustrative purposes and data comparability, one-period changes of the variables at a rate of 20% (10% for employment) have been suggested at the beginning of the 1st quarter of 2004. The resultant series obtained have been then compared to the series obtained from the dynamic model solution described above. The shock has also been modelled as a deviation from a series obtained from the dynamic model solution, and not from an actual series.

Exchange rate shock

This scenario envisages a 20%-devaluation of nominal exchange rate. The results are shown in the Appendix E. In the model, this shock mainly impacts money supply and inflation: price increase would accelerate but to a lesser extent than devaluation (inflation grows against the baseline scenario by 10% on average over a period). The likely reaction of the domestic economy is reduction of household consumption, while other components of the domestic demand would be intact. Moreover, after two quarters, household consumption would reach its previous level and even exceed it (in contrast to the baseline scenario).

The response of the external sector to nominal and real exchange rate shocks is more intriguing. Foreign trade adjustment would occur due to shrinking imports. So it appears that exchange rate shock would lead to improvement of trade balance after three quarters after this shock thanks to the dynamics of imports, not exports. The disequilibrium between supply and demand would be smoothened by change in investment in inventories. As a result, over the whole after-shock period, there would be no impact on the total level of income (although GDP is expected to decrease slightly). This shock illustrates the effects of administrative influence of the state on the functional interrelationships existing in the Belarusian economy. In the real world, this shock would be accompanied by changes at market for capital and credit (due to the response by households) and at currency market. In turn, this could cause some negative repercussions for the economy as a whole. However, these factors have not been considered in the model.

Government consumption shock

A 20%-increase in the volume of government consumption is suggested. The results are depicted in the Appendix F. In our model, this would lead to a corresponding decrease in investment in fixed assets (by 26.8% in the next quarter; on average over a period investment would go down by 16% against the basic level). It follows that there is a crowding-out effect that negatively affects domestic demand. This stems from the fact that investment/GDP ratio is two times higher than government consumption/GDP one. If there is a 3.7%-increase in domestic demand (against the basic level) in a period when a shock has occurred, then in the next, after-shock period, demand would likely to go down by 5.4% against the basic level. In turn, households would react by a slight reduction in their consumption. On average, domestic demand would decrease by 1.7% against the basic level. This is balanced by the corresponding reduction of the volume of imports improving trade balance. Intermediate fluctuations of demand would be smoothened by change in investment in inventories.

Imports shock

In this scenario, a 20%-increase in imports is suggested. The results are shown in the Appendix G. Initially, imports shock has been smoothened by change in investment in inventories (growth by 11.3% in a current period, and in an after-shock one – by 18.9% against the basic level). In other words, deterioration of trade balance would be compensated by expansion of domestic demand. Firms would react to increase in imports by investing more. This is related to the specific feature of the Belarusian economy, namely that a considerable increase in the volume of imports is usually related to favourable market conditions and increase in volume of investment in fixed assets. According to this scenario, investment would grow gradually, and by the 4^{th} quarter of 2005, their basic level is 1.5% higher than the basic one. Investment growth would also inform increase in capital stock, thereby pushing potential GDP up. As a result, after several quarters GDP would be increased. In the nominal sector, changes would be mainly related to growing money demand and, as a result, would decelerate price increase and thus lead to real exchange rate depreciation.

Exports shock

This shock is modelled as a 20%-decrease in volume of exports against the dynamic model solution. The results are provided in the Appendix H. This

shock is a very good illustration of the relationship between exports and imports in Belarus, and the dependence of the latter on the former. This dependency is caused by the necessity to increase intermediate imports when external demand for Belarusian goods goes up. Accordingly, the major consequence of exports reduction would be decline in the volume of imports albeit at a lesser extent. Deterioration of trade balance would be primarily compensated by increase in investment in inventories. In a quarter after shrinking imports (caused by exports shock) there would be outcomes observed similar to the previous shock. However, these repercussions could be ignored because of their negligibility.

Money supply shock

This scenario envisages a 20%-increase in the volume of aggregate *M*1 against the basic level. The results are shown in the Appendix I. The order of responses to this shock is rather specific. The first stage entails accelerated price increase against the basic level and real wage reduction. As a result, household consumption affected adversely. At the same time, real exchange depreciation (observed from the shocks discussed above) would lead to increase in the volume of exports and, at the same time, imports. However, trade balance would be improved. Investment in inventories would perform an equilibrating role in domestic and external demand. After three quarters, accommodating policy would drive real wages upwards. As a result, household consumption would increase (also because of the intertemporal substitution effect stemming from a high inflation). In response, enterprises would decrease volumes of their investment in inventories. In general, it is unlikely that money supply shock would substantially impact aggregate demand.

Employment shock

A 10%-decrease in employment (against the exogenous level) is suggested; the results can be found in the Appendix J. It is more appropriate to consider employment shock in conjunction with one of the other shocks. This is because employment correction mechanism is not included in our model. Nevertheless, employment is still important in determining the level of aggregate supply and short-term output dynamics. It follows that employment shock would likely ignite a continuous reaction of the economic system as a whole. This is a strong reason for the economic authorities to avoid adverse labour market shocks by using administrative levers available.

The shocks modelled above suggest a direction of response of the model variables. However, the modelling has not accounted for the exis-

tence of additional mechanisms. The latter are not included in the model. As a result, quantitative forecasts are not reliable in the strict sense. The model, however, shows what kind of behavioural responses have to be considered when estimating various effects. Moreover, employment shock illustrates the specific features of the Belarusian labour market and a more general supply-side interrelationships existing in the economy of Belarus.

6. LIMITS OF THE MODEL APPLICATION AND DIRECTIONS FOR FURTHER RESEARCH

The macromodel for Belarus presented in this research is based on the sectoral approach and takes into account specific features of the country. Peculiarities of the Belarusian economy distort the functions major performed by major markets. Such distortions are observed at the labour, capital, and credit markets, and – to some extent – at the money market. There are specific mechanisms of adjustment of demand and supply at the labour market and of interest rate at the money and credit markets. This complicates modelling of the Belarusian economy when the 'benchmark' functional and economic structure of macromodels is employed. For instance, our attempts to apply the concept of output gap to the Belarusian economy have not been successful. As a result, these markets have not been considered in the model.

However, in the real economy these markets perform their functions, but in distorted ways. Hence, exclusion of the mentioned markets from the scope of the model limits possibilities for its application. Like for any other model, it is not designed to encompass the whole Belarusian economy, but to describe its major characteristics in a simplified way. Despite the fact that there is a room to improve our model, the macromodel presented in this research has resulted in the following findings.

First, the model has revealed specific mechanism of the functioning of the economy and its structural relationships, which reflect realities of the Belarusian economy. This mechanism suggests that the nature of short-run fluctuations differs from the 'benchmark' economic system. Like in other economic models, the long-run equilibrium is determined at the supply side. However, in the model presented, the supply side determines short-run dynamics of GDP and some other short-run fluctuations in the Belarusian economy. In this case relationship between the national actors with the external sector, as well as functions of financial sector play secondary role in explanation of economic dynamics. Investment in inventories (variable 'change in inventories') is an additional element of the model allowing equilibrium correction in it.

Second, the model equations illustrate quantitative relationships among the sectors of the economy. In this respect, the model can be treated as economically consistent. One-period forecasts (or forecasts for small number of periods) are also consistent.

Third, the model built is in fact the first attempt to research the whole Belarusian economy in a comprehensive way. Thus, it could be used as a basis for building more specific models for selected sectors. For instance,

relationships revealed in the model can be incorporated into modelling of the monetary transmission in the Belarusian economy. Additionally, it can be illuminating in further modelling when a proper understanding of the structural relationships in the Belarusian economy is required.

However, the model has several drawbacks. The main theoretical drawback is the absence of interrelations of economic agents at the labour, credit, and money markets. As a result, a number of important economic indicators (e.g. interest rate) are missing in the model. Another problem is that exclusion of the labour market implies that employment is treated as an exogenous variable in the model. This makes the model more 'short-term', because it does not consider relationships between employment (or similar indicators) and demographic ones. All these drawbacks cause the major applied problem of the model, that is, it can hardly be used for forecasting, especially long-term one.

Given these drawbacks, directions for further research can be suggested. The main finding of the model – determination of the gross income at the supply side both in the long and short run – is caused by the initial assumption about rigidity of demand for labour because of the state interference into the labour market. However, in reality there is some flexibility at the labour market of Belarus. If this flexibility were accounted for in the model, then modified functions of demand and supply could be inserted into the model, thus making it to resemble reality closer. Similar result could be expected from the inclusion of capital and money markets into the model. Thus, the following prospective directions for improvement of the model can be mentioned:

- Quantitative analysis of the labour market agents' behaviour;
- Quantitative analysis of the money market agents' behaviour;
- Quantitative analysis of the credit market agents' behaviour;
- Quantitative analysis of the functions of the banking sector at the money and credit markets;
- Study of the relationship between the interest rate at the money market and the interest rates at the credit and capital markets;
- Quantitative analysis of the reaction of banks to shocks in the real sector of the economy;
- Separate modelling of behaviour of representatives of the state and the private segments of the real sector based on the differences in behavioural patterns of state-run and private enterprises and relationships among them;
- Inclusion of the taxing function of the government to the model.

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A. DYNAMICS OF LEVELS AND FIRST LOGARITHMIC DIFFERENCES OF THE VARIABLES

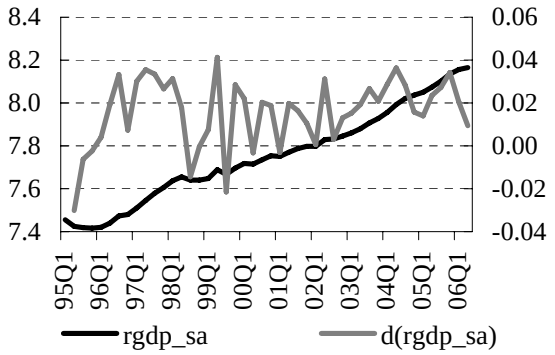

Figure A.1. GDP

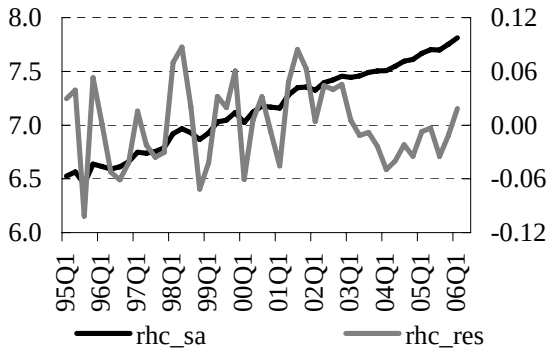

Figure A.2. Household consumption

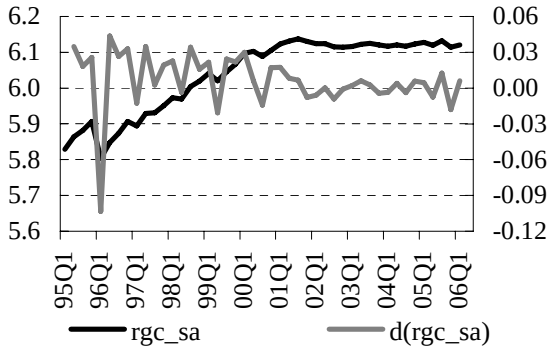

Figure A.3. Government consumption

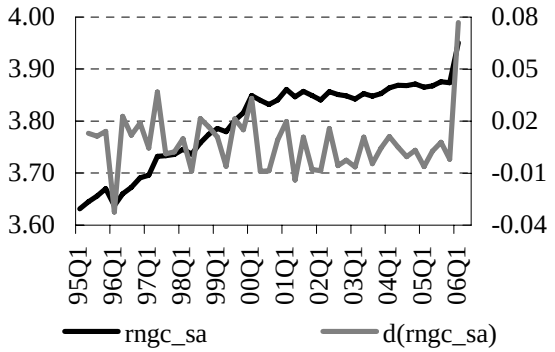

Figure A.4. NPISHs consumption

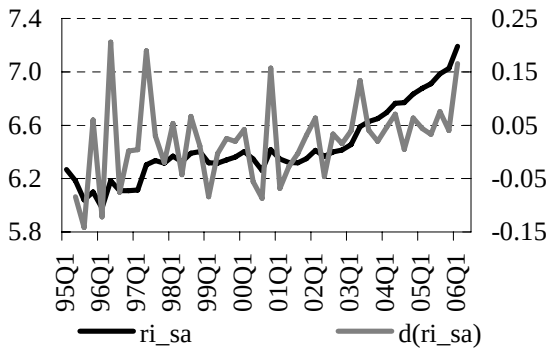

Figure A.5. Gross fixed capital formation

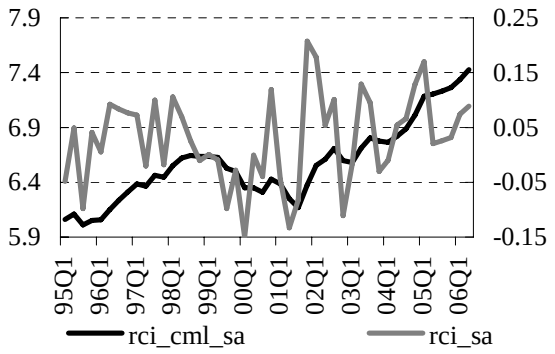

Figure A.6. Change in inventories

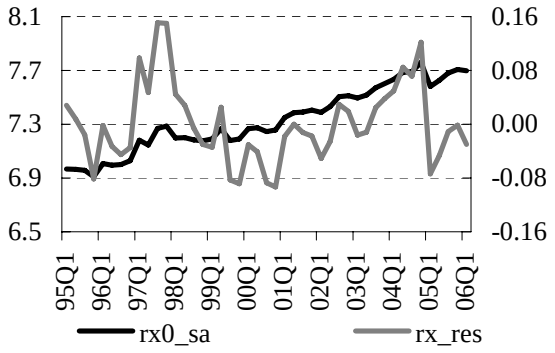

Figure A.7. Exports of goods and services

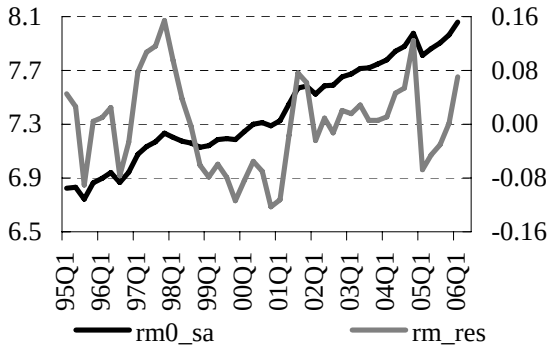

Figure A.8. Imports of goods and services

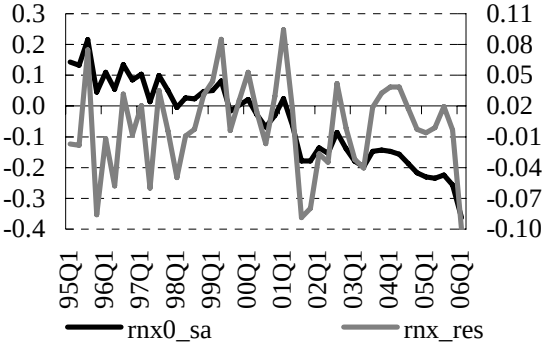

Figure A.9. Net exports of goods and services

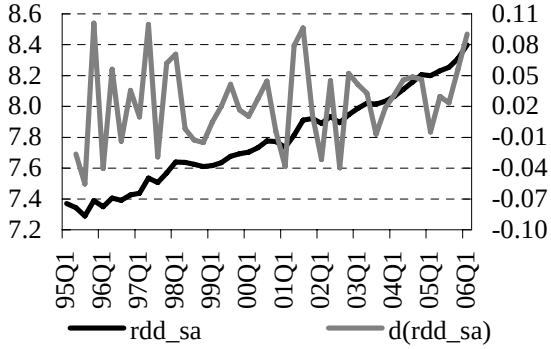

Figure A.10. Domestic demand

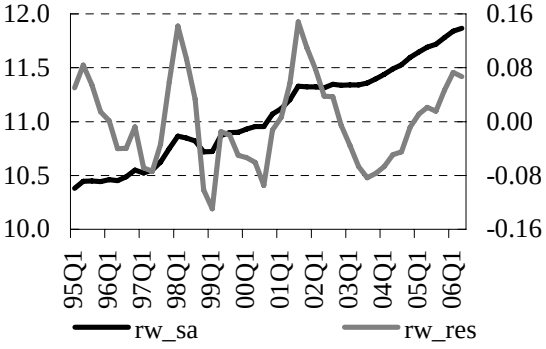

Figure A.11. Average monthly wage

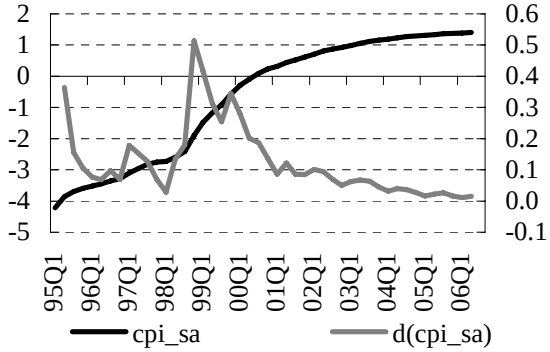

Figure A.12. Consumer price index

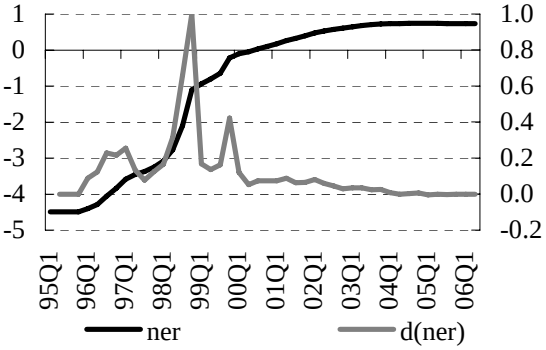

Figure A.13. Nominal exchange rate BYR/USD

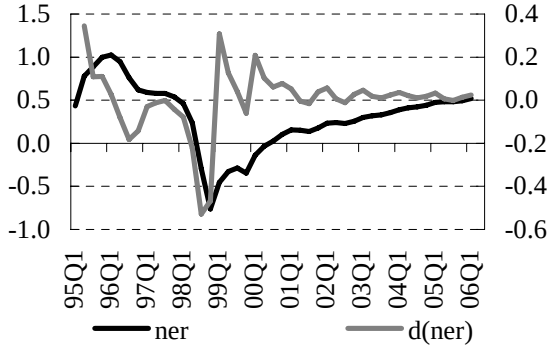

Figure A.14. Real exchange rate BYR/USD

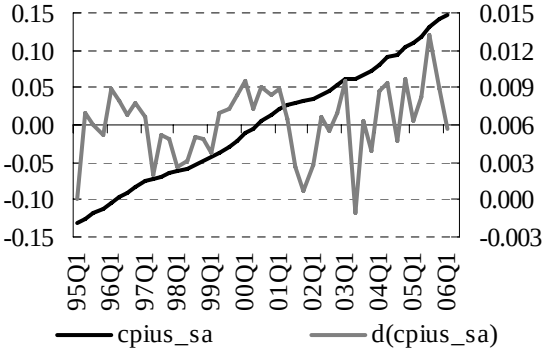

Figure A.15 Consumer price index, USD-denominated

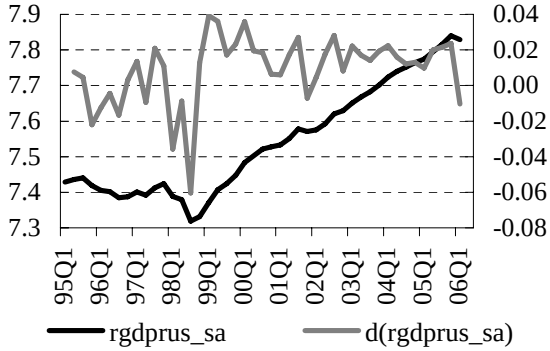

Figure A.16. Russia's GDP

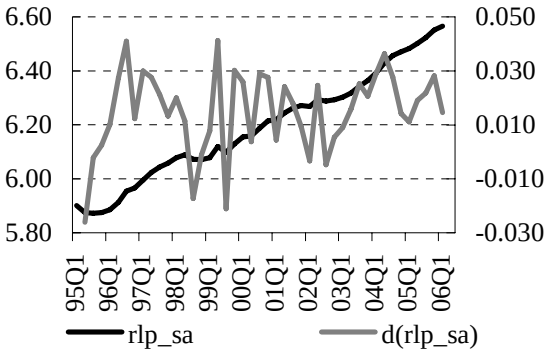

Figure A.17. Labour productivity

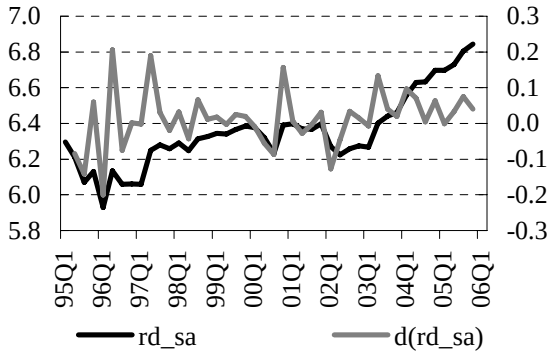

Figure A.18. Depreciation of capital

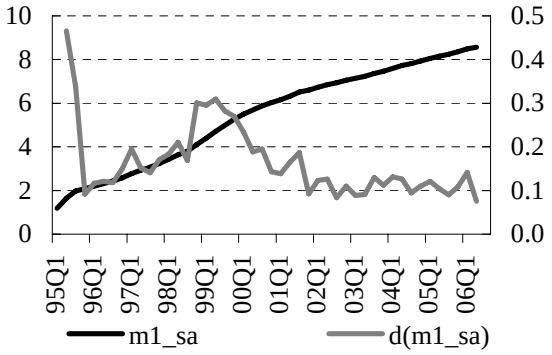

Figure A.19. Monetary aggregate M1 (in current prices)

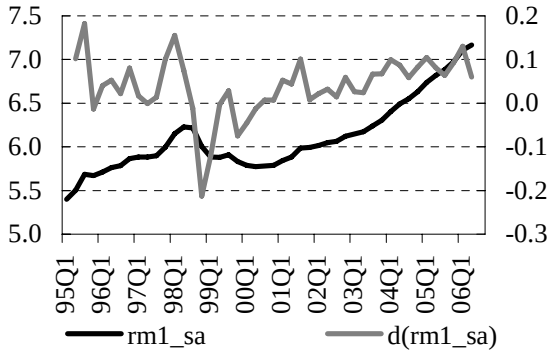

Figure A.20. Monetary aggregate M1

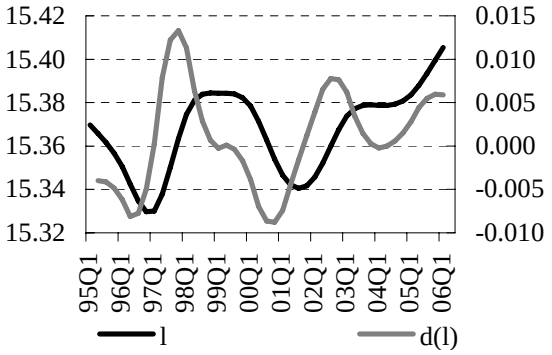

Figure A.21. Employment

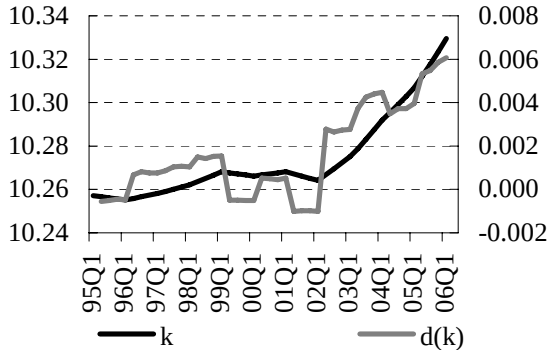

Figure A.22. Capital assets

B. FIT SOLUTION OF THE MODEL

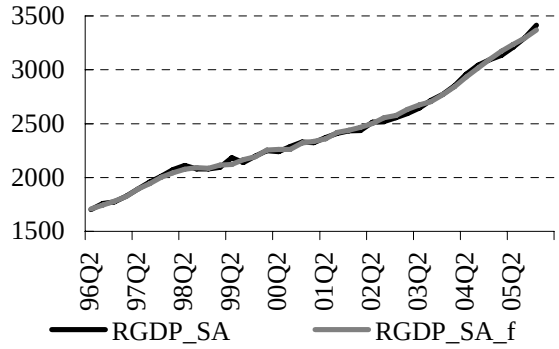

Figure B.1. GDP[1]

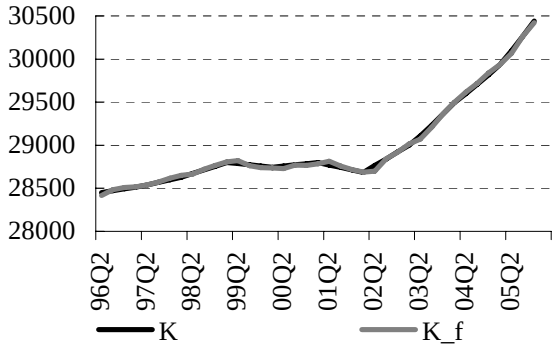

Figure B.2. Capital assets

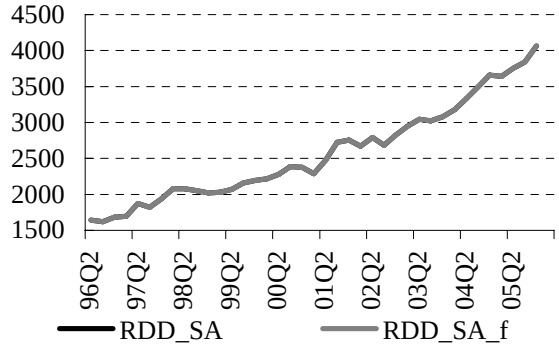

Figure B.3. Domestic demand

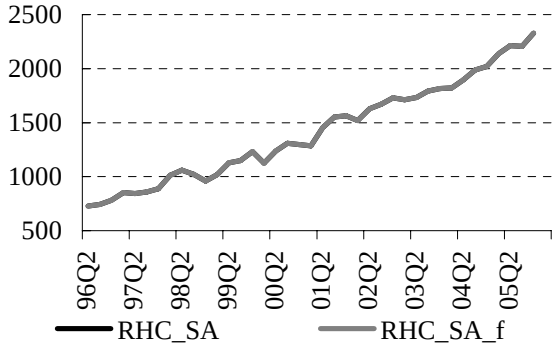

Figure B.4. Household consumption

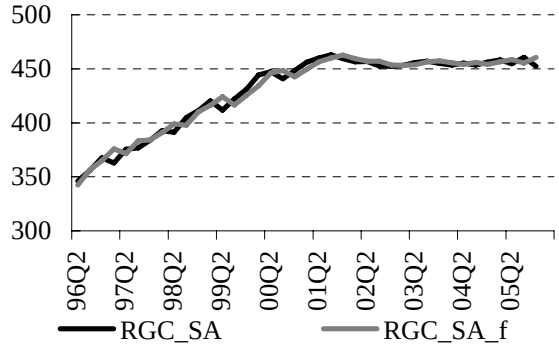

Figure B.5. Government consumption

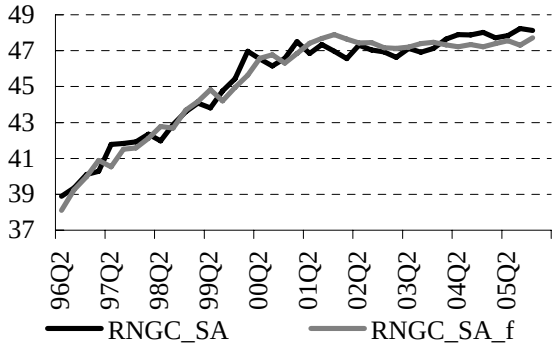

Figure B.6. NPISHs consumption

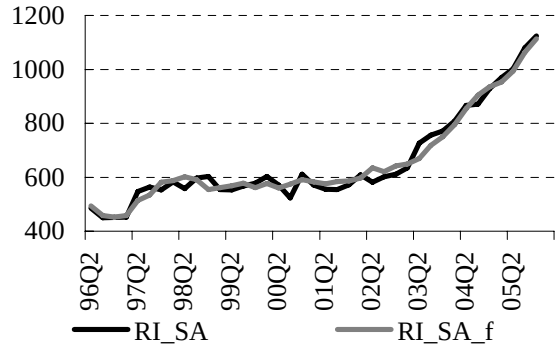

Figure B.7. Gross fixed capital formation

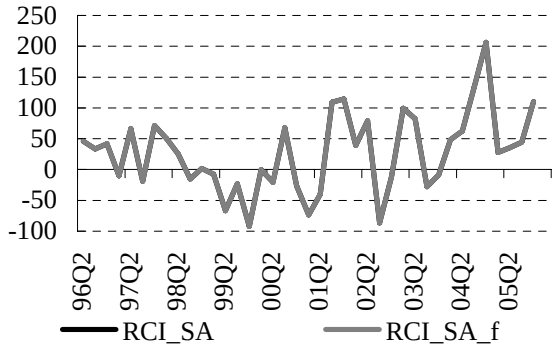

Figure B.8. Change in inventories

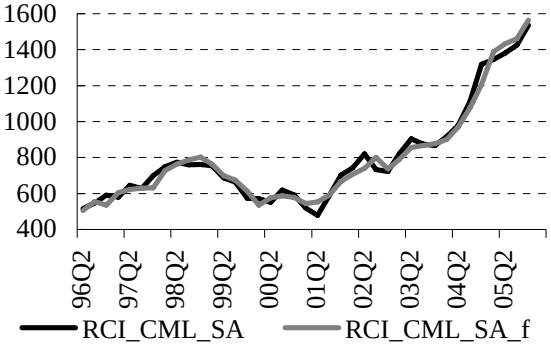

Figure B.9. Level of inventories

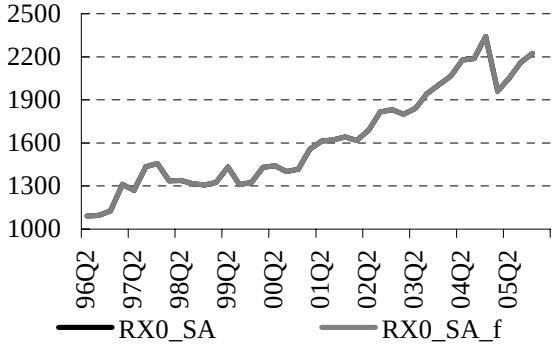

Figure B.10. Exports of goods and services

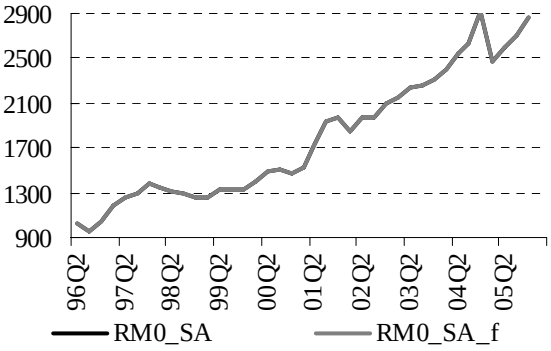

Figure B.11. Imports of goods and services

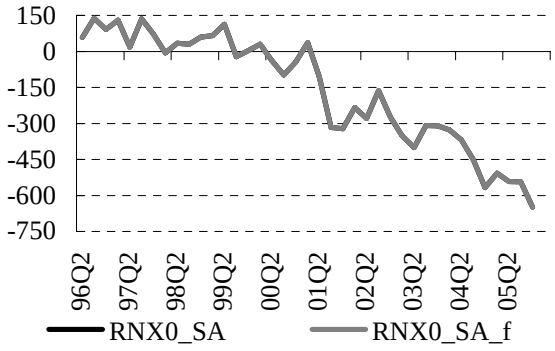

Figure B.12. Net exports of goods and services

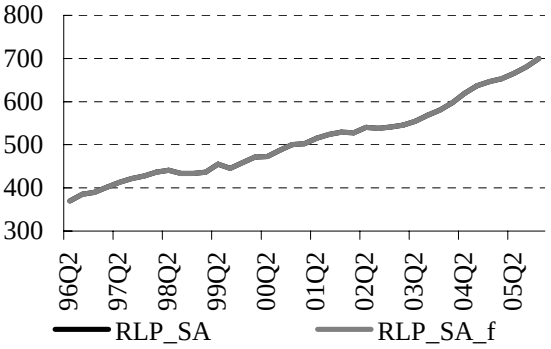

Figure B.13. Labour productivity, BYR thousand per employer

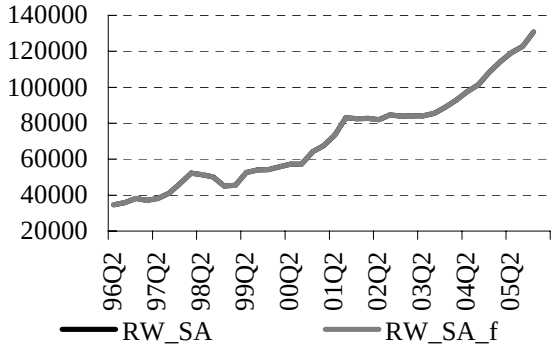

Figure B.14. Average monthly wage, BYR

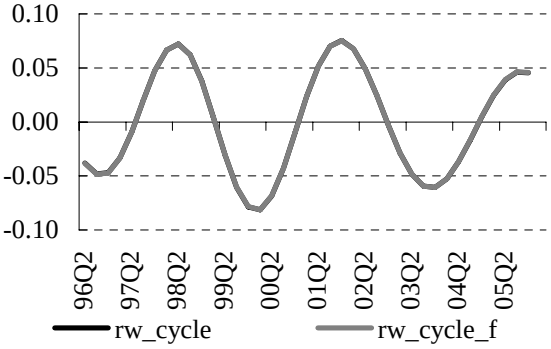

Figure B.15. Cyclical component of wages, logarithmic scale

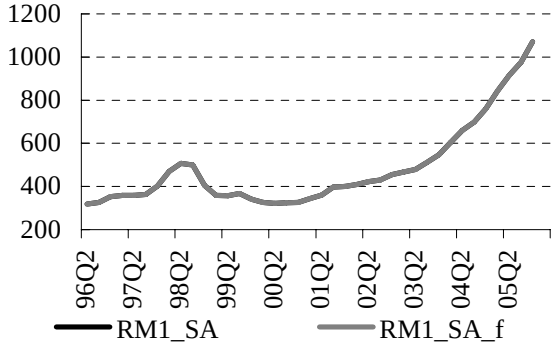

Figure B.16. Monetary aggregate M1

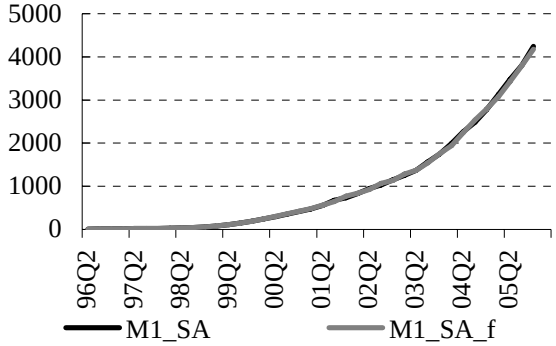

Figure B.17. Monetary aggregate M1[2]

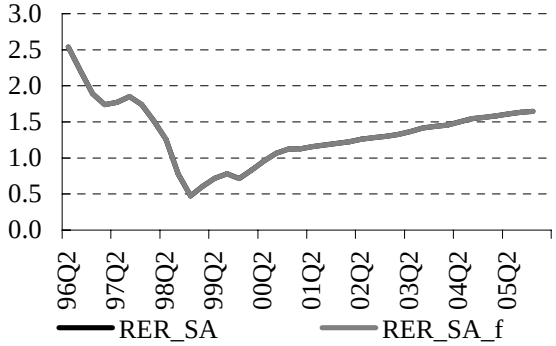

Figure B.18. Real exchange rate BYR/USD, index, 2000 = 1

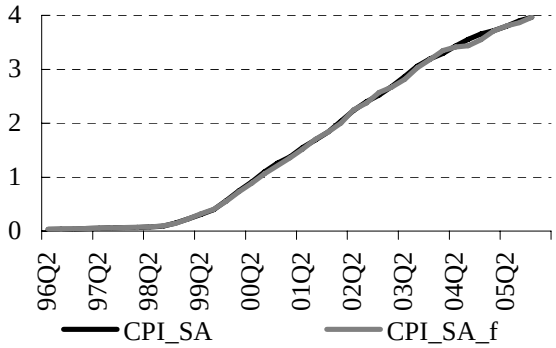

Figure B.19. Consumer price index, 2000 = 1

Notes.
[1] All series are in real terms in constant prices of 2000 (BYR bn), otherwise stated.
[2] In current prices, BYR bn (given denomination of 2000).

C. STATIC SOLUTION OF THE MODEL

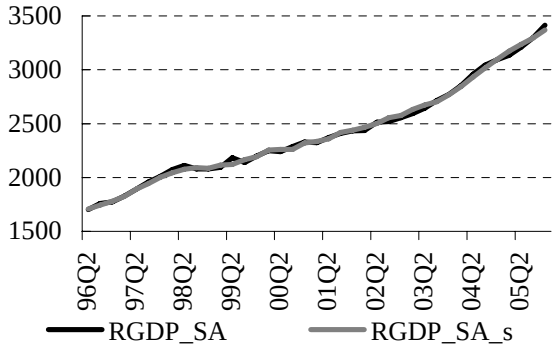

Figure C.1. GDP[1]

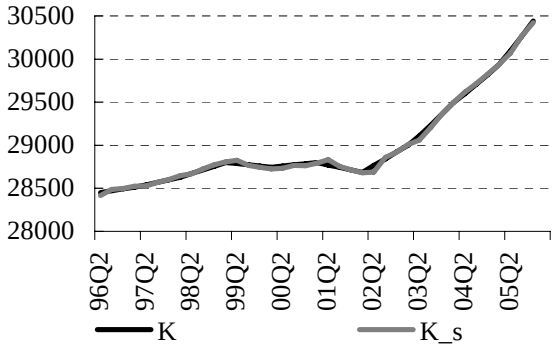

Figure C.2. Capital assets

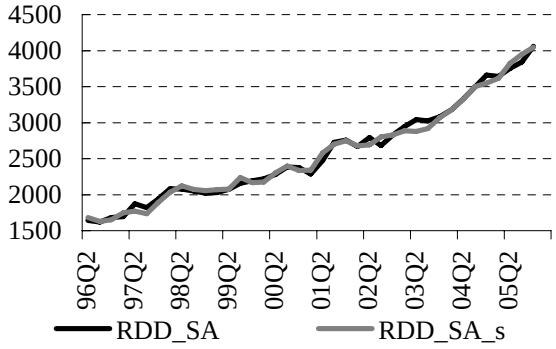

Figure C.3. Domestic demand

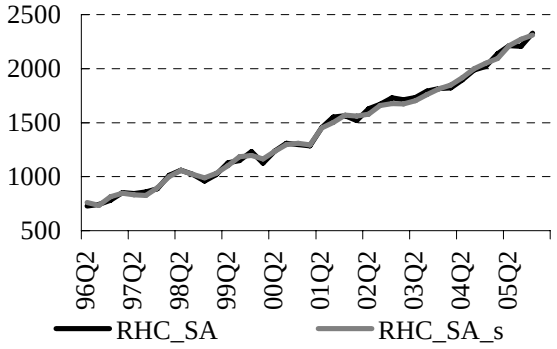

Figure C.4. Household consumption

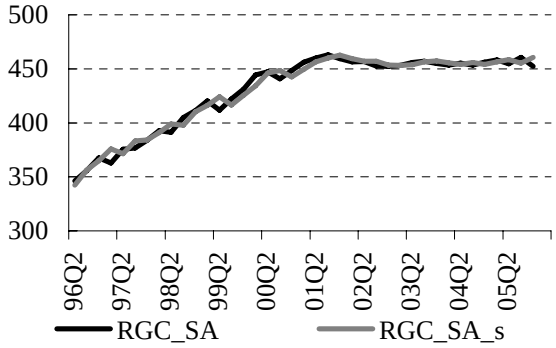

Figure C.5. Government consumption

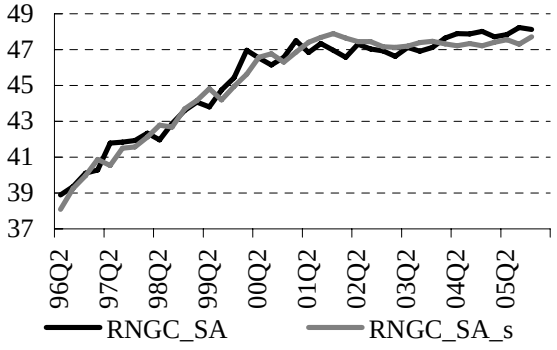

Figure C.6. NPISHs consumption

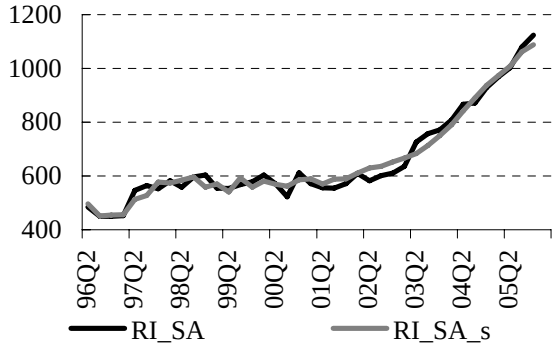

Figure C.7. Gross fixed capital formation

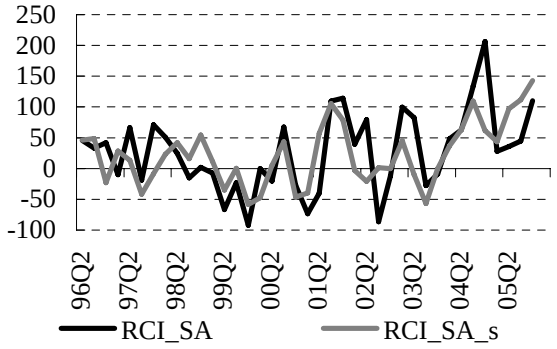

Figure C.8. Change in inventories

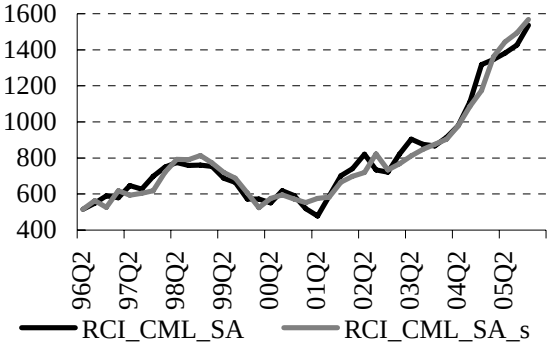

Figure C.9. Level of inventories

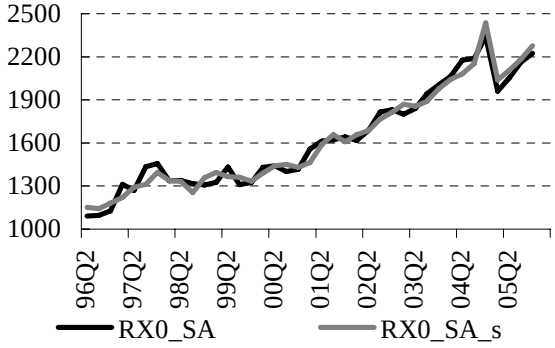

Figure C.10. Exports of goods and services

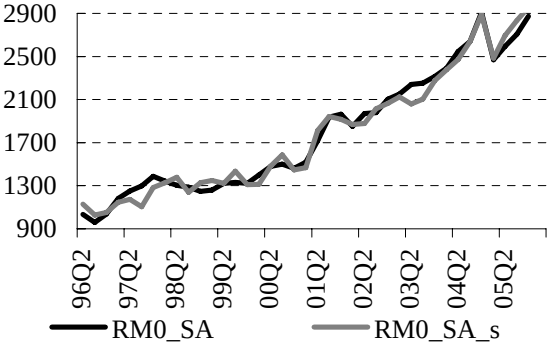

Figure C.11. Imports of goods and services

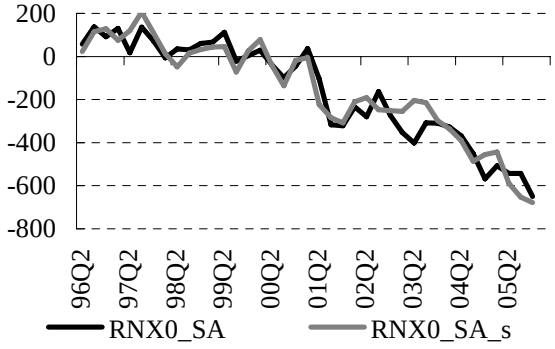

Figure C.12. Net exports of goods and services

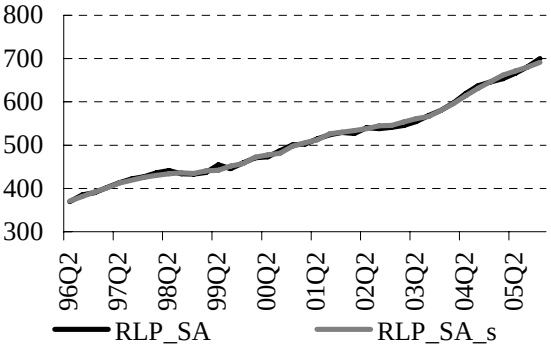

Figure C.13. Labour productivity, BYR thousand per employer

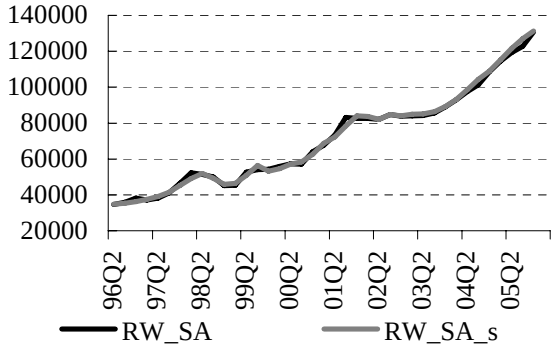

Figure C.14. Average monthly wage, BYR

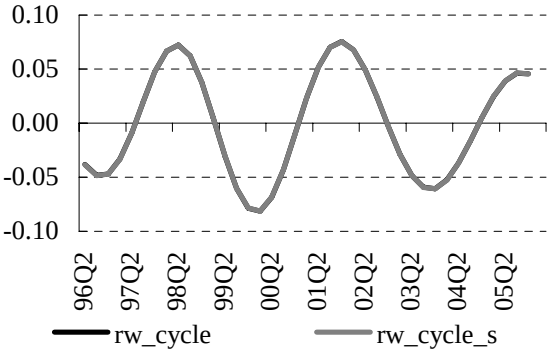

Figure C.15. Cyclical component of wages, logarithmic scale

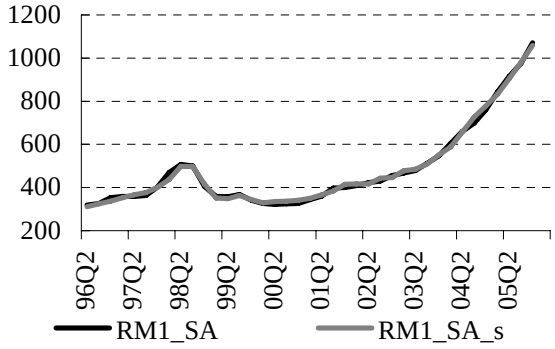

Figure C.16. Monetary aggregate M1

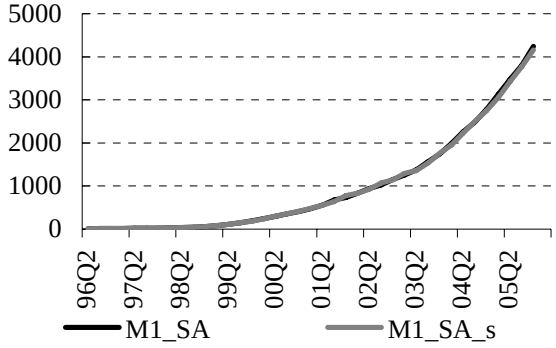

Figure C.17. Monetary aggregate M1[2]

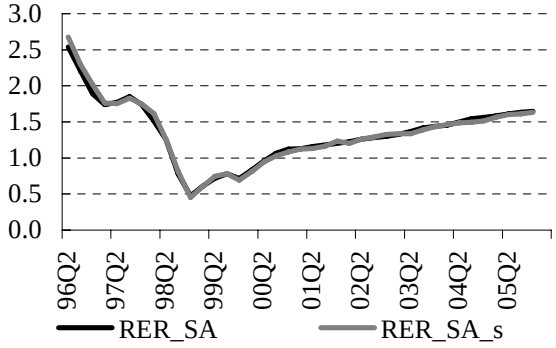

Figure C.18. Real exchange rate BYR/USD, index, 2000 = 1

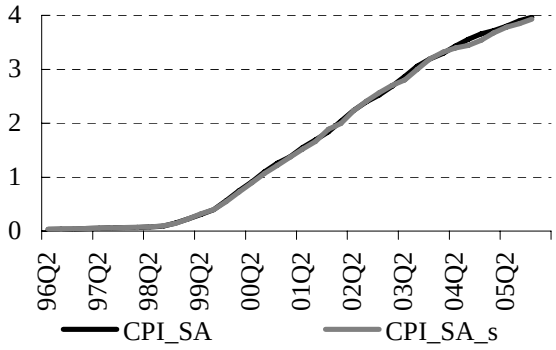

Figure C.19. Consumer price index, 2000 = 1

Notes.
[1] All series are in real terms in constant prices of 2000 (BYR bn), otherwise stated.
[2] In current prices, BYR bn (given denomination of 2000).

D. DYNAMIC SOLUTION OF THE MODEL

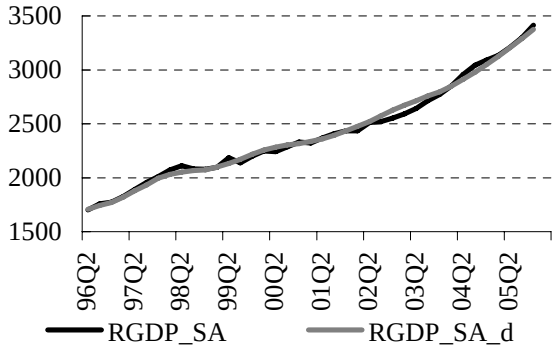

Figure D.1. GDP[1]

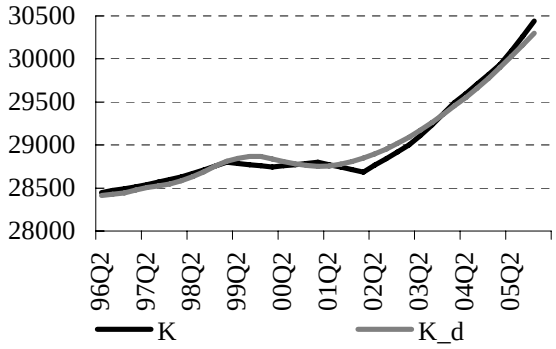

Figure D.2. Capital assets

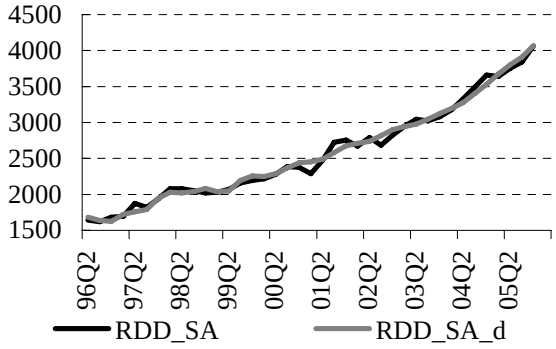

Figure D.3. Domestic demand

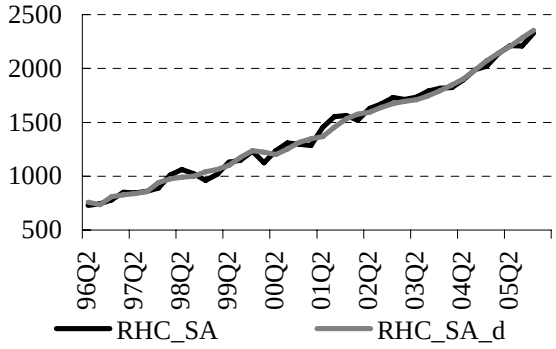

Figure D.4. Household consumption

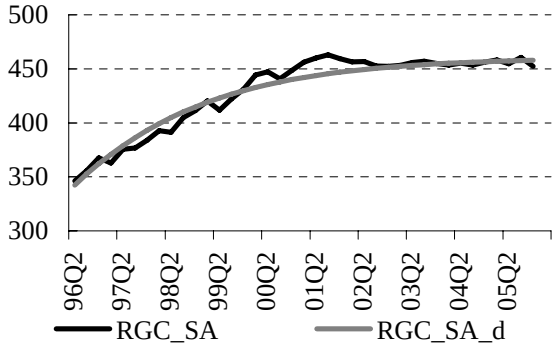

Figure D.5. Government consumption

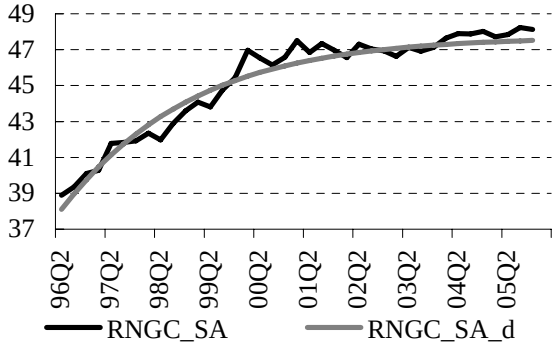

Figure D.6. NPISHs consumption

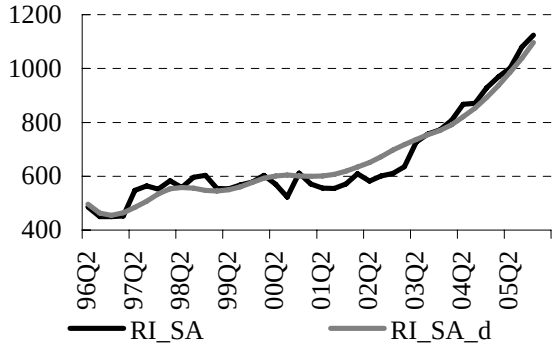

Figure D.7. Gross fixed capital formation

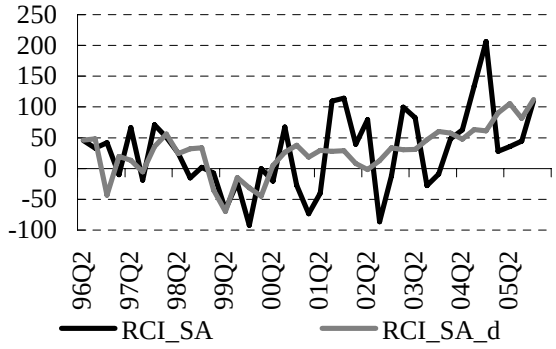

Figure D.8. Change in inventories

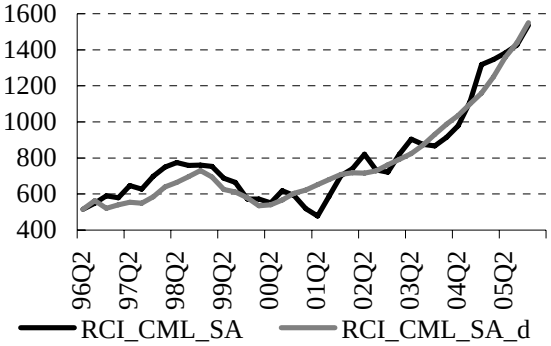

Figure D.9. Level of inventories

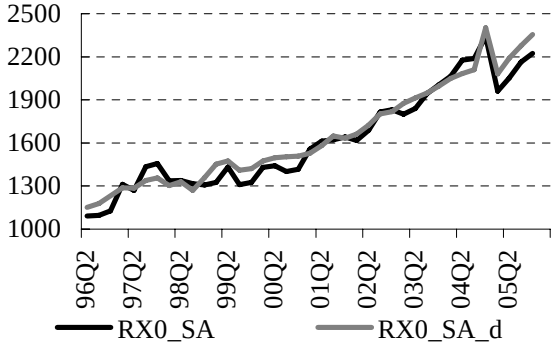

Figure D.10. Exports of goods and services

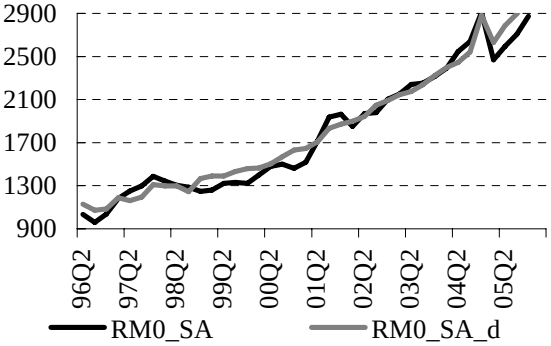

Figure D.11. Imports of goods and services

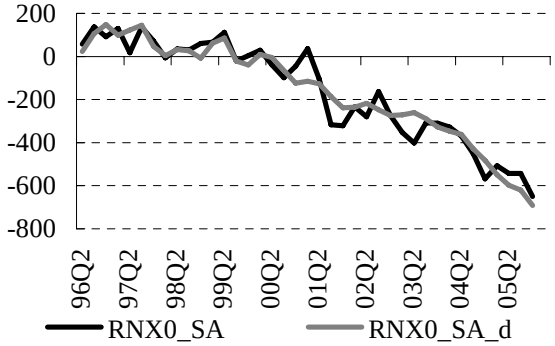

Figure D.12. Net exports of goods and services

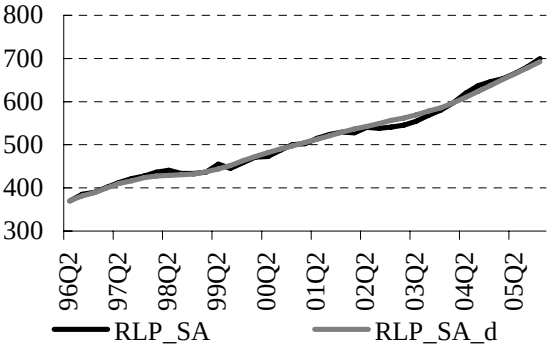

Figure D.13. Labour productivity, BYR thousand per employer

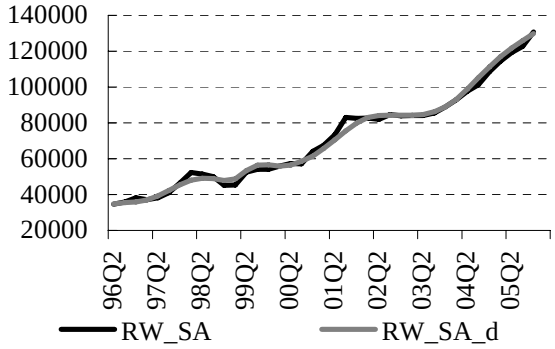

Figure D.14. Average monthly wage, BYR

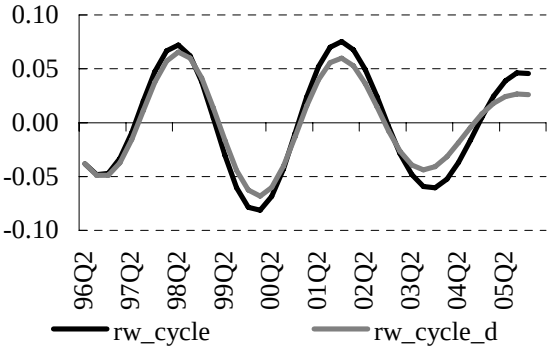

Figure D.15. Cyclical component of wages, logarithmic scale

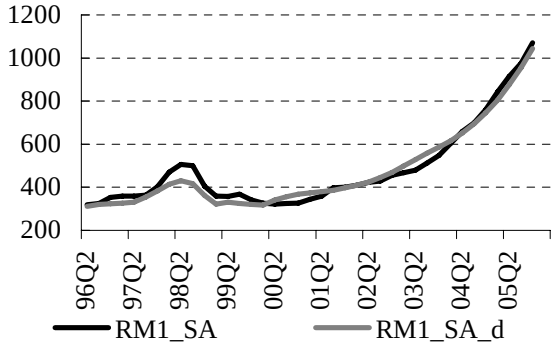

Figure D.16. Monetary aggregate M1

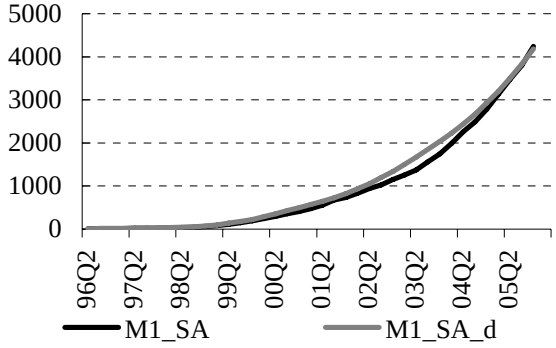

Figure D.17. Monetary aggregate M1[2]

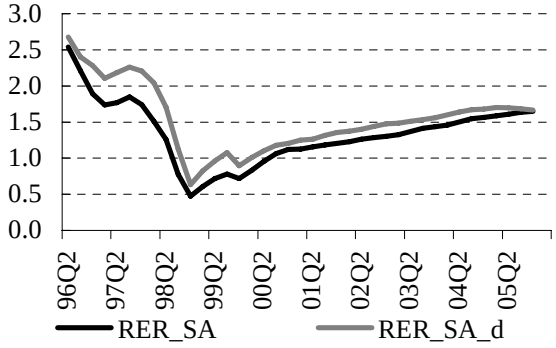

Figure D.18. Real exchange rate BYR/USD, index, 2000 = 1

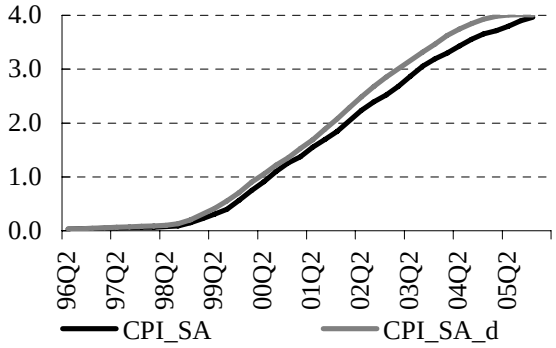

Figure D.19. Consumer price index, 2000 = 1

Notes.
[1] All series are in real terms in constant prices of 2000 (BYR bn), otherwise stated.
[2] In current prices, BYR bn (given denomination of 2000).

E. EXCHANGE RATE SHOCK

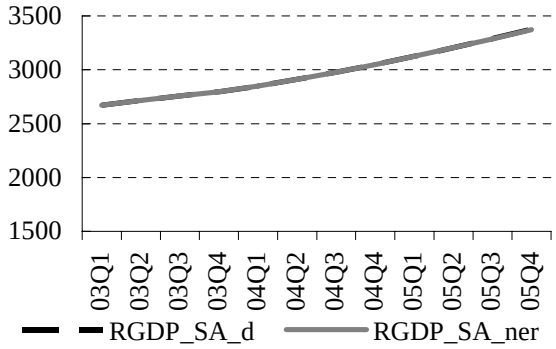

Figure E.1. GDP[1]

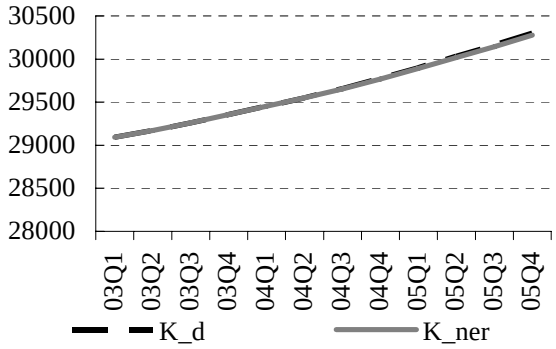

Figure E.2. Capital assets

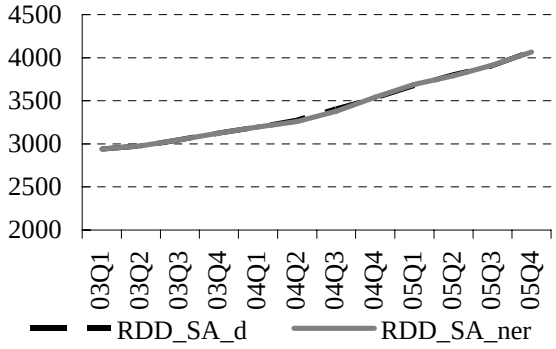

Figure E.3. Domestic demand

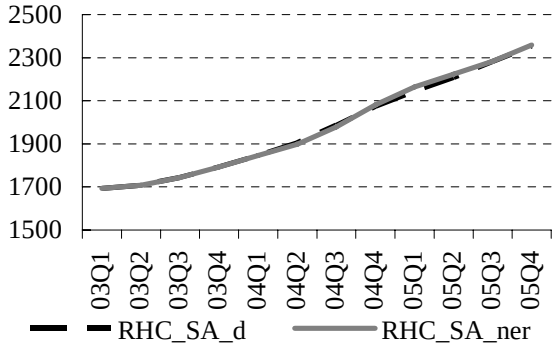

Figure E.4. Household consumption

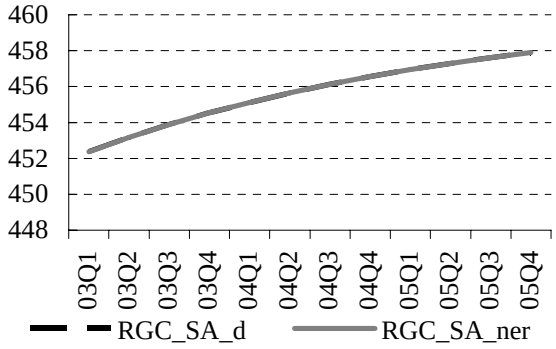

Figure E.5. Government consumption

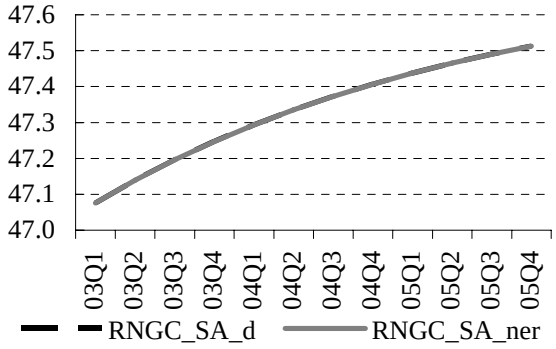

Figure E.6. NPISHs consumption

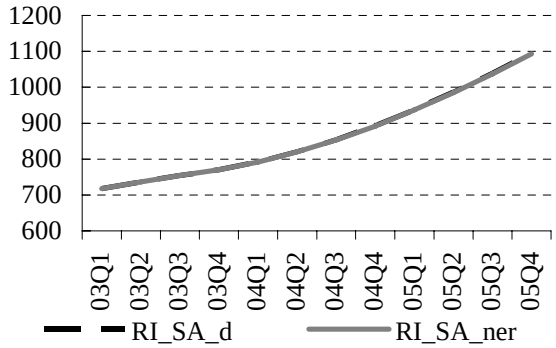

Figure E.7. Gross fixed capital formation

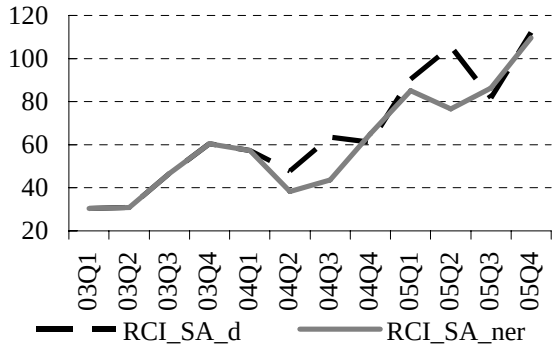

Figure E.8. Change in inventories

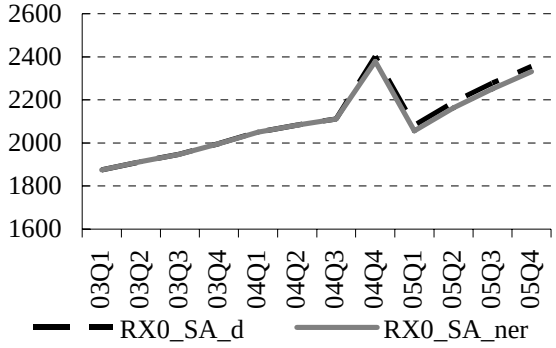

Figure E.9. Exports of goods and services

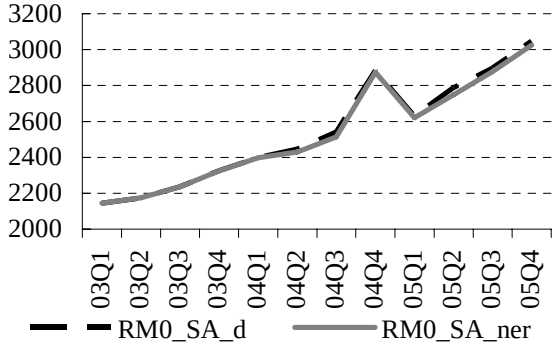

Figure E.10. Imports of goods and services

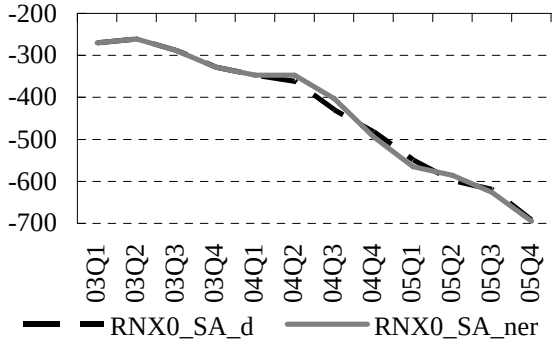

Figure E.11. Net exports of goods and services

Figure E.12. Labour productivity, BYR thousand per employer

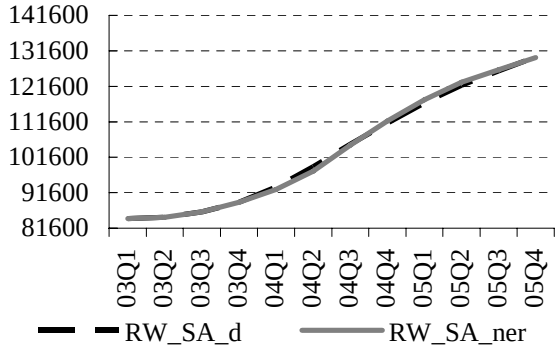

Figure E.13. Average monthly wage, BYR

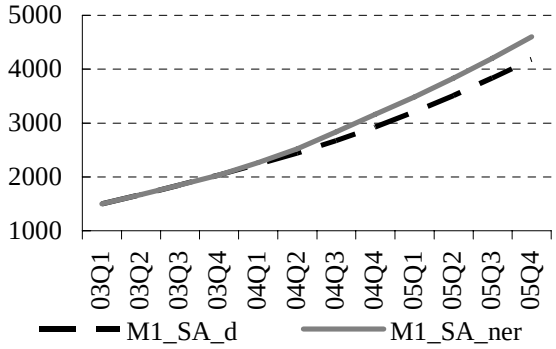

Figure E.14. Monetary aggregate M1[2]

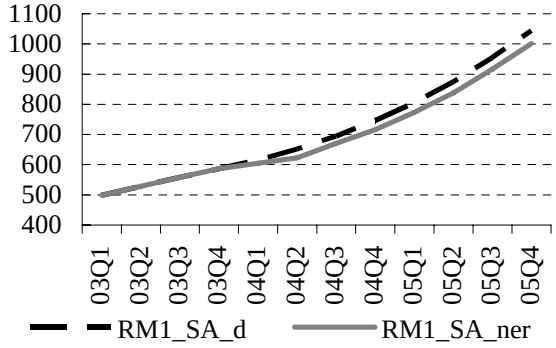

Figure E.15. Monetary aggregate M1

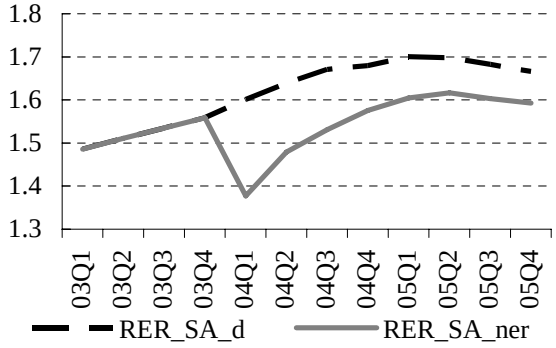

Figure E.16. Real exchange rate BYR/USD, index, 2000 = 1

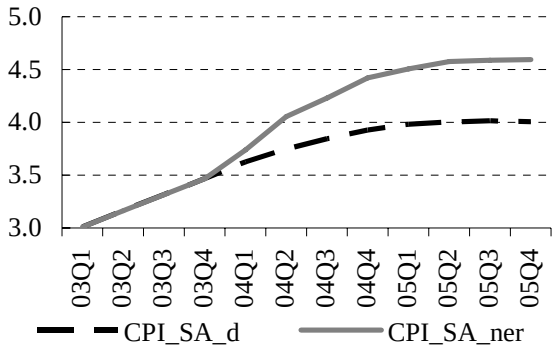

Figure E.17. Consumer price index, 2000 = 1

Notes.
[1] All series are in real terms in constant prices of 2000 (BYR bn), otherwise stated.
[2] In current prices, BYR bn (given denomination of 2000).

F. GOVERNMENT CONSUMPTION SHOCK

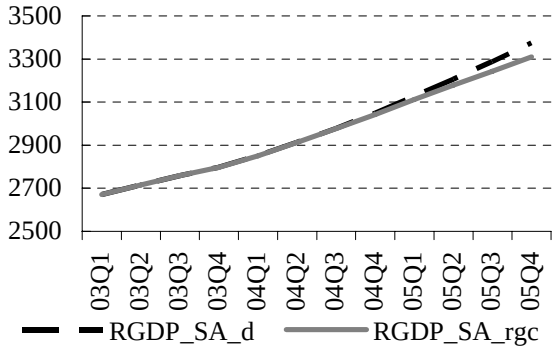

Figure F.1. GDP[1]

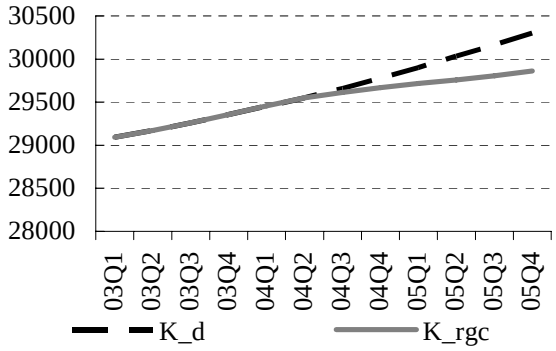

Figure F.2. Capital assets

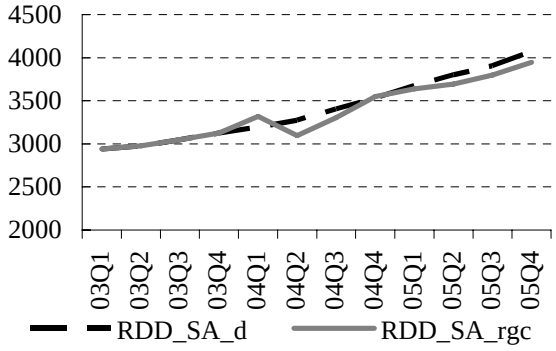

Figure F.3. Domestic demand

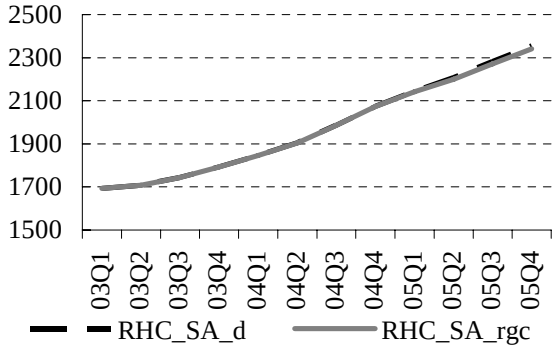

Figure F.4. Household consumption

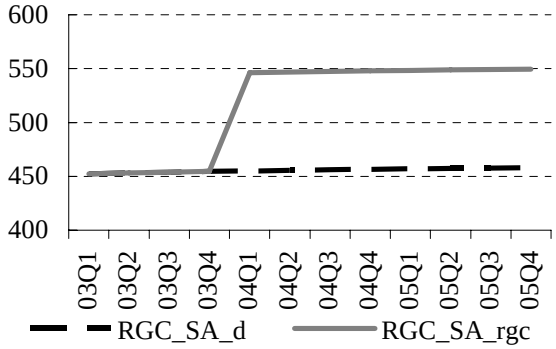

Figure F.5. Government consumption

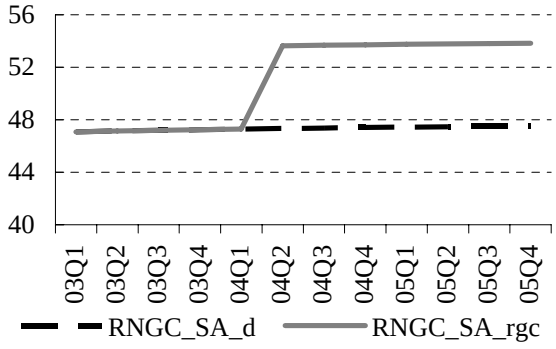

Figure F.6. NPISHs consumption

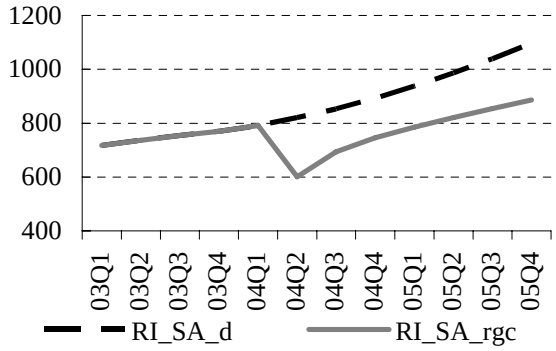

Figure F.7. Gross fixed capital formation

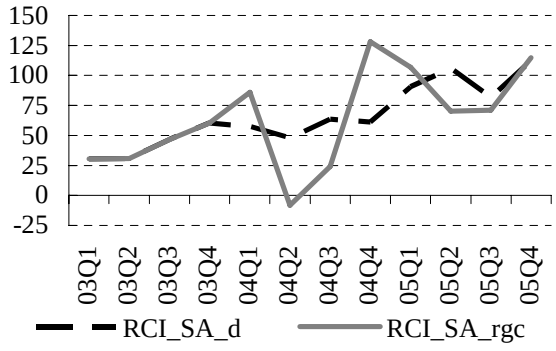

Figure F.8. Change in inventories

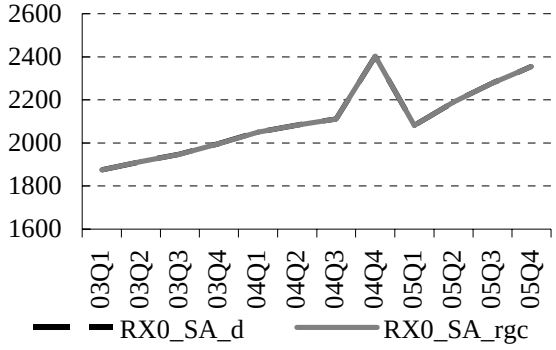

Figure F.9. Exports of goods and services

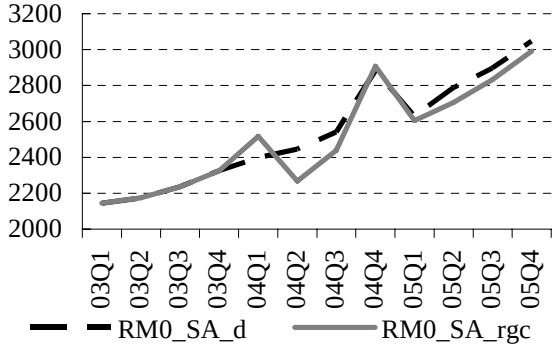

Figure F.10. Imports of goods and services

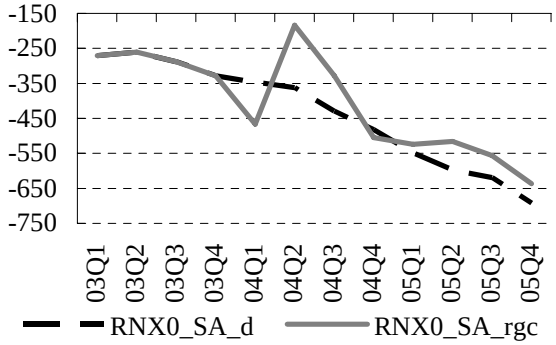

Figure F.11. Net exports of goods and services

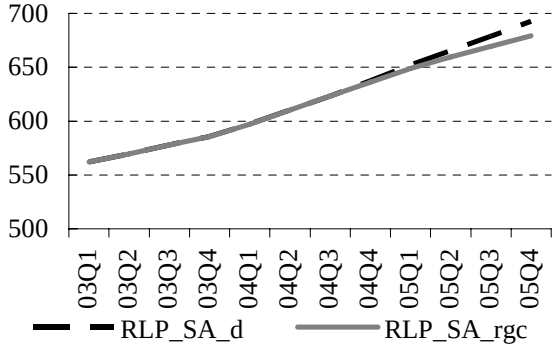

Figure F.12. Labour productivity, BYR thousand per employer

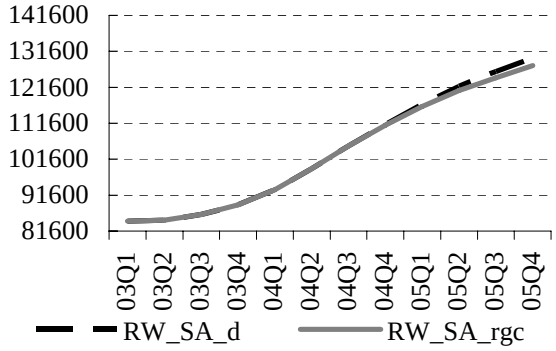

Figure F.13. Average monthly wage, BYR

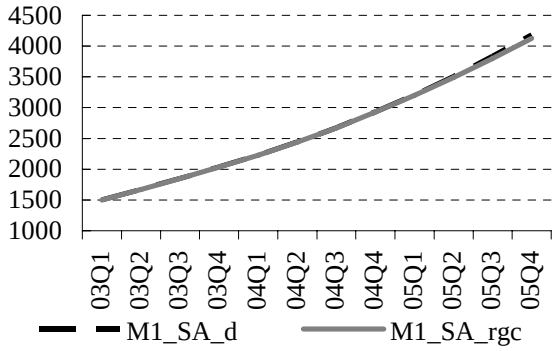

Figure F.14. Monetary aggregate M1[2]

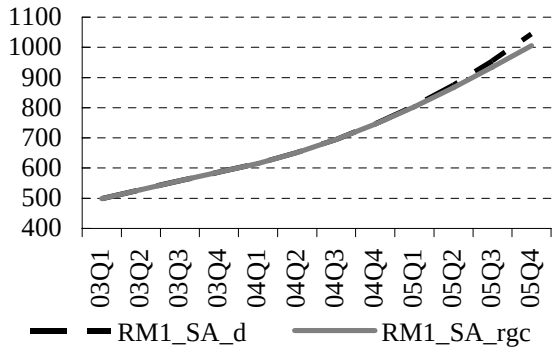

Figure F.15. Monetary aggregate M1

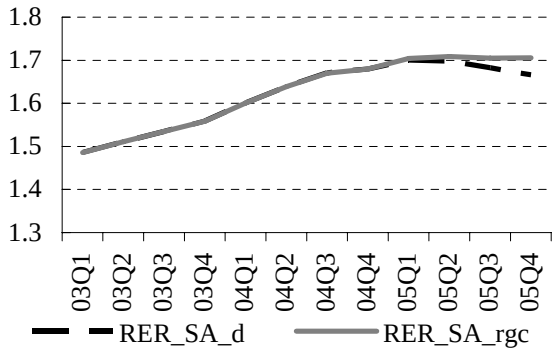

Figure F.16. Real exchange rate BYR/USD, index, 2000 = 1

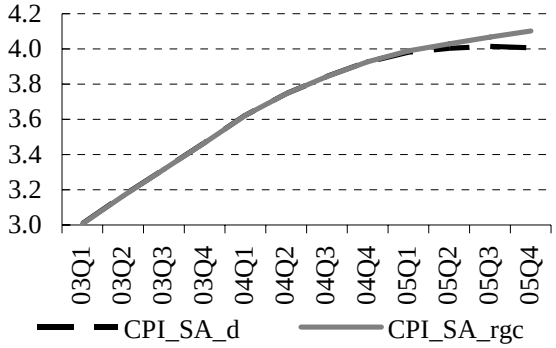

Figure F.17. Consumer price index, 2000 = 1

Notes.
[1] All series are in real terms in constant prices of 2000 (BYR bn), otherwise stated.
[2] In current prices, BYR bn (given denomination of 2000).

G. IMPORTS SHOCK

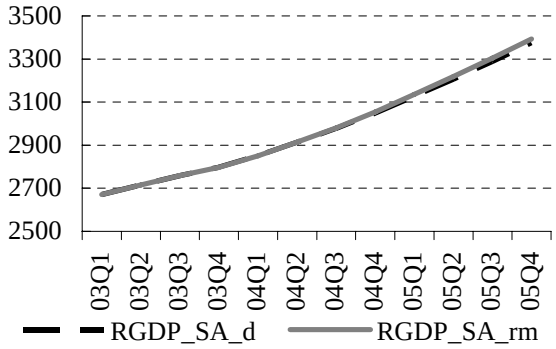

Figure G.1. GDP[1]

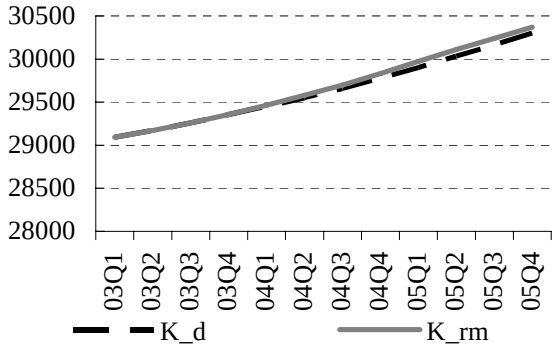

Figure G.2. Capital assets

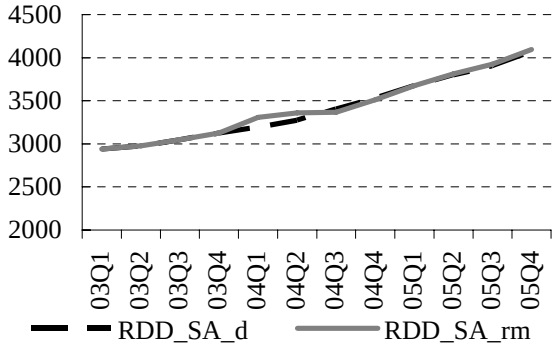

Figure G.3. Domestic demand

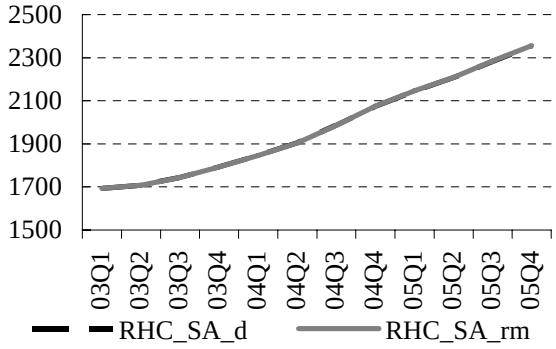

Figure G.4. Household consumption

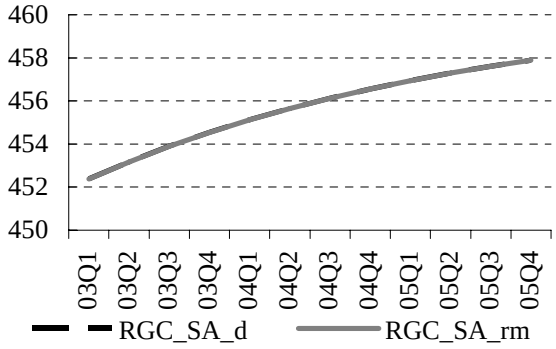

Figure G.5. Government consumption

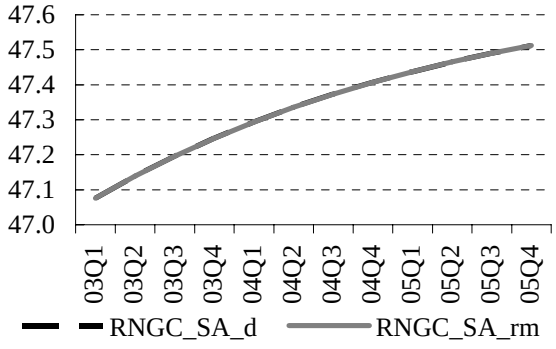

Figure G.6. NPISHs consumption

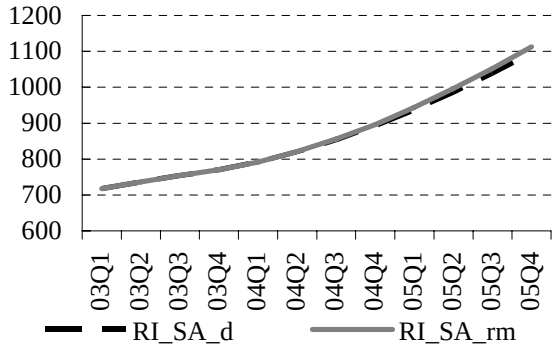

Figure G.7. Gross fixed capital formation

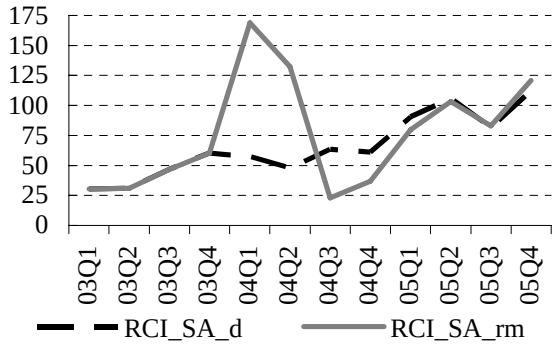

Figure G.8. Change in inventories

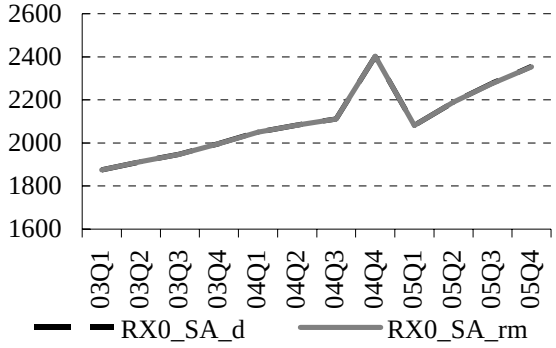

Figure G.9. Exports of goods and services

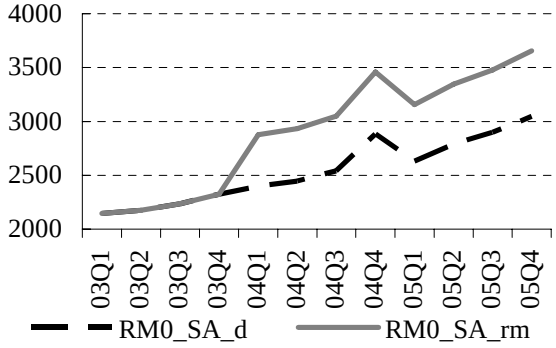

Figure G.10. Imports of goods and services

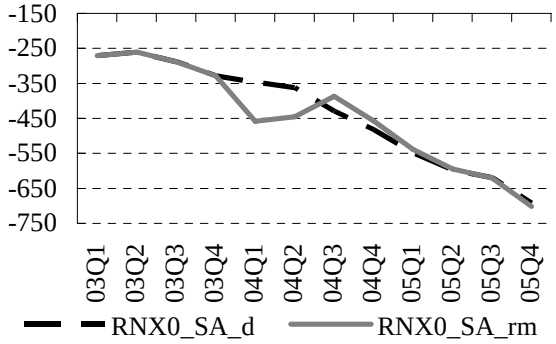

Figure G.11. Net exports of goods and services

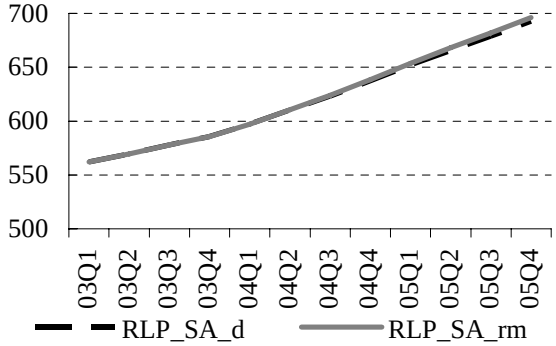

Figure G.12. Labour productivity, BYR thousand per employer

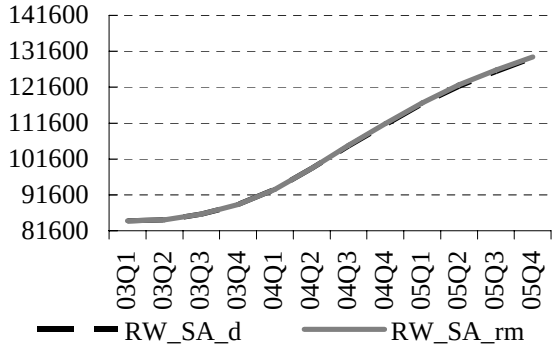

Figure G.13. Average monthly wage, BYR

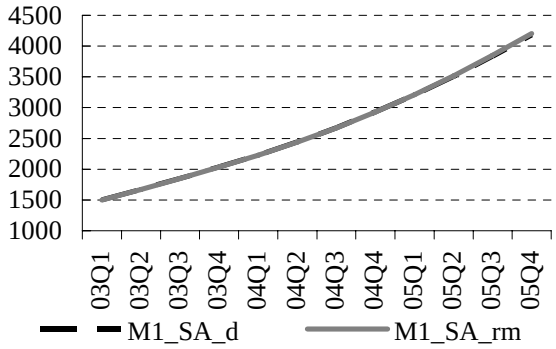

Figure G.14. Monetary aggregate M1[2]

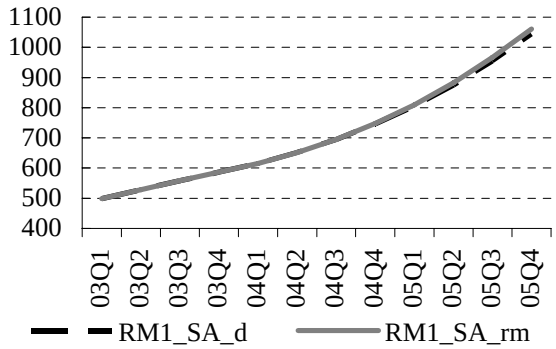

Figure G.15. Monetary aggregate M1

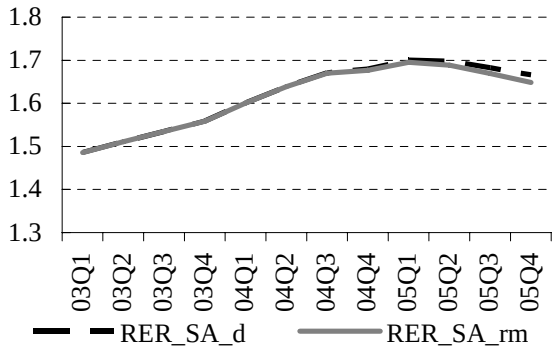

Figure G.16. Real exchange rate BYR/USD, index, 2000 = 1

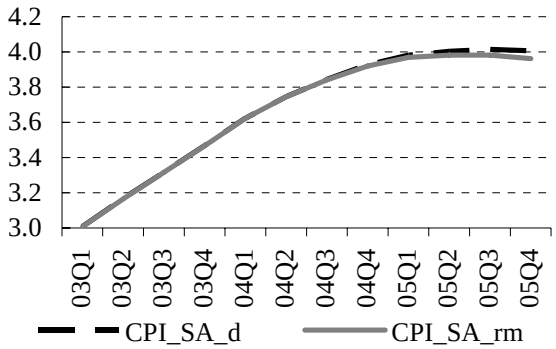

Figure G.17. Figure G.18. Consumer price index, 2000 = 1

Notes.
[1] All series are in real terms in constant prices of 2000 (BYR bn), otherwise stated.
[2] In current prices, BYR bn (given denomination of 2000).

H. EXPORTS SHOCK

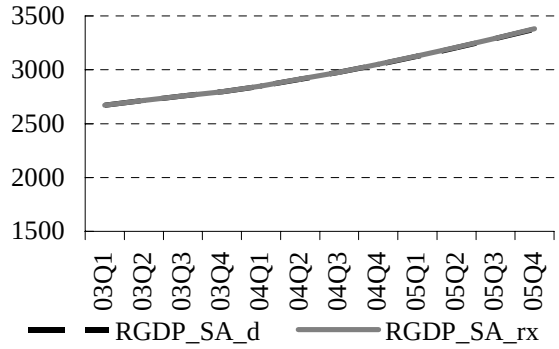

Figure H.1. GDP[1]

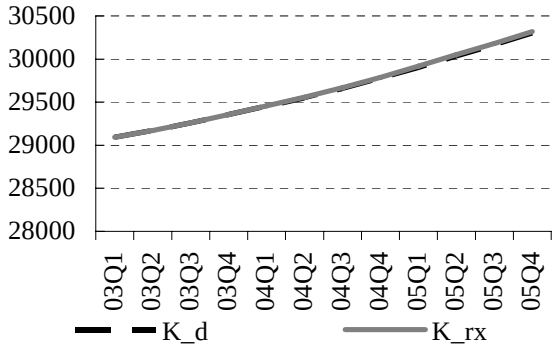

Figure H.2. Capital assets

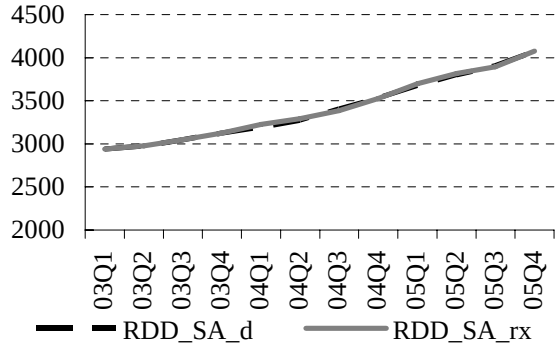

Figure H.3. Domestic demand

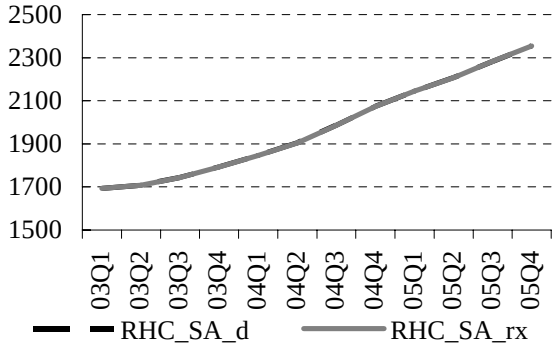

Figure H.4. Household consumption

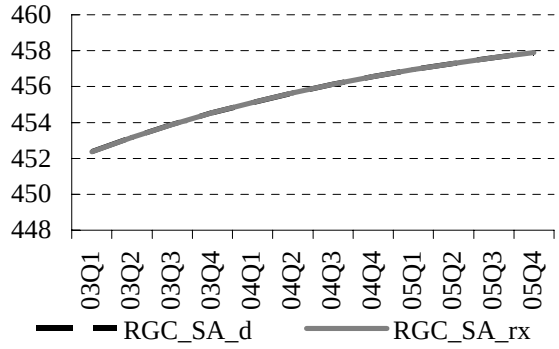

Figure H.5. Government consumption

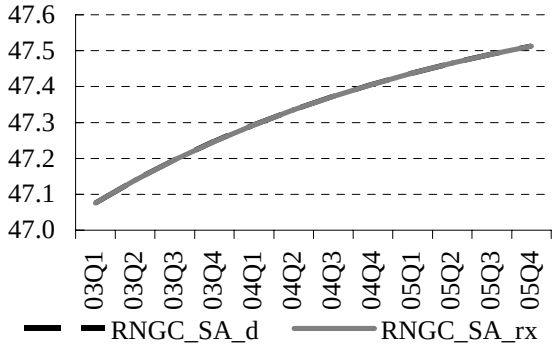

Figure H.6. NPISHs consumption

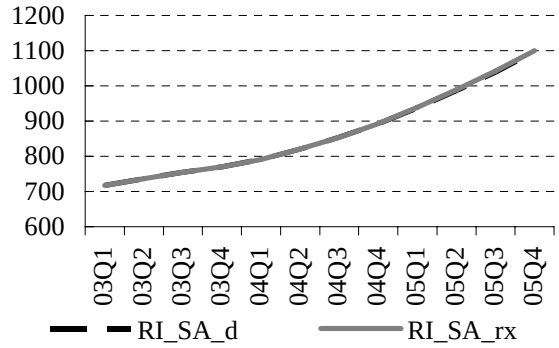

Figure H.7. Gross fixed capital formation

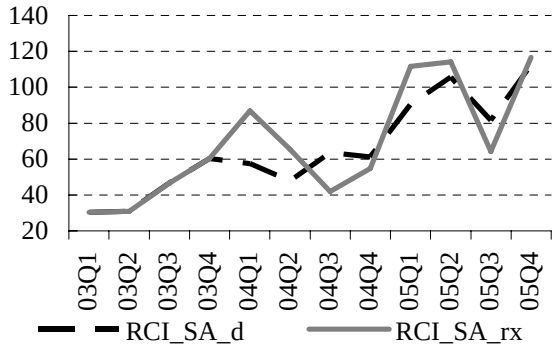

Figure H.8. Change in inventories

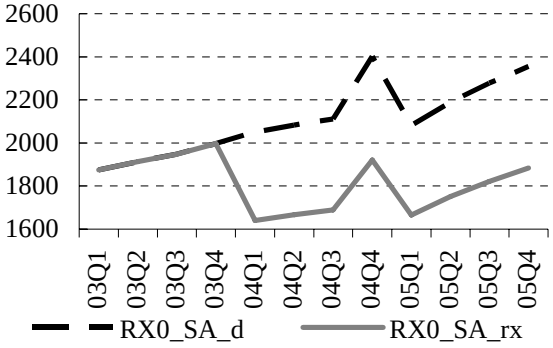

Figure H.9. Exports of goods and services

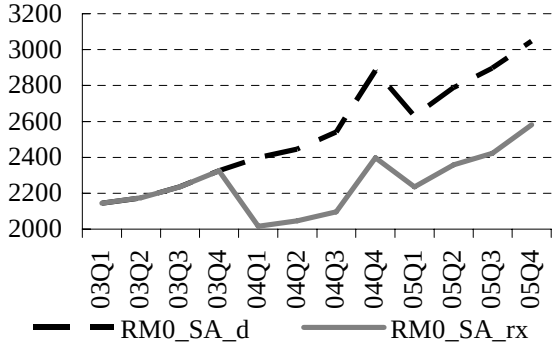

Figure H.10. Imports of goods and services

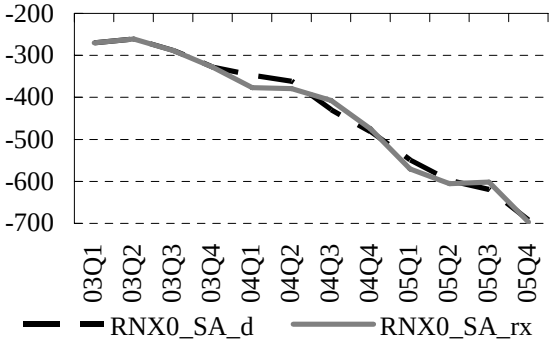

Figure H.11. Net exports of goods and services

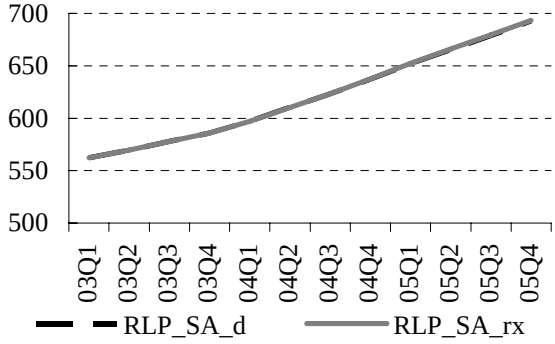

Figure H.12. Labour productivity, BYR thousand per employer

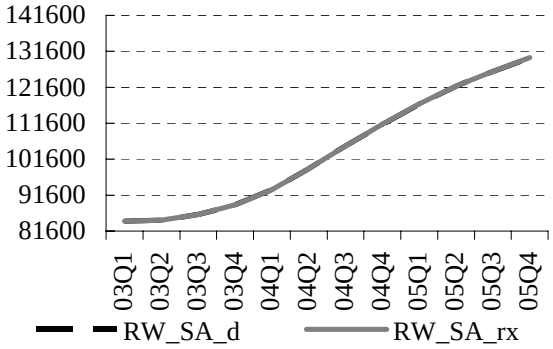

Figure H.13. Average monthly wage, BYR

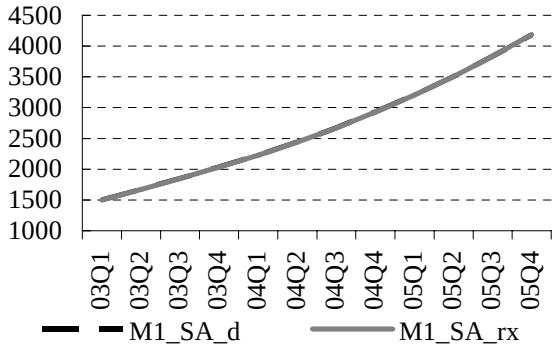

Figure H.14. Monetary aggregate M1[2]

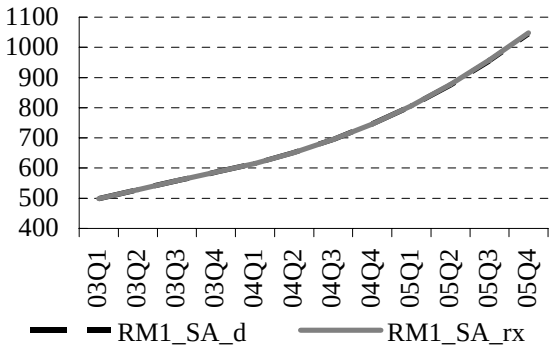

Figure H.15. Monetary aggregate M1

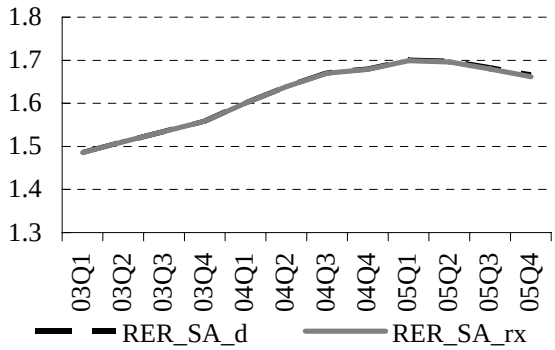

Figure H.16. Real exchange rate BYR/USD, index, 2000 = 1

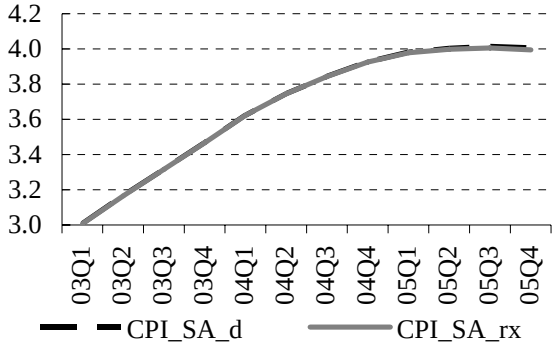

Figure H.17. Consumer price index, 2000 = 1

Notes.
[1] All series are in real terms in constant prices of 2000 (BYR bn), otherwise stated.
[2] In current prices, BYR bn (given denomination of 2000).

I. MONEY SUPPLY SHOCK

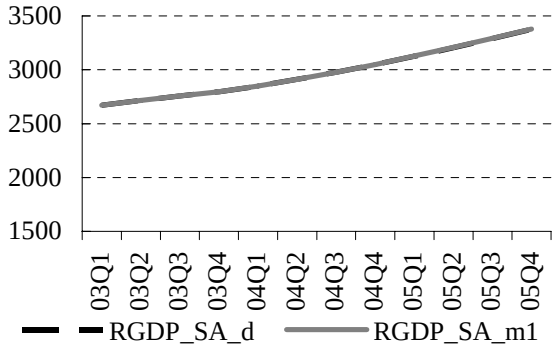

Figure I.1. GDP[1]

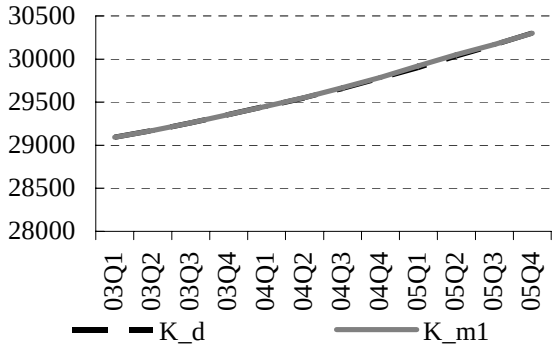

Figure I.2. Capital assets

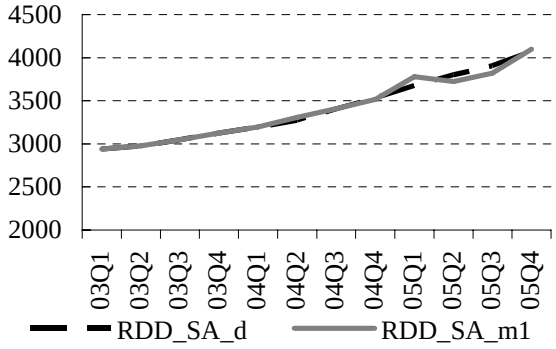

Figure I.3. Domestic demand

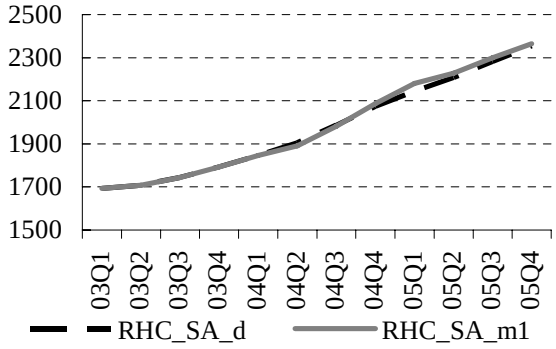

Figure I.4. Household consumption

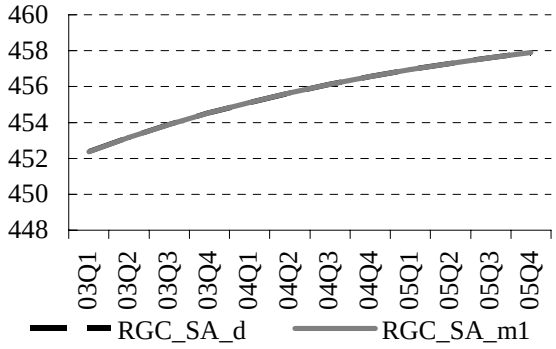

Figure I.5. Government consumption

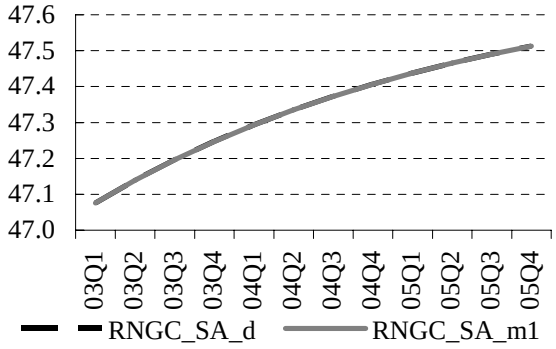

Figure I.6. NPISHs consumption

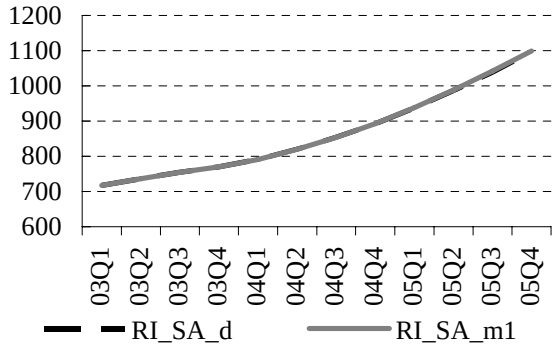

Figure I.7. Gross fixed capital formation

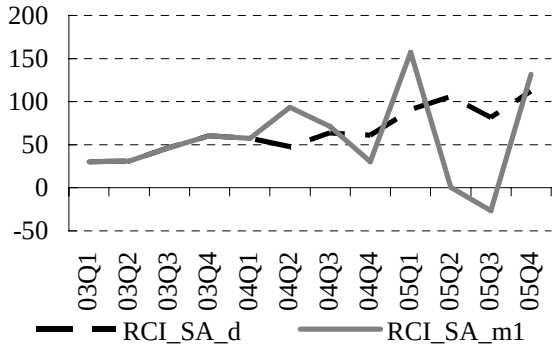

Figure I.8. Change in inventories

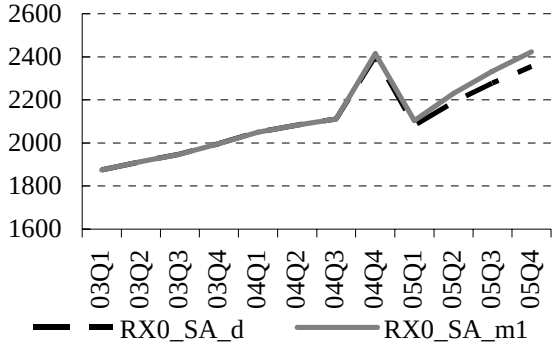

Figure I.9. Exports of goods and services

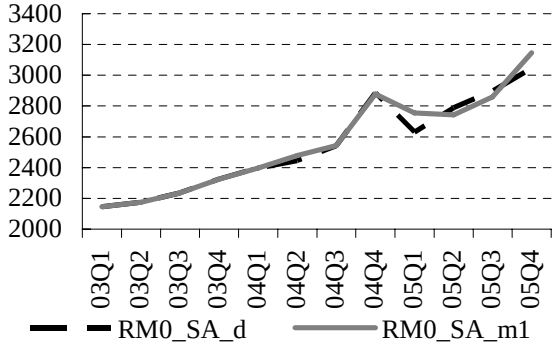

Figure I.10. Imports of goods and services

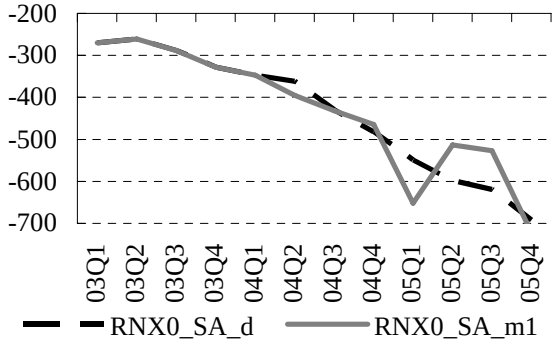

Figure I.11. Net exports of goods and services

Figure I.12. Labour productivity, BYR thousand per employer

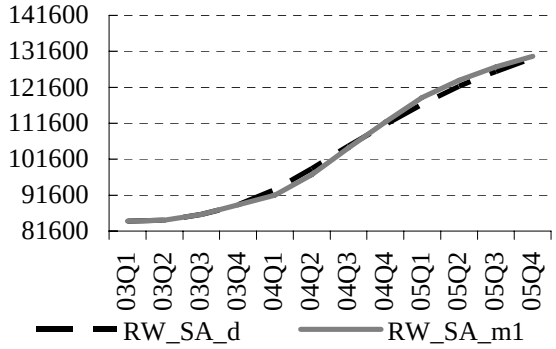

Figure I.13. Average monthly wage, BYR

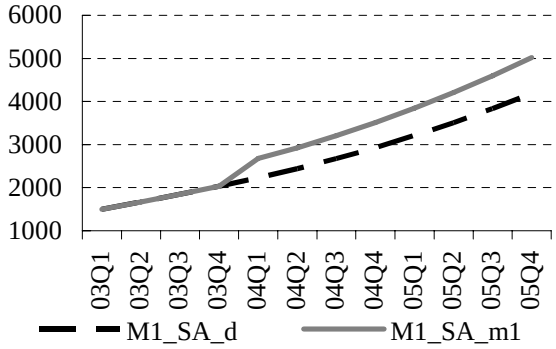

Figure I.14. Monetary aggregate M1[2]

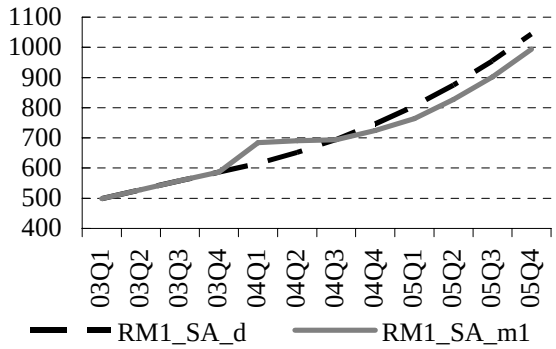

Figure I.15. Monetary aggregate M1

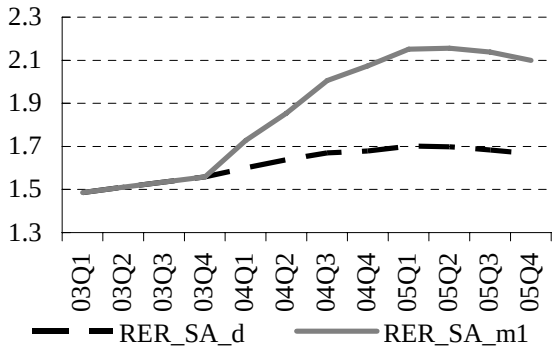

Figure I.16. Real exchange rate BYR/USD, index, 2000 = 1

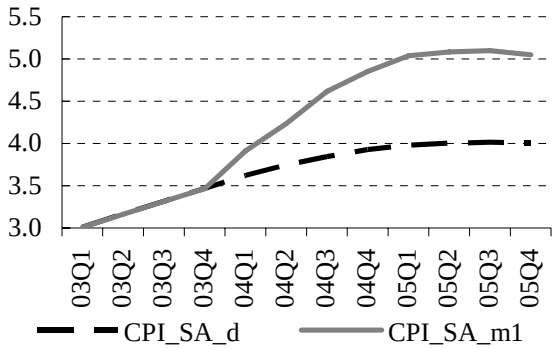

Figure I.17. Consumer price index, 2000 = 1

Notes.
[1] All series are in real terms in constant prices of 2000 (BYR bn), otherwise stated.
[2] In current prices, BYR bn (given denomination of 2000).

J. EMPLOYMENT SHOCK

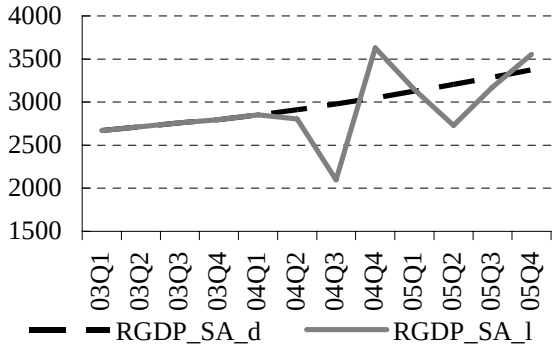

Figure J.1. GDP[1]

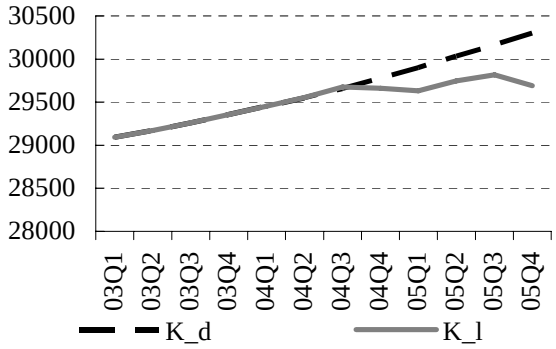

Figure J.2. Capital assets

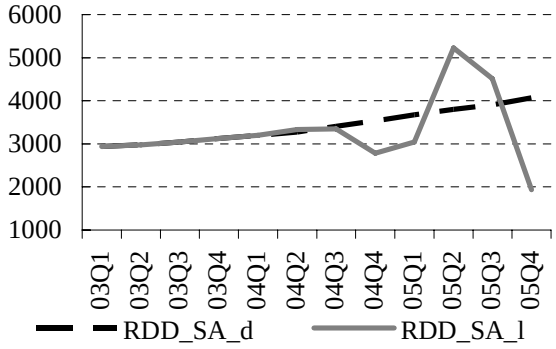

Figure J.3. Domestic demand

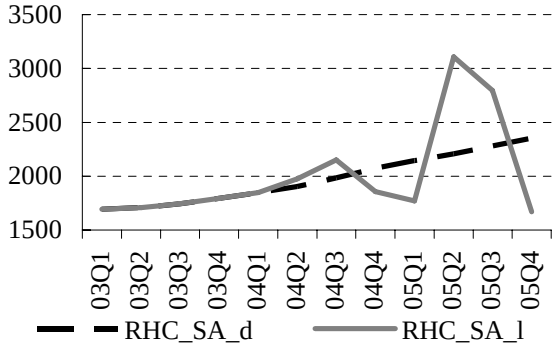

Figure J.4. Household consumption

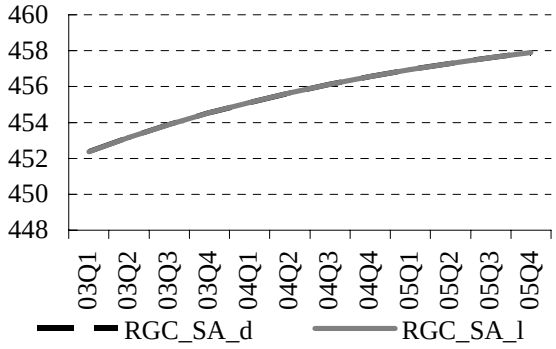

Figure J.5. Government consumption

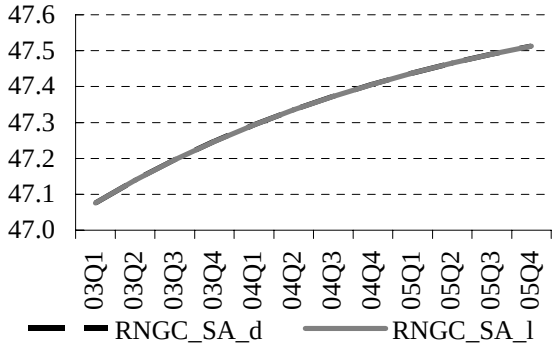

Figure J.6. NPISHs consumption

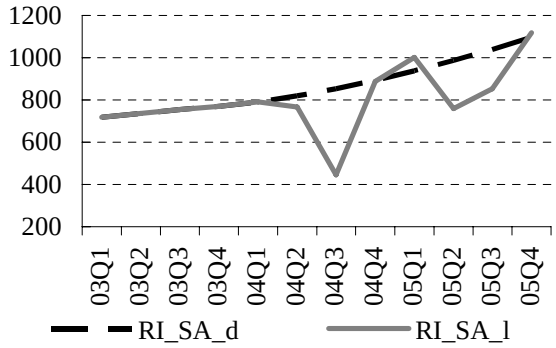

Figure J.7. Gross fixed capital formation

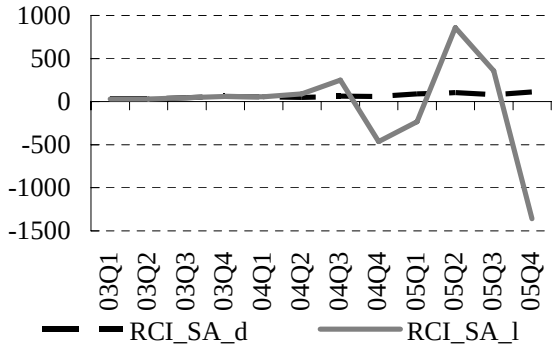

Figure J.8. Change in inventories

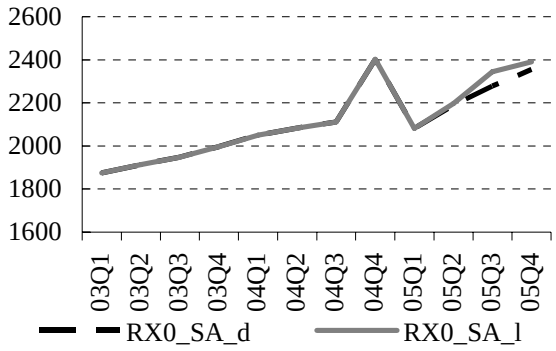

Figure J.9. Exports of goods and services

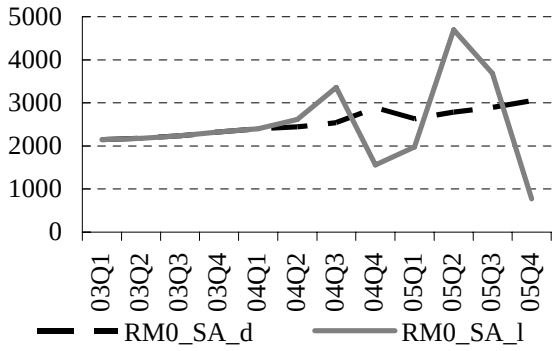

Figure J.10. Imports of goods and services

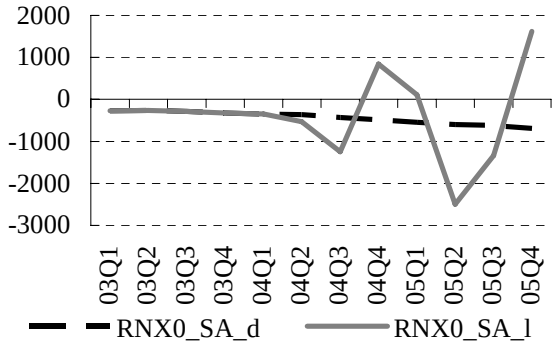

Figure J.11. Net exports of goods and services

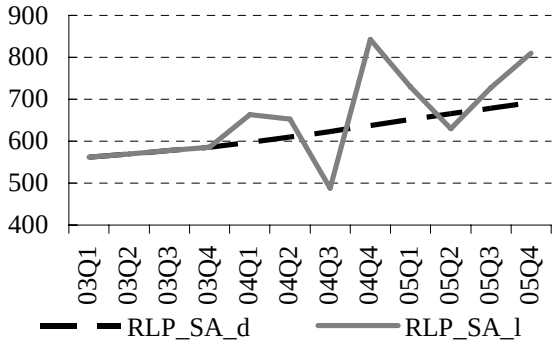

Figure J.12. Labour productivity, BYR thousand per employer

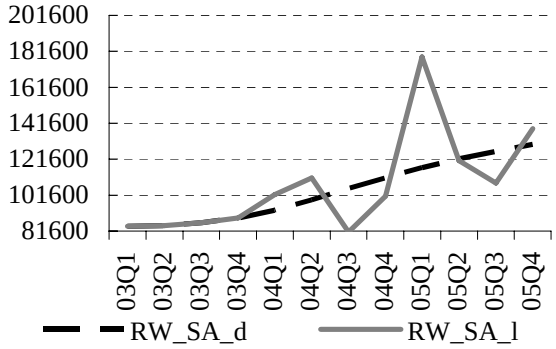

Figure J.13. Average monthly wage, BYR

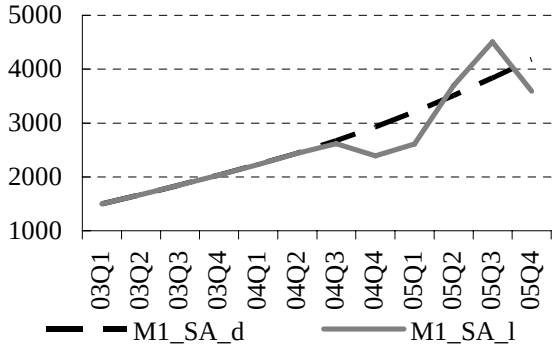

Figure J.14. Monetary aggregate M1[2]

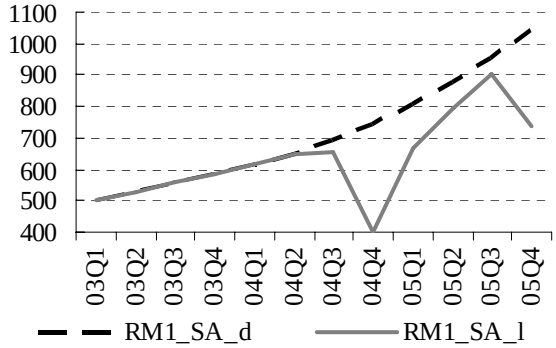

Figure J.15. Monetary aggregate M1

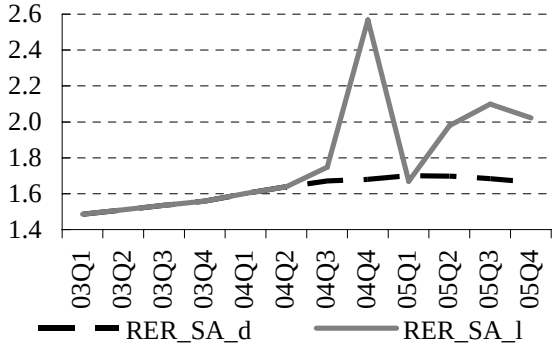

Figure J.16. Real exchange rate BYR/USD, index, 2000 = 1

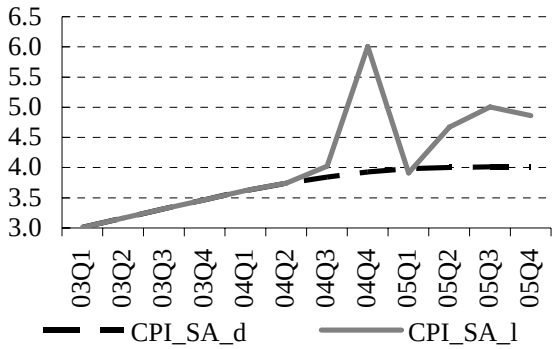

Figure J.17. Consumer price index, 2000 = 1

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[1] All series are in real terms in constant prices of 2000 (BYR bn), otherwise stated.
[2] In current prices, BYR bn (given denomination of 2000).

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The Results of Econometric Modelling

Chubrik, A., Kruk, D., Pelipas, I.

Cover design: Anna Drapeza
Makeup: Gleb Shymanovich

Printed at Nevskiy Prostor Ltd.,
6 M. Toreza Avenue, 194199, Saint-Petersburg, Russia