

LATVIAN MULTISECTORAL MACROECONOMIC MODEL

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1. Main features of the Latvian multisectoral macroeconomic model

The Latvian multisectoral macroeconomic model is being developed to analyse and forecast the Latvian economy. The model is developed at Riga Technical University in collaboration with the specialists from Florence University (see Grassini, Pocs, Pinke, Neiders (2004), Auzina, Pocs (2005)). The major issues of the development process were also reported at the 12th International INFORUM conference in 2004 (Ascea, Italy) and 14th International INFORUM conference in 2006 (Traunkirchen, Austria). The results are published in the conference materials (see Auzina (2006), Ozolina, Pocs (2006)).

Latvian multisectoral macroeconomic model is an economic model that combines the features of input-output models and econometric models. Latvian multisectoral macroeconomic model is INFORUM type model. The model is developed using special software – Interdyme¹. The data base and data banks of the model have been developed using software G7. As an additional tool for statistical data preparation and results analysis needs is applied MS Excel.

The national economy is subdivided into 55 branches in the model. The level of disaggregation in the model is chosen on the basis of the highest available level of disaggregation for statistical indicators. From 55 branches – 2 of them are agriculture and hunting branches, 1 fishing, 2 mining and quarrying, 23 manufacturing, 2 energy sector, 1 construction, and 24 service sector's branches.

The final demand is treated in detail in the model. The final demand consists of 7 elements – households consumption, final consumption of non-profit institutions serving households, government expenditure, fixed capital formation, changes in stocks, exports, and imports. All final demand elements have the same level of disaggregation corresponding to the number of branches included in the model.

Latvian multisectoral macroeconomic model as a dynamic econometric input-output model contains econometrically estimated behavioural equations.

The model includes the real side, price side, and the nominal side. It means that the real indicators have been modelled, at the same time, the prices are modelled. The majority of nominal indicators are obtained using the real indicators and price indicators that are modelled in the model. Sectoral prices and employment level, which is stated in thousands of persons, are used to link the real side with the nominal side.

¹ Interdyme – INFORUM models' developing software. It is developed at Maryland University, USA.

The model is intended as long-term modelling instrument. The time horizon for the model is from 1995 to 2020. The forecasting period is 2006-2020. The model can also be tailored for medium-term modelling applications.

Bilateral Trade Model (BTM) is used to model export indexes and import price indexes for models that are included in the INFORUM system. The Latvian multisectoral macroeconomic model is INFORUM type model and it is not included in INFORUM models system.

However, the Latvian multisectoral macroeconomic model is secondary linked with BTM, as the Latvian model applies the export indexes for 30 commodities generated by the bilateral trade tool for EU countries (see Grassini, Parve (2006)). At the present, this link is not reflexive, it means, the Latvian model's results do not influence the indicators of others countries.

2. Model's segments

Households consumption

Households final consumption is modelled using econometric equations in the model. Households consumption is modelled according to the classification of individual consumption by purpose (COICOP). The level of disaggregation is 12 groups of consumption purpose.

Households consumption according to consumption purpose ($pce_{h,t}$) are forecasted using different relation forms (see Equations (1) - (3)).

$$\log(pce_{e,t}) = a + b * \log(totpce_t), \quad (1)$$

$$\log(pce_{f,t}) = a + b * \log(totpce_t) + c * dummy05, \quad (2)$$

$$pce_{g,t} = a + b * totpce_t + c * dummy05, \quad (3)$$

where $totpce_t$ – beforehand modelled total households consumption (constant prices);

$dummy05_t$ – dummy ($dummy05_{2005,..,2020}=1$);

h – consumption purpose ($h=e+f+g$).

The choice of relation's form in the model depends on the result of econometrical estimation of the historical behaviour of time-series.

Modelling households consumption by consumption purpose, beforehand the total households consumption is econometrically estimated and forecasted. Households consumption by branch according to the industry disaggregation level are acquired by bridge matrix. This practice is common also for some INFORUM models. The German INFORUM model (INFORGE model) generates forecasts of households consumption by consumption purpose (43 groups) and by the bridge matrix obtains households consumption by branch (59 branches) (see Lutz, Distelkamp, Meyer, Wolter (2003)).

By means of the bridge matrix the households consumption by branches are obtained according to the level of disaggregation in the model (see Formula (4)).

$$pceio_{i,t} = pce_{h,t} * BM_t, \quad (4)$$

where $pceio_{i,t}$ – households consumption (constant prices) for products of branch i at time period t ($i=1, 2, \dots, 55$; $t=2000, 2001, \dots, 2020$);
 $pce_{h,t}$ – households consumption (constant prices) by purpose h at time period t ;
 BM_t – bridge matrix.

Despite of the use of beforehand predicted total households consumption level, each household consumption purpose forecast is obtained on the basis of its dependence on changes in total indicator. The forecast of the total households consumption level in the model is obtained as a sum of households consumption of 55 branches.

Final consumption of non-profit institutions serving households

The Latvian model contains the assumption that the growth rate of final consumption of non-profit institutions serving households is close to the growth rate of total households consumption.

The final consumption of non-profit institutions serving households by branch ($ccp_{i,t}$) is modelled according to the following formula:

$$ccp_{i,t} = ccp_{i,2005} * ccp_index_t, \quad (5)$$

where ccp_index_t – index of final consumption of non-profit institutions serving households (2005=1);

Non-profit institutions serving households are closely linked households and their development tendencies in the economy.

Exports

Exports are modelled according to the level of disaggregation in the model. Exports of goods and exports of services are modelled differently.

In the model, the exports of goods by branches are modelled on the basis of the BTM's exports indexes for 30 commodities produced in Latvia. BTM forecasts are produced for the time period till 2010. There are applied the exogenous growth rates for exports of goods for the time period from 2011 to 2020. The applied growth rates are based on the several assumptions concerning the future development of growth rates.

Exports of goods by branches are forecasted by Formula (6).

$$\exp_{g,t} = \exp_{g,2005} * \exp_index_{g,t}, \quad (6)$$

where $\exp_{g,t}$ – export of goods (constant prices) by branch g at time period t ;

$\text{exp_index}_{g,t}$ – export index of branch g (2005=1).

The base year of the BTM export indexes is 2000, they are recalculated to obtain that the base year is 2005.

In the Latvian model, an assumption is launched that the exports of service grow with the same growth rate as the total exports of goods in the long-run. The exports of services are modelled by the following formula:

$$\text{exp}_{s,t} = \text{exp}_{s,t-1} * \text{exp_}d_t, \quad (7)$$

where $\text{exp}_{s,t}$ - export of services (constant prices) by branch s at time period t;
 $\text{exp_}d_t$ – growth rate of total exports of goods.

Exports vector is formed by elements of exports of goods and services.

Motives due to them the mentioned approach is used in the Latvian model:

- This approach is used to integrate step-by-step into INFORUM modelling system and obtain forecasts that are obtained taking into account the development trends in other countries (especially in importer countries).
- Insufficient length of detailed time series;
- Exports are more determined by external factors rather than by domestic production capacity and historical development trends.

Imports

Imports of goods and services by branches are modelled using a single method in comparison with exports. Imports are modelled using the imports shares. Latvia integrates into the EU and others markets. The importance of imports in the Latvian economy increases because of free trade and trade barrier liberalization process.

Imports shares are modelled in the model by Formula (8):

$$\text{impsh}_i = \frac{\text{imp}_i}{\text{imp}_i + \text{out}_i}, \quad (8)$$

where impsh_i – imports share of branch i;
 imp_i – imports of branch i;
 out_i – output of branch i.

In Latvian model, firstly, the imports shares of branches are modelled. Each branch has its imports shares equation (see Formula (9)).

$$impsh_{i,t} = impsh_{i,t-1} + a * trend_t, \quad (9)$$

where a – slope coefficient;
 $trend_t$ – time.

On the basis of the modelled imports shares values, in Seidel² procedure imports and outputs of branches simultaneously are modelled. Transforming Formula (8), the result is Formula (10), which is used in the model.

$$imp_{i,t} = impsh_{i,t} * ds_{i,t}, \quad (10)$$

where $imp_{i,t}$ – imports by branch i at time period t (constant prices);
 $ds_{i,t}$ – total domestic use of products of branch i at time period t (constant prices).

Some branches especially in service sector produce such products that cannot be exported to Latvia; hence there are zero imports of some branches' products.

Government expenditure

Government expenditure by branches is modelled using exogenous growth trends (see Formula (11)).

$$gov_{i,t} = gov_{i,t-1} * gov_d_{i,t}, \quad (11)$$

where $gov_{i,t}$ - government expenditure by branch i at time period t (constant prices);
 $gov_d_{i,t}$ – growth rate of government expenditure at time period t ;

The growth rate of government expenditure is given on the basis of recent historical tendencies and the most probable development trends in the forecasting period.

Fixed capital formation

Fixed capital formation is an essential element of final demand. Since the length of time series is insufficient and no time series available according to the model's level of disaggregation, then fixed capital formation is modelled using similar approach as in the case of government consumption. Fixed capital formation is modelled using the following formula:

$$pde_{i,t} = pde_{i,2005} * pde_index_{i,t}, \quad (12)$$

where $pde_{i,t}$ – fixed capital formation by branch i at time period t (constant prices);
 $pde_index_{i,t}$ – fixed capital formation index by branch i at time period t .

Fixed capital formation is connected with total fixed capital in the economy that is employed by branches and the speed of depreciation. But as these data are not available, the total fixed capital is not modelled in the model.

² Seidel is widely used in INFORUM models.

Changes in stocks

Changes in stocks are connected with technologies employed in branches; each branch can have the so-called optimal level of stocks. Since the Latvian multisectoral macroeconomic model is used mainly for long-term modelling, then an assumption is introduced in the model concerning the future development of stocks. It is assumed that the changes in stocks will become close to zero in the long run.

The limited amount of detailed statistical data concerning the amount of stocks and their changes over time heavily influences the modelling process of them.

Output

Output by branch is obtained by Seidel procedure. In the model output is modelled in constant prices. And the matrix of technical coefficients is applied in the modelling process. The technical coefficients are not constant and they can be changed on the basis of predictable technological improvements and shifts in the economy during the forecasting period.

Output indicators are essential in the further calculations in the model.

Value added

Since there are not available sufficient long disaggregated time series of value added by its elements, the value added is modelled as single vectors in the model. Value added by branch is modelled by growth indexes (see Formula (13)).

$$vad_{i,t} = vad_{i,2005} * vad_index_{i,t}, \quad (13)$$

where $vad_{i,t}$ – value added by branch i at time period t (constant prices);
 $vad_index_{i,t}$ – value added index by branch i at time period t .

Using output by branch and value added by branch, value added coefficients are calculated (see Formula (14)).

$$unitva_{i,t} = \frac{vad_{i,t}}{out_{i,t}}, \quad (14)$$

where $unitva_{i,t}$ – value added coefficient of branch i at time period t .

Value added coefficient is important in the further calculations in the model, especially concerning the price side of the model.

Prices

Prices by branch are modelled by PSeidel procedure. On the basis of this procedure is Leontief, price equation.

Sectoral prices (prices by branch) are modelled by applying the identity:

$$p_{i,t} = A_t * p_{i,t} + unitva_{i,t}, \quad (15)$$

where $p_{i,t}$ – price of branch i at time period t (2000=1);
 A_t – matrix of technical coefficients.

PSeidel procedure is essential part of INFORUM model and it is one of the charactering and widely used features of this type of models.

Productivity and employment

There are two indicators that characterize the productivity in branches in the model. One of these indicators is output per employed person in branch i . The second indicator is the ratio between employed person and output of branch i (see Formulas (16) and (17)).

$$labpro_i = \frac{out_i}{emp_i}, \quad (16)$$

where $labpro_i$ – output per employee (thsd Ls/ persons);
 emp_i – average number of employed persons in branch i .

Output per employee and its changes over time are used in the further calculations in the model – to model the demand for employees by branches.

$$empro_i = \frac{emp_i}{out_i}, \quad (17)$$

where $empro_i$ – ratio between employed person and output of branch i (persons/thsd Ls).

In the Latvian model the output per employee is obtained using exogenously given growth rates. Output per employee $labpro_{i,t}$ is modelled by Formula (18).

$$labpro_{i,t} = labpro_{i,t-1} * labpro_d_{i,t}, \quad (18)$$

where $labpro_d_{i,t}$ – growth rate of output per employee at time period t .

Both indicators ($labpro_{i,t}$ and $empro_{i,t}$) are related and on the basis of Formulas (16) and (17) , it can be expressed as Formula (19).

$$empro_{i,t} = \frac{1}{labpro_{i,t}}. \quad (19)$$

Employment is modelled in absolute numbers, it means, employed persons by branch. The number of employed persons are calculated by the following formula:

$$emp_{i,t} = labpro_{i,t} * out_{i,t}, \quad (20)$$

where $emp_{i,t}$ – average number of employed persons in branch i at time period t .

It is assumed it is not significant whether a person works more or less hours in future in comparison with the base year, the only important issue is the amount of output produced on one employed person.

Macroeconomic indicators

In the Latvian model the macroeconomic indicators are mainly obtained as sums of branch values. There are modelled household consumption, final consumption of non-profit institutions serving, government expenditure, fixed capital formation, changes in stocks, exports, imports, output, and value added in the model. The mentioned indicators are in constant prices. Using price indexes, the nominal indicators can be obtained.

Total employment and productivity indicators are essential in further analysis of the national economy and its development trends and perspectives.

3. Modelling results

Base scenario is developed and it is based on the following assumptions:

- Government expenditure grows annually by 3% for the most of branches' products. This assumption is based on the average historical growth trends from 2000 to 2005.
- Output per employee grows annually on average by 3% from 2006 to 2010 (the rate differs over the branches). From 2011 the growth rates slow down.

The base scenario characterizes the most prospective development trends. According to the modelling results, the average growth rate of total output is 4.5% in the years 2006-2020. The growth rate is higher in the near future and then it slows down. Total output forecast is illustrated by Figure 1.

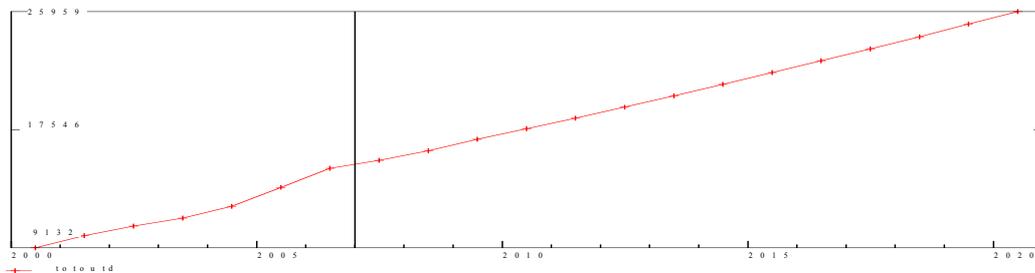


Figure 1. Output, mln Ls

Households consumption growth rate maintains considerably high level, however it slows down in the long-run. Figure 2 shows the total households forecast. The forecasted average growth rate for the time period 2006-2010 is 7.3%, for the period 2011-2020 it is 5.1%. From 2006 to 2020 the average growth rate is 5.9%.

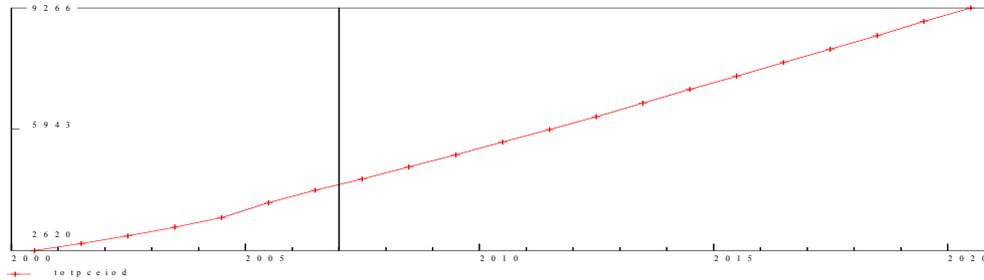


Figure 2. Households consumption, mln Ls

Forecast of total exports illustrated by Figure 3. The exports by branches develop with different growth rates. However the total exports growth rate is higher in the near future and slows down in the long run. The forecasted average growth rate for the time period 2006-2010 is 5.7%, 2011-2020 – 3.3%, and the average growth rate for the forecasting period is 4.1%.

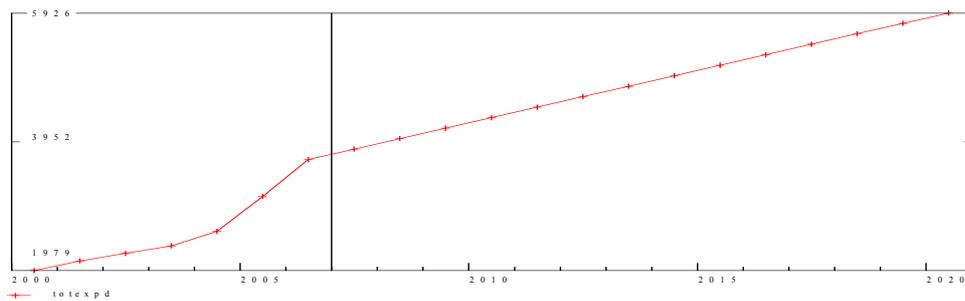


Figure 3. Exports, mln Ls

Imports are determined by both domestic factors and foreign factors (see Fig.4.).

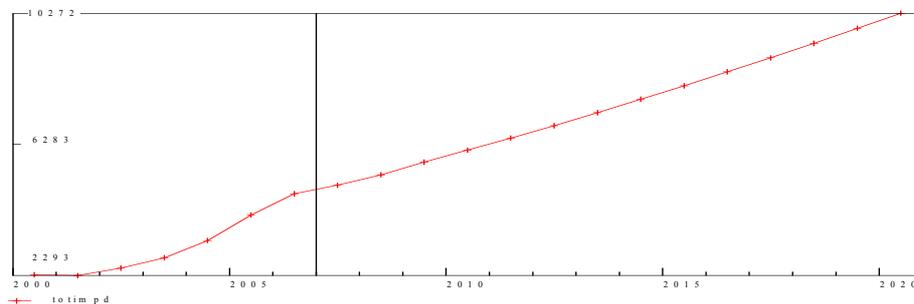


Figure 4. Imports, mln Ls

Imports penetration in the local market is a dominant trend, as a result the imports growth rate is higher than the domestic production growth rate. The forecasted average growth rate for the period 2006-2010 is 8.4%, 2011-2020 – 5.6%, and the average growth rate for the whole forecasting period is 6.5%.

A tendency regarding the growth rates slow down can be observed in the forecasts of output, households consumption, exports, and imports. As exports are linked with the external factors, the average growth rate is decreasing, though, at larger extent. However, the model is rather sensitive to the changes in the levels of exogenous variables. Different assumptions concerning the future development of exogenous variables have an affect on the results.

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