RIGA TECHNICAL UNIVERSITY
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Macroeconomic Modelling and Elaboration of the Macro-Econometric Model for the Latvian Economy

Scientific Monograph

Reviewers: P. Rivža, O. Barānovs

RTU Press
Riga, 2013

Ozoliņa V., Počs R. Macroeconomic Modelling and Elaboration of the Macro-Econometric Model for the Latvian Economy. Scientific Monograph. - Riga, RTU Press, 2013. – 191 p.

The scientific monograph presents general characterization of macroeconomic modelling and provides an overview of the most prominent world-renown econometric models. Analysis includes the study of the theoretical basis and the areas of model application, model structure and maintenance of the data basis and software. The general structure of the model, relationships included in the model and the overall logic of calculations are considered in the work in great detail. The logical and statistical basis of the behavioural equations is provided. These equations are used for modelling of GDP, prices and wages, balance of payments and foreign trade, employment, fiscal sector and energy sector relations. The work provides a detailed overview of the application of macroeconomic models in Latvia and presents forecasts of the macroeconomic indicators of Latvia.

The scientific monograph is devised for scientists and specialists, who deal with macroeconomic modelling issues, as well as for students, who study economics and management.

Readers are invited to send comments and suggestions to the authors to RTU, Department of International Business, Transport Economics and Logistics, Riga, 6 Kalnciema, Room 107, LV-1048, by fax +371 6708 9683 or by e-mail: velga.ozolina@rtu.lv or remigijs.pocs@rtu.lv

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Published in accordance with the resolution of the Council of the International Business and Customs Institute of RTU Faculty of Engineering Economics and Management, Minutes No. 2 of 18 October, 2013

Scientific monograph was approved for publishing at the meeting of RTU Scientific Council as of 25 November, 2013, Minutes No 04000-5/09.

ISBN 978-9934-10-511-1

Ozoliņa V., Počs R.. Latvijas makroekonometriskā modeļa izstrāde un izmantošana tautsaimniecības analīzē un prognozēšanā. Zinātniskā monogrāfija. Rīga, RTU Izdevniecība, 2013. – 191 lpp.

Zinātniskā monogrāfijā dots makroekonomiskās modelēšanas vispārīgs vērtējums un pasaulē pazīstamāko makroekonometrisko modeļu apskats. Analizēta modeļu teorētiskā bāze, struktūra, praktiskais pielietojums, informatīvais nodrošinājums, pielietotā programmatūra. Izklāstīta autoru izstrādātā Latvijas makroekonometriskā modeļa kopējā shēma, modeļa sakarības, aprēķinu loģika.

Ietvertas iekšzemes kopprodukta, cenu un darba samaksas, maksājumu bilances un ārējās tirdzniecības, nodarbinātības, fiskālā sektora un enerģētikas sektora modelēšanas sakarības un to pamatojums. Raksturots makroekonomisko modeļu pielietojums Latvijā, kā arī dotas Latvijas makroekonomisko rādītāju prognozes.

Zinātniskā monogrāfija paredzēta zinātniekiem un speciālistiem, kas nodarbojas ar makroekonomiskās modelēšanas jautājumiem, kā arī studentiem, kuri apgūst ekonomikas un vadībzinātnes programmas.

Kritiskās piezīmes un priekšlikumus lūgums sūtīt autoriem uz RTU Starptautisko ekonomisko sakaru, transporta ekonomikas un loģistikas katedru Rīgā, Kalnciema ielā 6, 107. kabinetā, LV-1048, pa faksu +371 6708 9683 vai pa e-pastu: velga.ozolina@rtu.lv vai remigijs.pocs@rtu.lv

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Iespiests saskaņā ar RTU Inženierekonomikas fakultātes Starptautisko ekonomisko sakaru un muitas institūta Padomes 2013. gada 18. oktobra lēmumu, protokols Nr. 2.

Zinātniskā monogrāfija apstiprināta publicēšanai RTU Zinātnes padomes sēdē 2013.gada 25. novembrī, protokols Nr. 04000-5/9.

ISBN 978-9934-10-511-1

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INTRODUCTION

Macroeconomic models are globally recognized as one of the most appropriate instruments for justification of important decisions, mostly at the level of the national economy or “macro” level. An appropriate and well-specified macroeconomic model allows its user to evaluate existing macroeconomic relationships, to study the impact of specific decisions on particular indicators, to judge possible development risks of the national economy, as well as to analyze other issues depending on specific features of a particular model.

Macroeconomic models differ with respect to application aims and possibilities, the type and number of included equations, their theoretical foundation, information maintenance, and other features. There are models with a long history and there are new ones. There are single models elaborated by one organization and linked models developed in different countries. Economic models have been built in all developed countries and in the majority of developing countries. The popularity of particular types of models is determined by available data, expertise of scientists and the aims of research. Thus, there are macro-econometric models that focus on general development of the economy or on particular fields like government budget or monetary issues, and there are detailed models that focus, for example, on inter-industry relationships.

Macro-econometric models as one of the types of economic models are widely used all over the world. Elaboration of such models and interpretation of their results may be comparatively simple in case of small or average scale models, however, it can be more complicated in the case of large and complex models. Despite the complexity of some models, the experience of many economic policy makers and model builders indicates that macroeconomic models are quantitative instruments of analysis of the national economy, which are irreplaceable for the support of the policy making process. At the same time, they also provide extensive application possibilities in the private sector.

Model elaboration, testing and application demand thorough research and justification for particular circumstances, because only the models that include comprehensive, theoretically and practically justified relationships, comprise equations of the most appropriate functional form and take into account other significant conditions may be successfully used in decision-making process. Ever widening international relations among different countries imply that there is growing international cooperation also in the field of modelling, which is exposed in the form of sharing experience, helping to develop macro-econometric models in the countries, where modelling specialists are not very experienced, and creating linked models or systems of models, which include models of several countries. At the same time, international cooperation in the field of modelling allows more and more extensive use of macro-econometric models in evaluating a position of a particular country in a region or even in the entire world.

Based on the analysis of macroeconomic models and their applications, the authors have built a macro-econometric model for Latvia, taking into account the peculiarities of Latvia's economy. The model can be used for evaluation of development trends of the national economy, it can also be adapted for the analysis of particular issues. Taking into account the structure of the model, it can be applied for the analysis of the national economy, forecasting, elaboration of economic and fiscal policy as well as for planning of entrepreneurship development. However, it should be done with caution due to recent dramatic changes in the development pattern of Latvia's economy.

It should be noted that several changes in the model structure will have to be made in the near future because new data is now being released in 2.0 edition of the NACE classification and the latest data are no longer available in 1.1 edition.

The aim of this publication is to give an insight into the current state of affairs in the field of macroeconomic modelling both worldwide and in Latvia, to analyze model application and to outline a possible structure of Latvia's macro-econometric model based on the global experience in macroeconomic modelling.

The work includes a thorough analysis of foreign macroeconomic models (which are mostly discussed in scientific literature in great detail), including general characterization of the models and the analysis of the theoretical basis and the areas of application of the models, model structure and informative and software maintenance. The book also covers theoretical foundations of the Latvia's macro-econometric model, the logical and statistical basis of its behavioural equations, provides a description of the overall logic of calculations and a detailed schematic representation of the relationships of the model, presents an overall evaluation of Latvia's macroeconomic models as well as the analysis and forecasting results of Latvia's macro-econometric model.

The development of the Latvian model has benefitted greatly from the cooperation among the researchers within INFORUM global network. INFORUM stands for the Interindustry Forecasting Project at the University of Maryland. It was initiated in 1967 by Clopper Almon. Each year the INFORUM partners convene a world conference to report on their work. Many of the sections covered in this paper were presented and discussed at the INFORUM World Conferences: in Traunkirchen (Austria) in 2006, in Trujillo (Spain) in 2007, in Kyrenia (Cyprus) in 2008, in Jūrmala (Latvia) in 2009 and in Listvyanka (Russia) in 2013.

The authors are grateful to all colleagues, INFORUM members and partners. Special thanks go to Dr. Maurizio Grassini, Professor of the University of Florence, who did a great job in introducing the authors to the INFORUM society, in advancing the modelling skills in Latvia, who made many useful suggestions that helped to improve this publication. The authors are also very grateful to Dr. Clopper Almon, Professor Emeritus of the University of Maryland, who facilitated many improvements in the Latvian macro-econometric model and made a major contribution to the development of this book.

1. OVERVIEW OF MACROECONOMIC MODELS IN THE WORLD

1.1. General Characterization of the Models

Macroeconomic models are widely used in the majority of world countries as one of the instruments of economic analysis and forecasting. The features of each model are determined both by the aims of their application and by specific features of the national economy. Different types of macroeconomic models are extensively used worldwide – predominantly macro-econometric, macroeconomic multisectoral, input-output and Computable General Equilibrium (CGE) models.

Model building began with a model built for the Netherlands by J. Tinbergen in 1936 [178, p. 5]. It was the first comprehensive national macroeconomic model; the approach was later applied in the United States and the United Kingdom.

Further modelling activities were facilitated by the development of the system of the national accounts, which forms the foundation of the majority of current macroeconomic models. The first official national income statistics were published in the United States in 1934 by S. Kuznets and in the United Kingdom in 1941 by R. Stone [100, p. 398]. Further activities of R. Stone led to the development of the first international accounting system – the 1953 Standard National Accounts (SNA).

After World War II, significant contributions to the development of macroeconomic models were made by the USA economist L. R. Klein. Together with A. S. Goldberger he developed the famous Klein-Goldberger model, which was based on the foundations laid by J. Tinbergen [84]. In the early 1960s, L. R. Klein and a number of colleagues built the Brookings Model, which was a detailed quarterly econometric model for the USA [64; 178, p. 6; 164]. This model played a crucial role in further theoretical and methodological research on econometric model building and influenced the development of other models [31, p.108], in particular the Wharton Econometric Forecasting Model developed by L. R. Klein and the Data Research, Inc. (DRI) model developed by G. Fromm, O. Eckstein and others in the late 1960s [55]. These models were the ancestors of a commercial U.S. macroeconomic model currently marketed by IHS Global Insight. At present, this model is the most widely-used econometric model and a forecasting service in the USA [45].

L. R. Klein also facilitated the development of macroeconomic modelling in Europe and in other parts of the world via the LINK project (initiated in 1969). The concept used in the LINK project was that each model builder knows his or her country or region best and therefore models should not be standardized and built in one single organization. Instead, models from different countries should be integrated in a consistent way. [85]

Model development is connected with the development of economic thought and various economic schools – classical, neoclassical, Keynesian, neo-Keynesian school and so on. The basic structure and theoretical basis of several models have not significantly changed for a couple of decades, at the same time, the latest versions of some other models are connected with significant changes in model structure and theoretical justification. Several models can be regarded as completely new models, as they are developed by particular authors or organizations for the first time. For example, the first version of R. C. Fair model was developed in 1974 – 1976. In the Fair model, equations are re-estimated each quarter together with the update of the database, simultaneously the accuracy of the previous forecasts is evaluated [63]. Extensions in the BbkM model of the Deutsche Bundesbank [58, p. 120] at the beginning of the 21st century were associated with the introduction of the euro. At the same time major structural and theoretical changes have been made in the econometric model of the Bank of Greece [58, p. 172]. In the National Bank of Belgium a larger multisectoral model was replaced by a smaller macro-econometric model [58, p. 101]. The model system LINK was initially built by the Wharton Econometric Forecasting Associates and in 1969 included the models of 7 countries. Since 1980 it has been coordinated by the United Nations (UN) and now includes the models of over 60 countries [132].

Macroeconomic models are elaborated in all developed countries and in the majority of developing countries. The available information both about separate macroeconomic models and their developers indicates that the most developed regions in this sense are the USA and the European countries.

In the USA, several types of models have been developed. Input-output models include regional model IMPLAN [35, p. 28]. CGE models are often used for government budget planning, e.g. TRAIN [35, p. 30] is used for analysis of tax revenues in the State of Nebraska and DRAM [35, p. 41] is used for analysis of budget revenues in the State of California. In addition, several macroeconomic multisectoral models have been developed, e.g. regional model REMI [35, p. 35] and INFORUM type model LIFT [76]. Model LIFT is a long-term inter-industry forecasting tool linked to other similar models (models of Austria, Belgium, South Korea, France, Italy, Japan, Canada, China, Great Britain, Mexico, Spain and Germany) via the BTM (Bilateral Trade Model), which ensures correct export-import relations among the participant countries [119; 137]. Macro-econometric models have also been built. These include the USA Federal Reserve model FRB [163], models of different universities and other organizations (including international organizations), such as R. C. Fair models – Fair model of the US economy [59; 62; 63] and MCD model [60; 61], QUEST – quarterly model for long-term forecasts and scenario analysis [4], multi-regional model MULTIMOD [116], global economic model GEM [65] of the International Monetary Fund (IMF), Global Insight model used by the Energy Information Administration (EIA) [114]. Models of other types are also developed in the USA (e.g. macroeconomic forecasting model CountryWatch [37]).

In Europe, macro-econometric models are developed and elaborated on a large scale. CGE, macroeconomic multisectoral and input-output models, are developed and applied, frequently even within a single institution for complex analysis (in the euro system [58, p. 1]). Information regarding the developed macro-econometric models is available practically for all the EU countries, at the same time other types of macroeconomic models are elaborated only in some countries or information about these models is not published.

CGE models are predominantly used for the analysis of energy sector and climate changes (European energy model GEM-E3 [117], Norwegian global model IMACLIM-R [68], Austrian model ATCEM-E3 for modelling of the interaction among energy, economy and environment [134], EMEC model of Sweden [120], Worldscan model of the Netherlands [115]). CGE models are also used for the development analysis of separate industries and spheres, for instance, for analysis of the tourism sector (Moffat Scenario CGE model of Great Britain [30]). There are also CGE models, which are elaborated for the analysis of the national economy as a whole (Danish model DREAM [38]).

The most widely known macroeconomic multisectoral models are INFORUM type models for Austria, Belgium, Denmark, France, Germany, Hungary, Italy, Poland, Spain, Switzerland and Russia [76], as well as model Athena for the economy of the Netherlands [115]. Input-output models are more frequently used for the analysis of separate industries, sectors or regions (Energy Input-Output Model for Switzerland [52], Regional Input-Output Model of the Slovak Republic [73]), or they are integrated in the systems of macroeconomic models [33; 85]. There are also input-output models, which can be used both independently and in connection with other models (Russian inter-industrial model CONTO [145] is linked with the model of the pension system [131]).

The most popular macro-econometric models of the euro area are the AWM model (Area-Wide Model) [57; 58] of the European Central Bank (ECB) and MCM model (Multi-Country Model) [58; 106; 146; 179] of the European System of Central Banks (ESCB). The structure of these models is repeatedly characterized as being appropriate for the development of other models (Latvia's LMM model [29], several Estonian models [82; 111], Finnish model EMMA [99] and AQM-06 model of the Oesterreichische Nationalbank [143]). Of course, there are also other models with different structure and theoretical bases (e.g. QUMMIR in Russia [145], A-LMM in Austria [26], SLOPOL6 in Slovenia [177], etc.).

Several significant macroeconomic models have been developed for the Canadian economy (ToTEM model of the Bank of Canada, models BoC-GEM, MUSE, etc. [71]). Modelling is also developing in the African countries (a model for Malawi was developed in cooperation with Norwegian specialists [32; 36], an INFORUM type macroeconomic multisectoral model SAFRIM was elaborated in the Republic of South Africa [76], also CGE models were developed [139]). In Asia [139] and Australia [44, p. 1] CGE models are more popular. In China, Japan and Thailand macroeconomic multisectoral models are also developed [76].

In many countries several models have been elaborated, including the models made at different organizations, for example, in the USA, Austria, Greece, Estonia, Great Britain, etc., however, there are also countries, where only one or several government institutions are involved in model building, in the majority of cases it is the Ministry of Finance or the Central Bank [178, p. 11]. As a result, in some of these countries only one model has been developed.

Usually the development of a particular model is connected with a particular country. However, models, which cover several countries, can be developed both in one country or organization and as a result of cooperation among several countries. For the euro area countries the MCM model is developed in cooperation between the European Central Bank and central banks of the respective countries [58]. The UN coordinates the Project LINK, more than 100 members from 60 countries – universities, private research organizations, government institutions and central banks – are involved in its implementation [132]. The model of the euro area EDGE [58] of the Bank of Finland is an example of a multi-country model made in one organization. Several global models can be also classified in this category. The MCD [60; 61] model includes the USA and 38 other countries, as well as the trading matrix with 59 countries or country groups. EUROMON of the Nederlandsche Bank [58] includes 13 individual countries and the group comprising all other countries. The macro-econometric multi-country model of the Deutsche Bundesbank BbkM [58] includes blocks dedicated to Germany, its 8 most significant trading partners (mostly G7 countries) and 4 regions, as well as the monetary and fiscal block describing the aggregation of the entire euro area. The several-region model of the IMF, MULTIMOD [116], includes the models of G7 countries and 3 regions. Such regional and global models are intended for the analysis of a particular country regarding the international economic relations and global economic processes.

Models are developed and/or used in different organizations. These include government agencies (USA Energy Information Administration (EIA), Statistics Denmark, Ministry of Finance of the Slovak Republic, Lithuanian Ministry of Economy, etc.) and central banks of individual countries (the Federal Reserve (USA), central banks of the EU countries, Bank of Canada, etc.). Many scientific research and academic institutions actively deal with modelling issues on a regular basis (Austrian Institute of Economic Research (WIFO), Austria's Institute for Advanced Studies (IHS), Finland's Labour Institute for Economic Research and Sweden's National Institute for Economic Research, etc.). Models are built and/or used in international organizations (IMF, UN etc.) and in commercial organizations (CountryWatch, etc.). Models are developed also as individual research projects (for example, models developed by R. C. Fair [63]). In the countries, where experienced modelling specialists are not available, experts from other countries are often involved in the model building process. For instance, the model for Malawi [32; 36] was built in cooperation with the specialists of Statistics Norway.

In the present book, macro-econometric models are analyzed more extensively than other types of macroeconomic models. The analysis deals with the macro-econometric models, which are based on the national accounts statistics and include theoretically justified relations among macroeconomic indicators, estimated with econometric methods. The analysis focuses on the models, which have been widely considered in numerous publications. It means that there is a detailed characterization of models, their structure, their use and other features of the models. The analysis includes the theoretical basis of the models, different aspects of their application, structure, informative and software maintenance. The list of the selected models is given in Table 1.1.

Table 1.1

List of Macro-Econometric Models

Country	Model Name	Organization	Author	Information Source
1	**2**	**3**	**4**	**5**
USA	Fair Model	Yale University	R. C. Fair	[59; 62; 63]
USA	Global Insight Model	IHS Global Insight/U.S. Department of Energy	F. Price and others	[114]
USA	QUEST	INFORUM, University of Maryland	C. Almon, D. S. Meade and others	[4; 7; 76; 185]
Euro area countries	AWM	European Central Bank (ECB)	G. Fagan, J. Henry, R. Mestre, A. Dieppe	[57; 58; 168]

Table 1.1 continued

1	2	3	4	5
Euro area countries	MCM	European System of Central Banks (ESCB) and central banks of the euro area	A. Estrada, G. Fagan, K. McQuinn and others	[53; 58; 106; 146; 168; 179]
Austria	AQM-06	Oesterreichische Nationalbank	M. Schneider, M. Leibrecht	[143]
Austria	A-LMM	Austrian Institute of Economic Research (WIFO) and Austrian Institute for Advanced Studies (HIS)	J. Baumgartner, S. Kaniovski, T. Url, H. Hofer, U. Schuh	[26]
Belgium	NBB	National Bank of Belgium	Ph. Jeanfils	[58]
Denmark	ADAM	Statistics Denmark	T. Kristensen, P. Jensen and others	[1; 86]
France	Mascotte	Banque de France	J. P. Villetelle, O. de Brandt, V. Brunhes-Lesage	[58]
Greece	Model of Greece	Bank of Greece	N. Zonzilos	[58]
Estonia	Estonian Model	Tartu University	J. Meriküll	[111]
Estonia	EMMA	Bank of Estonia	R. Kattai	[82]
Lithuania	LITMOD	Ministry of Economy in collaboration with LMA Ekonomikos Institutas and Danish Risø National Laboratory	D. Celov, E. Vilkas, D. Grinderslev, F. M. Andersen	[33]
Slovak Republic	Slovak Model	Ministry of Finance	S. Livermore	[103]
Slovenia	SLOPOL6	Klagenfurt University	K. Weyerstrass, R. Neck	[177]
Finland	EMMA	Labour Institute for Economic Research	M. Lehmus	[99]
Malawi	Model for Malawi	Malawian government in collaboration with Statistics Norway	A. Cappelen, R. Choudhury, T. Harding	[32; 36]
Country group	MCD	Yale University	R. C. Fair	[60; 61; 63]
Country group	BbkM	Deutsche Bundesbank	B. Hamburg, K. H. Tödter	[58]

As shown in Table 1.1., the analysis includes models from the USA, the Scandinavian countries, the Baltic States, Central and Eastern European countries and one country from Southern Africa – Malawi (the model developed in collaboration with the Norwegian economists).

1.2. Theoretical Framework of the Models

Macro-econometric models are usually built on the basis of the national accounts system, by adapting the structure of the model to some chosen economic theories.

The most popular direction in Europe is the so called “neoclassical synthesis”. Within this approach Keynesian theory and demand factors are used for modelling of short-term fluctuations, but in the long run neoclassical equilibrium is achieved. Thus, that in the long run economic development is determined by the available labour, capital and other resources (in BbkM model – also by imported supplies, in AQM-06 – also by oil) and technological progress. The short-term fluctuations are determined by demand factors and deviations from the state of economic equilibrium. The long-run equilibrium is determined by using a production function for the calculation of the potential GDP with full employment. Short-term deviations from the equilibrium result in a GDP gap, as well as in differences between actual and NAIRU (*Non-accelerating-inflation rate of unemployment* [25, p. 7]) unemployment rate. Long-term equilibrium is achieved as a result of wage and price corrections. This approach is used in AWM, MCM models, Estonian model, SLOPOL6 model, model of the Slovak Republic and Finland’s EMMA model. The most significant theories and functions used in several models are given in Table 1.2.

Table 1.2

Theoretical Framework of Macro-Econometric Models

Model Name	Theoretical Justification
1	**2**
Fair model	Features of various economic theories
Global Insight Model	Features of various economic theories
QUEST	Features of various economic theories
AWM	Short-term – demand factors, long-term – neoclassical theory, Cobb-Douglas production function, Phillips curve
MCM	Short-term – Keynesian theory, long-term – neoclassical theory, Cobb-Douglas production function, for Ireland – wage mark-up model in the long-term and Phillips curve in the short-term, for Spain – wage bargaining theory

Table 1.2 continued

1	2
AQM-06	Short-term – Keynesian theory, long-term – neoclassical theory, Cobb-Douglas production function, Phillips curve
A-LMM	Neoclassical theory, Cobb-Douglas production function, wage bargaining theory
NBB	Short-term – Keynesian theory, long-term – supply factors, CES production function, wage bargaining theory
ADAM	Keynesian theory, Input-output relations, Phillips curve
Mascotte	Neo-Keynesian theory, Cobb-Douglas production function, wage bargaining theory
Model of Greece	Short-term – Keynesian theory, long-term – neoclassical theory, Cobb-Douglas production function, wage bargaining theory
Estonian Model	Short-term – Keynesian theory, long-term – neoclassical theory, Phillips curve
Estonian EMMA	Short-term – Keynesian theory, long-term – neoclassical theory, Phillips curve
LITMOD	Input-output relations, Keynesian theory, Phillips curve
Slovak Model	Short-term – Keynesian theory, long-term – neoclassical theory, Cobb-Douglas production function, wage bargaining theory
SLOPOL6	Elements of Keynesian and neoclassical theory, Cobb-Douglas production function
Finnish EMMA	Keynesian theory, neoclassical theory for supply side and prices, Cobb-Douglas production function
Model for Malawi	Keynesian theory, Cobb-Douglas production function
MCD	Features of different economic theories
BbkM	long-term – neoclassical theory, Cobb-Douglas production function, Phillips curve

Table 1.2 shows that there are also models, which are based mainly on the Keynesian theory (ADAM, LITMOD and the model for Malawi) or on the neoclassical theory (Austrian A-LMM model) and traditional macroeconomic functions. According to the Keynesian theory, increase in demand creates increase in income, tax revenues and imports. If the increase in demand is connected with the increased government expenditures, then the government budget balance and current account deteriorate, if these indicators are not restricted or regulated. However, if the reason of the increased demand is increase in exports, then the government budget balance and current account improve.

In the models based on the neoclassical theory, conditions of steady state growth are included: the output to labour ratio and the capital stock per employee are rising at a constant rate, the capital to output ratio and the marginal productivity of capital are constant, which implies constant shares of labour and capital income in the output. Equilibrium in the goods market is secured by the demand adjustment mechanism via disequilibria in the trade balance. The labour market equilibrium is characterized by a time-varying natural rate of unemployment.

Some models are characterized as neo-Keynesian models (for example, the Mascotte model). In these models prices are almost fixed in the short term and the output is determined by the demand for goods and services. In the long run prices and wages are determined by the utility rate of production and unemployment.

Production functions are used for modelling of long-term supply and/or demand for production factors – mostly Cobb-Douglas or constant elasticity of substitution (CES) production functions and their derivatives. Production functions are used in all models with neoclassical features. Production factor demand is calculated in compliance with the production function theory in some models, which are characterized as Keynesia-tradition models (for example, LITMOD and the model for Malawi).

Several theories are used for modelling of wages such as neoclassical theory, Phillips curve theory, wage bargaining theory, and the wage mark-up model. The neoclassical theory can be used in the long term, when the changes in real wages depend on the changes in labour productivity. According to the Phillips curve theory, real wages mainly depend on the unemployment level and nominal wages depend on unemployment rate and inflation. Theories, which involve wage bargaining, use unemployment and changes in productivity as factors in wage equations. The wage mark-up model states that wages depend on the GDP deflator and productivity. The majority of models (Table 1.2) use the Phillips curve and wage bargaining theories. However, in the model for Malawi wages in the private sector are determined by exogenously given wages in the public sector.

In contrast to the European models, models of the USA emphasize less the use of particular economic theories. In some cases the use of elements of different theories is tolerated in order to form a stable long-term equilibrium and to accurately model short-term fluctuations (for example, in Global Insight model).

Regarding the theoretical basis of the models, it can be concluded that models are mostly built using approaches from several economic theories (theoretical justification of equations), but not in all cases. Sometimes the choice of factors included in an equation is dictated by available statistical information. That fact may impair their theoretical justification of a model, but improve the accuracy of the model in the sample period. Inclusion of the production function in the models is often connected with different problems. There may be no data on capital stock and additional calculations may be needed; there may be problems with estimation of parameters, and with the choice of a particular production function. Different theories chosen for wage modelling often result in the choice of the same variables (for example, in the Mascotte model and in LITMOD), because different theories may have similar features. Sometimes the choice of suitable factors is more important than the choice of the most appropriate theory.

1.3. Model Application Options

Application of macro-econometric models can be characterized considering several aspects – application purpose and tasks, application areas, application status, subject or user, regularity of use and forecasting horizon, etc. There are many options regarding construction and application of the models. The classification of the main model application options proposed by the authors is given in Figure 1.1.

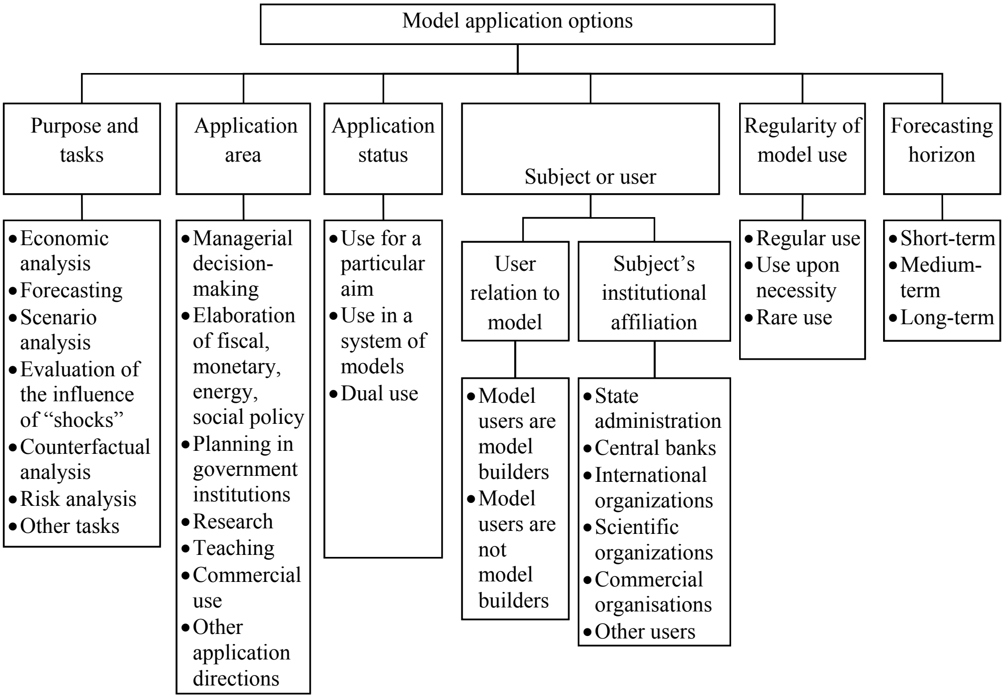

Figure 1.1. Classification of model application options.

Traditional model application purposes are economic analysis, forecasting, scenario analysis, evaluation of influence of different changes or "shocks" and counterfactual analysis. Some models are also used for risk analysis.

Most models are used for several purposes – all models are used for different kinds of economic analysis (to specify economic relations, to determine dynamic trends, etc.) and scenario analysis. Almost all of the reviewed models are used to forecast economic development. In this context, forecasting of economic development means both the formulation of alternative courses of economic development and the so called policy simulations. Policy simulations are made to evaluate the influence of fiscal and monetary policy instruments on the national economy.

Frequently, models are adjusted depending on their use either for forecasting or for scenario analysis. The adjustment is done to achieve greater accuracy in reflecting the development trends of the national economy or the influence of separate exogenous indicators and relations on the main macroeconomic indicators. The model structure can also be adjusted to the aim and peculiarities of a particular research question, by including additional equations or excluding particular equations, as well as by changing the type or set of factors of individual equations.

Evaluation of the influence of “shocks” is sometimes done in order to analyze the features of the model and thus to evaluate, whether the model will give reliable results and be applicable for its purpose. In some countries models are also used for counterfactual analysis in order to evaluate the influence of a definite event on the national economy during the sample period [58; 61; 62].

Models built for forecasting are usually used as one of the instruments of analysis together with expert evaluations, other models and methods. For example, in the European Central Bank forecasting process involves the use of both the AWM and MCM models, as well as other models, including the models of individual countries, and also expert evaluations. The model of Greece is used for forecasting together with expert evaluations.

Traditional model application areas are managerial decision-making, elaboration of fiscal, monetary, energy and social policy, planning in government institutions, research, teaching and commercial use.

Macro-econometric models are widely used in managerial decision-making process both by governments and by individual organizations and enterprises. The use of models by governments is connected with the development of economic, fiscal, monetary and social policy, for instance, Ireland’s MCM model is used to evaluate and control stability of its banking system; the A-LMM model is used to evaluate the influence of social security reforms on the development of the national economy and on the government budget; the SLOPOL6 model provides recommendations for monetary and fiscal policy; Global Insight model and LITMOD are used for elaboration of energy policy. AWM is used at the European Central Bank to develop optimal monetary policy.

Models are also often used in budget planning or in drawing up other plans as, for example, the model of Slovak Republic and the model ADAM. For elaboration of different plans, enterprises can use both forecasts published by different organizations (the Bank of Spain regularly publishes the forecasts of the MCM model) and publically available models built for commercial and non-commercial purposes and their results.

Another significant area of model application is research. AWM is used in the European Central Bank for analysis of specific issues of the euro area, among them, for estimation of the real exchange rate, evaluation of dynamics of labour force and for other purposes. Research as one of the model application areas is mentioned also in cases, where modelling results (mainly forecasts) are used in different reports, which can be applied for different purposes, for example, AQM-06 model, MCM model for Spain, Slovak model and R. C. Fair models.

Models are often applied in several areas simultaneously. Detailed information about definite models (like Fair models and QUEST) is available to everyone. For instance, R. C. Fair publishes model descriptions, equations, data base and software. Similar information is available on the model QUEST. Therefore, it is possible to use these models also in other areas depending on the interests of particular users. Summary of the application purposes and application areas of the particular models is given in Table 1.3.

Table 1.3

Application Areas and Purposes of Macro-Econometric Models

Model	Application Purposes	Application Areas
1	**2**	**3**
Fair model	Economic analysis, forecasting, scenario analysis, counterfactual analysis	Research, teaching, etc.
Global Insight model	Economic analysis, forecasting (medium term), scenario analysis	Elaboration of energy policy
QUEST	Economic analysis, forecasting, scenario analysis	Research, teaching, etc.
AWM	Economic analysis, forecasting, scenario analysis	Elaboration of monetary policy, research
MCM	Economic analysis, forecasting, scenario analysis	Elaboration of monetary policy, research
AQM-06	Economic analysis, forecasting, scenario analysis	Elaboration of monetary policy, research

Table 1.3 continued

1	2	3
A-LMM	Economic analysis, forecasting (till 2075), scenario analysis	Elaboration of social policy
NBB	Economic analysis, forecasting, scenario analysis	Research
ADAM	Economic analysis, forecasting, scenario analysis	Planning in government institutions
Mascotte	Economic analysis, forecasting (2-3 years), scenario analysis, counterfactual analysis	Research
Model of Greece	Economic analysis, forecasting, scenario analysis	Elaboration of monetary policy, research
Estonian Model	Economic analysis, scenario analysis	Research
Estonian EMMA	Economic analysis, forecasting (medium term), scenario analysis	Research
LITMOD	Economic analysis, forecasting (till 2020), scenario analysis	Elaboration of energy policy, research
Slovak Model	Economic analysis, forecasting (up to 10 years), scenario analysis, risk analysis	Elaboration of fiscal policy, budget planning, research
SLOPOL6	Economic analysis, scenario analysis	Elaboration of monetary and fiscal policy
Finnish EMMA	Economic analysis, forecasting, scenario analysis	Research
Model for Malawi	Economic analysis, scenario analysis	Research
MCD	Economic analysis, forecasting, scenario analysis (2009-2012), counterfactual analysis	Research, teaching, etc.
BbkM	Economic analysis, forecasting, scenario analysis	Research

One of the characteristic features of the models is the status of their application. The model can be used principally (individually, separately) for a particular aim, or as a sub-system or as an element in the system of models. Thus, models can be classified as principal or stand-alone models, assistant models, and dual use models.

Principal models are built and used for a particular purpose. Assistant models are initially planned as one of the elements in the system of models.

There models are either interconnected or model results are used in one or several other models as the values of the exogenous indicators.

Several models are used both as individual models or principal models and as assistant models. For instance, LITMOD is used for analysis of the Lithuanian economy as a whole, and as an assistant tool for forecasting energy consumption. The NBB model is used both as a stand-alone model and as an assistant model for more comprehensive research. Global Insight model is incorporated in the National Energy Modelling System (NEMS) of the EIA (USA), which has been developed for evaluation of energy supply, demand, prices and emissions, basing on the assumptions regarding the development of the national economy and energy policy. In the framework of Macroeconomic Activity Model (MAM), the results of the Global Insight model are used in several associated models in order to calculate output and employment indicators by industries, as well as the main macroeconomic indicators in the major regions of the USA. However, it is also used as a principal model at IHS Global Insight.

Some models are simultaneously used both for the needs of a particular government institution and in the regional or global context. For example, all the models of MCM system can be used both individually and as a single system.

With respect to the subject or the user of the models, several features can be used for classification.

Firstly, models can be divided by relations of the model users to the models. There are models, which are built and used in one organization/group of researchers. There are models, which are built in one organization, but are used in another organization. The first group of models can be further distinguished by the availability of results. The results of some models are available only within the particular organization, but the results of other models are available also to other users.

The first group comprises such models as AWM, Global Insight model, NBB, AQM-06, A-LMM, Mascotte, the model of Greece, the Estonian model, Estonian EMMA, Finish EMMA, as well as models, which are elaborated in cooperation of several organizations/researchers, for example, the system of MCM models, LITMOD, the Slovak model. One of the models, which are built in one organization but are used in another organization, is the model for Malawi. R. C. Fair models can be classified as belonging to both groups, as the information published regarding these models allows using both the modelling results and the models as such by any interested party.

Secondly, models can be classified by the institutional affiliation of their subjects, for example, as models built and/or used by state administration institutions, central banks, international organizations, scientific organizations, commercial organizations, or by other users.

There is a trend to build individual country models within a system of models of several countries. This approach allows evaluation of the position of a particular country in a regional (MCM model) or global context (MCD model, BbkM model). Models built in one institution, usually contain more or less standardized blocks for separate countries, which typically contain fewer equations than a model of the main country. However, model systems, which are built in individual countries, contain more differential sub-models. It is connected with the reflection of specific features of these countries in the model equations. Moreover, a model of a particular country, which is used in the regional/global context and individually, often has several versions. In the regional/global context the model structure has to be integrated with the structure of sub-models of other countries and the sub-model, which unites all countries. The analysis of an individual country does not require such integration.

The majority of the models, which are developed for the needs of central banks or other government institutions, are used regularly (Global Insight model, AWM, MCM, AQM-06, NBB, ADAM and the Mascotte models, the model of Greece and BbkM model). Fair models are also regularly updated and used. Other models are regularly updated, however, they are used either only upon necessity or rarely.

A particular forecasting period is not reported in all reviewed model descriptions. Models are more often used for short-term forecasting (2 – 3 years). In some cases it is possible to use models also for long-term forecasting. Longer forecasting horizon is chosen for the models, which are used in the development of the social policy (A-LMM model), energy policy (Global

Insight's model and LITMOD model) and fiscal policy (the model of Slovak Republic). Shorter horizon is mostly used in research.

1.4. Model Structure

The structure of the macro-econometric models of particular countries differs. Therefore, the division of model equations into different sections is not the same either. Summary of the blocks included in several models is given in Table 1.4. The main blocks included in the models are:

- supply side, where the output of goods and services and demand for production factors is estimated,
- demand side, where the elements of GDP use are modelled,
- section of wages and prices,
- foreign trade section,
- fiscal or government sector.

Table 1.4

Blocks of Macro-Econometric Models

Model	Number of Blocks	Blocks
1	**2**	**3**
Fair model	5	Households, enterprises, financial and government sector, imports and equations
Global Insight model	7	Domestic expenditures, domestic income, tax policy, foreign trade, financial block, inflation block, potential demand
QUEST	1	GDP accounts, employment, unemployment, inflation and Treasury bill rates
AWM	6	Production function and factor demand, components of aggregate demand, prices and costs, foreign trade, fiscal policy and government sector, monetary and financial sector
MCM	4	Production function and factor demand, components of aggregate demand, prices and costs, government sector
AQM-06	7	Supply, demand, wages and prices, labour market, public sector, conditions of monetary and fiscal policy
A-LMM	6	Supply, household consumption, labour market, income, public sector, social insurance

Table 1.4 continued

1	2	3
NBB	8	Households, supply side, wages, prices, government sector, foreign trade, monetary and financial sector
Mascotte	7	Production function and factor demand, components of aggregate demand, prices and costs, fiscal policy and government sector, trade, monetary and financial sector
Model of Greece	5	Aggregate demand, supply side, wages and prices, foreign trade, fiscal block
Estonian Model	5	Supply side, prices, wages, demand side, government sector
Estonian EMMA	6	Demand, supply, foreign trade, prices, labour market, government sector
LITMOD	7	Households, government finances, investment, foreign trade, production and GDP, factor demand, wages and prices
Slovak Model	6	Demand, financial indicators, supply, prices and costs, government sector, private sector
Finnish EMMA	4	Output and factor demand, aggregate demand, wages and prices, public sector
Model for Malawi	6	Government, households, foreign sector, enterprises, national accounting identities and financial sector
MCD	40	Models of 39 countries and international trade block
BbkM	13	Germany, 8 most important trading partners, other EU countries, other OECD countries, OPEC countries and the rest of the world

The size of each block in a model depends on the chosen disaggregation. Models often do not include a monetary block, assuming that the central bank of a particular country cannot influence (significantly) the fluctuations of interest rates and exchange rates, but these fluctuations depend on fluctuations of these indicators in other countries. It can be noted that because of increasing topicality of the issues connected with energy efficiency and environment protection, certain models are integrated into the model systems for the analysis of these issues (Global Insight model for USA and Lithuania's LITMOD).

Besides the calculation of the most significant macroeconomic indicators, all models analyzed share one more common feature – they are not considered to be complete or finished. Possibilities to improve the models are connected with information updates – both regarding a larger disaggregation of particular indicators and data updates of indicators already included in the model.

Updating often leads to smaller or larger changes in model equations. Significant changes in the model structure are connected with the changes in classification of different indicators, if a certain aspect included in the model is calculated in detail. Improvement perspectives of model parts are connected with the necessity to improve the features of separate model blocks thus making the models more precise and their results more reliable.

Models also differ by the number of equations (see Table 1.5). The majority of the models analyzed are medium-sized models with 70 – 150 equations. This ensures convenient and foreseeable use of the models for the chosen purposes, as well as provides extensive information for representation of interrelations of macroeconomic indicators. Average and small models usually do not include disaggregation of industries or other indicators. One of the rare models with more than 1,000 equations is the Danish model ADAM, where a large number of equations is conditioned by the presence of detailed characterization of industries, consumption and foreign trade. Models ADAM and LITMOD also include input-output tables and respective equations, which allows evaluating the inter-sectoral or inter-industrial relations more objectively.

Model size depends on different factors – model application purposes, data availability, chosen disaggregation of particular indicators, experience of model builders, users and developers, available software and the level of knowledge about its use, time limitations, as well as other factors.

Table 1.5

Size of Macro-Econometric Models

Model	Number of equations	Inter alia econometrically estimated
1	**2**	**3**
Fair model	225	30
Global Insight model	1,700	>500
QUEST	200	22
AWM	84	15
MCM	80-100[4]	15-20[1]
AQM-06	107	38
A-LMM	>100	>10

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[4] Depending on the country.

Table 1.5 continued

1	2	3
NBB	150	30
ADAM	2,500	>500
Mascotte	280	60
Model of Greece	93	17
Estonian Model	34	17
Estonian EMMA	84	14
LITMOD	>200	>100
Slovak Model	>50	26
SLOPOL6	57	21
Finnish EMMA	71	15
Model for Malawi	116	7
MCD	>1,000	314
BbkM	691	292

As can be seen from Table 1.5, the share of econometric equations in macro-econometric models is mostly relatively high (often 20 – 40%). There are comparatively few econometric equations in the model for Malawi (approximately 6%) and relatively many in the Estonian model (almost 50%). The share of econometric equations depends on the model structure, on data availability and quality and on the number of additional equations included in the model (for calculation of growth rates, structure indicators, etc.).

Regarding the equation estimation methods, single equation estimation econometric methods are the most usual. This fact is connected both with the ease of changing only one equation if necessary without having to re-estimate the whole equation system, and with the technical problems, which are connected with the specification of large systems of equations [178, p. 15]. Ordinary Least Squares (OLS) is still used quite extensively, largely because more complicated methods have not proven to give better results in practice [7; 185]. In some models it is substantiated with the small sample size, which does not allow using other methods efficiently. Other model builders stress that it is not possible to obtain unbiased and efficient estimators using this method [111, p. 141]. The problem arises due to the fact that through another equation in the simultaneous system an explanatory variable may be correlated with the error term in the equation, in which it is an independent variable [7, p. 10]. Two-Stage Least Squares (2SLS) is the most widely used alternative.

In certain models not all the parameters are estimated using econometric methods (for example, the Slovak model, Austrian A-LMM model) in order to ensure preferable characteristics of the model.

In the majority of the models general to specific methodology is used for the development of equations. According to this methodology, at first fairly general equations are estimated, including all the relevant variables according to the economic theory. Further in the estimation process variables with too small statistical significance are removed [32, p. 36]. In such a way theoretically justified relations among the indicators are adjusted to particular data.

In the majority of the European models Error Correction Model (ECM) methodology is used for the estimation of equations. It is done taking into account the theoretical justification of the models and the necessity to "separate" long-term and short-term relations. It is important to ensure that in the course of time the importance of the short-term factors diminishes and the long-term equilibrium is reached.

1.5. Informative and Software Maintenance

In the majority of the models discussed here, quarterly data are used, which allows obtaining a larger number of observations and creating more precise equations. In many of these models, the data are seasonally adjusted before estimation of the equations in order to eliminate the influence of seasonality on the estimated parameters. However, in some cases (for example, LITMOD) it is emphasized that initial or raw information gives more credible results. Moreover, it is possible to use seasonal dummies, which allow eliminating the influence of the seasonal fluctuations. At the same time, there are models, which are based on annual data, and that allows estimating long-term trends and relations more precisely. Characteristics of the databases of several models are given in Table 1.6.

Table 1.6

Databases of Macro-Econometric Models

Model	Used Data	Sample Start Time
1	**2**	**3**
US model	Quarterly	1954:1
Global Insight model	Annual	1980
QUEST	Quarterly	1980:1
AWM	Quarterly	1970:1
MCM	Quarterly	1980:1
AQM-06	Quarterly (SA)	1983:1
A-LMM	Annual	1976
NBB	Quarterly (SA)	1980:1
ADAM	Annual	1948
Mascotte	Quarterly	1975:1
GR-MCM	Quarterly	1980:1
Model of Greece	Annual	1964
Estonian Model	Quarterly	1996:1
Estonian EMMA	Quarterly	1996:1
MCM block for Ireland	Quarterly	1980:1
LITMOD	Quarterly	1996:1
Slovak Model	Quarterly	1994:1
SLOPOL6	Quarterly	1995:1
Finnish EMMA	Quarterly (SA)	1990:1
MCM block for Spain	Quarterly (SA)	1986:1
Model for Malawi	Annual	1979

SA – seasonally adjusted data

The use of the quarterly data has several advantages, including larger number of observations and the possibility to elaborate more precise short-term forecasts. At the same time, quarterly data are not always sufficient and then the experience to transform annual data into quarterly data is needed. Problems may be connected also with the seasonal adjustment, if the most appropriate method is not used. Moreover, the obtained forecasts disregard seasonality, which requires additional calculations in order to use the results for short-term planning. Experience of the authors indicates that even if annual data are used as the basic source of information, it is possible to use also quarterly and monthly data for short-term estimation of exogenous indicators, for evaluation of reliability of short-term forecasts, as well as for adjustment of separate parameters of the equations.

Databases of the models, which are used regularly, are also regularly updated. However, in other models databases are updated when it is necessary to use the model for new researches and other needs.

In the process of model elaboration and specification of equations, specialized software (TROLL, EViews, etc.) is usually used, including specially developed kinds of software. Several of these programs are available for free use (Fair-Parke, G7 [165], etc.). Widely applied software (for example, Excel, etc.) is also used. Excel is also often used as an assistant tool for the development of databases and representation of results.

2. THE LATVIAN MACRO-ECONOMETRIC MODEL

2.1. Theoretical Framework of the Model

In the course of building the macro-econometric model for the Latvian economy, several matters are taken into account connected with the specific features of the national economy, availability of data and the intended application of the model. First of all, the fact that Latvia is a small open country influences export and import relations, the flows of foreign investments, interest rates and how the economy reacts to the economic crises in other countries and other internationally significant events. If necessary, such events can be represented in the equations of the model by dummy variables, that is, by variables that have a value of 0 or 1. The fact that Latvia is an open economy with fixed exchange rates implies that monetary policy instruments will have little effect. No doubt, the role of monetary indicators in the model should be carefully analyzed, but that is not done here.

Regarding statistical information, both the length of time series and the coverage of available data should be taken into account. In most cases, information on the main macroeconomic indicators and their components is available annually; some indicators are calculated and published quarterly, and some indicators are also available monthly. Therefore, annual data cover most of the information essential for adequate estimation of equations. At the same time, quarterly information gives more detail about timing and more observations, which enhance the credibility of the estimated parameters. However, the comparatively limited availability of the quarterly series creates the need to transform annual to quarterly data. This transformation can introduce additional imprecision, thus offsetting the gains from the use of longer time series.

Many economists view the presence of seasonality in quarterly data as a problem. In order to eliminate this problem, two approaches are employed – seasonal adjustment of the time series and the use of seasonal dummies in the equations. The use of seasonal dummies has several advantages: firstly, there is no need for additional processing of primary information; secondly, the quality of information is not reduced as can happen if an inappropriate seasonal adjustment method is applied; and thirdly, the results contain seasonality and thus can be directly used for forecasting. Monthly data can be used for additional short-term analysis.

Given the available data, Latvia's model is made on an annual data base with some quarterly blocks where the necessary information is available.

Peculiarities of the Latvian economy, as well as the data chosen, influence also the choice of the theoretical framework of the model. Latvia's macro-econometric model is primarily of the Keynesian type. There are several reasons for that choice: (1) during the period covered by the sample data, demand factors were dominant (except from 2006 to 2008, the period of rapid growth of wages, prices and costs characterized by a low unemployment level), and (2) there is insufficient information on capital stock in the national economy overall and in separate industries in constant prices to support a supply-side analysis. Thus, Keynesian theory and demand factors are the basis of the Latvian model. At the same time, the influence of supply can be studied with the help of separate exogenous indicators, for example, by covering growing demand with additional imports instead of domestic production to ensure that employment does not exceeded the labour force.

A medium-term forecasting horizon of three to seven years is used for the model. This choice is a compromise. The use of Keynesian theory suggests a short horizon, but the use of annual time series limits the precision of short-term forecasts. On the other hand, the model is not appropriate for long-term forecasting, because the relations it uses change with time.

A medium-term forecasting horizon is appropriate also for the expected application of the model to the formation of economic and financial policy. Although the short-term impacts of the policy on the national economy are very important, medium-term and long-term impacts are more significant. At the same time, it should be noted that the policy elaboration process in Latvia is more or less dynamic, that is, policy is frequently reviewed and revised; therefore a long-term forecasting horizon is not always useful. Important issues also include the dynamics of industries, the development of the energy sector and environment protection. Therefore, the model structure has to be built in a way which allows extending the model to analyze these aspects of economy in detail.

Relatively short time series restrict the possibilities of using the model in some kinds of calculations. Therefore, the model is intended for scenario analysis, using information about development trends of exogenous indicators, as well as opinions held by the users of the model.

2.2. General Structure of the Model

The structure of the Latvian macro-econometric model was designed to take into account the conditions described in the previous section and to include the main macroeconomic indicators, industry aspects, energy sector and economic policy relations. The Latvian model contains seven sections:

1. GDP sources and uses.
2. Supply of goods and services and production factors.
3. Prices and wages.
4. Foreign trade and the balance of payments.
5. Employment and demographic indicators.
6. The fiscal sector.
7. The energy sector.

1. The section dedicated to GDP sources and uses contains calculation of private and government consumption, investment and changes in stocks in constant and current prices, as well as components of the national income in current prices – compensation of employees, gross operating surplus, and mixed income and subsidies. Total export, which is calculated in the foreign trade section, is also used to determine aggregate demand. Aggregate demand determines the volume of aggregate supply, the volume of output of goods and services and import.

2. In the second section, the output of goods and services, value added and real capital investment by industries are determined. The starting point is 10 industries defined in the NACE classification (1.1. rev.). The model structure allows adding industries, if needed.

3. In the prices and wages section, the necessary price indexes by industries, deflators for GDP and its components, as well as average nominal gross wage are determined.

4. In the section of foreign trade and the balance of payments, the model determines exports of goods by country groups and export of transportation, tourism and other services and imports in constant and current prices, as well as the main components of the balance of payments.

5. For the calculation of labour supply, the model contains the total population, the age structure of the population, and the number of retirees. It then calculates the economically active population, the number of employees by industry, and the unemployment rate.

6. Within the fiscal sector, the general government consolidated budget revenues by the most significant tax groups and non-tax revenues are calculated, as well as the main components of expenditures. Indicators for calculation of tax revenues, which characterize the tax base, and factors which influence particular components of expenditures are taken from other sections. Elements of fiscal policy used in this section are tax rates, the ratio of budget deficit to GDP and the breakdown of expenditures.

7. The energy sector includes the calculation of electricity consumption by the main consumer groups. Comparing these consumption rates with the potential production yields the amount of electricity that has to be imported from other countries or provided by increasing power plant capacity.

The Latvian macro-econometric model is developed using the software Portable Dyme [67] and G7 [165], additional calculations are made using EViews [180]. The model includes 378 equations, of which 63 are estimated econometrically. Ordinary Least Squares is used for estimation of the behavioural equations because other often recommended methods do not give substantially better results [7].

Model structure can be considered to be flexible. If necessary, additional sections can be added to the model. The model can also be simplified by substituting some calculations with exogenous indicators in accordance with the modelling needs.

2.3. The Section of GDP Sources and Uses

The components of GDP use – total final consumption (private or household and government final consumption expenditures), investment and exports – influence the amount of output. Imports include goods and services needed for production and consumption but not extracted or produced in Latvia. Within the model, total imports are calculated by multiplying total output with the ratio of import to output. Detailed calculation of exports and imports is included in the foreign trade section of the model. Components of GDP by source (income approach) are calculated using indicators from other sections of the model.

2.3.1. Private Consumption

Several factors are taken into account while modelling private consumption, which is final consumption expenditure of households plus that of non-profit institutions serving households. These factors differ in various countries depending on the economic situation, development level, specific features of economic cycles and other characteristics of the particular country. Table 2.1 summarizes the factors used for private consumption modelling in several macroeconomic models.

Table 2.1

Factors Influencing Private Consumption in Macro-Econometric Models

	Factors									
Models	Yd	Yd/CP	W	W/Yd	CP in previous periods	r	u	PCI	Cr	t
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
AWM	x		x			x	x			
MCM	x		x			x			x	
MCM block for Spain	x		x							
MCM block for Ireland	x		x							
GR-MCM	x		x			x				x
A-LMM	x		x							
AQM-06	x		x		x	x				
NBB	x		x				x			
Mascotte	x							x	x	

Table 2.1 continued

1	2	3	4	5	6	7	8	9	10	11
Estonian Model	x		x							
Estonian EMMA	x		x	x	x					
LITMOD	x					x	x	x		
SLOPOL6	x					x				
Slovak Model	x				x	x				
Finnish EMMA	x		x		x			x		
Model for Malawi	x	x								
BbkM	x					x		x		
CountryWatch	x									

where

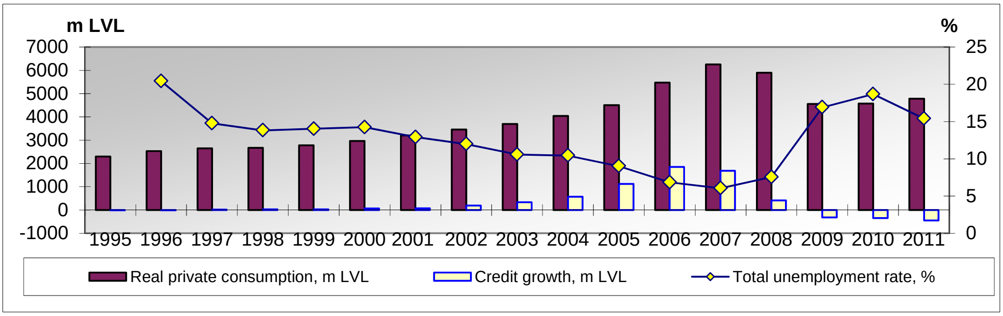
CP – private consumption in constant prices;
Yd – disposable income in constant prices;
W – wealth in constant prices;
r – interest rate;
u – unemployment rate;
PCI – private consumption price index;
Cr – credits;
t – time trend;
x – factor is included in the private consumption function.

Table 2.1 shows that the most frequently used factors in the private consumption functions (in real terms) are real disposable income and real wealth. In the ADAM model, particular components of the wealth indicator are used as individual factors [70], in case of SLOPOL6, the wealth indicator is replaced by a long-term interest rate [177, p. 87], but in the Finnish EMMA – by price index of flats, because flats form the major component of wealth [99, p. 10]. The wealth indicator is used more frequently in long-term relations. The basis of the wealth indicator is net foreign assets (capital and financial account of the balance of payments) and stock of total or private capital. In the AWM model [57, p. 15] and the MCM block for Ireland [106, p. 17] the calculation of wealth includes also government debt.

In calculation of the wealth indicator, statistics on capital stock is of major significance. In the opening and closing balance sheets of the Latvian national accounts statistics, there is an indicator “fixed assets” (AN.11), which might be considered as capital stock. However, changes in the values of this indicator do not correspond to the dynamics of the indicator “gross fixed capital formation”, which characterizes the growth of fixed capital in the economy (amortization in this case is of negative value). Moreover, the data on fixed assets is not published in constant prices. Thus, it is not possible to include capital stock in the model without additional calculations and assumptions. The analysis of this issue is not considered to be useful at the moment, because it is possible to use alternative indicators in the private consumption equation instead of wealth.

Therefore, disposable income is used as the main factor for calculation of the private consumption in the Latvian model. One or more additional factors are used to characterize consumption fluctuations, which are not connected with the changes in the disposable income.

Figure 2.1 shows that fluctuations of the private consumption correlate with the unemployment rate as a factor restricting consumption (value of correlation coefficient r = -0.90 in 1995 – 2008), and the credit growth as a factor facilitating consumption, more likely with a one period lag (r = 0.97 in 1996 – 2008). The economic crisis caused some disturbance, but generally the correlation is still strong (value of r for time period until 2011 is -0.6 for the relation with the unemployment rate and 0.75 with credit growth).



Source: CSB database [96], LB statistics [22]

Fig. 2.1. Factors influencing the private consumption in Latvia.

A strong relation between interest rates and private consumption was not observed. Therefore, these indicators are not viewed as potential factors influencing private consumption. Incorporation of lagged values of private consumption in the model might result in more accurate forecasts in the short term; however, at the same time it would lessen the significance of other factors [4, p. 2], which would lead to the creation of equation less suited for medium or long term forecasting.

Private consumption price index and private consumption are closely related. However, explicitly adverse trends in 2008 indicate that inflation expectations, which might be characterized as the value of the private consumption price index in the next period, are of greater significance. At the same time, such trend can be explained as “adjustment” of price level to the consumption. Entrepreneurs react to the growing consumption by increasing prices; however, it happens with a certain lag.

Approach to the calculation of the disposable income is also chosen selecting the most appropriate consumption function for the Latvian model. According to the macroeconomic theory, disposable income can be calculated on the basis of GDP by subtracting amortization of fixed assets and indirect taxes (VAT, excise tax, etc.), retained surpluses of enterprises, enterprise income tax, obligatory social insurance payments and personal taxes, at the same time adding transfer payments from the government budget [118, p. 22]. Several approaches are used for the calculation of disposable income in applied modelling. In some models disposable income is calculated based on the nominal GDP, in other models – on total compensation of employees. Summary of the calculation approaches of the disposable income is given in Table 2.2. Disposable income is usually calculated in current prices, but the consumption function is specified in constant prices. Therefore, the real disposable income is used in the consumption function, calculated as a ratio of its nominal value to the private consumption price index.

Table 2.2

Calculation of the Disposable Income in Macro-Econometric Models

	Components of Calculation								
Models	GDP	W · E	GR	TI	TD	TR	OI	NFN	NX
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
AWM	+		-	+			+	+	
MCM		+			-	+	+		
AQM-06		+			-	+	+		
Estonian Model	+		-	+				+	
Estonian EMMA		+			-	+	+	+	
LITMOD		+			-	+	+		
SLOPOL6	+				-	+			
Slovak Model		+			-	+	+		
Finnish EMMA		+			-	+	+		

Table 2.2 continued

1	2	3	4	5	6	7	8	9	10
Model for Malawi		+			-	+	+		
BbkM	+								
CountryWatch	+			-	-	+			-

where

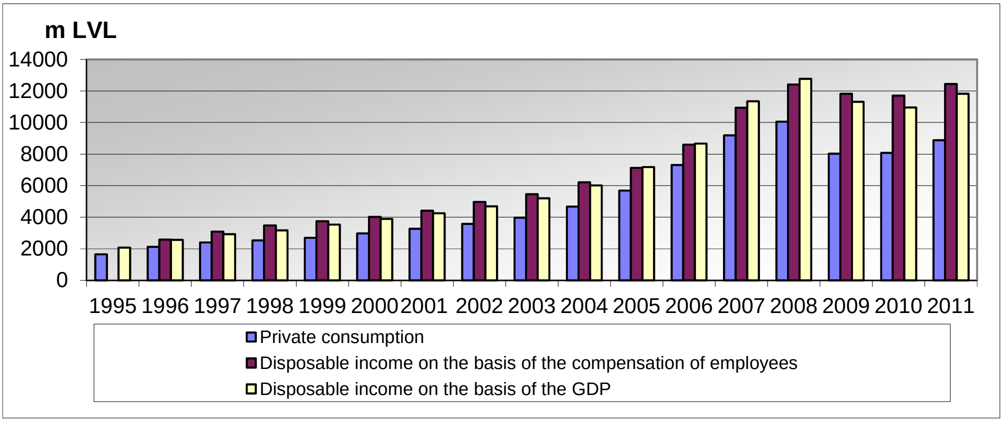
W – average gross wage;
E – number of employees;
GR – revenues of general government consolidated budget;
TI – indirect tax revenues;
TD –direct tax/ labour tax revenues;
TR – transfers to households;
OI – other income of households;
NFN – net income and transfers from abroad;
NX – net export;
„+” – indicator is added;
„-” – indicator is subtracted.

As shown in Table 2.2, comparatively more models use total compensation of employees (product of the wage rate and the number of employees) as the basis for the calculation of the disposable income. Then income and capital taxes and social insurance payments are subtracted and government transfers and other income are added in most cases. In the Estonian EMMA, net income and transfers from abroad are also added. Other income mainly contains a part of gross operating surplus and mixed income, which refers to the income of households and enterprises. In LITMOD profit after taxes is used instead of other personal income indicator.

Using this approach, an appropriate indicator of the disposable income is obtained. However, there are certain problems with identifying the component of other income, which in Latvian statistics is not fully reflected. Nevertheless, the indicator for other income can be replaced by the total of gross operating surplus and mixed income. The main reason for that is a large share of the hidden economy in Latvia, mainly manifested as “envelope” wages and hidden profit. According to the SSE Riga Hidden Economy Index for Latvia, the share of the shadow economy was 21.1% in 2012, but the recent highest value was observed in 2010 – 38.1% [147]. The other reason is the fact that the capital stock and thus also capital amortization is not yet calculated in the model.

GDP as the basic element of the disposable income is used comparatively rarely. It can be partly explained by the feedback between the private consumption and GDP, because the private consumption is used in the calculation of GDP directly. However, the advantages are connected with the scope of indicators included in the calculation. They are mostly easy to interpret and there are no data availability problems. In comparison, using the compensation of employees as the basic element, the data on the number of employees is available starting with 1996.

The Latvian nominal disposable income calculated both on the basis of the total compensation of employees and GDP is given in Figure 2.2. The obtained results do not differ significantly. Therefore, it is possible to choose any of these calculation approaches. Within the former approach, the total compensation of employees in summed up with the expenditures of the general government consolidated budget (further in the text – the government budget) for social benefits and gross operating surplus and mixed income. Income and property tax revenues as well as a part of the social security contributions paid by employees are subtracted from this sum. Within the latter approach, government budget expenditures for social benefits are added to GDP and all tax revenues are subtracted from this sum.



Source: Calculated by the authors on the basis of CSB database [96]

Fig. 2.2. Private consumption and disposable income in current prices.

Evaluation of several approaches to the calculation of the disposable income and several combinations of the factors influencing consumption resulted in the choice of calculation approach based on GDP. In the Latvian model the disposable income is calculated by subtracting tax revenues of the general government consolidated budget from GDP and by adding expenditures of the social benefits to this sum.

In the course of specification of the private consumption equation, using different factor combinations, certain problems arose. They were associated with statistical characterization of equation, accuracy in the last sample years, and the credibility of the estimated parameters. For example, if disposable income together with unemployment rate and credit growth is included in the equation, then t-value of unemployment rate (-0.4) shows that it is not statistically significant. Accuracy of the equation is very high (R^2 = 0.99); however, comparatively large deviations in 2009 – 2011 indicate that a similar problem might arise also in the coming years.

Private consumption equation disregarding the unemployment rate is given in equation (2.1).

$$\text{cons\_fp\_priv} = 385.3 + 0.67 \cdot (\text{di}/\text{pi\_cons\_pr}) + 0.47 \cdot (\text{cred}(-1)/\text{pi\_cons\_pr}(-1)) \qquad (2.1)$$

where

cons_fp_priv – real private consumption;
di – disposable income;
pi_cons_pr – private consumption price index;
cred (-1) – credit growth in the previous period.

Statistical characteristics obtained using G7 software for the equation are given in Table 2.3. The equation fits the data reasonably well. The value of the coefficient of multiple determination is close to 1 and the Mean Absolute Percentage Error is just 2.12%. The value of the Durbin-Watson statistic points at possible autocorrelation problems. However, it is argued that an appropriate value of RHO depends on the variables included in the equation [6, p.45], therefore, the value of 0.24 can be considered as a good starting point. All the coefficients of the equation are statistically significant. The elasticity of disposable income is 0.87, which is comparatively high. It can be explained by the lowering importance of loans as a result of the recent economic crisis. Households are relying more on their own income to finance their consumption needs.

Table 2.3

Statistical Characteristics of Private Consumption Equation

```
:                    Private Consumption in Constant Prices
 SEE   =     116.95 RSQ   = 0.9900 RHO =   0.24 Obser  =   16 from 1996.000
 SEE+1 =     114.87 RBSQ  = 0.9885 DW  =   1.52 DoFree =   13 to   2011.000
 MAPE  =      2.12
   Variable name          Reg-Coef  Mexval  Elas   NorRes    Mean   Beta  t-value  F-Stat
 0 CONS_FP_PRIV        - - - - - - - - - - - - - - - - -  4016.22 - - - - - - - - - - -
 1 intercept           385.32657    26.7   0.10  100.12      1.00        2.804
 2 DI/PI_CONS_PR          0.67419   555.7   0.87    2.86   5190.67  0.865  23.366  644.29
 3 CRED[1]/PI_CONS_PR[1]    0.46936    69.1   0.03    1.00    279.94  0.182   4.915   24.16
```

where

SEE – Standard error of estimate (not adjusted for degrees of freedom);
SEE+1 – Standard error of estimate for one period ahead;
MAPE – Mean absolute percentage error;
RSQ – Coefficient of multiple determination;
RBSQ – Coefficient of multiple determination adjusted for degrees of freedom;
RHO – Autocorrelation coefficient of the residuals, ρ;
DW – Durbin-Watson statistic;
Obser – Number of observations;
DoFree – Degrees of freedom;
Reg-Coef – Regression coefficients for the variable;
Mexval – Marginal explanatory value;
Elas – Elasticity at mean;
NorRes – The “normalized” sum of squared residuals using this and all preceding variables;
Mean – Mean of the variable;
Beta – Beta coefficient;
t-value – Student’s t-statistics;
F-Stat – F statistics.

G7 software provides extensive statistical description of each equation. Standard error of estimate, mean absolute percentage error, coefficient of multiple determination and adjusted coefficient of multiple regression can be used to evaluate the closeness of the fit of the equation. The measures of autocorrelation are the Durbin-Watson statistic and RHO. The Durbin-Watson statistic has been widely discussed in many theoretical sources. The values of RHO, which are not used as frequently, are calculated using the Durbin-Watson statistic and their ideal values are zero.

Statistics for each independent variable includes marginal explanatory value, elasticity at mean, the “normalized” sum of squared residuals, mean, Beta, t-statistics and F-statistics. Marginal explanatory value shows the percentage increase in the standard error of estimate if this variable is left out of the regression. Elasticity at mean shows to what extent the dependent variable will change (in percentage) if the value of the independent variable changes by one percent. The "normalized" sum of squared residuals indicates how the sum of squared residuals was gradually reduced by introducing new variables in the equation. The mean is the average value of the variable over the sample period. The beta coefficient shows the values of the regression coefficients if the variance of each variable was equal to one. T-statistics helps to evaluate the statistical significance of each dependent variable. F-statistics is used for testing joint statistical significance of the particular variable and all the following variables in the equation.

Predicted values of the private consumption calculated by the equation (2.1) together with the actual data are given in Figure 2.3.

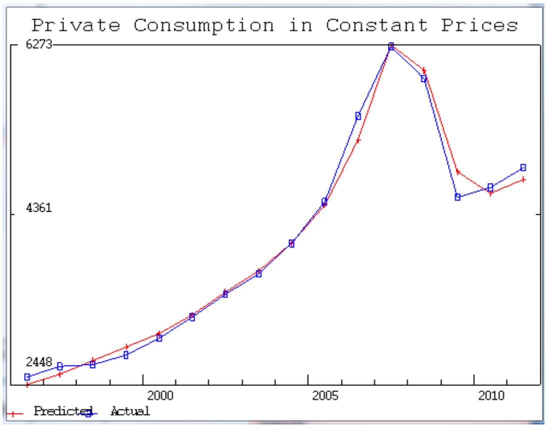


Fig. 2.3. Graph of actual and predicted values of private consumption equation.

Figure 2.3 shows the close fit of the private consumption equation. In 2009 a visible difference between actual and forecasted value of the private consumption can be observed. Also in 2011 there is an almost similar difference, but on the opposite side. These differences may suggest that the estimated equation does not fully capture the recent dramatic changes in economic development.

Equation (2.2) can be used as an alternative for the calculation of the private consumption. In this case the private consumption depends on the disposable income and exogenous marginal propensity to consume. In this case, it is possible to avoid problems with statistical characterization of the equation. The importance of credits is neither under- or overestimated.

$$\log(\text{cons\_fp\_priv}) = \text{cons\_fp\_di} \cdot \log(\text{di\_fp}) \tag{2.2}$$

where

cons_fp_priv – real private consumption;
cons_fp_di – marginal propensity to consume;
di_fp – real disposable income.

As the disposable income is the only factor used, the marginal propensity to consume characterizes not only the part of additional disposable income, which is used for consumption, but also the influence of other sources of consumption expenditures like savings and credits. Additional loans influence consumption positively and thus the value of the marginal propensity to consume also increases as additional resources for consumption expenditures are becoming available. Growing values of credit repayments influence the marginal propensity to consume negatively.

2.3.2. Government Consumption

According to the European System of Accounts ESA 95, final consumption expenditures of the general government consist of compensation of employees (D.1)[5], intermediate consumption (P.2), social transfers in kind provided via market producers (D.6311 + D.63121 + D.63131), consumption of fixed capital (K.1), and net operating surplus of market establishments (B.2n) less market output (P.11), output for own final use (P.12), and partial payments for other non-market output (P.131) [105, p. 30]. In macroeconomic models government consumption is mostly exogenous. It is used in scenario analysis in connection with government decisions regarding the increase or decrease of the government expenditures. In the Finnish EMMA [99, p. 31] government consumption is calculated as a sum of government purchases and compensation of employees in constant prices. In the model for Malawi [32, p. 6] government consumption is modelled both in current and constant prices by adding

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[5] Codes according to ESA 95 classification.

government sector wage costs, material costs for consumption purposes and a residual term, which includes other components of government consumption. Real public sector wages are calculated as a multiplication of the number of employees and the wage rate in the base year.

Thus it is possible to use one of the two approaches in the Latvian model. The first option is to model the government consumption either in constant or in current prices and the government consumption price index. The second option is to model government consumption both in constant and in current prices and to calculate price index as a ratio of the government consumption in current prices to its values in constant prices.

Using the first approach and the government budget expenditures for compensation of employees as the main component, it is possible to control the dynamics of government consumption price index more easily. In the long run, the government consumption price index should not differ significantly from other price indexes.

The second approach implies calculation of the government budget expenditures for compensation of employees in constant prices as a multiplication of the number of employees and constant wages. The remaining part of the government consumption is characterized by a growing trend. Therefore, it is problematic to model the dynamics of other government consumption expenditures according to the dynamics of this indicator in current prices.

Due to the previously mentioned considerations, the government consumption in the Latvian model is calculated in current prices. The most significant government consumption position is the expenditures of general government consolidated budget for compensation of employees. Other government consumption expenditures are modelled depending on other expenditures of the government budget (except the expenditures for capital formation, subsidies, social benefits and interest payments). The government consumption in constant prices is calculated using the corresponding price index.

2.3.3. Investment Demand

In the Latvian model calculations of capital investment and foreign direct investment are included together with gross fixed capital formation or total investment demand. For the calculation of investment demand, the calculation principle used in LITMOD [33, p. 26] is exploited. It implies linear equation with the coefficient value of 1 for total capital investments as they are included fully in gross fixed capital formation. The rest of investment is connected with foreign direct investment and the dummy for the Russian crisis. The value of foreign direct investment coefficient of 0.553 indicates that approximately a half of foreign direct investment can be associated with gross fixed capital formation. GDP is mentioned as a possible additional factor, however, it is not included in the equation due to insufficient statistical significance.

In the course of development of the investment equation for the Latvian model, it was first assumed that it is necessary to fully include total capital investments and also foreign direct investments as factors in the equation. As foreign direct investments are published in current prices, investment deflator is used to obtain this indicator in constant prices. Regression was run twice – for the first time using GDP in constant prices and for the second time using time trend as an additional factor, however, the obtained results were not satisfactory. Releasing the assumption that the coefficient of the capital investment should be 1 has resulted in statistically acceptable equation (2.3) (time trend is significant at 67% level).

$$\begin{array}{lllll} inv\_fp\_fix = & -23.5 & +\ 1.3 \cdot inv\_fp\_nef & +\ 0.39 \cdot (mb\_fdi\_inlv/pi\_inv\_fix) & -\ 6.9 \cdot t \\ \text{t-stat} & (-0.5) & (18.1) & (2.8) & (-1.0) \\ \text{mexval} & (1.0) & (411.0) & (25.8) & (3.9) \end{array} \qquad (2.3)$$

$R^2 = 0.99$; DW = 2.13; P(F-stat) = 0.00 [1995 – 2011],[6]

where

---

[6] Further only the most significant measures are used for statistical evaluation of equations – the values of t-statistics and mexval – marginal explanatory value (given in brackets below the values of the coefficients), determination coefficient (R^2), the Durbin-Watson criterion (DW) and probabilities, which correspond to F-statistics (P(F-stat)). If not specified otherwise, the values of t-statistics in the equations correspond to 95% confidence interval. The values of the coefficient of determination are high, which indicates close relations among the factors and the dependent variable. The values of the Durbin-Watson statistics do not point at autocorrelation problems. Probabilities, which correspond to F-statistics, are lower than 5%. The data sample is given in square brackets.

inv_fp_fix – gross fixed capital formation in constant prices;
inv_fp_nef – capital investments in constant prices;
mb_fdi_inlv – foreign direct investments in current prices;
pi_inv_fix – investment deflator;
t – time trend (1995 = 1).

In equation (2.3) foreign direct investment is less significant than in the case of the Lithuanian model, however, more importance is ascribed to capital investment.

2.3.4. Changes in Inventories and Total GDP

In many models, where changes in inventories are included, this variable is exogenous. In some models changes in inventories are included in total investment. In other models, as, for example, in the Austrian model [143, p. 8] stock of inventories is calculated. Thus, first of all stock of inventories is modelled and afterwards the changes in inventories are calculated as a difference. In the Estonian model [111, p. 160] the ratio of the changes in inventories to GDP in the previous period is used as a factor together with the average value of this ratio, which has a negative sign.

Since the ratio of the changes in inventories to GDP in Latvia is similar to other EU countries and it is relatively small, specification of complicated equations for this indicator is not useful. Moreover, the problems associated with the specification of such an equation are connected not only with relatively large fluctuations of this indicator, but also with negative values of the changes in stocks in several years (in 2000 and 2009 in current prices and in 1998, 2000, 2008, 2009 and 2010 in constant prices). Therefore, the changes in stocks are modelled by exogenous ratio to GDP both in current and constant prices.

Total value of GDP is calculated by adding the above mentioned components of the domestic demand and exports and by subtracting imports, which are calculated in the section of foreign trade and the balance of payments. Schematic representation of GDP use relations is given in Figure 2.4.

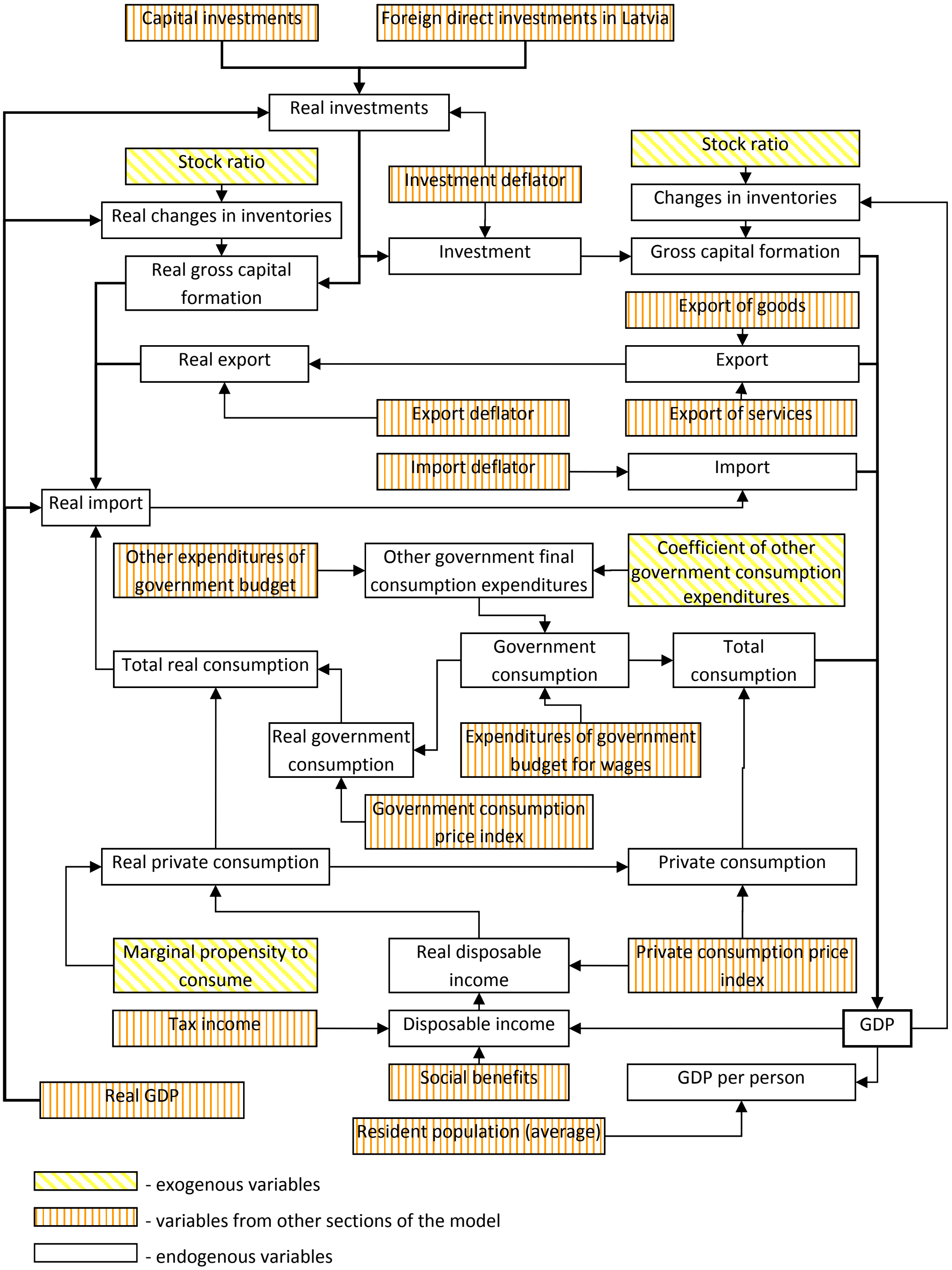


Fig. 2.4. Calculation of GDP uses in the Latvian model.

This section includes also several identities. Calculation of the disposable income is given in the system of equations (2.4).

Di = gdp_cp + gov_tr – gov_rev_tax
di_fp = di / pi_cons_pr (2.4)
di_gr_fp = (di_fp / di_fp(-1)[4] – 1) · 100

where
di – disposable income in current prices;
gdp_cp – GDP in current prices;
gov_tr – expenditures of general government consolidated budget for social benefits;
gov_rev_tax – tax revenues of general government consolidated budget;
di_fp – real disposable income;
pi_cons_pr – private consumption price index;
di_gr_fp – growth rate of real disposable income.

Calculation of the GDP use components in constant prices is given in the system of equations (2.5).

cons_fp_gov = cons_cp_gov / pi_cons_gov
cons_fp = cons_fp_priv + cons_fp_gov
inv_fp_stock = gdp_fp · inv_fp_stockgdp / 100 (2.5)
inv_fp_gross = inv_fp_fix + inv_fp_stock
ex_fp = ex_cp / pi_ex
im_fp = cons_fp + inv_fp_gross + ex_fp – gdp_fp

where
cons_fp_gov – government consumption in constant prices;
cons_cp_gov – government consumption in current prices;
pi_cons_gov – government consumption price index;
cons_fp – total final consumption in constant prices;
cons_fp_priv – private consumption in constant prices;
inv_fp_stock – changes in inventories in constant prices;
gdp_fp – real GDP;
inv_fp_stockgdp – share of changes in inventories in GDP in constant prices;
inv_fp_gross – gross capital formation in constant prices;
inv_fp_fix – fixed capital formation in constant prices;
ex_fp – real exports;
ex_cp – exports in current prices;
pi_ex – export price index;
im_fp – real imports.

Calculation of the growth rates of the GDP use components in constant prices is given in the system of equations (2.6).

---

[4] Lag period is given in brackets after the variable.

$$\begin{aligned}
\text{cons\_gr\_fp\_pr} &= (\text{cons\_fp\_priv} / \text{cons\_fp\_priv}(-1) - 1) \cdot 100 \\
\text{cons\_gr\_fp\_g} &= (\text{cons\_fp\_gov} / \text{cons\_fp\_gov}(-1) - 1) \cdot 100 \\
\text{inv\_gr\_fp\_fix} &= (\text{inv\_fp\_fix} / \text{inv\_fp\_fix}(-1) - 1) \cdot 100 \\
\text{inv\_gr\_fp\_st} &= (\text{inv\_fp\_stock} / \text{inv\_fp\_stock}(-1) - 1) \cdot 100 \\
\text{ex\_gr\_fp} &= (\text{ex\_fp} / \text{ex\_fp}(-1) - 1) \cdot 100 \\
\text{im\_gr\_fp} &= (\text{im\_fp} / \text{im\_fp}(-1) - 1) \cdot 100
\end{aligned} \tag{2.6}$$

where

cons_gr_fp_pr – growth rate of private consumption;
cons_gr_fp_g – growth rate of government consumption;
inv_gr_fp_fix – growth rate of fixed capital formation;
inv_gr_fp_st – growth rate of changes in inventories;
ex_gr_fp – growth rate of exports;
im_gr_fp – growth rate of imports.

Calculation of the GDP use components in current prices is given in the system of equations (2.7).

$$\begin{aligned}
\text{cons\_cp\_priv} &= \text{cons\_fp\_priv} \cdot \text{pi\_cons\_pr} \\
\text{cons\_cp\_gov\_o} &= \text{gov\_oth} \cdot \text{cons\_cp\_gov\_coef} \\
\text{cons\_cp\_gov} &= \text{gov\_w} + \text{cons\_cp\_gov\_o} \\
\text{cons\_cp} &= \text{cons\_cp\_priv} + \text{cons\_cp\_gov} \\
\text{inv\_cp\_fix} &= \text{inv\_fp\_fix} \cdot \text{pi\_inv\_fix} \\
\text{inv\_cp\_stock} &= \text{gdp\_cp} \cdot \text{gdp\_str\_inv\_st} / 100 \\
\text{inv\_cp\_gross} &= \text{inv\_cp\_fix} + \text{inv\_cp\_stock} \\
\text{ex\_cp} &= \text{ex\_goods} + \text{ex\_serv} \\
\text{im\_cp} &= \text{im\_fp} \cdot \text{pi\_im} \\
\text{gdp\_cp} &= \text{cons\_cp} + \text{inv\_cp\_gross} + \text{ex\_cp} - \text{im\_cp} \\
\text{gdp\_per\_capita} &= (\text{gdp\_cp} / \text{pop\_aver}) \cdot 1000
\end{aligned} \tag{2.7}$$

where

cons_cp_priv – private consumption in current prices;
cons_cp_gov_o – other government final consumption expenditures;
gov_oth – other expenditures of general government consolidated budget;
cons_cp_gov_coef – coefficient of other government final consumption expenditures;
gov_w – expenditures of general government consolidated budget for compensation of employees;
cons_cp – total final consumption in current prices;
inv_cp_fix – fixed capital formation in current prices;
pi_inv_fix – investment price index;
inv_cp_stock – changes in inventories in current prices;
gdp_str_inv_st – share of changes in inventories in GDP;
inv_cp_gross – gross capital formation in current prices;
ex_goods – export of goods in current prices;
ex_serv – export of services in current prices;
im_cp – imports in current prices;
pi_im – import price index;
gdp_per_capita – GDP per person;
pop_aver – number of population, annual average.

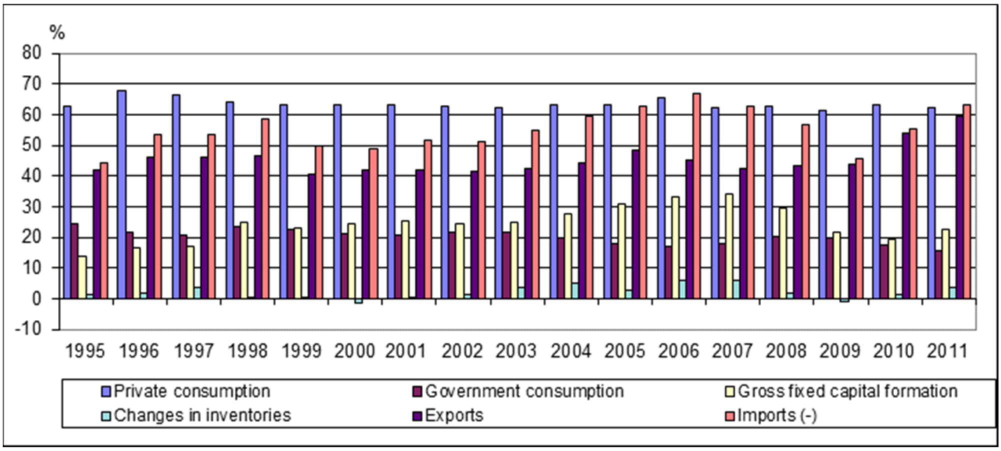
Calculation of the GDP use structure in current prices is given in the system of equations (2.8).

$$\begin{aligned}
\text{gdp\_str\_c\_priv} &= (\text{cons\_cp\_priv} / \text{gdp\_cp}) \cdot 100 \\
\text{gdp\_str\_c\_gov} &= (\text{cons\_cp\_gov} / \text{gdp\_cp}) \cdot 100 \\
\text{gdp\_str\_invfix} &= (\text{inv\_cp\_fix} / \text{gdp\_cp}) \cdot 100 \\
\text{gdp\_str\_ex} &= (\text{ex\_cp} / \text{gdp\_cp}) \cdot 100 \\
\text{gdp\_str\_im} &= (\text{im\_cp} / \text{gdp\_cp}) \cdot 100
\end{aligned} \qquad (2.8)$$

where

gdp_str_c_priv – share of private consumption in GDP;
gdp_str_c_gov – share of government consumption in GDP;
gdp_str_invfix – share of fixed capital formation in GDP;
gdp_str_ex – share of exports in GDP;
gdp_str_im – share of imports in GDP.

The GDP use structure is used also for verification of plausibility of the forecasts. Dynamics of the structure in 1995 – 2011 is reflected in Figure 2.5.



Source: Calculated by the authors on the basis of CSB database [96]

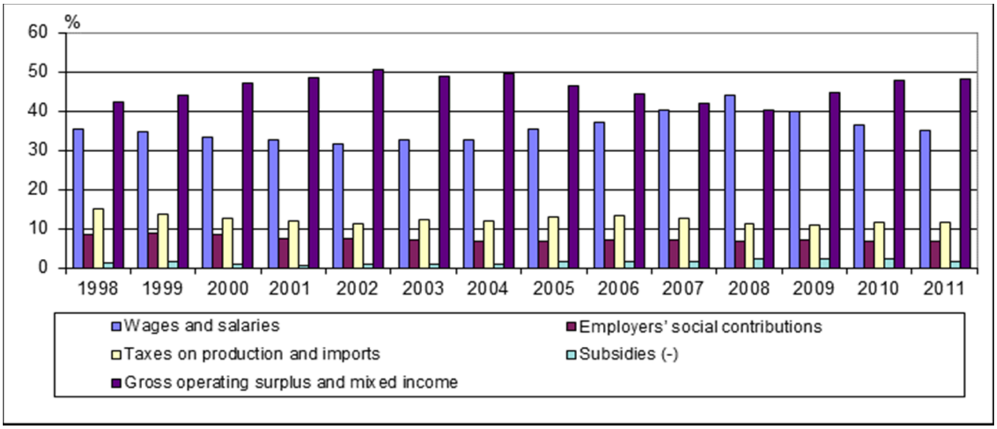
Fig. 2.5. GDP use structure.

The GDP use structure in Latvia is similar to that of other EU countries, where import exceeds export, and it does not change dramatically over time. According to the previous trends in Latvia (see Figure 2.5), in future the share of the private consumption should be within the limits of 50% to 70%, the share of government consumption – 15% to 25%, and the share of investment – 15% to 35%.

2.3.5. GDP by Income Approach

The GDP source section is modelled only in current prices. It includes wages and salaries, employers' social security contributions, taxes on production and import, subsidies and gross operating surplus and mixed income.

The main part of GDP (except in 2008) is gross operating surplus and mixed income, as it is shown in Figure 2.6. In 1998 – 2002 the share of gross operating surplus and mixed income grew from 42.3% to 51.0%. Afterwards it decreased to 40.0% in 2008 and then increased again, reaching 48.2% in 2011. This part of income is connected mainly with profit – with enterprises' profit and profit of the owners of enterprises, which includes also conventional remuneration for work to entrepreneurs and members of their families. A part of gross operating surplus and mixed income can be associated with the so called "envelope" wages, which are illegally paid to official and unofficial employees. Therefore, the dynamics of this component of income can be influenced by the ability of enterprises to gain profit. This is to a large extent connected with the ratio of price to costs of production and its changes, as well as with the government policy and changes in legislation. Efficiency of the government institutions is also important, for example, regarding inspections of illegal employment and labour contracts.



Source: Calculated by the authors on the basis of CSB database [96]

Fig. 2.6. GDP structure by income approach.

Wages and salaries are usually the second most important component of the GDP in Latvia. Only in 2008 it was the most significant income part. Figure 2.6. shows that the dynamics of the share of wages and salaries are opposite to the dynamics of the share of gross operating surplus and mixed income. It can be partly explained by the option to use revenues from economic activities for remuneration of work in the form of wages and in some other form (dividends, "envelope" wages, etc.). The importance of wages and salaries in the income structure increases along with the increase in minimal wages, growing control of labour legislation, as well as improvements in efficiency of tax collection. However, as the data on other EU countries indicate, the difference between the share of wages and salaries and the share of gross operating surplus and mixed income should not exceed 10% – 15% of GDP. The share of employers' social security contributions depends on the norms regarding the compulsory social insurance stipulated in legal acts and on total wages and salaries.

Although gross operating surplus and mixed income is one of the major components of GDP according to income approach, it is modelled as a difference between GDP and all other income components (subsidies are added). It is connected with the fact that other components are related with other indicators included in the model or they are calculated within other sections of the model.

The value of wages and salaries is close to the product of gross nominal wages by the number of employees. The difference between the previously mentioned indicators is eliminated with the help of a coefficient. Similarly, employers' social security contributions are calculated by multiplying the employers' share of the social security contribution income of the general government consolidated budget by a coefficient. Taxes on production and import are calculated within the fiscal section of the model. Subsidies consist of the expenditures of the general government consolidate budged for subsidies and the EU subsidies to farmers, which are included in the balance of payments.

The value of gross operating surplus and mixed income is used for the calculation of the profit of enterprises before taxes. Initially, the possibility to express this relation with the help of regression equation was evaluated. However, the value of the coefficient associated with gross operating surplus and mixed income indicated that the growth of this indicator creates approximately five times faster growth (or decrease) of profit, which cannot be sustained in the long run. Therefore, the profit is calculated using the ratio of profit to gross operating surplus and mixed income and estimating the further development of this ratio.

Relations included in the section of GDP by income approach are visualized in Figure 2.7.

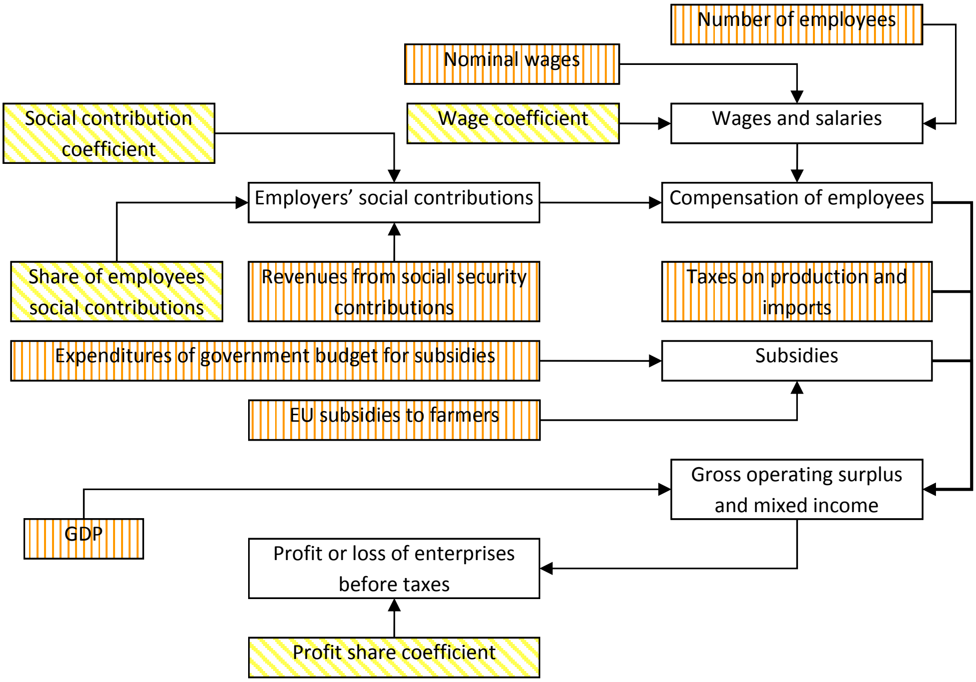


Fig. 2.7. Calculation of GDP by income approach in the Latvian model[5].

Identities of the section of GDP by income approach are given in the system of equations (2.9).

$$\begin{aligned}
inc\_w &= empl \cdot w\_nom \cdot inc\_coef\_w / 1000 \\
inc\_soc &= (1 - tax\_soc\_e) \cdot tax\_soc \cdot inc\_coef\_soc \\
inc\_empl &= inc\_w + inc\_soc \\
inc\_subs &= gov\_subs + mb\_tr\_eu\_subs \\
inc\_oper &= gdp\_cp - inc\_empl - tax\_d2 + inc\_subs \\
prof &= inc\_oper \cdot prof\_oper
\end{aligned} \tag{2.9}$$

---

[5] See the legend in Fig.2.4

$$\text{inc\_str\_w} = (\text{inc\_w} / \text{gdp\_cp}) \cdot 100$$
$$\text{inc\_str\_soc} = (\text{inc\_soc} / \text{gdp\_cp}) \cdot 100$$
$$\text{inc\_str\_tax} = (\text{tax\_d2} / \text{gdp\_cp}) \cdot 100$$
$$\text{inc\_str\_subs} = (\text{inc\_subs} / \text{gdp\_cp}) \cdot 100$$
$$\text{inc\_str\_oper} = (\text{inc\_oper} / \text{gdp\_cp}) \cdot 100$$

where

inc_w – wages and salaries;
empl – total number of employees;
w_nom – average nominal gross wage, annual;
inc_coef_w – wage coefficient;
inc_soc – employers' social security contributions;
tax_soc_e – proportion of the social security contribution rate applicable to employees;
tax_soc – government budget revenues from social security contributions;
inc_coef_soc – social security contribution coefficient;
inc_empl – compensation of employees;
inc_subs – subsidies;
gov_subs – expenditures of general government consolidated budget for subsidies;
mb_tr_eu_subs – government received EU subsidies to farmers;
inc_oper – gross operating surplus and mixed income;
gdp_cp – real GDP;
tax_d2 – revenues from taxes on production and imports of government budget;
prof – profit of enterprises before taxes;
prof_oper – coefficient of profit of enterprises;
inc_str_w – share of wages and salaries in the GDP;
inc_str_soc – share of employers' social security contributions in the GDP;
inc_str_tax – share of taxes on production and imports in the GDP;
inc_str_subs – share of subsidies in the GDP;
inc_str_oper – share of gross operating surplus and mixed income in the GDP.

2.4. Supply of Goods and Services and Production Factors

Formation of the supply side relations in the Latvian model was done taking into account the possibility to develop this model, including input-output relations among industries. Therefore, the model is based on the output in 10 industries (by NACE classification 1.1 rev.). For calculation of production factor demand (in this section – capital investment), value added is used in order to isolate the influence of intermediate consumption on production amount. Intermediate consumption is considered as one of the production factors and an indicator characterizing raw materials and semi-finished goods used in production. These relations are specified in constant prices.

2.4.1. Output of Goods and Services

For determination of the output of goods and services, its value is associated with demand, which is satisfied with domestically produced and imported production. In several models the connection between the demand and the output is ensured with the help of input-output relations. However, in the Lithuanian model [140, p. 193] total output is calculated depending on the private consumption, exports, investment and the ratio of GDP deflator to import deflator. The ratio of the GDP deflator to the import deflator is connected with consumers' choice between domestically produced and imported goods and services. If import prices increase faster than the GDP deflator, which characterizes prices of domestic production, then consumers will demand more domestic goods and services.

In the Latvian model, the value of the total supply or the sum of output and imports is determined by the total demand. The ratio of the GDP deflator to the import deflator in this context can be used to evaluate the share of the imports in the total supply. In order to simplify the calculations, the ratio of the imports to the output is used instead of import share.

According to GDP calculation approaches, total demand minus imports results in the GDP by use approach. It is equal to the output minus intermediate consumption, which gives the value added, plus net taxes on products (equation (2.10)). Equation (2.11) is obtained by expressing the value added as a proportion of the output and calculating imports according to the ratio of the imports to the output. Thus, total output is calculated by equation (2.12).

As mentioned above, the ratio of imports to the output is connected with the choice of consumers to purchase domestically produced or imported goods and services. Therefore, equation (2.13) was specified to model this ratio depending on the ratio of domestic to import prices. The use of the ratio of the GDP deflator and the import deflator did not result in the appropriate equation in the case of Latvia. Instead, the GDP deflator of the EU-15 countries was used as a substitute of the import deflator. The increase of the ratio of the GDP deflators by 1% causes the increase of the ratio of imports to the output by 0.89%. Equation (2.13) is not included in the model, because incorporation of the data of 2008 – 2011 led to statistically insignificant results. Therefore, the import share is exogenous in the model.

$$\text{va} + \text{va\_d21} - \text{va\_d31} = \text{cons} + \text{inv\_gross} + \text{ex} - \text{im} \tag{2.10}$$

$$\text{va\_out} \cdot \text{out} + \text{va\_d21} - \text{va\_d31} = \text{cons} + \text{inv\_gross} + \text{ex} - \text{impsh} \cdot \text{out} \tag{2.11}$$

$$\text{out} = (\text{cons} + \text{inv\_gross} + \text{ex} - \text{va\_d21} + \text{va\_d31})/(\text{va\_out} + \text{impsh}) \tag{2.12}$$

$$\log(\text{impsh}) = -1.33 + 0.89 \cdot \log(\text{pi\_gdp}/\text{pi\_eu15\_gdp}) \tag{2.13}$$

t-stat (-100.5) (10.5)
mexval (2930.7) (233.1)

$R^2 = 0.91$; DW = 2.00; P(F-stat) = 0.00 [1995 – 2007],

where

va – total value added;
va_d21 – taxes on products;
va_d31 – subsidies on products;
cons – final consumption expenditures;
inv_gross – gross capital formation;
ex – exports of goods and services;
im – imports of goods and services;
out – output;
va_out – share of value added in output;
impsh – ratio of imports to output;
pi_gdp – GDP deflator of Latvia;
pi_eu15_gdp – GDP deflator of the EU-15 countries.

When total output is obtained, its value has to be distributed by industries. It can be done by multiplying the total output by the share of a particular industry in the total output (in constant prices) according to the assumptions regarding future changes of the industrial structure. The second option is to specify regression equations for the majority of industries, relating total supply of an industry (including imports) to the most appropriate components of the demand. Afterwards the supply of the remaining industry is calculated as a difference. Using assumptions about future changes of the industrial structure, problems arise due to the traditional practice to calculate the industrial structure in current prices and to use the value added as the basic indicator for that. Therefore, model users have to adjust their views regarding the future industrial structure.

According to the input-output principle, output in a particular industry is calculated as a sum of intermediate consumption of all the industries and components of final use for products of the particular industry adjusted by import share. Although the input-output relations allow determining the value of the output depending on consumption reasonably well, the shortcoming of the method is related to the data availability. The last officially published input-output tables in Latvia are of 1998. Therefore, it is doubtful that relations among industries and consumers, which were in force in 1998, have still remained the same. The situation changed in 2012, when the World Input-Output Database (WIOD) was opened for the general public. The database covers 27 EU countries (including Latvia) and 13 other major countries in the world for the period from 1995 to 2009 [167]. However, also this information cannot be regarded as a true reflection of inter-industry relations in Latvia, as these tables are computed using national Supply and Use Tables, which are published every 5 years and various adjustments are made in order to harmonize the input-output tables across the countries. Therefore, the information included in the input-output tables can be used only as a supplementary aid for the specification of output relations.

Traditionally, direct cost coefficients form the basis of the input-output relations. These coefficients characterize the proportion of the products of a particular industry in the cost structure of the industry. On the other hand, specification of econometric equations requires performing the analysis of the most significant factors, which influence the output of a particular industry. Therefore, in this case it is more useful to use untraditional aspect of the input-output analysis and to evaluate the amount of products of a particular industry, which are used in other industries and for the final use. Thus, the choice of a factor is connected with the output in industries and the components of the final use, which use the larger shares of products of the particular industry.

In total, all equations must contain all demand elements – private and government consumption, investment and exports, as well as the main intermediate consumption flows among industries. In such a way it is possible to ensure reasonably adequate response of the output to the changes in demand. At the same time, one must take into account that the obtained relations may be interpreted as the traditional input-output relations in the case of linear equations with demand components and intermediate consumption as the only factors. The total influence of the intermediate consumption and the components of the final use cannot exceed 100% (in total output). Moreover, the number of factors that can be used in econometric equations is limited. It is possible that one component of the demand influences the supply only in several industries, which results in overvaluation of the coefficients and therefore in smaller plausibility of the obtained results. This problem can be partly eliminated by using log-log relations, and the most significant intermediate consumption and final use components as the main factors. The output is also used as a proxy of the intermediate consumption, as it is part of the output.

In order to ensure the specification of the appropriate relations, the ratio of imports to output by industries also has to be taken into account. Equation (2.14) is used for the calculation of the import shares in industries. The Lithuanian model LITMOD [33, p. 95] uses the same approach.

$$impsh\_z = im\_str\_z \cdot im\_fp \;/ \;out\_fp\_\; z \qquad (2.14)$$

where

impsh_z – ratio of imports to output in industry z in constant prices (z is assigned according to the NACE classification (1.1.rev.) for 10 industries, that is, z is AB for agriculture, hunting, forestry and fishing; CDE for industry; F for construction; GH for trade; hotels and restaurants; I for transport, storage and communication; JK for financial intermediation and real estate, L for public administration; M for education; N for health and social work and O for other services);
im_str_z – share of imports of industry z in total imports;
im_fp – imports of goods and services in constant prices;
out_fp_z – output in industry z in constant prices.

Import structure by industries in Latvia can be considered to be relatively stable (see Table 2.4). Major fluctuations are related to 1995 – 1997 and then again to 2008-2009. In most industries, import shares in 1997 – 2008 fluctuated within the interval of 0.01 – 0.8%. It was wider only in the industry sector– 1.78% points between the lowest and the largest value; however, it was only 2.2% of the minimum value. Although there were comparatively significant changes in 2009, they are associated with the recent economic crisis, which led to dramatic decrease of imports in Latvia. As the import structure by product groups in 2011 returned to the state of 2008, similar process should be observed also in the import structure by industries. It means that it is possible to use constant import structure when calculating import shares or ratios of imports to output.

Table 2.4

Dynamics of Import Structure, %

	Industries (NACE 1.1.rev.)										
Year	Agriculture, hunting, forestry and fishing (AB)	Industry (CDE)	Construction (F)	Trade, hotels and restaurants (GH)	Transport, storage and communication (I)	Financial intermediation and real estate (JK)	Public administration (L)	Education (M)	Health and social work (N)	Other services (O)	Total
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
1995	2.99	79.67	0.97	1.53	8.94	4.08	1.66	0.01	0.02	0.12	100
1996	4.00	79.33	0.95	1.56	8.24	4.11	1.62	0.01	0.02	0.15	100
1997	3.04	81.84	0.38	2.23	5.34	4.06	2.76	0.01	0.02	0.33	100
1998	2.99	82.04	0.40	2.26	5.15	4.10	2.71	0.02	0.02	0.33	100
1999	3.08	81.70	0.42	2.30	5.32	4.13	2.74	0.01	0.02	0.28	100
2000	3.34	82.01	0.39	2.08	5.22	4.00	2.68	0.01	0.02	0.25	100
2001	3.22	81.31	0.42	2.54	5.35	4.06	2.79	0.02	0.02	0.27	100
2002	3.43	81.23	0.43	2.57	5.26	3.97	2.82	0.02	0.02	0.24	100
2003	3.06	81.62	0.41	2.53	5.29	3.99	2.83	0.02	0.02	0.24	100
2004	3.03	82.04	0.40	2.16	5.14	4.04	2.91	0.02	0.02	0.24	100
2005	2.98	82.51	0.43	1.87	5.12	4.05	2.77	0.02	0.02	0.23	100
2006	2.63	82.55	0.44	1.95	5.29	4.14	2.74	0.02	0.02	0.22	100
2007	3.13	81.54	0.48	2.00	5.51	4.33	2.76	0.02	0.01	0.21	100
2008	3.36	80.77	0.49	2.37	5.77	4.29	2.69	0.02	0.01	0.22	100
2009	4.04	77.94	0.50	2.73	6.63	4.81	3.05	0.02	0.02	0.26	100
Average	3.22	81.21	0.50	2.18	5.84	4.14	2.64	0.02	0.02	0.24	100

Source: Calculated by the authors using WIOD database [167]

The structure of supply and demand by industries is given in Table 2.5. In the majority of industries, except industry sector, the demand in 2009 was satisfied mainly using domestically produced goods and services. Significant import share was also observed in agriculture and fishing, transport, storage and communications, as well as in public administration.

Table 2.5

Structure of Supply and Demand in 2009, %

	Supply			Demand				
Industries (NACE 1.1.rev.)	Output	Imports	Total	Intermediate consumption	Private consumption	Government consumption	Gross capital formation	Exports
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Agriculture, hunting, forestry and fishing (AB)	84.6	15.4	100	40.1	39.4	0.6	-2.3	22.2
Industry (CDE)	58.5	41.5	100	38.9	21.2	0.1	0.7	39.1
Construction (F)	99.2	0.8	100	44.1	2.2	0.1	48.3	5.3
Trade, hotels and restaurants (GH)	96.2	3.8	100	34.7	37.7	0.2	6.0	21.4
Transport, storage and communication (I)	90.1	9.9	100	43.4	16.8	0.0	0.3	39.5
Financial intermediation and real estate (JK)	95.8	4.2	100	61.7	26.4	0.5	6.6	4.9
Public administration (L)	90.4	9.6	100	0.7	0.3	93.4	0.1	5.6
Education (M)	99.9	0.1	100	8.3	23.0	68.5	0.1	0.2
Health and social work (N)	99.9	0.1	100	5.9	43.8	50.3	0.0	0.0
Other services (O)	98.8	1.2	100	28.4	60.5	10.2	0.3	0.6

Source: Calculated by the authors using WIOD database [167]

In many industries both domestically produced and imported goods and services are mainly distributed for intermediate consumption (except industries closely related to the government). Products of several industries are largely consumed by households, for example, agriculture and fishing (39.4%), trade, hotels and restaurants (37.7%), health and social work (43.8%) and other services (60.5%). A large share of expenditures in public administration (93.4%), education (68.5%), health and social work (50.3%) and other services (10.2%) is associated with the government consumption. Construction services are very important for investment (48.3%). A large part of goods and services are exported in such sectors as industry (26.9%), agriculture and fishing

(22.2%), as well as trade, hotel and restaurant services (21.4%) and transportation, storage and communication services (39.5%).

The share of intermediate consumption is given in Table 2.6. Intermediate consumption in agriculture and fishing is mainly related to industry (48.2%) and agriculture and fishing itself (42.5%). Industrial production is mainly used in industry (44.7%), in construction (16.3%) and in financial intermediation and real estate (11.8%). Construction is mainly related to the construction itself (55.0%), it is also quite considerably used in such sectors as financial intermediation and real estate (17.6%) and industry (11.7%). Trade, hotels and restaurants provide their services to industry (40.6%), construction (13.3%) and transport, storage and communications (11.4%). Transport, storage and communications services are consumed in the same industry (35.3%), as well as in the sectors of financial intermediation and real estate (13.6%) and industry (13.5%). Financial intermediation and real estate besides itself (37.7%) also provides services to trade, hotels and restaurants (18.9%), transport, storage and communications (11.8%) and industry (10.6%).

Table 2.6

Structure of Intermediate Consumption, %

Industries (NACE 1.1.rev.)	AB	CDE	F	GH	I	JK	L	M	N	O	Total
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Agriculture, hunting, forestry and fishing (AB)	42.5	48.2	1.9	3.9	0.9	1.0	0.4	0.5	0.5	0.3	100
Industry (CDE)	3.7	44.7	16.3	7.5	6.0	11.8	2.8	2.4	1.7	3.0	100
Construction (F)	0.5	11.7	55.0	4.0	4.0	17.6	3.4	1.4	0.7	1.7	100
Trade, hotels and restaurants (GH)	9.3	40.6	13.3	9.6	11.4	7.7	2.4	1.2	2.2	2.4	100
Transport, storage and communication (I)	2.6	13.5	9.2	16.4	35.3	13.6	5.8	0.9	0.7	1.9	100
Financial intermediation and real estate (JK)	1.7	10.6	8.6	18.9	11.8	37.7	3.1	0.8	0.9	5.8	100
Public administration (L)	4.5	13.1	7.3	20.0	11.6	29.2	4.4	1.2	0.8	8.0	100
Education (M)	2.7	12.0	4.3	7.3	22.8	23.0	12.9	10.9	1.4	2.5	100

Table 2.6 continued

1	2	3	4	5	6	7	8	9	10	11	12
Health and social work (N)	23.1	13.7	2.5	4.8	13.1	5.7	9.8	1.8	23.3	2.3	100
Other services (O)	1.3	15.0	4.7	4.1	8.1	16.3	15.2	3.0	3.7	28.7	100

Source: Calculated by the authors using WIOD database [167]

The final use structure by industries is given in Table 2.7. The largest share of private consumption comes from financial intermediation and real estate services (23.8%), trade, hotels and restaurants services (21.4%) and industry (19.4%). Significant are also products of agriculture and fishing (7.3%), transport, storage and communication (8.5%) and other services (11.0%). For government consumption mostly public administration (56.6%), education (23.8%) and health and social work (12.8%), as well as other services (4.7%) are used. Endowment of investment and inventories or gross capital formation is mostly connected with construction (71.2%), financial intermediation and real estate (17.4%) and trade, hotels and restaurants (10.0%) are also important sectors. However, in export production of industry (44.4%), transport, storage and communications (24.8%) and trade, hotels and restaurants (15.1%) services dominate.

Table 2.7

Final Use Structure by Industries in 2009, %

Industries (NACE 1.1.rev.)	Private consumption	Government consumption	Gross capital formation	Exports
1	2	3	4	5
Agriculture, hunting, forestry and fishing (AB)	7.27	0.29	-1.24	5.09
Industry (CDE)	19.4	0.31	1.86	44.4
Construction (F)	1.12	0.07	71.2	3.32
Trade, hotels and restaurants (GH)	21.4	0.32	10.1	15.1
Transport, storage and communication (I)	8.47	0.05	0.45	24.8
Financial intermediation and real estate (JK)	23.8	1.05	17.4	5.49
Public administration (L)	0.06	56.6	0.04	1.64

Table 2.7 continued

1	2	3	4	5
Education (M)	3.12	23.8	0.03	0.03
Health and social work (N)	4.36	12.8	0.01	0.01
Other services (O)	11.0	4.71	0.15	0.12
Total	100	100	100	100

Source: Calculated by the authors using WIOD database [167]

Based on the analysis of the supply and demand structure by industries, as well as on the relations among actual data, equations (2.15) – (2.23) are set for the calculation of supply by industries. Additional considerations are also taken into account. For example, the volume of credits grew from 890.6 m LVL in the 1st quarter of 2001 to 15,195.6 m LVL in the 1st quarter of 2008, inter alia credits granted to private persons – from 111.4 m LVL to 6,315.1 m LVL or from 12.5% to 41.6% of all loans [21]. These data provide additional information on the dynamics in the sector of financial intermediation and real estate. Supply in public administration in equation (2.21) is related to the expenditures of the government budget (excluding social benefits) and not to the government consumption, because the former relation is stronger. Large significance of the private consumption in education (see equation (2.22)) can be explained by the increase in the share of tuition fees as a private contribution to education. If till the academic year of 1996/1997 tuition fees of the majority of students were subsidized by the state or local government budgets, then in the academic year of 2005/2006 already 77.2% of the students were studying on their own expense. Afterwards this proportion decreased to 64.1% in 2011/2012. Nevertheless, the equation also contains the government consumption, because expenditures of the government budget (statistical significance of the coefficient is 90%) are still an important source of education funding. Statistical characterization is not very satisfactory in the case of financial intermediation and real estate, where dummies included in the model are significant at 88% level and the Durbin-Watson statistic points at possible autocorrelation problems.

$$\log(out\_fp\_ab \cdot (1+impsh\_ab)) = 3.0 + 0.42 \cdot \log(cons\_fp\_priv) + 0.13 \cdot d\_0911 \qquad (2.15)$$

t-stat (12.9) (14.6) (5.4)

mexval (357.5) (228.2) (83.1)

$R^2 = 0.96$; DW = 2.01; P(F-stat) = 0.00 [1995 – 2011],

$$\log(out\_fp\_cde \cdot (1+impsh\_cde)) = -1.27 + 1.1 \cdot \log(out\_fp) - 0.15 \cdot d\_09 \tag{2.16}$$

t-stat (-3.9) (30.4) (-3.7)
mexval (5.5) (713.8) (44.7)

$R^2 = 0.99$; DW = 1.75; P(F-stat) = 0.00 [1995 – 2011],

$$\log(out\_fp\_f \cdot (1+impsh\_f)) = -8.1 + 1.6 \cdot \log(out\_fp) - 0.31 \cdot d\_1011 \tag{2.17}$$

t-stat (-27.2) (50.0) (-11.9)
mexval (571.9) (1239.8) (233.7)

$R^2 = 0.99$; DW = 1.58; P(F-stat) = 0.00 [1995 – 2011],

$$\log(out\_fp\_gh \cdot (1+impsh\_gh)) = -5.6 + 1.5 \cdot \log(out\_fp) - 0.047 \cdot d\_0911 \tag{2.18}$$

t-stat (-27.2) (68.3) (-4.1)
mexval (727.1) (1961.3) (58.1)

$R^2 = 0.99$; DW = 2.36; P(F-stat) = 0.00 [1998 – 2011],

$$\log(out\_fp\_i \cdot (1+impsh\_i)) = -3.2 + 0.56 \cdot \log(ex\_serv/pi\_ex) + 0.89 \cdot \log(out\_fp\_cde) +$$

t-stat (-8.8) (7.2) (10.3)
mexval (24.0) (38.8) (175.5)

$$+ 0.10 \cdot d\_0911 \tag{2.19}$$

t-stat (4.1)
mexval (59.9)

$R^2 = 0.99$; DW = 2.25; P(F-stat) = 0.00 [1995 – 2011],

$$\log(out\_fp\_jk \cdot (1+impsh\_jk)) = -4.8 + 1.3 \cdot \log(out\_fp) - 0.084 \cdot d\_98 + 0.083 \cdot d\_10 \tag{2.20}$$

t-stat (-11.7) (29.5) (-1.7) (1.7)
mexval (178.2) (673.9) (11.0) (10.5)

$R^2 = 0.99$; DW = 1.23; P(F-stat) = 0.00 [1995 – 2011],

$$\log(out\_fp\_l \cdot (1+impsh\_l)) = 3.1 + 0.46 \cdot \log((gov\_expend - gov\_tr)/pi\_gdp) \quad -$$

t-stat (16.5) (17.7)
mexval (567.2) (409.2)

$$- 0.10 \cdot d\_1011 \tag{2.21}$$

t-stat (-3.8)
mexval (63.4)

$R^2 = 0.96$; DW = 1.58; P(F-stat) = 0.00 [1995 – 2011],

$$\log(out\_fp\_m \cdot (1+impsh\_m)) = 2.0 + 0.28 \cdot \log(cons\_fp\_gov) + 0.24 \cdot \log(cons\_fp\_priv) -$$

t-stat (4.1) (2.8) (7.5)
mexval (83.7) (25.8) (121.5)

$$- 0.05 \cdot d\_0911 \tag{2.22}$$

t-stat (-4.3)
mexval (53.4)

$R^2 = 0.98$; DW = 1.67; P(F-stat) = 0.00 [1995 – 2011],

$$\log(out\_fp\_n \cdot (1+impsh\_n)) = 2.6 + 0.37 \cdot \log(cons\_fp) - 0.069 \cdot \log(t) - 0.030 \cdot d\_0911 \quad (2.23)$$

t-stat (12.7) (14.0) (-7.4) (-3.1)

mexval (356.4) (287.2) (125.4) (30.5)

$R^2 = 0.96$; DW = 2.05; P(F-stat) = 0.00 [1995 – 2011],

where

out_fp_z – output in industry z in constant prices (z is assigned according to the NACE classification (1.1.rev.) for 10 industries);
impsh_z – ratio of import to output in industry z in constant prices;
cons_fp_priv – private consumption in constant prices;
cons_fp_gov – government consumption in constant prices;
cons_fp – final consumption expenditures in constant prices;
ex_serv – export of services in current prices;
pi_ex – export price index;
inv_fp_fix – gross fixed capital formation in constant prices;
out_fp – total output of goods and services in constant prices;
gov_expend – expenditures of general government consolidated budget;
gov_tr – expenditures of general government consolidated budget for social benefits;
pi_gdp – GDP deflator;
t – time trend (1995 = 1);
d_98 – dummy variable (1998 = 1, other periods = 0);
d_09 – dummy variable (2009 = 1, other periods = 0);
d_10 – dummy variable (2010 = 1, other periods = 0);
d_0911 – dummy variable (1995 – 2008 = 0, other periods = 1);
d_1011 – dummy variable (1995 – 2009 = 0, other periods = 1).

Output of other services is calculated as a residual between the total output and the output in other industries. Calculation of the output is displayed in Figure 2.8 and calculation of the total output and the real GDP is shown in Figure 2.9.

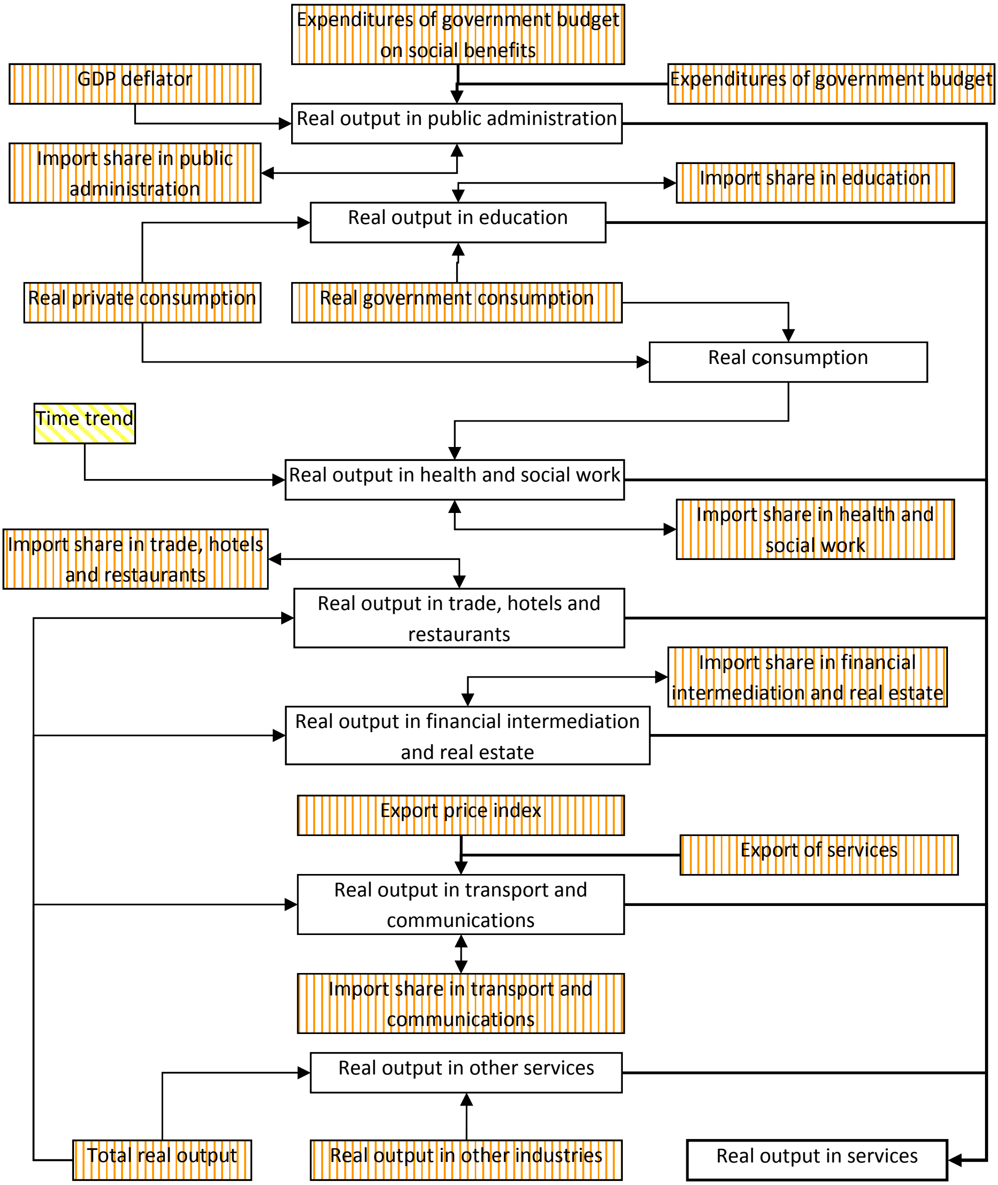


Fig. 2.8. Calculation of output in service industries in the Latvian model[6].

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[6] See the legend in Fig.2.4

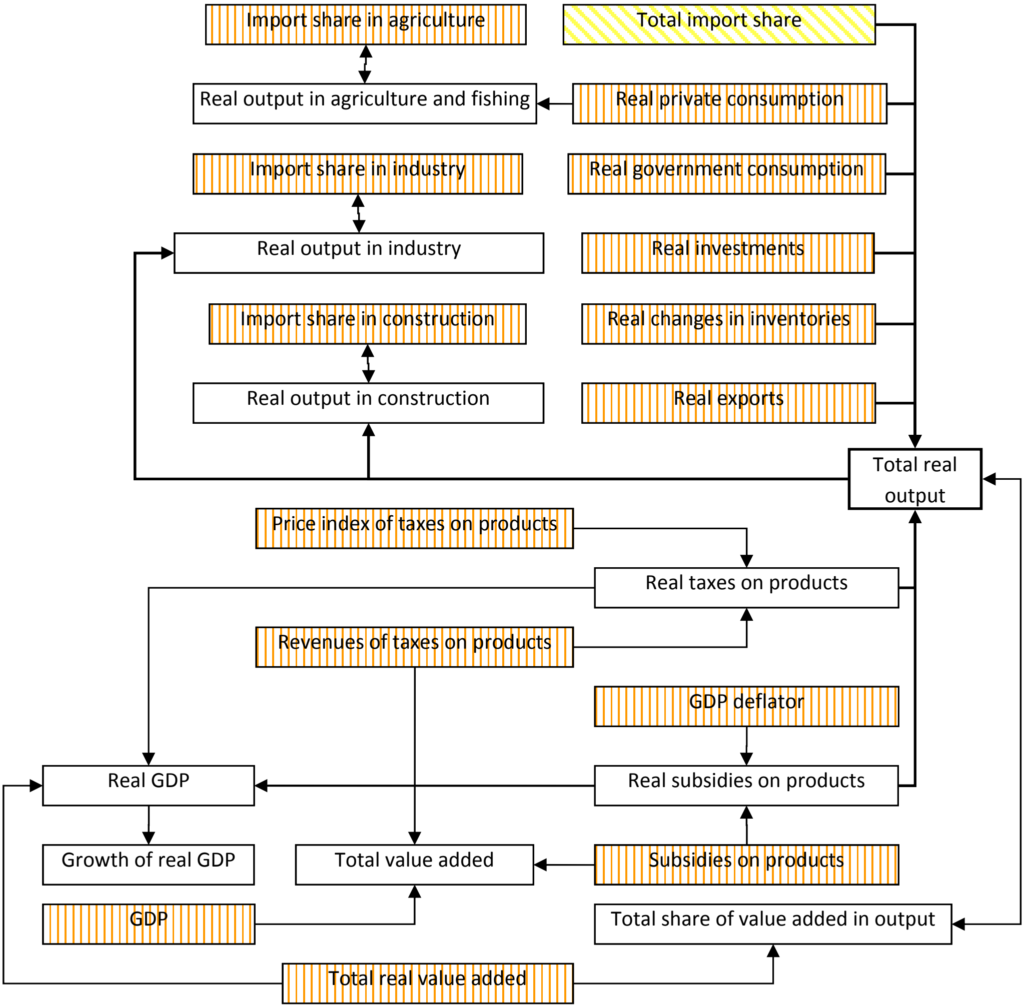

Fig. 2.9. Calculation of output of goods and services and real GDP in the Latvian model[7].

The system of equations (2.24) is also used for the calculation of real output and GDP.

$$\begin{aligned}
\text{out\_fp} &= (\text{cons\_fp} + \text{inv\_fp\_gross} + \text{ex\_fp} - \text{va\_fp\_d21} + \text{va\_fp\_d31}) / (\text{va\_out} + \text{impsh}) \\
\text{out\_fp\_o} &= \text{out\_fp} - \text{out\_fp\_ab} - \text{out\_fp\_cde} - \text{out\_fp\_f} - \text{out\_fp\_gh} - \text{out\_fp\_i} - \\
&\quad \text{out\_fp\_jk} - \text{out\_fp\_l} - \text{out\_fp\_m} - \text{out\_fp\_n} \\
\text{out\_fp\_go} &= \text{out\_fp\_gh} + \text{out\_fp\_i} + \text{out\_fp\_jk} + \text{out\_fp\_l} + \text{out\_fp\_m} + \text{out\_fp\_n} + \\
&\quad + \text{out\_fp\_o} \\
\text{va\_fp\_d21} &= \text{tax\_d21} / \text{pi\_d21} \\
\text{va\_fp\_d31} &= \text{va\_cp\_d31} / \text{pi\_gdp}
\end{aligned} \tag{2.24}$$

---

[7] See the legend in Fig.2.4

gdp_fp = va_fp + va_fp_d21 - va_fp_d31
gdp_gr_fp = (gdp_fp / gdp_fp(-1) - 1) · 100
va_out = va_fp / out_fp

where

out_fp – real output of goods and services;
cons_fp – total consumption expenditures in constant prices;
inv_fp_gross – gross capital formation in constant prices;
ex_cp – exports of goods and services in constant prices;
va_fp_d21 – taxes on products in constant prices;
va_fp_d31 – subsidies on products in constant prices;
va_out – share of value added in output in constant prices;
impsh – ratio of imports to output;
out_fp_oth – real output in other services;
out_fp_z – real output in industry z (z is assigned according to the NACE classification (1.1.rev.) for 10 industries);
out_fp_go – real output in services;
tax_d21 – taxes on products in current prices;
pi_d21 – price index of taxes on products;
va_cp_d31 – subsidies on products in current prices;
pi_gdp – GDP deflator;
gdp_fp – real GDP;
va_fp – total value added in constant prices;
gdp_gr_fp – GDP growth rate.

2.4.2. Value Added

Within the model, the real value added is calculated proportionally to the output, using the ratios of value added to output. Table 2.8 shows that in the majority of industries this ratio was almost constant in 2000 – 2008 (only in other activities the share of value added in output fluctuated significantly). Recent global financial crisis has made some adjustments, but still the values in 2010 – 2011 were similar for all the industries. This indicates that also in the future the ratio of the value added to output should not change significantly, although these values may return to their levels in the pre-crisis period in some industries.

Table 2.8

Share of Value Added in Output, %

Industries (NACE 1.1.rev.)	1995	2000	2005	2008	2010	2011
1	**2**	**3**	**4**	**5**	**6**	**7**
Agriculture, hunting, forestry and fishing (AB)	38.9	40.3	40.5	39.6	36.0	35.7
Industry (CDE)	31.9	32.7	32.6	32.7	33.9	34.2

Table 2.8 continued

1	2	3	4	5	6	7
Construction (F)	37.7	38.2	38.2	38.2	33.1	33.0
Trade, hotels and restaurants (GH)	46.5	48.5	49.2	48.5	47.1	46.9
Transport, storage and communication (I)	43.7	44.3	44.3	43.9	41.3	41.0
Financial intermediation and real estate (JK)	57.4	64.3	64.4	64.3	66.5	66.2
Public administration (L)	70.5	70.3	70.3	70.3	70.4	70.4
Education (M)	68.8	68.7	70.9	68.7	68.8	69.0
Health and social work (N)	58.0	57.9	57.9	57.9	58.5	58.5
Other services (O)	25.8	36.9	37.5	45.6	29.0	30.8

Source: Calculated by the authors on the basis of CSB database [96]

Calculation of the real value added in services is shown in Figure 2.10, but the calculation of the total value added and imports in industries A-E is shown in Figure 2.11.

The system of equations (2.25) is used for the calculation of value added and import in constant prices.

$$
\begin{aligned}
im\_fp\_ab &= impsh\_ab \cdot out\_fp\_ab \\
im\_fp\_cde &= impsh\_cde \cdot out\_fp\_cde \\
im\_fp\_ae &= im\_fp\_ab + im\_fp\_cde \\
va\_fp\_ab &= out\_fp\_ab \cdot va\_out\_ab \\
va\_fp\_cde &= out\_fp\_cde \cdot va\_out\_cde \\
va\_fp\_f &= out\_fp\_f \cdot va\_out\_f \\
va\_fp\_gh &= out\_fp\_gh \cdot va\_out\_gh \\
va\_fp\_i &= out\_fp\_i \cdot va\_out\_i \\
va\_fp\_jk &= out\_fp\_jk \cdot va\_out\_jk \\
va\_fp\_l &= out\_fp\_l \cdot va\_out\_l \\
va\_fp\_m &= out\_fp\_m \cdot va\_out\_m \\
va\_fp\_n &= out\_fp\_n \cdot va\_out\_n \\
va\_fp\_o &= out\_fp\_o \cdot va\_out\_o \\
va\_fp\_go &= va\_fp\_g + va\_fp\_h + va\_fp\_i + va\_fp\_j + va\_fp\_k + va\_fp\_l + va\_fp\_m + \\
&\quad + va\_fp\_n + va\_fp\_o \\
va\_fp &= va\_fp\_ab + va\_fp\_cde + va\_fp\_f + va\_fp\_go
\end{aligned}
\qquad (2.25)
$$

where

im_fp_ab – real imports in agriculture and fishing;
impsh_ab – ratio of imports to output in agriculture and fishing
out_fp_z – real output in industry z (z is assigned according to the NACE classification (1.1.rev.) for 10 industries);
im_fp_cde – real imports in industry;
impsh_cde – ratio of imports to output in industry;
im_fp_ae – real imports in agriculture, fishing and industry;
va_fp_z – real value added in industry z;
va_out_z – share of value added in output in industry z;

va_fp_go – real value added in services;
va_fp – total real value added.

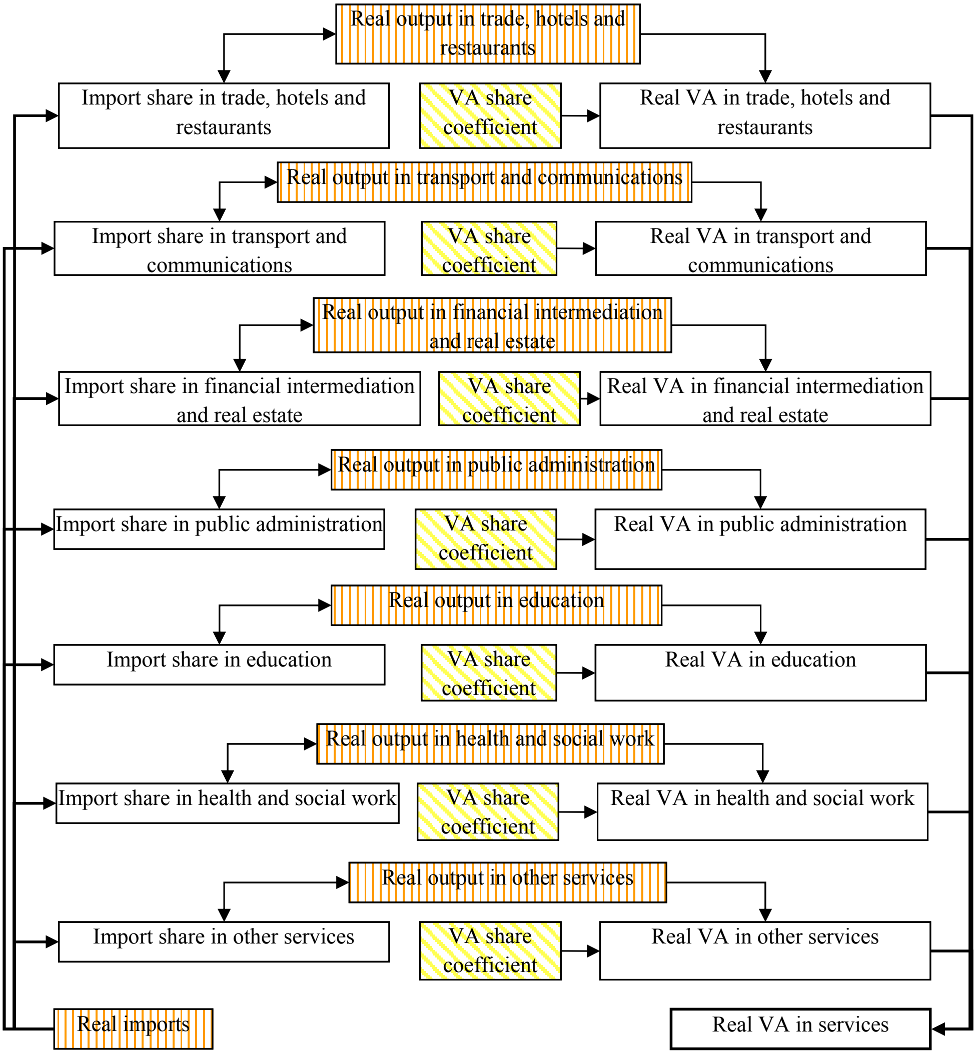

Fig. 2.10. Calculation of real value added in service industries in the Latvian model[8].

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[8] See the legend in Fig.2.4

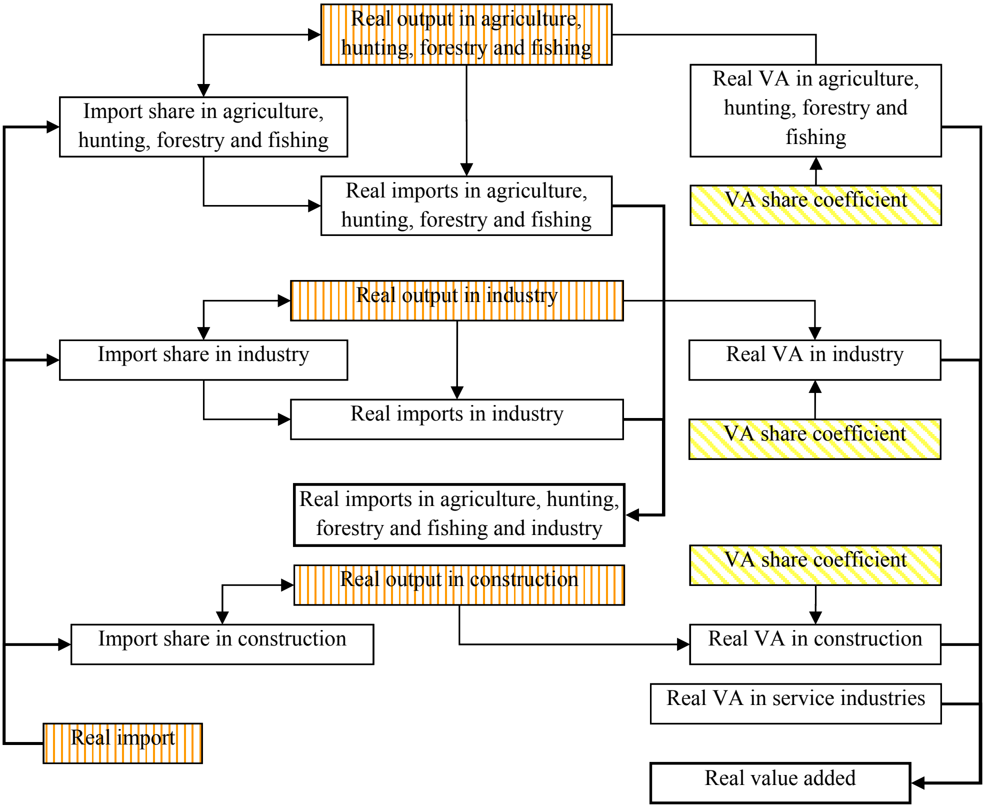

Fig. 2.11. Calculation of real value added and import in the Latvian model[9].

The system of equations (2.26) is used for the calculation of the value added in current prices.

$$\begin{aligned} va\_cp\_d21 &= tax\_d21 \\ va\_cp\_d31 &= gov\_subs \cdot va\_cp\_d31\_coef \\ va\_cp\_tax\_sub &= va\_cp\_d21 - va\_cp\_d31 \\ va\_cp &= gdp\_cp - va\_cp\_tax\_sub \end{aligned} \tag{2.26}$$

where

va_cp_d21 – taxes on products;
tax_d21 – revenues of government budget from taxes on products;
va_cp_d31 – subsidies on products;
gov_subs – expenditures of government budget for subsidies;
va_cp_d31_coef – coefficient of subsidies on products;
va_cp_tax_sub – net taxes on products;
va_cp – value added in current prices;
gdp_cp – GDP in current prices.

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[9] See legend in Fig.2.4

Revenues from taxes on products are calculated in the fiscal sector of the model. Subsidies on products are calculated as a share of the budget expenditures on subsidies.

2.4.3. Capital Investment

Investment functions in macroeconomic models differ depending on the choice between investment demand approach and investment supply approach. In case of the investment demand approach, investment is calculated depending on prospective capital stock. Using investment supply approach, investment depends on the available resources (usually GDP) and other factors, including those, which characterize investment costs. For the calculation of investment production function approach is often used, when investment equation is specified according to the derived production function. Investment equations on the basis of the production function are included in AWM, Estonian model, Slovak model, Finnish EMMA and in some other models. Summary of the factors included in the investment functions in several macro-econometric models is given in Table 2.9. Investment here is mainly gross fixed capital formation in the whole economy, however in the case of LITMOD capital investments by industries are characterized.

Table 2.9

Factors Influencing Investments

	Factors											
Model	I/GDP	GDP (VA)	GDP/K	K	P	GI	FDI	pi/p	p	r	d	t
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
AWM	x		x							x	x	
MCM		x	x						x	x	x	
Model of Greece		x							x	x	x	
Mascotte		x			x				x	x	x	
Estonian Model		x	x							x	x	
Estonian EMMA		x		x					x	x	x	
LITMOD		x						x		x		x
SLOPOL6		x								x	x	
Slovak Model			x		x	x	x		x	x	x	
Finnish EMMA		x					x	x	x	x	x	x

where

I – investment;

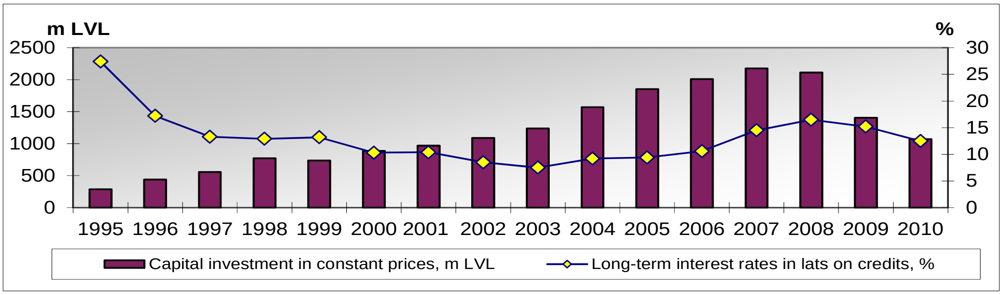
VA – value added;

K – capital stock;
P – profit;
GI – government investment;
FDI – foreign direct investment;
r – interest rate;
p – GDP deflator or consumption price index;
d – depreciation rate;
t – time trend;
x – factor is included in investment equation.

Investment factors used in models can be divided into two significant groups. The first group comprises the indicators, which characterize investment resources (such as GDP, government investments, foreign direct investments, profit) or investment demand (GDP and capital stock). The second group includes the indicators, which characterize investment costs (such as price indexes and their ratios, interest rates and depreciation rate). In several models capital use costs are expressed as a single indicator, which includes interest rate, depreciation and in separate cases also a price index and/or the ratio of price indexes, for example, in MCM, model of Greece, Estonian EMMA, SLOPOL6 and Finnish EMMA models.

The Latvian model includes capital investment by industries. The chosen factors comply mainly with the disaggregation by industries (except, for example, interest rates). It is not useful to calculate separate indicators by industries or it is not possible due to the available statistical information (capital stock, profit, government investment, foreign direct investment, depreciation rate etc.). Four main factors can be distinguished and included in investment function in the Latvian model. The first is the value added in the particular industry with the positive influence. The second is a long-term credit interest rate with the negative influence, which characterizes costs of credit resources. The third is the ratio of investment deflator and price index of the particular industry with the negative influence, which characterizes the expensiveness of investments. The fourth is the time trend, negative value of which indicates the increase in productivity.

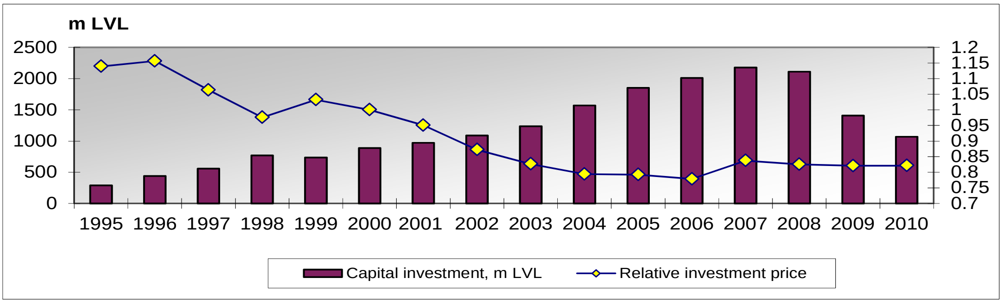
Figure 2.12 shows that in Latvia the connection between capital investment and long-term interest rate on credits in 1995 – 2003 was negative and comparatively close (the value of correlation coefficient is -0.90). However, since 2004, despite the increase in the interest rates on credits, the investment volume has also been increasing (except for 2008). That indicates that the interest rates have comparatively small significance during the implementation process of capital investment. Accordingly, also the value of the correlation coefficient has decreased and in 1995 – 2010 it was just -0.35. Situation in industries is mostly similar to the state of the entire economy, that is, the significance of the interest rates was larger till 2004. However, for example, in transportation, storage and communications the value of correlation coefficient during the whole period is larger than 0.60 in absolute value and therefore this factor is still significant enough. Medium significance (the value of correlation coefficient is 0.40 – 0.60 in absolute value) of the interest rates is also observed in industry, trade, hotel and restaurant services, and education.



Source: Calculated by the authors on the basis of CSB database [96]

Fig. 2.12. Relation of capital investment and long-term credit interest rates.

Investment deflator divided by the output price index gives relative investment price. Relative investment price relates negatively to the capital investment in 1996 – 2006 (see Figure 2.13). In 2007 both investment volume and relative investment price increased and in 2008 and 2009 the values of both indicators decreased, but the value of the correlation coefficient between both indicators in 1996 – 2010 was still high (-0.86). In industrial disaggregation there is a significant correlation between capital investment and relative investment price (absolute value of the correlation coefficient in 1996 - 2011 was larger than 0.6) in agriculture and fishing, financial intermediation and real estate, public administration, education, and health and social work (till 2009 also in other services). Positive correlation is evident in industry; therefore relative investment price cannot be used as a factor in this sector.



Source: Calculated by the authors on the basis of CSB database [96]

Fig. 2.13. Relation of capital investment and relative investment price.

In the Latvian macro-econometric model, capital investment is included in constant prices by industries. The Central Statistical Bureau of the Republic of Latvia publishes information regarding capital investment by industries in prices of the last available year. Therefore, the database does not provide information on the investment in prices of 2000, which is the basic year of the model. In order to obtain approximate values of real investment, information regarding capital investment in 2000 is used as the basis. Investment volumes in other periods are calculated using growth rates of investment in the prices of 2008 (according to the latest available information in NACE classification, 1.1.rev.). Data on 2009 – 2011 are estimated using the information on the capital investment by industries according to the 2nd revision of the NACE classification.

Capital investment in each industry is calculated using equation (2.27). It is assumed that there is a constant return to scale in industries. Therefore, the coefficient a_1 in all equations is equal to one. Thus, the increase in the value added by 1% causes investment to increase by 1%. At the same time, the possibility to use econometrically estimated parameters was analyzed, but the values were mainly significantly larger than one. Therefore, the use of these equations in the medium-term and long-term forecasting is limited. Statistically insignificant factors are not included in the equations of particular industries. Dummy variables d_ are used in periods, where large deviations between actual and forecasted investment values are observed, and for the characterization of the recent economic crisis.

$$\log(inv\_nef\_z) = a_0 + a_1\log(va\_fp\_z) + a_2\log(pi\_inv\_fix/pi\_z) + a_3intr\_l + a_4\log(t) + a_5d\_ \quad (2.27)$$

where

inv_nef_z – capital investment in industry z (z is assigned according to the NACE classification (1.1.rev.) for 10 industries),
va_fp_z – value added in industry z,
pi_inv_fix – investment deflator,
pi_z – production price index in industry z,
intr_l – long-term credit interest rate,
t – time trend (1995 = 1),
d_ – dummy variable.

Estimated parameters of the investment equations by industries are summarized in Table 2.10. Statistical characterization of the equations is mainly sufficiently good. However, it was not possible to estimate a statistically acceptable equation for construction industry. Only in three industries there is a statistically significant and theoretically justified value of the coefficient a_2, which characterizes expensiveness of investment. The coefficient connected with the interest rates a_3 is important only in one industry (transport, storage and communications). In the majority of industries time trend is used, however, only in transport, storage and communications industry the value of the coefficient is negative. In LITMOD positive coefficients of time trend are explained with the increase of capital intensity in production process [33, p. 42]. It may be connected with the lack of qualified workforce. As a result, more resources are invested in improvement of equipment, which allows increasing productivity on the account of equipment rather than the labour.

Table 2.10

Estimated Parameters in Investment Equations

Industries (NACE 1.1.rev.)	a_0	a_1	a_2	a_3	a_4	a_5	R^2	DW	Period
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Agriculture, hunting, forestry and fishing (AB)	-4.1 (-22.4) (528.5)	1	-1.5 (-3.7) (43.2)	-	1.1 (12.5) (261.7)	-0.75^* (-3.7) (43.9)	0.93	1.72	1995 - 2011

Table 2.10 continued

1	2	3	4	5	6	7	8	9	10
Industry (CDE)	-2.1 (-27.2) (632.6)	1	-	-	0.52 (13.4) (271.9)	-0.62* (-7.8) (132.3)	0.93	2.32	1995 - 2011
Trade, hotels and restaurants (GH)	-2.1 (-51.2) (1273.3)	1	-1.9 (-5.5) (78.7)	-	-	-0.58* (-5.8) (84.6)	0.86	1.64	1995 - 2011
Transport, storage and communication (I)	-0.51 (-2.7) (24.8)	1	-	-0.04 (-4.8) (67.2)	-0.14 (-2.5) (21.9)	-0.41* (-4.8) (65.5)	0.86	2.25	1995 - 2011
Financial intermediation and real estate (JK)	-3.2 (-30.9) (731.8)	1	-	-	0.80 (15.3) (320.8)	-0.72** (-5.7) (82.8)	0.94	1.62	1995 - 2011
Public administration (L)	-2.7 (-33.1) (823.4)	1	-	-	0.84 (20.4) (475.7)	-0.43** (-4.4) (58.1)	0.97	1.59	1995 - 2011
Education (M)	-4.3 (-29.4) (691.4)	1	-	-	0.80 (10.8) (204.2)	-0.63* (-4.2) (49.9)	0.89	1.70	1995 - 2011
Health and social work (N)	-3.2 (-27.0) (604.5)	1	-	-	0.70 (12.3) (232.9)	-	0.91	1.42	1995 - 2011
Other services (O)	-2.1 (-8.6) (151.6)	1	-1.5 (-2.1) (14.6)	-	-	-1.4* (-3.1) (29.8)	0.43	1.85	1995 - 2011

* d_0911 (1995 – 2008 = 0, other periods = 1)
** d_1011 (1995 – 2009 = 0, other periods = 1)

Investment in public administration is connected with the public sector. Therefore, it is possible to model investment in this industry depending on the expenditures of the government budget on investment. However, such a relationship from statistical point of view is acceptable only starting with 1998. For that reason, equation (2.27) is also used in this sector.

Calculation of capital investment in service industries is shown in Figure 2.14, and the calculation of total capital investment – in Figure 2.15. Identities of capital investment section are given in the system of equations (2.28).

inv_go = inv_nef_gh + inv_nef_i + inv_nef_jk + inv_nef_l + inv_nef_m + + inv_nef_n + inv_nef_o
inv_fp_nef = inv_nef_ab + inv_nef_cde + inv_nef_f + inv_go (2.28)
inv_gr_fp_nef = (inv_fp_nef / inv_fp_nef(-1) - 1) · 100
inv_s_go = (inv_go / inv_fp_nef) · 100

where

inv_go – real capital investment in services;

inv_nef_z	– real capital investment in industry z (z is assigned according to the NACE classification (1.1.rev.) for 10 industries);
inv_fp_nef	– real capital investment, total;
inv_gr_fp_nef	– growth rate of the real capital investment;
inv_s_go	– share of capital investment in services in constant prices.

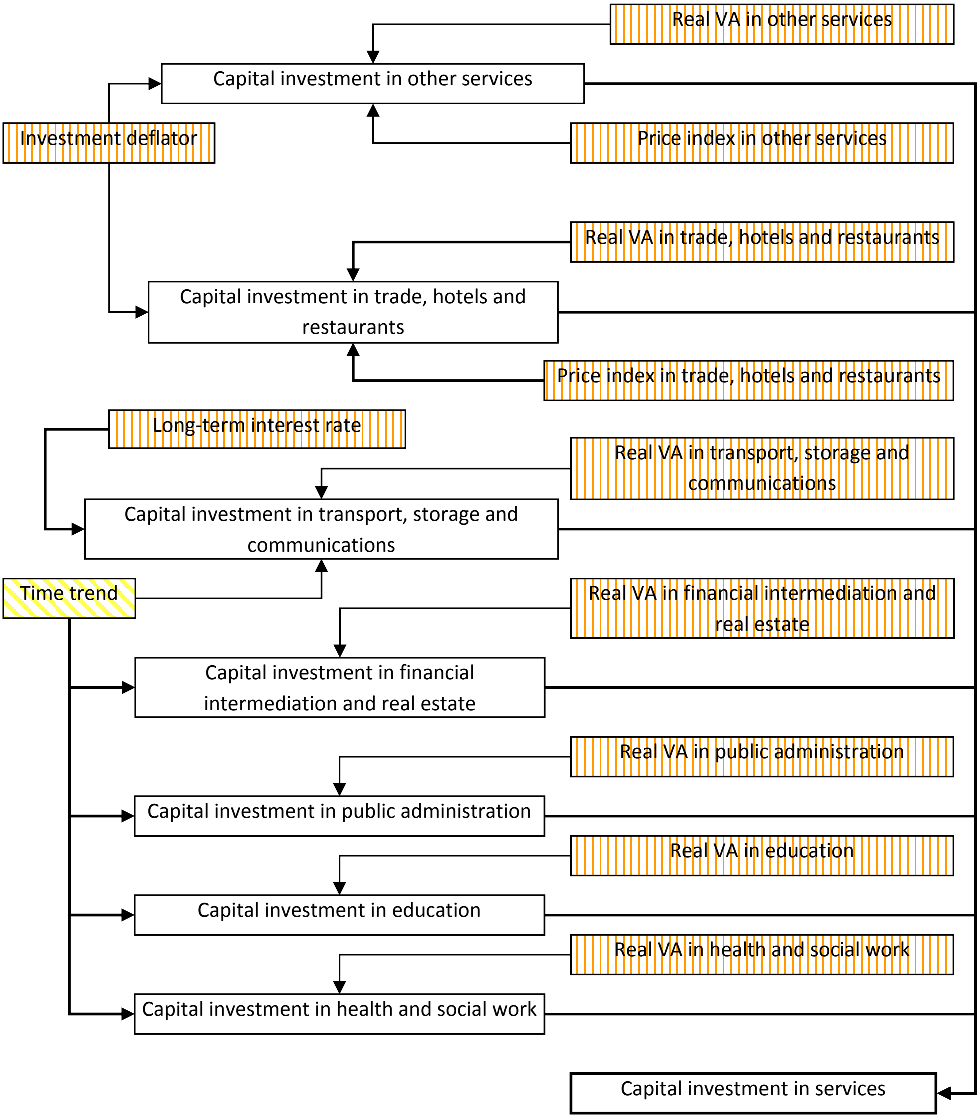


Fig. 2.14. Calculation of capital investment in service industries in the Latvian model[10].

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[10] See the legend in Fig.2.4

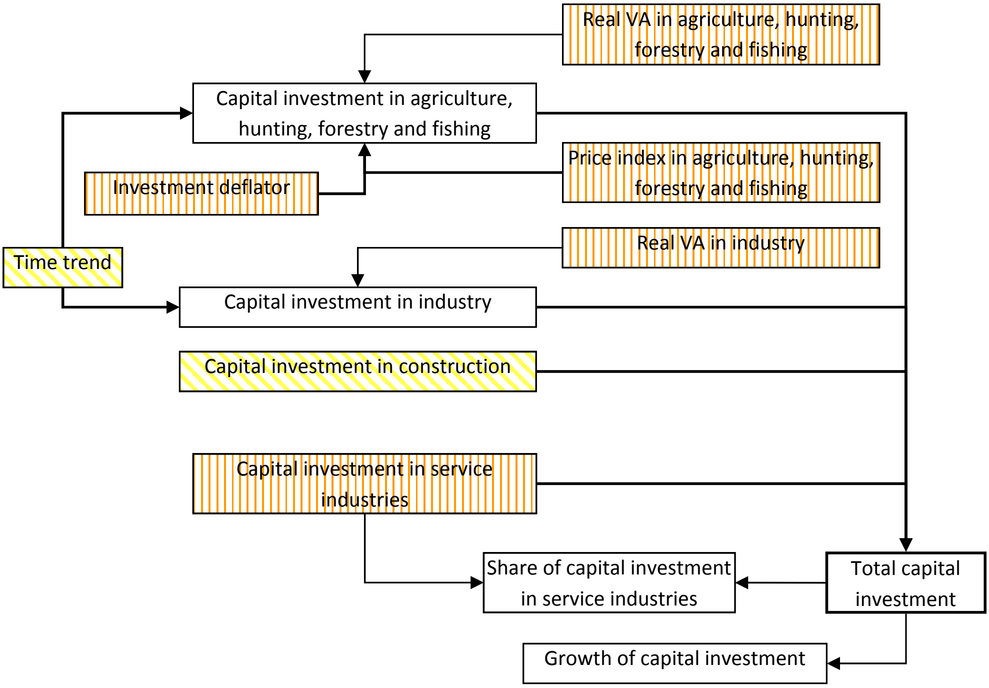

Fig. 2.15. Calculation of capital investment in the Latvian model[11].

Further total capital investment influences gross capital formation and thus the value of GDP.

2.5. Prices and Wages

Macro-econometric models usually contain relations of the GDP deflator, private consumption price index, investment price index, export price index, and import price index. Sometimes also the equation of government consumption price index is included in the model. Some of the previously mentioned indicators can be exogenous like import price index in the Lithuanian model LITMOD [33] and the model for Malawi [32].

The models with industrial disaggregation contain also production price indexes by industries. Price indexes are mainly determined by production costs. Import prices are important in the industries, where domestic and foreign producers compete. Export prices are relevant in the industries with large export

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[11] See the legend in Fig.2.4

volumes. In certain models the value added price index is used as the main price index instead of the GDP deflator, thus eliminating the influence of indirect taxes and subsidies. In AWM model [58, p. 54] and the model for Malawi [32, p. 14] unit labour costs and import deflator are used as factors.

In the Latvian model the GDP deflator is used as the main price index, which characterizes the price level in the whole economy. It is calculated as the ratio of the GDP in current prices to the GDP in constant prices, as the components of the GDP use are modelled both in constant prices and current prices using corresponding price indexes.

Several indicators characterizing production costs are used for the calculation of price indexes by industries (except the price index in transport, storage and communications, which is exogenous). These include wages per unit of output, capital investments per unit of output and price indexes in related industries. The ratio of the revenues of taxes on products to value added is used to characterize the influence of tax rate on the price formation process. Equations (2.29) – (2.37) are estimated to model price indexes for the Latvian economy. Many of these equations also provide the feedback between wages and prices in industries. Wages as one of the factors are included in price index equations for industry (2.30), financial intermediation and real estate (2.33), public administration (2.34), education (2.35), health and social work (2.36) and in other services (2.37).

$$\begin{array}{lll}
\log(pi\_ab/(1+tax\_d21/va\_cp)) = & 0.83 + 0.30 \cdot \log(inv\_nef\_ab \cdot pi\_inv\_fix/out\_fp\_ab) + & \\
\text{t-stat} & (7.4) \quad (7.2) & \\
\text{mexval} & (136.0) \ (130.3) & \\
 & + 0.53 \cdot d\_1011 & (2.29) \\
\text{t-stat} & (4.9) & \\
\text{mexval} & (72.2) &
\end{array}$$

$R^2 = 0.90$; DW = 1.65; P(F-stat) = 0.00 [1997 – 2011],

$$\begin{array}{lll}
\log(pi\_cde/(1+tax\_d21/va\_cp)) = & -3.0 + 0.64 \cdot \log(w\_nom \cdot empl\_cde/out\_fp\_cde) + & \\
\text{t-stat} & (-6.3) \quad (6.2) & \\
\text{mexval} & (108.8) \ (105.4) & \\
 & + 0.38 \cdot \log(pi\_ab) - 0.14 \cdot \log(t) & (2.30) \\
\text{t-stat} & (4.9) \qquad\qquad (-3.0) & \\
\text{mexval} & (72.7) \qquad\qquad (32.9) &
\end{array}$$

$R^2 = 0.96$; DW = 1.73; P(F-stat) = 0.00 [1996 – 2011],

log(pi_f/(1+tax_d21/va_cp)) = -0.14 + 1.3 · log(pi_inv_fix) (2.31)
t-stat (-6.2) (17.6)
mexval (98.4) (398.8)

R^2 = 0.96; DW = 1.68; P(F-stat) = 0.00 [1997 – 2011],

log(pi_gh/(1+tax_d21/va_cp)) = 0.84 + 0.35 · log(inv_nef_gh · pi_inv_fix/out_fp_gh) +
t-stat (5.4) (6.7)
mexval (76.1) (105.3)

+ 0.85 · log(pi_cde) (2.32)
t-stat (11.8)
mexval (230.7)

R^2 = 0.94; DW = 1.78; P(F-stat) = 0.00 [1995 – 2011],

log(pi_jk/(1+tax_d21/va_cp)) = -1.6 + 0.44 · log(w_nom · empl_jk/out_fp_jk) +
t-stat (-4.6) (7.9)
mexval (62.8) (139.9)

+ 0.21 · log(inv_nef_jk · pi_inv_fix/out_fp_jk) (2.33)
t-stat (4.9)
mexval (69.2)

R^2 = 0.98; DW = 2.11; P(F-stat) = 0.00 [1996 – 2011],

log(pi_l/(1+tax_d21/va_cp)) = -4.2 + 0.68 · log(w_nom · empl_l/out_fp_l) +
t-stat (-15.7) (11.0)
mexval (363.9) (233.3)

+ 0.16 · log(t) – 0.16 · d_05 (2.34)
t-stat (3.2) (-3.3)
mexval (36.4) (37.5)

R^2 = 0.99; DW = 2.29; P(F-stat) = 0.00 [1996 – 2011],

log(pi_m/(1+tax_d21/va_cp)) = -6.4 + 1.0 · log(w_nom· empl_m/out_fp_m) +
t-stat (-13.7) (13.9)
mexval (291.6) (299.2)

– 0.35· d_1011 (2.35)
t-stat (-3.3)
mexval (35.9)

R^2 = 0.95; DW = 1.51; P(F-stat) = 0.00 [1996 – 2011],

log(pi_n/(1+tax_d21/va_cp)) = -2.1 + 0.45 · log(w_nom · empl_n/out_fp_n) +
t-stat (-3.0) (5.0)
mexval (30.1) (71.3)

+ 0.26 · log(inv_nef_n · pi_inv_fix/out_fp_n) (2.36)
t-stat (4.1)
mexval (52.1)

R^2 = 0.98; DW = 1.54; P(F-stat) = 0.00 [1996 – 2011],
log(pi_o/(1+tax_d21/va_cp)) = -4.3 + 0.77 · log(w_nom · empl_oth/out_fp_oth) +

t-stat	(-9.1)	(9.5)
mexval	(181.5)	(192.6)

$$+ 0.56 \cdot d\_06 + 0.31 \cdot d\_1011 \qquad (2.37)$$

t-stat	(3.8)	(2.6)
mexval	(48.4)	(25.0)

$R^2 = 0.93$; DW = 1.68; P(F-stat) = 0.00 [1996 – 2011],

where

pi_z – price index in industry z (z is assigned according to the NACE classification (1.1.rev.) for 10 industries),
tax_d21 – revenues of taxes on products;
va_cp – value added in current prices;
inv_nef_z – capital investment in industry z;
pi_inv_fix – investment deflator;
out_fp_z – output in industry z in constant prices;
w_nom – average annual gross wage;
empl_z – number of employees in industry z;
t – time factor (1995 = 1);
d_05 – dummy variable (2005 = 1, other periods = 0);
d_06 – dummy variable (2006 = 1, other periods = 0);
d_1011 – dummy variable (1995 – 2009 = 0, other periods = 1).

Investment element is included in the price index equations for agriculture, hunting, forestry and fishing (2.29), trade and hotel and restaurant services (2.32), financial intermediation and real estate (2.33) and health and social work (2.36). As construction is closely related to the establishment of investment objects and thus to investment as such, price index in construction depends on the investment deflator (2.31). It is also important to note that interrelations between several industries are also captured in price equations. Prices in industry are influenced by the prices in agriculture, hunting, forestry and fishing (2.30). Price index in trade, hotel and restaurant services is related to the price index in industry (2.32).

Figure 2.16 illustrates the calculation of price indexes by industries.

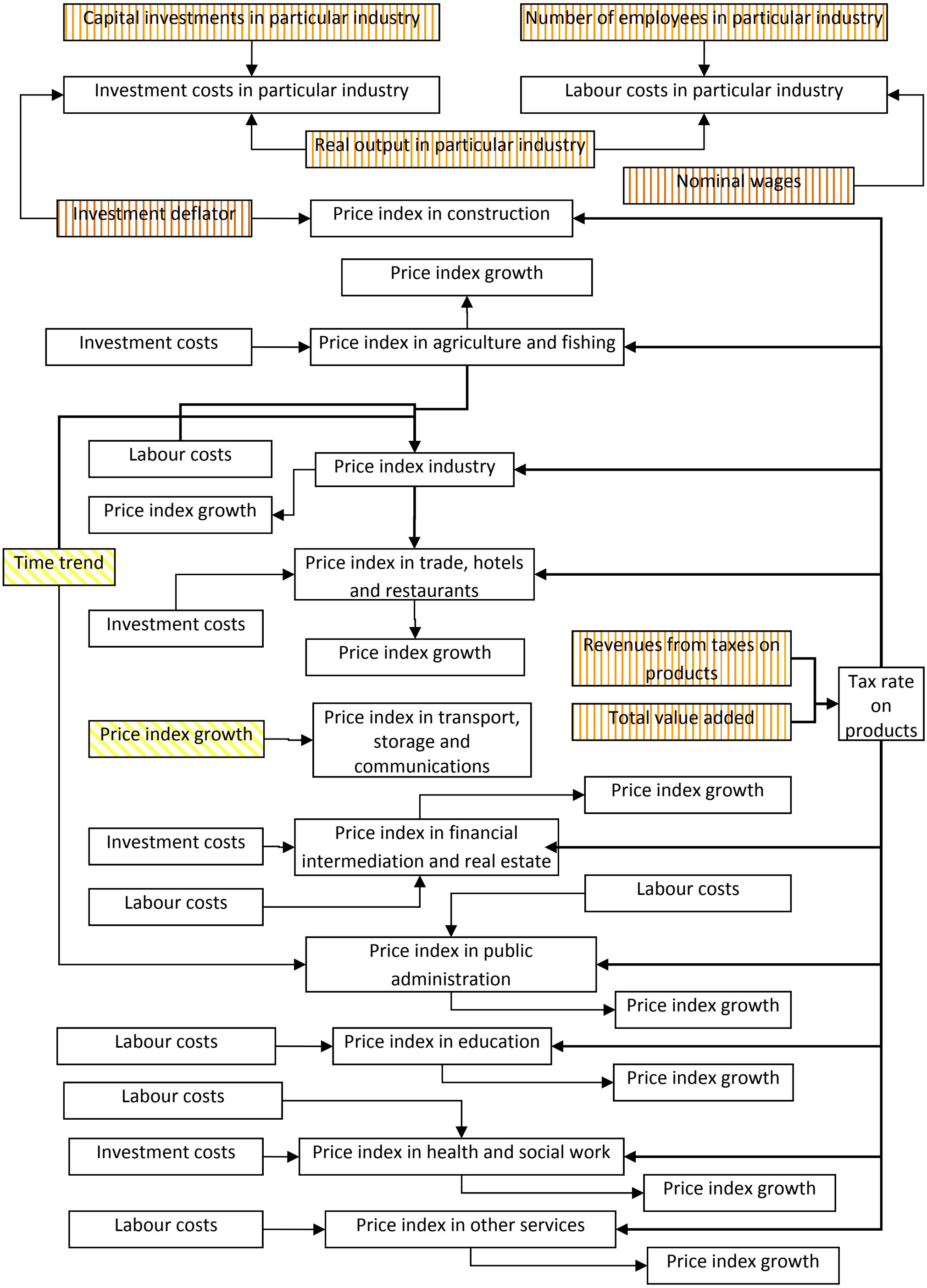

Fig. 2.16. Calculation of price indexes by industries in the Latvian model[12].

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[12] See the legend in Fig.2.4

In the equations of private consumption price index the GDP and import deflators are usually used as the factors, sometimes also lagged values of private consumption price index are used. In the Lithuanian model LITMOD [33, p. 50] consumption price index is calculated as the weighted average of production price index and import deflator, taking into account also value added tax rate. Analysis of the input-output table of 2009 shows that the most significant industries in the private consumption are financial intermediation and real estate, trade, hotel and restaurant services, industry, transport, storage and communications and agriculture, hunting, forestry and fishing. Taking into account the significance of imports in particular industries, the import deflator can also be used in the calculation of private consumption price index.

After the evaluation of the compliance of the combinations of factors influencing consumption price index to the Latvian data, equation (2.38) is included in the Latvian macro-econometric model. Private consumption price index is calculated using consumption price index in the previous year, which characterizes inflation expectations, the GDP deflator and time trend.

$$\log(pi\_cons\_pr) = -0.047 + 0.16 \cdot \log(pi\_cons\_pr(-1)) + 0.71 \cdot \log(pi\_gdp) + 0.035 \cdot \log(t) \tag{2.38}$$

t-stat	(-1.4)	(2.1)	(11.9)	(1.9)
mexval	(7.5)	(16.7)	(257.5)	(14.0)

$R^2 = 0.99$; DW = 1.71; P(F-stat) = 0.00 [1996 – 2011],

where

pi_cons_pr – private consumption price index;
pi_gdp – GDP deflator;
t – time trend (1995 = 1).

In the Latvian LMM model [29, p. 42] the calculation of government consumption price index depending on GDP and the import deflator and time trend is included. In the Slovak model [103, p. 52] government consumption price index depends on private consumption price index and the GDP deflator, but in the Lithuanian model LITMOD [33, p. 52] it is connected with production price index in the public sector. Government consumption price index in the Latvian macro-econometric model is exogenous.

Investment price index is frequently modelled depending on the import deflator. In certain models value added price index [57, p. 40] or the GDP deflator [29, p. 42] is also used as a factor. In the Lithuanian model LITMOD

[33, p. 53] the investment deflator is calculated as a weighted average of the import deflator and production price index in manufacturing and construction. Interest rate is also used, negative influence of which indicates possible lowering of prices of investment objects due to more expensive credits. In the Latvian model investment deflator equation (2.39) uses the GDP deflator, time trend and the dummy variable for 2001 as the factors, because other possible factors turned out to be statistically insignificant or had negative signs, which is not acceptable in the context of the weighted average.

$$\log(pi\_inv\_fix) = 0.096 + 1.1 \cdot \log(pi\_gdp) - 0.093 \cdot \log(t) + 0.08 \cdot d\_01 \qquad (2.39)$$

t-stat (2.4) (17.1) (-3.7) (2.0)
mexval (20.4) (384.0) (42.6) (14.3)

$R^2 = 0.99$; DW = 1.83; P(F-stat) = 0.00 [1995 – 2011],

where
pi_inv_fix – investment deflator;
pi_gdp – GDP deflator;
t – time trend (1995 = 1);
d_01 – dummy variable (2001 = 1, other periods = 0).

In the calculation of export deflators, import price index and the GDP deflator are most frequently used as the factors. In AWM model [57, p. 19] nominal exchange rate is used in addition. In the Lithuanian model LITMOD [33, p. 54] export price index is modelled as a weighted average of the domestic producer price (average of exporting sectors) and the average price in three export markets (EU, CIS, and Central Europe). The most significant factors influencing the import deflator in AWM model [57, p. 20] are the foreign demand deflator, which is based on the world GDP adjusted by nominal exchange rate, and the lagged value of the import deflator. In the Latvian LMM model [29, p. 43] Brent oil price in lats is also used as the factor.

In the Latvian macro-econometric model import price index is exogenous. Alternative approach would be to find an equation, where GDP deflators of other countries influence import prices in Latvia. Export price index is modelled by equation (2.40) depending on import price index.

$$\log(pi\_ex) = 0.008 + 1.09 \cdot \log(pi\_im) \qquad (2.40)$$

t-stat (1.1) (49.4)
mexval (3.6) (1178.8)

$R^2 = 0.99$; DW = 1.87; P(F-stat) = 0.00 [1995 – 2011],

where

pi_ex – export price index;
pi_im – import deflator.

Regarding wages, typically only one nominal wage indicator is used in the models, but there are also exceptions. In NBB, LITMOD and Finnish EMMA econometric equation is estimated for wages in the private sector, but wages in the public sector are calculated depending on the wages in the private sector. In the model for Malawi wages in the public sector are exogenous, and they influence wages in the private sector. In the majority of models wages are expressed in real values using private consumption price index, but in LITMOD, SLOPOL6 and the Slovak model nominal wages are calculated.

Specification of average wage equation implies the choice among several approaches, which determines the scope of factors. In the long term it is possible to use neo-classical theory, where the changes in real wages depend on the changes in productivity. According to the Phillips curve theory, real wages are mainly determined by unemployment rate or nominal wages depend on unemployment rate and inflation. According to the theories, which are connected with “wage bargaining”, unemployment rate and changes in labour productivity are used as factors in wage equations [33, p. 56]. Factors used in average wage equations included in the models developed by other authors are summarized in Table 2.11.

Table 2.11

Indicators Influencing Wages

	Factors								
Model	Pr	PCI or p	PCI/p	u	Ub/w	ULC	t_s	WS	t
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
AWM	x	x		x		x			
MCM block for Spain	x	x		x	x		x		
MCM block for Ireland	x	x		x					
Gr-MCM	x	x		x					x
A-LMM	x			x	x		x		
NBB	x	x		x			x		

Table 2.11 continued

1	2	3	4	5	6	7	8	9	10
Mascotte	x	x		x			x		
Model of Greece	x	x		x					
AQM-06	x	x		x					x
Estonian Model	x	x		x		x			
Estonian EMMA	x	x	x	x					x
LITMOD	x	x		x			x		
SLOPOL6	x	x		x			x		
Slovak Model	x	x		x			x		
Finnish EMMA	x			x				x	
BbkM		x		x					

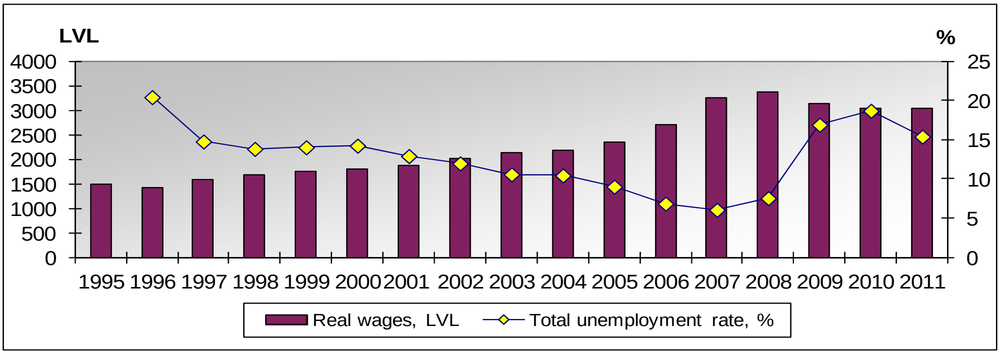
where

w – nominal wages;
Pr – productivity;
PCI – consumption price index;
p – GDP deflator;
u – unemployment rate;
Ub – unemployment benefits;
ULC – unit labour costs;
t_s – social insurance rate or labour taxes;
WS – standard wage rate;
t – time trend;
x – indicator is included in wage equation.

Basic indicators, which are included in wage equations in almost all models, are productivity and unemployment rate. Ratio or difference of the unemployment rate and NAIRU – Non-Accelerating Inflation Rate of Unemployment – is used in AWM, MCM, the model of Greece, Estonian model, Finnish EMMA and BbkM. In several models consumption price index is used for the calculation of real wages. In the models, where nominal wages are calculated, consumption price index is used as one of the factors. In certain cases models also use the ratios of price indexes, unit labour costs, labour tax rates, ratio of unemployment benefits to wages, standard wage rate and time trend.

Thus labour productivity, which influences wages positively, consumption price index, which characterizes inflation and influences wages positively, and unemployment rate, which influences wages negatively, can be chosen as the factors for the average gross wage equation in the Latvian model. In this equation the real wages are expressed as a ratio between nominal gross wages and private consumption price index. There is a close relation both with productivity (r = 0.95 in 1996 – 2011), which in the Latvian model is calculated as a ratio of the real output to the number of employees, and with total unemployment level (r = -0.89 in 1996 – 2008, r = -0.65 in 1996 – 2009 and r = -0.35 in 1996 – 2011).

The relation between real wages and unemployment rate is illustrated in Figure 2.17. Negative relation between both indicators is evident in 1996 – 2007 and in 2009 – 2010. However, both wages and unemployment rate increased in 2008 and decreased in 2011. This adverse trend in 2008 can be explained by the fact that the first priority during the economic crisis was to make operations more efficient. In these circumstances employees were laid off, mainly the ones with lower salaries, which resulted in the increase in the average wages. In December 2008 within the income bracket 100 – 700 LVL there were by 94.5 thousand employees less than in January 2008, but by 45.1 thousand more employees within the income bracket of more than 700 LVL [96]. Only at the end of 2008 the law was passed with the aim to restrict the size of the wages of officials and other employees of state and municipal institutions in 2009 [101] and it was planned to cut wages repeatedly. In 2011 employers were not that optimistic regarding future development trends, therefore wage increases did not exceed inflation.



Source: Calculated by the authors on the basis of CSB database [96]

Fig. 2.17. Relation of real gross annual wage and unemployment rate.

Using the Latvian data, equation (2.41) was estimated using productivity as the main factor. Productivity together with the unemployment rate did not give satisfactory results. Therefore, real wages in the previous period are also used, partly indicating the presence of strong trade unions and laws, which do not allow decreasing wages easily.

log(w_nom/pi_cons_pr) = 1.7 + 0.35 · log(out_fp/empl) – 0.0094 · unempl_r_tot +
t-stat (3.3) (1.9) (-3.2)
mexval (35.0) (13.3) (33.5)

\+ 0.69 · log(w_nom(-1)/pi_cons_pr(-1)) (2.41)
t-stat (5.5)
mexval (81.7)

$R^2 = 0.99$; DW = 1.79; P(F-stat) = 0.00 [1996 – 2012],

where
w_nom – average gross wage per year;
pi_cons_pr – private consumption price index;
out_fp – real output;
empl – total number of employees;
unempl_r_tot – total unemployment rate.

Relations in the section of prices and wages are illustrated in Figure 2.18, but identities included in the section are given in the systems of equations (2.42).

pi_im = pi_im(-1) · (1 + pi_gr_im / 100)
pi_gr_ex = (pi_ex / pi_ex(-1) - 1) · 100
pi_gr_cons_pr = (pi_cons_pr / pi_cons_pr(-1) - 1) · 100
pi_cons_gov = pi_cons_gov(-1) · (1 + pi_gr_cons_gov / 100)
pi_gr_inv_fix = (pi_inv_fix / pi_inv_fix(-1) - 1) · 100
pi_gdp = gdp_cp / gdp_fp
pi_gr_gdp = (pi_gdp / pi_gdp(-1) - 1) · 100
pi_i = pi_i(-1) · (1 + pi_gr_i / 100)
pi_gr_ab = (pi_ab / pi_ab(-1) - 1) · 100 (2.42)
pi_gr_cde = (pi_cde / pi_cde(-1) - 1) · 100
pi_gr_f = (pi_f / pi_f(-1) - 1) · 100
pi_gr_gh = (pi_gh / pi_gh(-1) - 1) · 100
pi_gr_jk = (pi_jk / pi_jk(-1) - 1) · 100
pi_gr_l = (pi_l / pi_l(-1) - 1) · 100
pi_gr_m = (pi_m / pi_m(-1) - 1) · 100
pi_gr_n = (pi_n / pi_n(-1) - 1) · 100
pi_gr_o = (pi_o / pi_o(-1) - 1) · 100
w_month = w_nom / 12
wempl = w_nom · empl / 1000

where
pi_im – import deflator;
pi_gr_im – growth rate of import deflator;
pi_gr_ex – growth rate of export deflator;
pi_ex – export deflator;
pi_gr_cons_pr – growth rate of private consumption price index;
pi_cons_pr – private consumption price index;

pi_cons_gov – government consumption price index;
pi_gr_cons_gov – growth rate of government consumption price index;
pi_gr_inv_fix – growth rate of investment deflator;
pi_inv_fix – investment deflator;
pi_gdp – GDP price index;
gdp_cp – nominal GDP;
gdp_fp – real GDP;
pi_gr_gdp – growth rate of GDP deflator;
pi_z – price index in industry z (z is assigned according to the NACE classification (1.1.rev.) for 10 industries);
pi_gr_z – growth rate of price in industry z;
w_month – average monthly gross wage in the whole economy;
w_nom – average nominal gross wage per year;
wempl – total annual compensation of employees;
empl – number of employees.

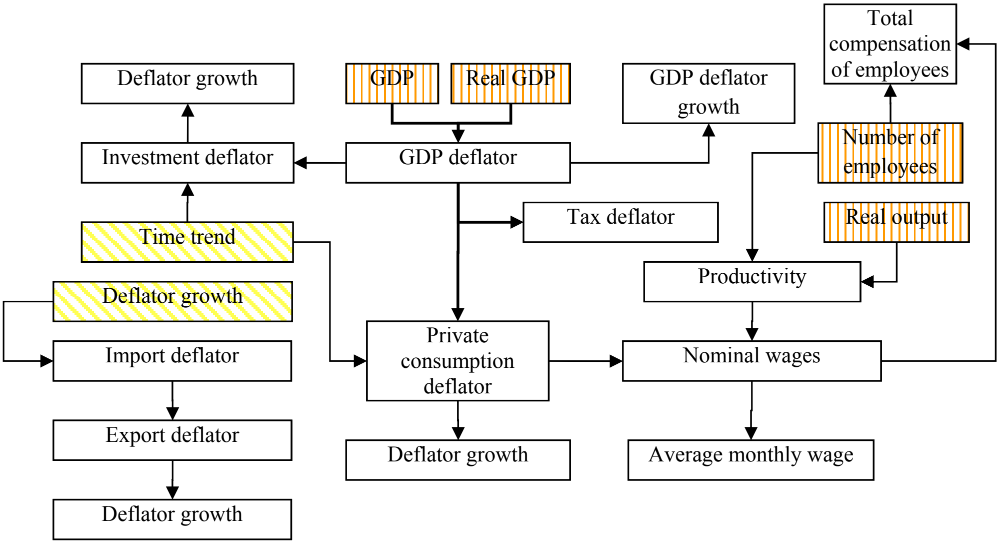


Fig. 2.18. Calculation of price indexes and wages in the Latvian model[13].

The feedback between wages, which influence enterprise costs and prices, is not fully implemented in the model. However, this drawback can be partly eliminated by adjusting the values of exogenous price indexes according to the dynamics of wages.

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[13] See the legend in Fig.2.4

2.6. Foreign Trade and Balance of Payments

In the Latvian macro-econometric model the GDP use indicators are used for total exports and imports in current prices. These indicators differ slightly (by 0.01% - 2.2%) from total exports and imports in the balance of payments. Despite these seemingly small differences, net exports in the GDP use differ from the same indicator of the balance of payments as much as by 7% in some years. Therefore, in the calculation of the current account and the overall balance of payments an additional indicator is used in the model, which characterizes the mentioned deviations in the sample period.

For the needs of the model, the value of exports of goods and imports of goods (for the sample period) is calculated by subtracting accordingly exports or imports of services from the total exports or imports.

2.6.1. Analysis of Factors Influencing Exports and Imports

In the majority of macroeconomic models, equations of total exports and imports are estimated. These equations are typically based on the Armington model (see, for example, LITMOD [33, p. 27]) with demand and relative prices as the main factors. Other indicators characterizing competitiveness can also be used instead of relative prices, as, for instance, exchange rate or real exchange rate. The real exchange rate incorporates both relative prices and exchange rate. In the calculation of the real exchange rate, unit labour costs, normalized unit labour costs, value added deflators, unit value of exports and consumption deflators can be used instead of prices [183, p. 55]. In the Slovenian model SLOPOL6 [177, p. 89] the ratio of consumption price indexes is used in the calculation of the real exchange rate and in Finland's model EMMA [99, p. 10] the ratio of import prices to value added price index is used to characterize competitiveness.

The use of exchange rate both individually and within the competitiveness indicator is important if it fluctuates. In separate time periods it raises or reduces price competitiveness of exported goods or services.

The choice of the most appropriate price index depends both on the structure of the exported production and the available data. Relatively extensive information both regarding actual information and forecasts is usually available for the GDP deflator and private consumption price index. If the majority of exported goods are consumption goods, private consumption price index is more appropriate. Otherwise, the GDP deflator is more suitable. Since the share of consumption goods comprises less than one third in the exports of Latvia, the GDP deflator is chosen to be used in the model. Substitution of the foreign GDP deflator with the import deflator does not give adequate results in the case of Latvia, which can be explained by a certain adjustment of importers to the situation in the Latvian market.

GDP or imports of partner countries is used in the majority of macroeconomic models to characterize foreign demand. In MCM block for Spain [53, p. 18] weighted average imports of the most important partner countries is used for determination of foreign demand for exports of goods. Weighted average GDP value of the partner countries is used for export of services to characterize real income of households, which is the main demand factor of tourism services. In comparison, in the Slovenian model SLOPOL6 [177, p. 89] and in the Estonian model [111, p. 147] real GDP of 12 euro zone countries is used for determination of total exports. If import of services is modelled, foreign trade volume of goods is used to characterize the foreign demand [58, p. 30].

Taking into account that in Latvia imports significantly depend on GDP and GDP is used more frequently in different relations of the model, real GDP of the partner countries is used to characterize foreign demand in the Latvian model. The use of weighted average indicators may give more precise results in the sample period. However, if export structure tends to change, the forecasted foreign demand will not be more accurate comparing with the summary indicators. Therefore, this approach is more suitable for the countries with a stable export structure. The advantages of the use of the summary indicators are flexibility and simplicity, also regarding the forecasting period, where the precise export structure is not known. The use of the summary indicators regarding the EU can also be justified by the presence of the single European market. Therefore, in the Latvian model export of goods is modelled by country groups – EU-15 countries, CIS countries and other countries. Exports to the new EU member states, which joined the EU on May 1, 2004, could be modelled separately as the importance of these countries increases in the export structure. However, in this case it would be problematic to choose the factors, which would characterize demand and competitiveness of the remaining countries.

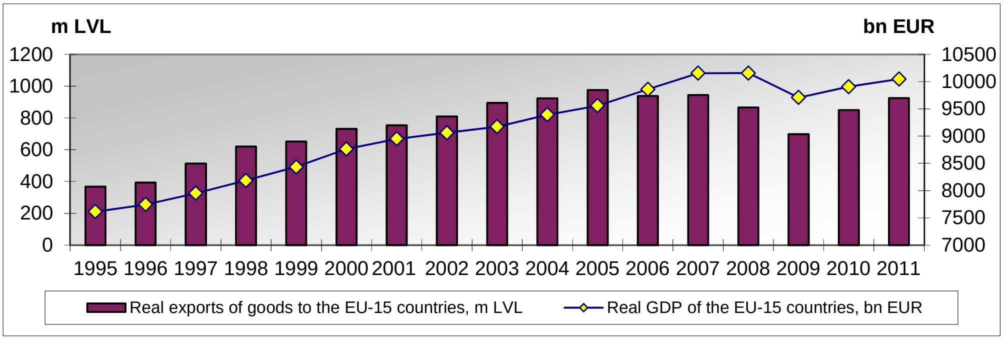
Total demand (consumption, investment and exports) is used in import equations in several models [177, p. 89] to characterize domestic demand. Private consumption is also used in cases, when consumption products make up the major part of imports [1, p. 27]. Exports are used if imported products are used for production of exported products [99, p. 10], and the share of re-exports in total exports is high [111, p. 147].

Sometimes demand indicator is used as the only factor in export and import equations, for example, in export equation in the Estonian model [111, p. 147] and in the import equation in the Slovenian model SLOPOL6 [177, p. 89]. In the Estonian model it is assumed that Estonian exporters adjust to the foreign prices, therefore it is not necessary to include price factors in the export equation.

Economic theory states that investment in new technologies can also facilitate exports and improve competitiveness of goods. Moreover, as Latvia's domestic market is small, investors tend to focus mainly on exporters [104, p. 48]. Therefore, the volume of exports can be connected to investments both in the current and in the previous periods. In the export equation of MCM block for Ireland [106, p. 23] the share of manufacturing is used to characterize high export ability of foreign enterprises. As in 2009 manufacturing products comprised 82.9% of total export of goods in Latvia, significance of a similar factor is tested also in equations of export of goods in the model, but statistical significance has not been satisfactory.

2.6.2. Exports and Imports of Goods

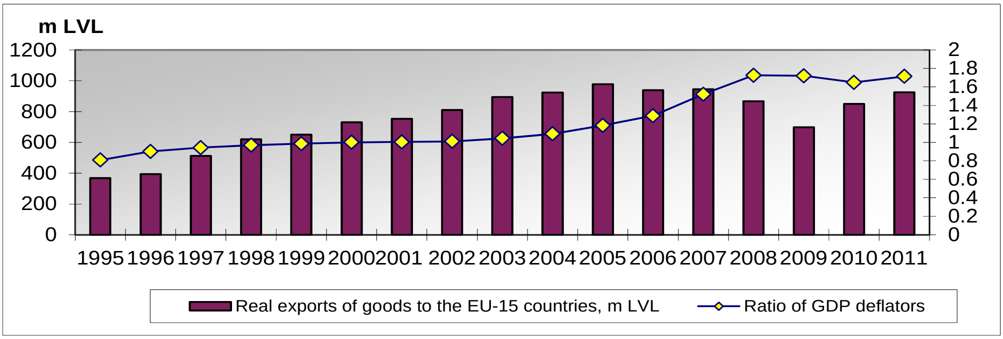
Direct correlation between Latvia's real exports of goods to the EU-15 countries (for the calculation of constant prices total export price index is used for all export indicators) and the real GDP of the EU-15 countries was observed in 1995 – 2005 and in 2009 – 2011 (see Fig. 2.19). However, in 2006 – 2008 exports in nominal terms continued to grow together with the decrease in exports in real terms, but the demand in the EU-15 countries continued to grow. Nevertheless, the correlation coefficient for the whole sample is 0.89.



Source: Eurostat database [54]; calculated by the authors on the basis of CSB database [96]

Fig. 2.19. Relation between Latvian export of goods to the EU-15 countries and real GDP of the EU-15 countries.

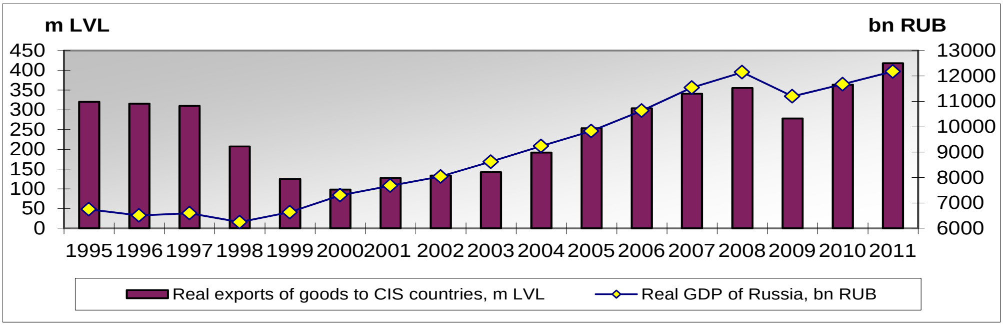
Since the Latvian lat is pegged to the euro from January 1, 2005 [87], the importance of the exchange rate both as a single factor and within the competition indicator has significantly decreased. However, the ratio between GDP deflators of Latvia and the EU-15 countries is important and must be taken into account. Figure 2.20. shows that in the majority of periods, the relation between Latvia's exports of goods to the EU-15 countries and the ratio of the GDP deflators is positive, which contradicts the theoretical assumptions. Starting with 2001, the value of the correlation coefficient between these indicators has been negative. It means that initially foreign demand was of a greater importance, but afterwards relative prices have become a decisive factor determining the volume of exports to the EU-15 countries.



Source: Calculated by the authors on the basis of Eurostat database [54] and CSB database [96]

Fig. 2.20. Relation between Latvian exports of goods to the EU-15 countries and ratio of GDP deflators.

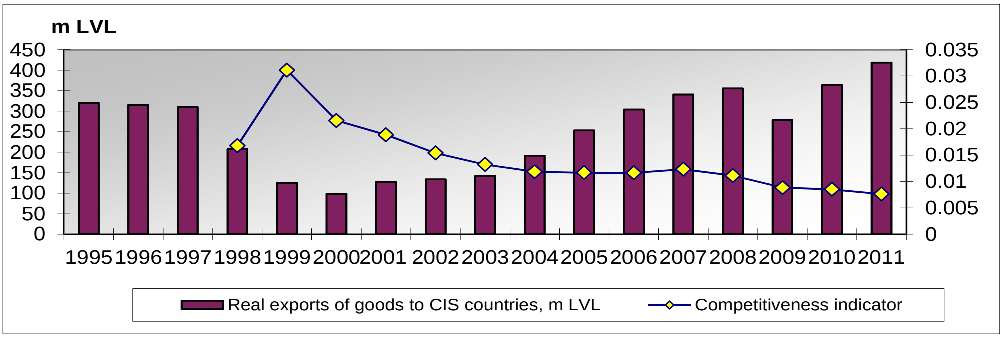
Indicators characterizing Russia are used for evaluation of demand and competitiveness of Latvian exports of goods to CIS countries. The reason is that the largest share of goods in the group of CIS countries are exported to Russia (48.1% in 2000 to 70.3% in 2010), also the largest fluctuations of export volume are related to this country. Besides, Russian statistics are more detailed than the statistics available for the whole CIS region. Figure 2.21 shows that there is a strong relation between Latvia's exports of goods to CIS countries and the real GDP of Russia starting with 2000. Adverse trends in 1999 and 2000 are connected with the influence of the economic crisis in Russia on the possibilities to sell Latvian production in the Russian market.



Source: Calculated by the authors on the basis of CSB database [96] and the Federal State Statistics Service of Russia [187]

Fig. 2.21. Relation between Latvian exports of goods to CIS countries and the real GDP of Russia.

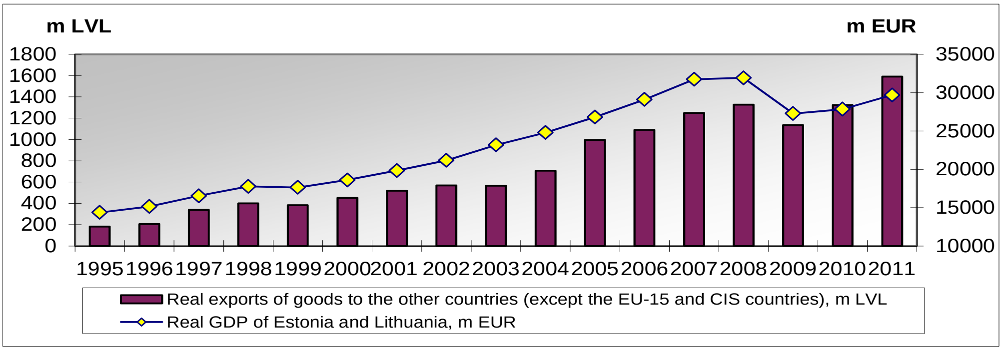
The choice of the most appropriate indicator characterizing competitiveness is based on the analysis of the relation between Latvian exports of goods to CIS countries and the ratio of GDP deflators of Latvia and Russia, competitiveness indicator and exchange rate. The influence of the average exchange rate of LVL to RUB has not been very significant. However, together with the ratio of GDP deflators, it gives comparatively close relation with exports starting with 1998 (see Fig. 2.22). In comparison, the relation between the ratio of GDP deflators and exports of goods to CIS countries is strong enough since 1999. Therefore, during the estimation of the equation, significance of both indicators (competitiveness indicator and the ratio of GDP deflators) has to be evaluated.



Source: Calculated by the authors on the basis of database of CSB database [96] and the Federal State Statistics Service of Russia [187]

Fig. 2.22. Relation between Latvian export of goods to CIS countries and competitiveness indicator.

In the group of other countries, goods of similar value are exported to Lithuania and Estonia, 29.8% and 24.8% respectively in 2010. Therefore demand and competitiveness indicators of Lithuania or Estonia are included in the model. Demand is characterized by the total real GDP of Estonia and Lithuania – a proxy characterizing the main export partners in this group. As seen in Figure 2.23, the dynamics of the real GDP of Estonia and Lithuania is similar to the dynamics of exports of goods to other countries.



Source: Eurostat database [54]; calculated by the authors on the basis of CSB database [96]

Fig. 2.23. Relation between Latvian exports of goods to other countries and the real GDP of Estonia and Lithuania.

In order to find the most appropriate competitiveness variable for export equation to other countries, Lithuanian and Estonian price and exchange rate indicators were tested individually and together as single indicators for both countries. The Lithuanian indicators give more adequate results than the indicators of Estonia or compound indicators of Estonia and Lithuania. Thus, more competitive prices of Latvia relative to Lithuania ensure that Latvian goods are competitive also in other countries.

In the Latvian model, the real GDP of the EU-15 countries and the ratio of GDP deflators, as well as time trend and the dummy for 2009 are included as the factors in equation (2.43) for modelling of exports of goods to the EU-15 countries. Real GDP of Russia, competitiveness indicator and the dummy of 1998 (Russian crisis), are included as the factors in equation (2.44) of exports of goods to CIS countries. Equation (2.45) is estimated for modelling of exports of goods to other countries, where the real GDP of Lithuania and Estonia, and the ratio of GDP deflators of Latvia and Lithuania, as well as the dummy variable from 2009 onwards are used. The Durbin-Watson statistic indicates the possible autocorrelation in this case.

$$\begin{array}{llll} \log(ex\_goods\_eu/pi\_ex) = & -\ 10.9 + & 1.88 \cdot \log(gdp\_eu15\_fp) + & 0.33 \cdot \log(t) - \\ \text{t-stat} & (-2.0) & (3.1) & (5.5) \\ \text{mexval} & (16.1) & (34.6) & (86.5) \end{array}$$

$$-\ 0.68 \cdot \log(pi\_gdp/pi\_eu15\_gdp)\ -\ 0.16 \cdot d\_09 \qquad (2.43)$$

t-stat (-5.9) (-2.7)
mexval (97.4) (26.5)

$R^2 = 0.98$; DW = 2.14; P(F-stat) = 0.00 [1995 – 2011],

$$\log(\text{ex\_goods\_cis}/\text{pi\_ex}) = -12.4 + 1.8 \cdot \log(\text{gdp\_rus\_fp}) + 0.80 \cdot \text{d\_98} -$$

t-stat (-7.2) (10.0) (4.6)
mexval (123.4) (194.1) (61.8)

$$- 0.27 \cdot \log(\text{lvl\_rub\_aver} \cdot \text{pi\_gdp}/\text{pi\_rus\_gdp}) \qquad (2.44)$$

t-stat (-9.8)
mexval (189.7)

$R^2 = 0.91$; DW = 1.87; P(F-stat) = 0.00 [1995 – 2011],

$$\log(\text{ex\_goods\_oth}/\text{pi\_ex}) = -24.1 + 3.1 \cdot \log(\text{gdp\_eelt\_fp}) - 1.6 \cdot \log(\text{pi\_gdp}/\text{pi\_lt\_gdp}) +$$

t-stat (-10.8) (13.5) (-3.7)
mexval (207.9) (264.7) (51.9)

$$+ 0.48 \cdot \text{d\_0911} \qquad (2.45)$$

t-stat (5.7)
mexval (81.1)

$R^2 = 0.99$; DW = 1.64; P(F-stat) = 0.00 [1995 – 2011],

where

ex_goods_eu – exports of goods to the EU-15 countries;
ex_goods_cis – exports of goods to CIS countries;
ex_goods_oth – exports of goods to other countries;
pi_ex – export price index;
gdp_eu15_fp – real GDP of the EU-15 countries;
pi_gdp – GDP deflator;
pi_eu15_gdp – GDP deflator of the EU-15 countries;
gdp_rus_fp – real GDP of Russia;
lvl_rub_aver – currency exchange rate of lat to Russian rouble;
gdp_eelt_fp – real GDP of Estonia and Lithuania;
pi_lt_gdp – GDP deflator of Lithuania;
t – time trend (1995 = 1);
d_98 – dummy variable (1998 = 1, other periods = 0);
d_09 – dummy variable (2009 = 1, other periods = 0);
d_0911 – dummy variable (1995 – 2008 = 0, other periods = 1).

Real imports in producing industries (except construction) are calculated in the section of the supply of goods and services and production factors. For the calculation of imports of goods in nominal terms, real imports are multiplied by the correction coefficient and import price index. Calculation scheme of exports and imports of goods is given in Figure 2.24.

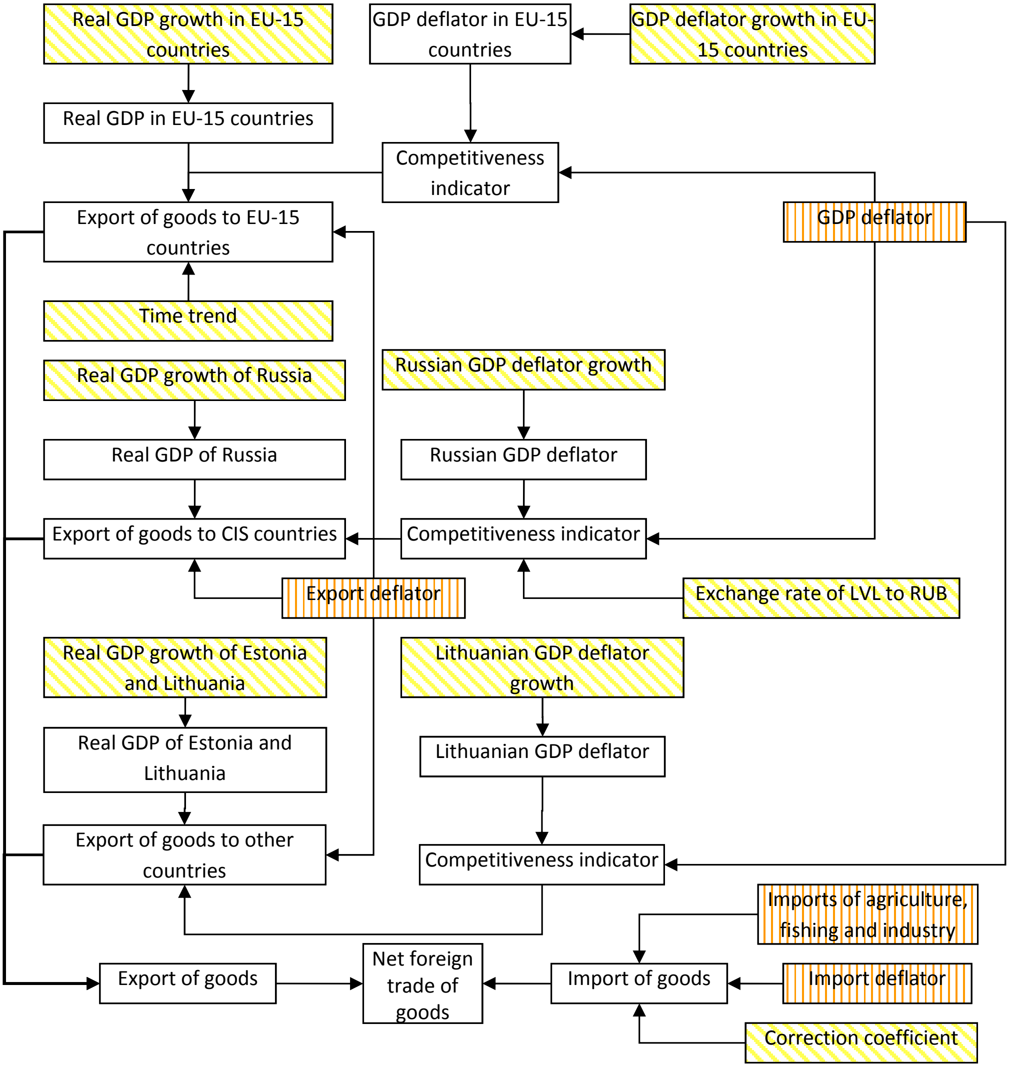


Fig. 2.24. Calculation of exports and imports of goods in the Latvian model[14].

2.6.3. Export and Import of Services

In the section of export and import of services, the main elements of the balance of payments – transportation, travel and other services – are modelled. The chosen disaggregation of services characterizes significant industries in the sense of export ability (39.5% of transport, storage and communication services

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[14] See the legend in Fig.2.4

are exported, according to Table 2.5, tourism helps to improve the balance of the current account in many countries, as well as facilitates economic growth).

Usually total exports and imports are included in macro-econometric models without further division between goods and services. Therefore, the factor choice for export and import of services should not differ much. That is, equations for export and import of services should contain appropriate demand and competitiveness indicators. Other indicators can also be added to reflect the peculiarities of particular services. For example, the volume of trade of goods can be used for determination of export and import of transportation services.

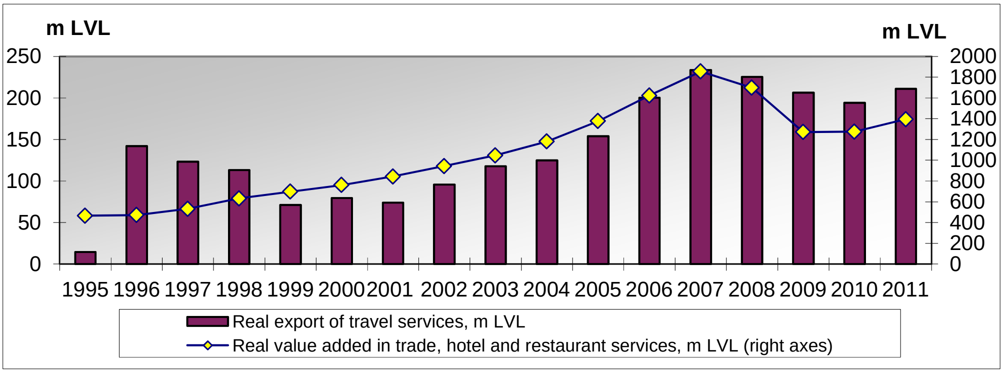
Export of transportation services in Latvia is mainly connected with freight transportation. Therefore, it can be assumed that demand for transportation depends on the volume of exports and imports of goods. In freight traffic by road, international transportation cargo turnover is to a similar extent related to imports, exports and cross-trade and cabotage transportation. Comparatively stronger relationship is observed between export of transportation services and export of goods (see Fig. 2.25).

Source: Calculated by the authors on the basis of CSB database [96] and the database of the Bank of Latvia [95]

Fig. 2.25. Relation between export of transportation services and export of goods.

Export and import of travel services is in fact expenditures of international tourists abroad or in Latvia respectively. Consumption price index is used for the calculation of the real export of travel services, because expenditures of travelling are mainly connected with consumption expenditures.

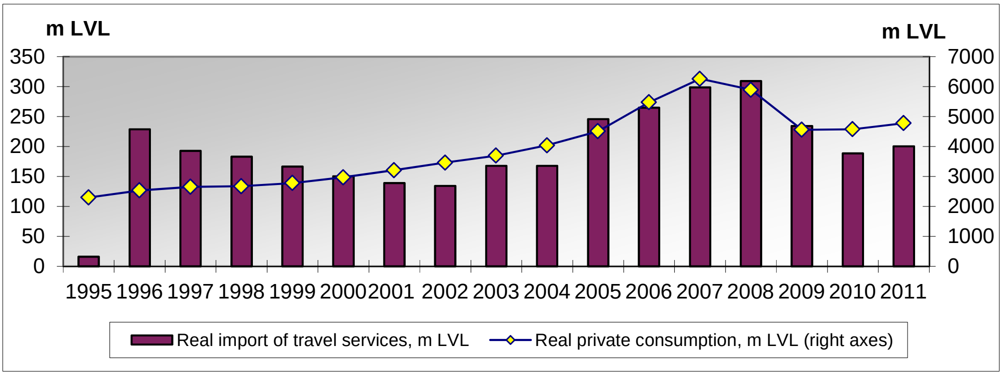
In Latvia, the largest share of expenditures of inbound tourists come from the EU-15 (Germany, Finland) and other countries (Estonia, Lithuania), as well as from the Russian tourists. In order not to increase the number of indicators to be included in the model, real GDP of particular countries is used for characterization of demand. Relations between export of travel services and GDP of the EU-15 countries, Estonia, Lithuania and Russia are comparatively close ($r > 0.74$). Nevertheless, none of these indicators explains the trends of export of travel services to a full extent. Relations between export of travel services and competitiveness indicators are contrary to the theoretical assumptions, so they cannot be used. Strong relation is observed between export of travel services and the value added in trade, hotels and restaurants ($r = 0.83$ in 1995 – 2011), as it is seen in Figure 2.26.



Source: Calculated by the authors on the basis of CSB database [96] and the database of the Bank of Latvia [95]

Fig. 2.26. Relation between export of travel services and value added in trade, hotels and restaurants.

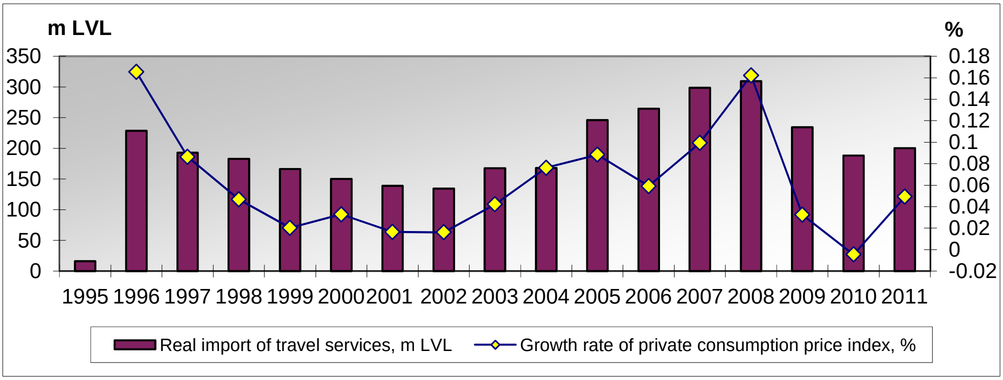
Private consumption is the most appropriate demand factor for the modelling of import of travel services. It is due to the fact that the most significant motives for travelling (by total expenditures) are holidays and shopping. Figure 2.27 shows that this factor does not explain all fluctuations of import of travel services.



Source: Calculated by the authors on the basis of CSB database [96] and the database of the Bank of Latvia [95]

Fig. 2.27. Relation between import of travel services and private consumption.

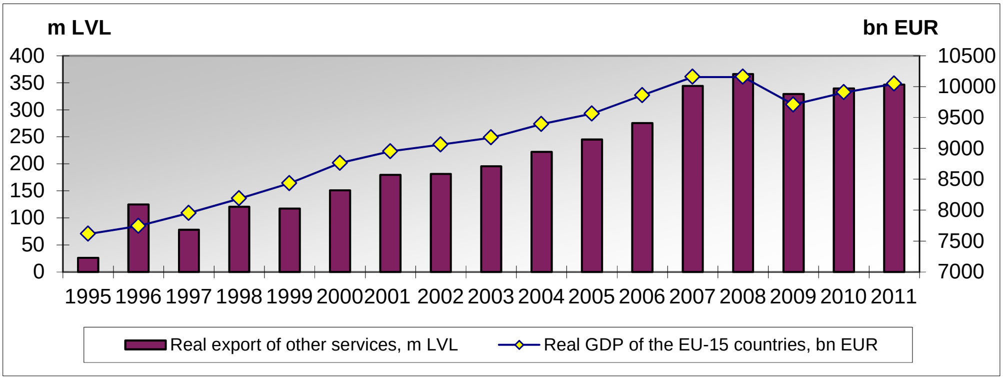
Part of the fluctuations can be explained by the increase of consumption prices in Latvia (see Fig. 2.28). It can be associated with the element of tourist expenditures, which fluctuates the most – expenditures of travellers with the aim of shopping.



Source: Calculated by the authors on the basis of CSB database [96] and the database of the Bank of Latvia [95]

Fig. 2.28. Relation between import of travel services and private consumption price index.

Other business services are the main component of export of other services. Other business services include merchanting and other trade-related services, operational leasing services and miscellaneous business, professional, and technical services. Thus, these services are largely related to different export and import transactions. Nevertheless, strong relation is observed between export of other services and the real GDP of the EU-15 countries (see Fig. 2.29).



Source: Calculated by the authors on the basis of Eurostat database [54], CSB database [96] and the database of the Bank of Latvia [95]

Fig. 2.29. Relation between export of other services and the real GPD of the EU-15 countries.

Foreign trade turnover is included in equation (2.46) to characterize transportation services. Within the sample period, there were no statistically significant competitiveness indicators, which would allow evaluating the choice among domestic and foreign carriers. The equation (2.46) contains also two dummy variables to explain indistinctive fluctuations in 2004 and 2008. Import of transportation services is modelled by multiplying import in transport, storage and communications industry by the correction coefficient and import price index.

Equation (2.47) is estimated for the calculation of export of travel services. Although the value of determination coefficient is only 0.48, the equation can be regarded as being precise enough for the evaluation of long-term trend, because larger deviations are associated with the 1990s. In the equation of import of travel services, the combination of the private consumption and private consumption price index as the factors did not give satisfactory results. Instead, equation (2.48) is included in the model with the private consumption, time trend and the dummy variable for 2009 as the factors.

Equation (2.49) is estimated as the most suitable for modelling of export of other services with export of goods as the main factor. Import of other services is calculated as a residual between import of all services and import of transportation and travel services.

$$\log(ex\_s\_tran/pi\_ex) = 4.4 + 0.21 \cdot \log(ex\_im\_fp\_goods) - 0.15 \cdot d\_04 + 0.11 \cdot d\_08 \tag{2.46}$$

t-stat	(19.2)	(7.4)	(-3.6)	(2.3)
mexval	(441.8)	(129.3)	(42.2)	(18.5)

$R^2 = 0.87$; DW = 1.98; P(F-stat) = 0.00 [1995 – 2011],

$$\log(ex\_s\_trav/pi\_cons\_pr) = - 39.1 + 4.8 \cdot \log(gdp\_eu15\_fp) \tag{2.47}$$

t-stat	(-3.4)	(3.8)
mexval	(32.3)	(39.4)

$R^2 = 0.48$; DW = 1.57; P(F-stat) = 0.00 [1995 – 2011],

$$\log(im\_s\_trav/pi\_im) = - 7.2 + 1.7 \cdot \log(cons\_fp\_priv) – 0.61 \cdot \log(t) + 0.28 \cdot d\_09 \tag{2.48}$$

t-stat	(-4.6)	(8.0)	(-6.0)	(2.4)
mexval	(68.0)	(150.8)	(99.6)	(20.9)

$R^2 = 0.86$; DW = 1.66; P(F-stat) = 0.00 [1996 – 2011],

$$\log(ex\_s\_oth/pi\_ex) = - 6.4 + 1.57 \cdot \log(ex\_goods/pi\_ex) \tag{2.49}$$

t-stat	(-4.1)	(7.4)
mexval	(45.6)	(116.3)

$R^2 = 0.79$; DW = 2.08; P(F-stat) = 0.00 [1995 – 2011],

where

ex_s_tran – export of services in current prices;
ex_s_trav – export of travel services in current prices;
im_s_trav – import of travel services in current prices;
ex_s_oth – export of other services in current prices;
pi_ex – export price index;
ex_im_fp_goods – export and import of goods in constant prices;
pi_cons_pr – private consumption price index;
gdp_eu15_fp – real GDP of the EU-15 countries;
pi_im – import price index;
cons_fp_priv – private consumption in constant prices;
ex_goods – export of goods in current prices;
t – time trend (1995 = 1);
d_04 – dummy variable (2004 = 1, other periods = 0);
d_08 – dummy variable (2008 = 1, other periods = 0);
d_09 – dummy variable (2009 = 1, other periods = 0).

Illustration of the calculation of export and import of services and total net exports is given in Figure 2.30.

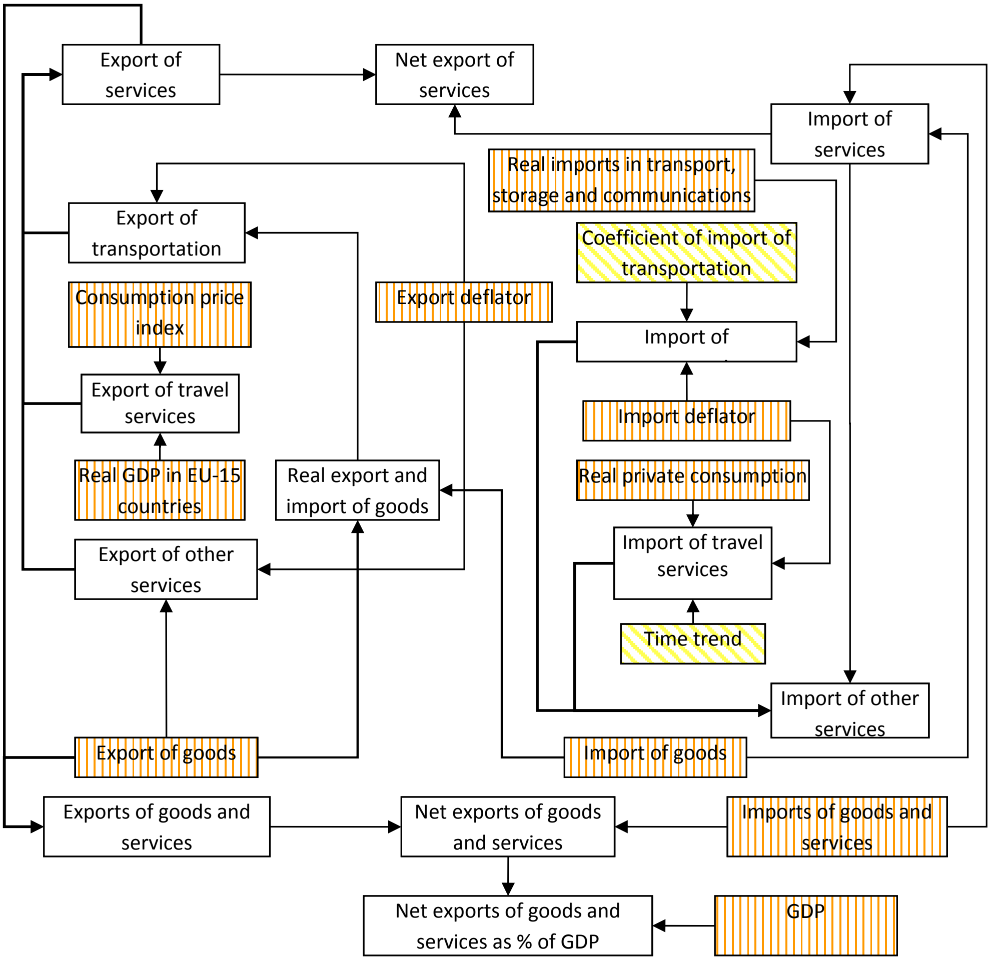


Fig. 2.30. Calculation of export and import of services and total net exports in the Latvian model[15].

Foreign trade section of the model contains also the identities for the calculation of GDP and GDP deflators of foreign countries included in the system of equations (2.50).

$$\begin{array}{lcl} gdp\_eu15\_fp & = & gdp\_eu15\_fp(-1)\cdot(1+gdp\_eu15\_gr/100) \\ pi\_eu15\_gdp & = & pi\_eu15\_gdp\cdot(1+pi\_gr\_eu15\_gdp/100) \\ gdp\_rus\_fp & = & gdp\_rus\_fp(-1)\cdot(1+gdp\_rus\_gr/100) \\ pi\_rus\_gdp & = & pi\_rus\_gdp\cdot(1+pi\_gr\_rus\_gdp/100) \\ gdp\_eelt\_fp & = & gdp\_eelt\_fp(-1)\cdot(1+gdp\_eelt\_gr/100) \\ pi\_lt\_gdp & = & pi\_lt\_gdp\cdot(1+pi\_gr\_lt\_gdp/100) \end{array} \qquad (2.50)$$

where

gdp_eu15_fp – real GDP of the EU-15 countries;

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[15] See the legend in Fig.2.4

gdp_eu15_gr – growth rate of the real GDP of the EU-15 countries;
pi_eu15_gdp – GDP deflator of the EU-15 countries;
pi_gr_eu15_gdp – growth rate of the GDP deflator of the EU-15 countries;
gdp_rus_fp – real GDP of Russia;
gdp_rus_gr – growth rate of the GDP of Russia;
pi_rus_gdp – GDP deflator of Russia;
pi_gr_rus_gdp – growth rate of the GDP deflator of Russia;
gdp_eelt_fp – real GDP of Estonia and Lithuania;
gdp_eelt_gr – growth rate of the real GDP of Estonia and Lithuania;
pi_lt_gdp – GDP deflator of Lithuania;
pi_gr_lt_gdp – growth rate of the GDP deflator of Lithuania.

Identities for the calculation of exports, imports and net exports are included in the system of equations (2.51).

$$
\begin{aligned}
\text{ex\_goods} &= \text{ex\_goods\_eu} + \text{ex\_goods\_cis} + \text{ex\_goods\_oth} \\
\text{im\_goods} &= \text{im\_fp\_ae} \cdot \text{im\_g\_coef} \cdot \text{pi\_im} \\
\text{ex\_im\_fp\_goods} &= \text{ex\_goods}/\text{pi\_ex} + \text{im\_goods}/\text{pi\_im} \\
\text{ex\_serv} &= \text{ex\_s\_tran} + \text{ex\_s\_trav} + \text{ex\_s\_oth} \\
\text{im\_serv} &= \text{im\_cp} - \text{im\_goods} \\
\text{im\_s\_tran} &= \text{im\_fp\_i} \cdot \text{im\_s\_tran\_coef} \cdot \text{pi\_im} \\
\text{im\_s\_oth} &= \text{im\_serv} - \text{im\_s\_tran} - \text{im\_s\_trav} \\
\text{bal\_goods} &= \text{ex\_goods} - \text{im\_goods} \\
\text{bal\_serv} &= \text{ex\_serv} - \text{im\_serv} \\
\text{bal\_tot} &= \text{ex\_cp} - \text{im\_cp} \\
\text{bal\_tot\_gdp} &= (\text{bal\_tot}/\text{gdp\_cp}) \cdot 100
\end{aligned}
\tag{2.51}
$$

where
ex_goods – export of goods in current prices;
ex_goods_eu – export of goods to the EU-15 countries in current prices;
ex_goods_cis – export of goods to CIS countries in current prices;
ex_goods_oth – export of goods to other countries in current prices;
im_goods – import of goods in current prices;
im_fp_ae – real imports in agriculture, fishing and industry;
im_g_coef – correction coefficient of import of goods;
pi_im – import deflator;
ex_im_fp_goods – exports and imports of goods in constant prices;
pi_ex – export deflator;
ex_serv – export of services in current prices;
ex_s_tran – export of transportation services in current prices;
ex_s_trav – export of travel services in current prices;
ex_s_oth – export of other services in current prices;
im_serv – import of services in current prices;
im_cp – imports of goods and services in current prices;
im_s_tran – import of transportation services in current prices;
im_fp_i – real imports in transport, storage and communication;
im_s_tran_coef – correction coefficient of import of transportation services;
im_s_oth – import of other services in current prices;
im_s_trav – import of travel services in current prices;
bal_goods – net export of goods in current prices;
bal_serv – net export of services in current prices;
bal_tot – net exports of goods and services in current prices;

ex_cp	– exports of goods and services in current prices;
bal_tot_gdp	– net exports of goods and services in current prices, % of GDP;
gdp_cp	– nominal GDP.

2.6.4. The Balance of Payments

Macroeconomic models usually contain only the calculation of the current account, where net exports are added to the exogenous net income and exogenous net transfers. Elimination of other sections of the balance of payments is mostly substantiated with their relation to the monetary indicators, which are not included in a particular model. In the Latvian LMM model [29, p. 20] net income depends on GDP and multiplication of net foreign assets in the previous period by the long-term interest rate, but net transfers depend on GDP. In MCM block for Spain [179, p. 42] net transfers are exogenous. Net income depends on net foreign assets in the previous period. Net foreign assets are calculated by adding current account balance to the value of net foreign assets in the previous period. In AWM [57, p. 48] current account balance is calculated as the sum of net exports and net factor income from abroad, which depend on net foreign assets in the previous period. In the Estonian model [111, p. 166] overall balance of payments is calculated by summing up net exports, net foreign assets (the sum of capital and financial account) and net factor income from abroad (net income and net transfers from the current account), which depend on net foreign assets in the previous period and time trend.

It means that the indicators of the balance of payments in macroeconomic models are included as aggregated as possible and often as exogenous variables. Net foreign assets are the indicator, which is often used as a factor for the calculation of net income and net transfers, but calculation principles of this indicator vary among different models. None of the previously mentioned ways of calculation of net foreign assets fully corresponds to the Latvian data. Therefore, net foreign assets are not calculated within the model. However, the relation between net income and net transfers with the value of capital and financial account can be used in the model.

In the Latvian model larger disaggregation is used, as separate components of the balance of payments are used also in other sections of the model (received EU fund resources, including subsidies to farmers, government payments to the EU budget and foreign direct investment). Net income is calculated by the equation (2.52) depending on the value of financial account in the previous period, time trend and the dummy variable. Thus, it characterizes the part of income, which is connected with different investments, changes in stock value of which is to a large extent explained by the value of financial account. Compensation of employees can also be related to investment, if investors attract particular employees in particular enterprises. Other components of the balance of payments are exogenous or depend on the GDP.

$$\begin{array}{lllll} mb\_inc = 310.8 + & 0.13\cdot mb\_fin(-1) - & 63.0\cdot t + & 854.0\cdot d\_0911 & \qquad (2.52) \\ \text{t-stat} \quad (2.5) & (2.5) & (-3.8) & (4.3) & \\ \text{mexval} \quad (21.2) & (21.3) & (46.1) & (55.5) & \end{array}$$

$R^2 = 0.59$; DW = 1.00; P(F-stat) = 0.00 [1996 – 2012],

where

mb_inc – net income;
mb_fin – financial account (excluding reserve assets);
t – time trend (1995 = 1);
d_0911 – dummy variable (1995-2008 = 0, other periods = 1).

Relations of the indicators of the balance of payments are visualized in Figure 2.31, and identities for the calculation of the current account are given in the system of equations (2.53).

$$\begin{array}{lcl} mb\_ex\_bal & = & (ex\_cp - im\_cp) \cdot mb\_ex\_bal\_coef \\ mb\_tr\_g\_r\_eu & = & mb\_tr\_eu\_subs + mb\_tr\_eu\_oth \\ mb\_tr\_g\_rec & = & mb\_tr\_g\_r\_eu + mb\_tr\_g\_r\_oth \\ mb\_tr\_g\_p\_eu & = & mb\_tr\_g\_p\_eu\_coef \cdot gdp\_cp \\ mb\_tr\_g\_pd & = & mb\_tr\_g\_p\_eu + mb\_tr\_g\_p\_oth \\ mb\_tr\_gov & = & mb\_tr\_g\_rec - mb\_tr\_g\_pd \\ mb\_tr\_oth & = & mb\_tr\_oth\_coef \cdot gdp\_cp \\ mb\_tr & = & mb\_tr\_gov + mb\_tr\_oth \\ mb\_cur & = & mb\_ex\_bal + mb\_inc + mb\_tr \\ mb\_cur\_gdp & = & (mb\_cur/gdp\_cp) \cdot 100 \end{array} \qquad (2.53)$$

where

mb_ex_bal – net exports of goods and services, the balance of payments;
ex_cp – exports of goods and services in current prices;
im_cp – imports of goods and services in current prices;
mb_ex_bal_coef – correction coefficient of net export, the balance of payments;
mb_tr_g_r_eu – EU funds received by the government;
mb_tr_eu_subs – government received EU subsidies to farmers;
mb_tr_eu_oth – other government received EU funds and structural funds;
mb_tr_g_p_eu – transfers paid in the EU budget;
mb_tr_g_p_eu_coef – coefficient of transfers paid in the EU budget;

gdp_cp – GDP in current prices;
mb_tr_g_pd – transfers paid by the government;
mb_tr_g_p_oth – other transfers paid by the government;
mb_tr_gov – net government transfers, the balance of payments;
mb_tr_oth – net transfers of other sectors, the balance of payments;
mb_tr_oth_coef – coefficient of the net transfers of other sectors, the balance of payments;
mb_tr – net transfers, the balance of payments
mb_cur – current account balance, the balance of payments;
mb_inc – net income, the balance of payments;
mb_cur_gdp – current account balance in % of GDP, the balance of payments.

Identities for the calculation of the capital and financial account are given in the system of equations (2.54).

$$
\begin{aligned}
\text{mb\_cap\_tr\_g} &= \text{mb\_cap\_tr\_g\_eu} + \text{mb\_cap\_tr\_g\_o} \\
\text{mb\_cap\_tr} &= \text{mb\_cap\_tr\_g} + \text{mb\_cap\_tr\_o} \\
\text{mb\_cap} &= \text{mb\_cap\_tr} + \text{mb\_cap\_nef} \\
\text{mb\_fdi\_lv} &= \text{mb\_fdi\_lv\_coef} \cdot \text{gdp\_cp} \\
\text{mb\_fdi\_inlv} &= \text{mb\_fdi\_inlv(-1)} \cdot (1 + \text{inv\_gr\_fdi} / 100) \\
\text{mb\_inv\_dir} &= \text{inv\_fdi} - \text{mb\_fdi\_lv} \\
\text{mb\_inv\_portf} &= \text{mb\_inv\_pf\_gov} + \text{mb\_inv\_pf\_oth} \\
\text{mb\_inv\_oth} &= \text{mb\_inv\_oth\_g} + \text{mb\_inv\_oth\_o} \\
\text{mb\_fin} &= \text{mb\_inv\_dir} + \text{mb\_inv\_portf} + \text{mb\_inv\_oth} + \text{mb\_fin\_oth} \\
\text{mb\_fin\_g\_fg} &= \text{mb\_inv\_pf\_gov} + \text{mb\_inv\_oth\_g} \\
\text{mb\_cap\_fin} &= \text{mb\_cap} + \text{mb\_fin} \\
\text{mb\_err} &= \text{mb\_cur} + \text{mb\_cap\_fin} - \text{mb\_res}
\end{aligned}
\qquad (2.54)
$$

where

mb_cap_tr_g – net government capital transfers, the balance of payments;
mb_cap_tr_g_eu – EU funds, net government capital transfers;
mb_cap_tr_g_o – net other government capital transfers;
mb_cap_tr – net capital transfers, the balance of payments;
mb_cap_tr_o – net capital transfers of other sectors, the balance of payments;
mb_cap – capital account balance, the balance of payments;
mb_cap_nef – net non-produced non-financial assets, the balance of payments;
mb_fdi_lv – Latvian direct investment abroad, the balance of payments;
mb_fdi_lv_coef – coefficient of Latvian direct investment abroad;
mb_fdi_inlv – foreign direct investment in Latvia;
inv_gr_fdi – growth of foreign direct investment in Latvia;
mb_inv_dir – net direct investment, the balance of payments;
mb_inv_portf – net portfolio investments, the balance of payments;
mb_inv_pf_gov – net government portfolio investments, the balance of payments;
mb_inv_pf_oth – net portfolio investments of other sectors, the balance of payments;
mb_inv_oth – net other investment, the balance of payments;
mb_inv_oth_g – net other government investment, the balance of payments;
mb_inv_oth_o – net other investment of other sectors, the balance of payments;
mb_fin – financial account balance (without reserve assets), the balance of payments;
mb_fin_oth – net financial derivatives, the balance of payments;
mb_fin_g_fg – foreign financing of the government;
mb_cap_fin – capital and financial account balance, the balance of payments;
mb_err – net errors and omissions, the balance of payments.

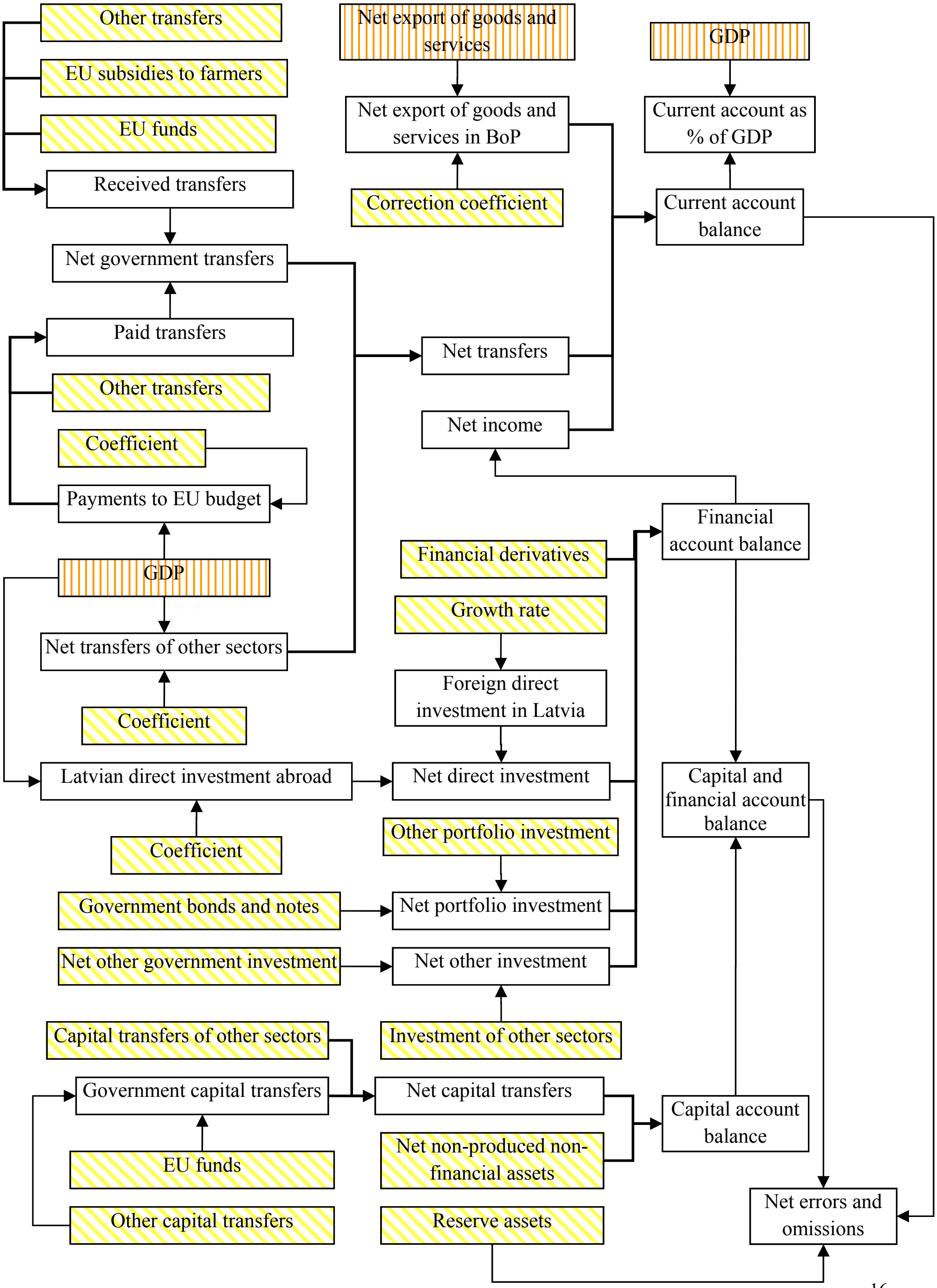

Fig. 2.31. Calculation of the balance of payments in the Latvian model[16].

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[16] See the legend in Fig.2.4

2.7. Employment and Demographic Indicators

In the section of employment and demographic indicators, the calculation of the number of employees and unemployment as well as resident population is included. This ensures modelling of economically active population and the number of pensioners as well. Therefore, the age structure of the population is also computed within the model.

2.7.1. Employment Indicators

Similarly as capital and investment, employees or labour are also one of the production factors. Therefore, in AWM, MCM, A-LMM, the model of Greece, Estonian EMMA and other models it is calculated using derivation of production function. In the majority of models the number of employees in the whole economy is included. In LITMOD the number of employees by industries is calculated. Summary of the factors influencing the number of employees is given in Table 2.12. For characterization of labour hours worked (Finnish EMMA) or the number of fulltime workers (AQM-06) is often used. However, with respect to Latvia, statistical data in the Eurostat database [54] are available regarding the hours worked in industries except manufacturing only in 2006 (in the whole economy since 1998). Therefore, the indicator chosen is the number of employees by industries.

Table 2.12

Factors Influencing the Number of Employees

	Factors									
Model	E_{-1}	GDP (VA)	GDP/w	K	K/E	O	w/p	ULC	LF	t
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
AWM		x		x			x		x	x
MCM		x			x		x			x
A-LMM		x					x			
AQM-06		x		x		x	x			x
NBB		x					x			
Model of Greece		x		x			x			x
Mascotte		x						x		
Estonian Model		x		x			x			x

Table 2.12 continued

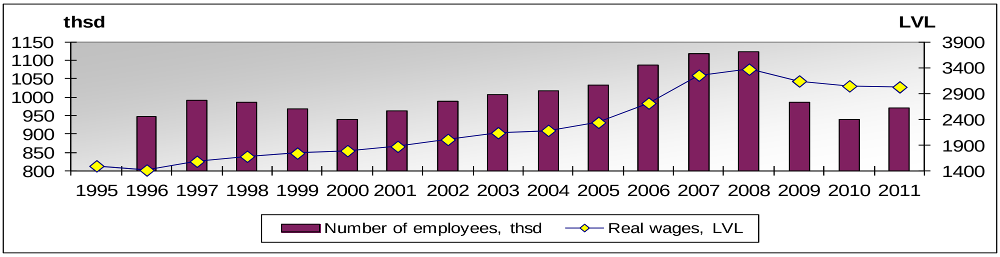
1	2	3	4	5	6	7	8	9	10	11
Estonian EMMA		x		x						x
LITMOD		x					x			x
SLOPOL6	x	x						x		
Slovak Model	x	x	x							
Finnish EMMA		x					x			x
Model for Malawi	x	x		x						x
BbkM		x					x			

where

E_{-1} – number of employees in the previous period;
VA – value added;
w – nominal wage;
K – capital stock;
O – oil demand;
p – price index;
ULC – unit labour costs;
LF – labour supply;
t – time trend;
x – factor is included in equation of the number of employees.

Table 2.12 shows that mostly real GDP or real value added by industries is used as a factor in the models. Other factors are connected with the production function (capital stock, oil demand, trend for characterization of productivity), or with labour costs (real wages or unit labour costs). In certain models the number of employees in the previous period is also used as a factor. For the calculation of the number of employees, it is useful to use also labour supply or the number of economically active population as a factor, which is done in AWM. However, trying to relate this indicator to the number of employees by industries, rather the qualification of this part of population has to be taken into account. Qualification characterizes the possibilities of the population to start working in a particular industry. Inclusion of such an aspect in the model demands additional research and assumptions regarding further development of education.

Real wages are chosen for characterization of labour costs in the Latvian model, because information regarding unit labour costs by industries in CSB database [96] is available only since 2004. For the calculation of real wages similar principle as in LITMOD is used, where nominal wages in the whole economy are divided by production price index in a particular industry. Figure 2.32 shows that the dynamics of the number of employees and real wages in the majority of periods is similar and the relation between these two indicators is positive. However in some industries: in agriculture, hunting, forestry and fishing, industry and health and social work this relation is negative, therefore wages cannot be used as a factor in these industries.



Source: Calculated by the authors on the basis of CSB database [96]

Fig. 2.32. Relation of the number of employees and real wages.

In the Latvian model the number of employees by industries is calculated using equation (2.55). In order to ensure integrated calculation of the number of employees and capital investment, it is assumed that there is a constant return to scale in industries. Therefore, the coefficient of the value added in all equations is set equal to one. In addition, indicators of relative wages and productivity (time trend) are used, and values of their coefficients are expected to be negative. In cases, when in certain periods significant differences between the forecasted and the actual values are observed, dummy variables for according periods are used.

$$\log(empl\_z) = a_0 + a_1 \cdot \log(va\_fp\_z) - a_2 \cdot \log(w\_nom/pi\_z) + a_3 \cdot t + a_4 \cdot d\_, \qquad (2.55)$$

where

empl_z – number of employees in industry z (z is assigned according to the NACE classification (1.1.rev.) for 10 industries);
va_fp_z – value added in industry z;
w_nom – average gross wage in a year;
pi_z – production price index in industry z;
t – time trend (1995 = 1);
d_ – dummy variable.

Estimated parameters of equations by industries are given in Table 2.13.

Table 2.13

Estimated Parameters in Equations of the Number of Employees

Industries (NACE 1.1.rev.)	a_0	a_1	a_2	a_3	a_4	R^2	DW	Period
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Agriculture, hunting, forestry and fishing (AB)	0.97 (8.5) (165.7)	1	-	-0.68* (-13.3) (296.7)	-0.22** (-2.1) (16.4)	0.95	1.55	1997 – 2011
Industry (CDE)	-1.07 (-38.0) (958.1)	1	-	-0.054 (-19.7) (454.1)	0.13*** (2.5) (20.9)	0.97	1.56	1996 – 2011
Construction (F)	-0.69 (-31.9) (759.4)	1	-	0.022 (9.1) (163.9)	-0.14**** (-4.1) (47.5)	0.86	2.02	1996 – 2011
Trade, hotels and restaurants (GH)	-1.1 (-31.4) (776.2)	1	-	-0.08 (-21.0) (490.9)	0.40***** (8.9) (166.3)	0.97	1.83	1996 – 2011
Transport, storage and communication (I)	-0.02 (-0.1) (0.0)	1	-0.23 (-3.5) (39.4)	-0.15* (-4.3) (55.5)	-	0.94	1.81	1996 – 2011

* log(t)
** d_09 (2009= 1, other periods = 0)
*** d_08 (2009= 1, other periods = 0)
**** d_1011 (1995 - 2009= 0, other periods = 1)
***** d_0911 (1995 - 2008= 0, other periods = 1)

Mainly the value added and time factor are used as factors in the estimated equations. However, in construction, the trend coefficient is positive, therefore it is not possible to use this equation in the model. Real wages are used only in transport, communication and storage industry.

The relation of the increase in the number of employees to the increase in the value added and productivity is used in industries, where it was not possible to specify statistically justified econometric equations [123, p. 92]. Therefore, the number of employees in construction, financial intermediation and real estate and other services are calculated by equation (2.56), using employment elasticity coefficients to the value added and growth rate of the value added in a particular industry. If the value of the elasticity coefficient is equal to one, then the number of employees grows at the same rate as the value added. If the value of the coefficient is larger than one, labour productivity decreases and the number of employees in the industry grows faster than the value added. If the value of the coefficient is positive, but less than one, labour productivity increases and the number of employees grows slower than the value added. However, if the elasticity coefficient is negative, the dynamics of the number of employees and the value added are opposite.

$$empl\_z = empl\_z(-1) \cdot (1 + empl\_el\_z \cdot va\_gr\_z/100), \quad (2.56)$$

where

empl_z – number of employees in industry z (z is assigned according to the NACE classification (1.1.rev.) for 10 industries);

empl_el_z – elasticity of employment to value added in industry z;

va_gr_z – growth rate of value added in industry z.

The number of employees in public administration, education and health and social work is calculated using growth rates. Since three previously mentioned industries are traditionally associated with the public sector, changes in the number of employees in these industries can be associated with political decisions, which can be represented in the model using exogenous growth rates.

Calculation of labour productivity is also included in the section of employment and demographic indicators, which allows evaluating the differences in the changes of productivity in different industries. Productivity is more often calculated as the ratio of the value added to the number of employees. However, the choice of the real value added, which allows eliminating the price effect on productivity changes, may cause problems with interpretation of the obtained results, because there is no consensus regarding economic interpretation of this indicator [107, p. 97]. Therefore, productivity in the Latvian model is expressed as the ratio of real output to the number of employees.

Calculation of the number of employees and productivity in service industries is illustrated in Figure 2.33 and the calculation of the total number of employees and productivity, as well as unemployment indicators, is given in Figure 2.34.

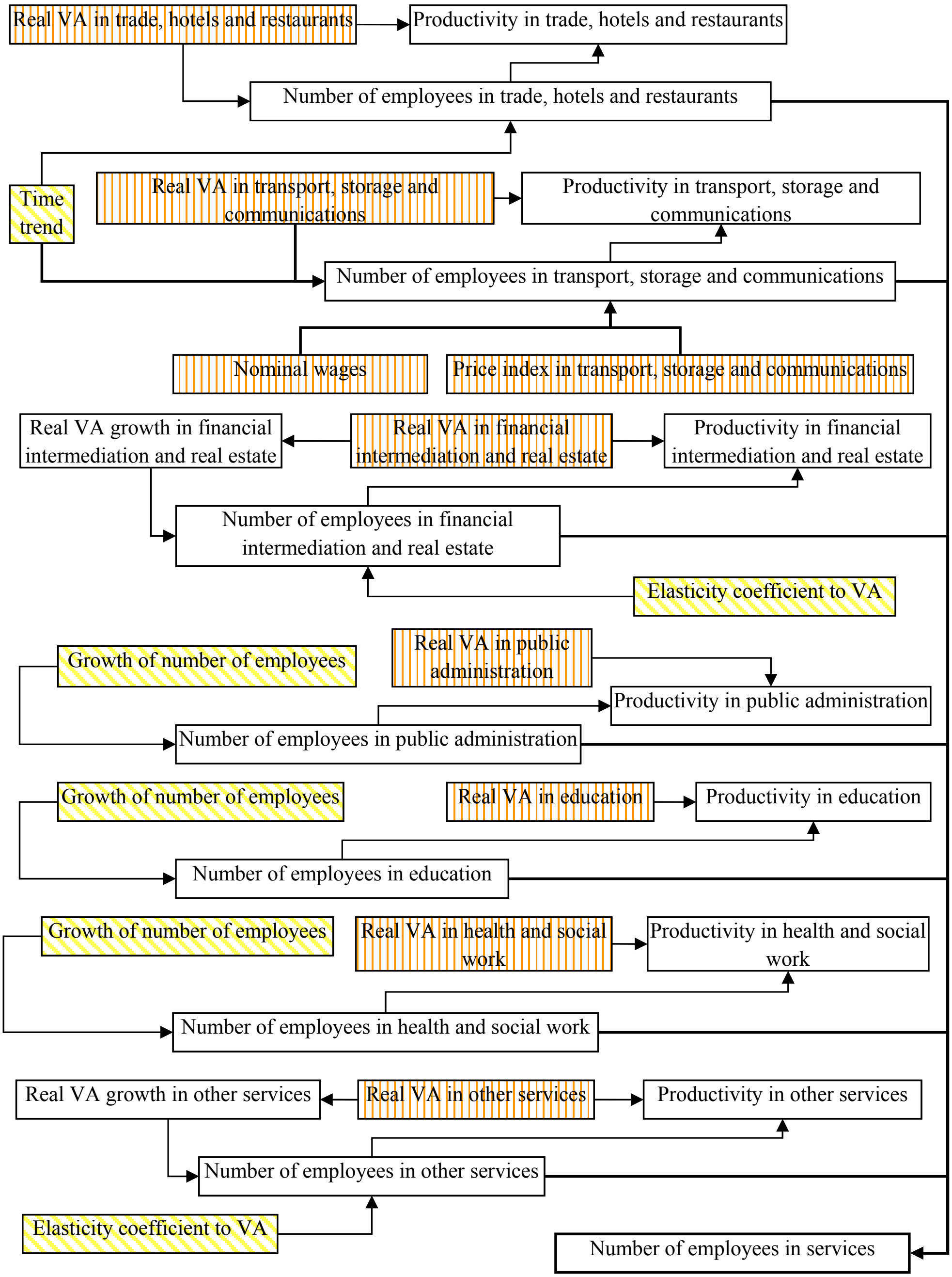


Fig. 2.33. Calculation of the number of employees in service industries in the Latvian model[17].

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[17] See the legend in Fig.2.4

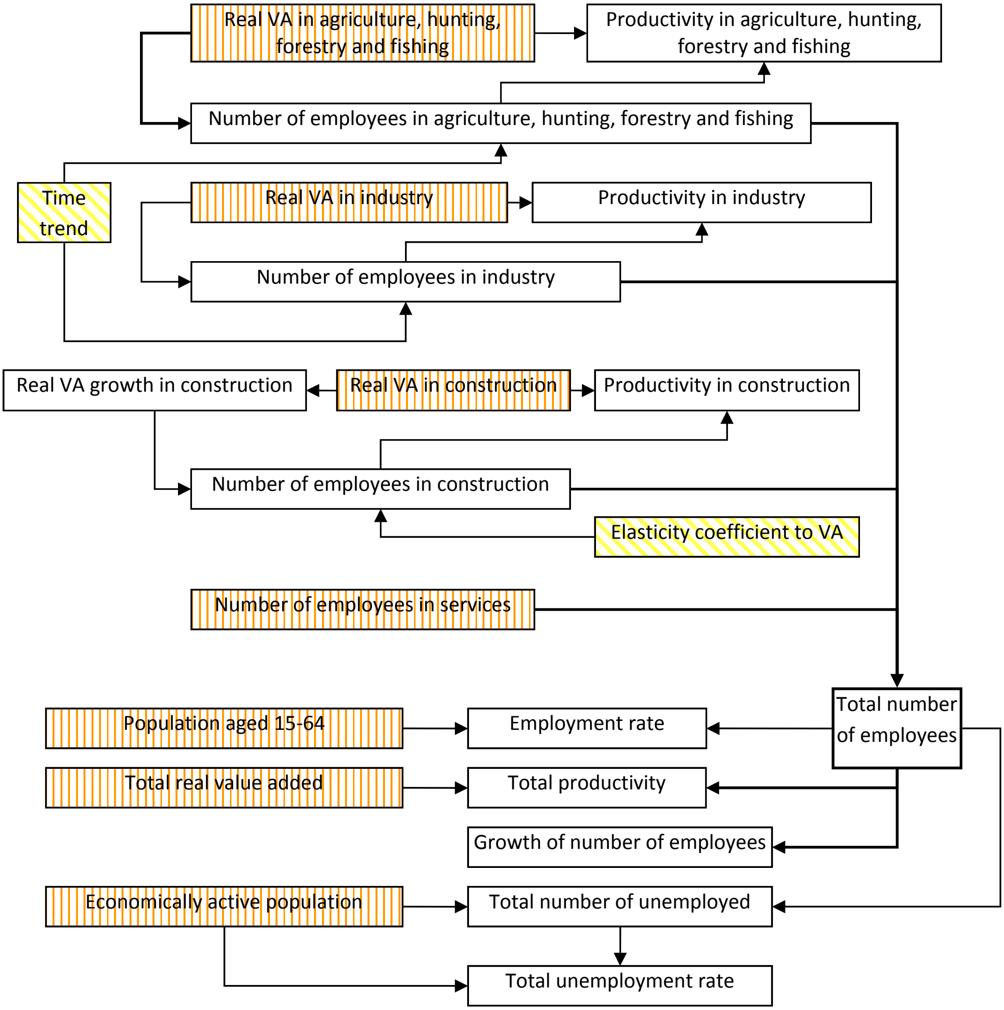


Fig. 2.34. Calculation of employment and unemployment in the Latvian model[18].

In the section of employment and unemployment the identities represented in the system of equations (2.57) are also included for the calculation of the number of employees by industries.

$$
\begin{aligned}
empl\_l &= empl\_l(-1) \cdot (1 + empl\_gr\_l / 100) \\
empl\_m &= empl\_m(-1) \cdot (1 + empl\_gr\_m / 100) \\
empl\_n &= empl\_n(-1) \cdot (1 + empl\_gr\_n / 100) \\
empl\_gov &= empl\_l + empl\_m + empl\_n \\
empl\_go &= empl\_gh + empl\_i + empl\_jk + empl\_gov + empl\_oth \\
empl &= empl\_ab + empl\_cde + empl\_f + empl\_go
\end{aligned}
\qquad (2.57)
$$

---

[18] See the legend in Fig.2.4

$$
\begin{aligned}
\text{empl\_r} &= (\text{empl}/\text{pop\_15\_64}) \cdot 100 \\
\text{empl\_gr} &= (\text{empl} / \text{empl}(-1) - 1) \cdot 100
\end{aligned}
$$

where

empl_z – number of employees in industry z (z is assigned according to the NACE classification (1.1.rev.) for 10 industries);
empl_gr_z – growth rate of the number of employees in industry z;
empl_gov – number of employees in government services;
empl_go – number of employees in services;
empl – total number of employees;
empl_r – employment rate;
pop_15_64 – number of population at the age of 15-64 years;
empl_gr – growth rate of the total number of employees.

Calculation of the unemployment rate and employment structure by industries is included in the system of equations (2.58).

$$
\begin{aligned}
\text{unempl\_tot} &= \text{pop\_ea} - \text{empl} \\
\text{unempl\_r\_tot} &= (\text{unempl\_tot} / \text{pop\_ea}) \cdot 100 \\
\text{empl\_str\_ab} &= (\text{empl\_ab} / \text{empl}) \cdot 100 \\
\text{empl\_str\_cde} &= (\text{empl\_cde} / \text{empl}) \cdot 100 \\
\text{empl\_str\_f} &= (\text{empl\_f} / \text{empl}) \cdot 100 \\
\text{empl\_str\_gh} &= (\text{empl\_gh} / \text{empl}) \cdot 100 \\
\text{empl\_str\_i} &= (\text{empl\_i} / \text{empl}) \cdot 100 \\
\text{empl\_str\_jk} &= (\text{empl\_jk} / \text{empl}) \cdot 100 \\
\text{empl\_str\_l} &= (\text{empl\_l} / \text{empl}) \cdot 100 \\
\text{empl\_str\_m} &= (\text{empl\_m} / \text{empl}) \cdot 100 \\
\text{empl\_str\_n} &= (\text{empl\_n} / \text{empl}) \cdot 100 \\
\text{empl\_str\_oth} &= (\text{empl\_oth} / \text{empl}) \cdot 100 \\
\text{empl\_str\_gov} &= \text{empl\_str\_l} + \text{empl\_str\_m} + \text{empl\_str\_n}
\end{aligned}
\tag{2.58}
$$

where

unempl_tot – total number of unemployed;
pop_ea – economically active population;
unempl_r_tot – total unemployment rate;
empl_str_z – share of employees in industry z;
empl_str_gov – share of employees in government services.

Calculation of productivity by industries is included in the system of equations (2.59).

$$
\begin{aligned}
\text{prod\_ab} &= \text{va\_fp\_ab} / \text{empl\_ab} \\
\text{prod\_cde} &= \text{va\_fp\_cde} / \text{empl\_cde} \\
\text{prod\_f} &= \text{va\_fp\_f} / \text{empl\_f} \\
\text{prod\_gh} &= \text{va\_fp\_gh} / \text{empl\_gh} \\
\text{prod\_i} &= \text{va\_fp\_i} / \text{empl\_i} \\
\text{prod\_jk} &= \text{va\_fp\_jk} / \text{empl\_jk} \\
\text{prod\_l} &= \text{va\_fp\_l} / \text{empl\_l} \\
\text{prod\_m} &= \text{va\_fp\_m} / \text{empl\_m} \\
\text{prod\_n} &= \text{va\_fp\_n} / \text{empl\_n} \\
\text{prod\_oth} &= \text{va\_fp\_oth} / \text{empl\_oth} \\
\text{prod\_va} &= \text{va\_fp} / \text{empl}
\end{aligned}
\tag{2.59}
$$

where

prod_z – labour productivity in industry z;
va_fp_z – real value added in industry z;
va_fp – total value added in constant prices.

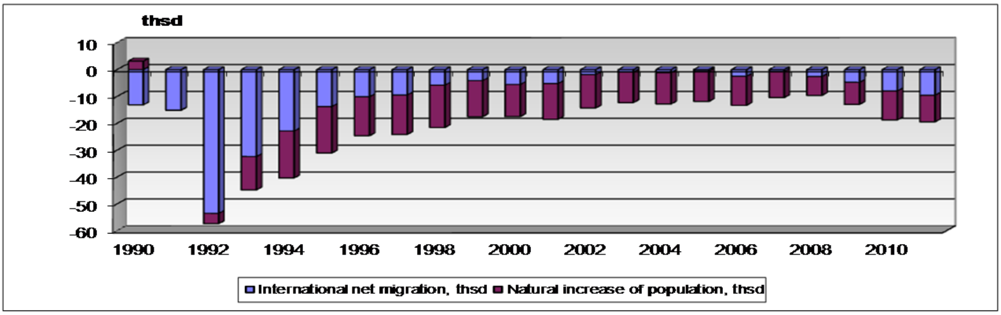
2.7.2. Demographic Indicators and Labour Supply

Modelling of resident population is usually done using age shift-share or component method. It implies that for each of the gender and age groups the number of residents, who became a year older, is calculated. Using birth rates by age groups, the total number of the newborn is calculated, which goes into the youngest age group. Further the number of the newborn and existing residents in each of the territorial units and age groups is multiplied by net migration coefficient, thus reducing or increasing the number of people in each group. The calculated number of resident population and its structure serves as a basis for the calculations for the next year. The number of population is calculated in the similar manner for the whole forecasting period. Total number of resident population is calculated by adding the forecasted number of residents in each age group in a particular territorial unit. [46, p. 104]

The use of age shift-share or component method demands thorough knowledge in demographic issues. It is connected with the development of a separate model, updating of which would take comparatively much time. The fact that the detailed statistical data are available later than the information about the main demographic indicators also has to be taken into account. The use of the forecasts elaborated by other authors is not always useful, because the latest demographic research results usually are not published, when it is necessary to use them. The results of research of the past years may not be well suited for the short and medium-term analysis. However, the use of comparatively simple approaches allows adjusting the estimated relations to the latest data, if such a necessity occurs. The comparison of the obtained results of the number of Latvian population in the future allows concluding that medium-term forecasts obtained with comparatively simple methods do not differ much from those, which are obtained using more comprehensive models [125, p. 139]. Therefore, the Latvian macro-econometric model contains equations, which characterize the main demographic indicators – international net migration, natural increase of population, total number of population and its division in the main age groups, as well as labour supply or the number of economically active population and the number of pensioners.

Labour supply can be defined as a difference between the total number of population and inactive population, which contains non-working pupils, students, housewives, pensioners, disabled persons, prisoners and other inactive residents. Therefore, the labour force is determined by the same factors as the number of population – natural increase of population, net migration and administrative-territorial changes. Real average wage in the private sector is considered to be the main factor, which influences net migration and participation rate in the labour market. For example, labour supply equation is included in LITMOD, where the ratio of economically active population and total population depends on the real wages [33, p. 44]. The possibility to include unemployment rate and the ratio of the Lithuanian GDP to the world GDP as factors in the equation was also tested, however, the estimated coefficients are evaluated as statistically insignificant. Similar approach is used also in the Austrian A-LMM model, where the levels of economic activity in the chosen age groups depend on relative wages and trends. Based on this information, it is possible to test the possibility to model the share of economically active population in the total population in the Latvian model depending on the average wage in economy (positive influence is expected) and/or the ratio of GDP of Latvia and the EU countries, which would characterize comparatively larger/smaller opportunities to earn in Latvia and in other EU countries.

When describing the changes in the Latvian population, it can be seen that during the last decades (beginning with 1990) the number of Latvian inhabitants is continuously decreasing. In 1990 – 1994, depopulation was more dependent on negative net migration (see Fig. 2.35). It was especially significant in 1992, when the deportation of the Russian army from Latvia began, which concluded in 1994 (in September 1991 there were approximately 50 thousand military persons of the USSR forces in Latvia [158]). After 1994 the importance of this factor gradually lowered and in 2005 net migration was only minus 564 people, as compared with minus 53 thousand in 1992. However, in 2011 both factors were equally important.



Source: CSB database [96]

Fig. 2.35. The factors causing the decrease of the population in Latvia.

Taking into account that the main factors determining the number of population are natural increase of population and net migration, as well as diverse dynamics of these factors, resident population is calculated using both of these indicators. Equation (2.60) is elaborated for forecasting of the coefficient of natural increase of population. Net migration is exogenous in the model. As the recent economic crisis led to the shift in the trend of the natural increase of population, an additional dummy variable is used in equation (2.60).

$$pop\_k = - 0.68 + 0.021 \cdot t - 0.15 \cdot d\_1011 \qquad (2.60)$$

t-stat (-31.9) (9.1) (-4.1)
mexval (759.4) (163.9) (47.5)

$R^2 = 0.86$; DW = 2.02; P(F-stat) = 0.00 [1995 – 2011],

where
pop_k – coefficient of natural increase of population;
t – time trend (1995 = 1);
d_1011 – dummy variable (1995 – 2009 = 0, other periods = 1).

In order to calculate different indicators, which are related to the number of population, the average number of population is also included in the model. It is calculated as the average of the number of residents at the beginning and at the end of the year. In order to evaluate labour supply or economically active population, the number of population in the age groups up to 15 years of age, in the range 15 to 64 years and 65 and over are calculated using the assumptions regarding possible age structure of the population in the future.

The model uses economically active population in the age range 15 to 74, therefore, it is calculated proportionally to the residents older than 15 years.

Equation (2.61) is estimated as an alternative. There the ratio of economically active population to the total number of residents depends on the ratio of real GDP of Latvia and the EU-15 countries and the time trend. Coefficients of real wages and unemployment rate did not appear to have sufficient level of statistical significance. Therefore, these indicators are not included in the equation. According to the equation, if the real GDP of Latvia grows faster than the real GDP of the EU-15 countries, economic activity of the population increases and the trend factor enhances this tendency. It can be explained with the choice of people to work in Latvia or in another country (taking into account free labour movement within several EU countries, indicator of the EU-15 countries is chosen). The choice depends on whether the standard of living in Latvia is approaching the EU-15 level, which shows in comparatively larger increase of GDP in Latvia. However, there are significant deviations in several years, including 2011 and the Durbin-Watson statistic points at possible autocorrelation problems. Therefore, equation (2.61) is not included in the model.

$$
\begin{array}{llll}
\log(pop\_ea/pop\_aver) = & -0.73 + 0.11 \cdot \log(gdp\_fp/gdp\_eu15\_fp) & + 0.0053 \cdot t + & (2.61) \\
\text{t-stat} & (-21.0) \quad (2.4) & (3.1) & \\
\text{mexval} & (605.9) \quad (28.8) & (44.0) & \\
 & & & \\
 & + 0.035 \cdot d\_08 & & \\
\text{t-stat} & (2.1) & & \\
\text{mexval} & (21.9) & &
\end{array}
$$

$R^2 = 0.90$; $DW = 1.61$; $P(F\text{-stat}) = 0.00$ [1999 – 2011],

where

pop_ea – number of economically active population,
pop_aver – average number of population,
gdp_fp – real GDP,
gdp_eu15_fp – real GDP in the EU-15 countries,
t – time trend (1995 = 1),
d_08 – dummy variable (2008 = 1, other periods = 0).

For the calculation of social benefits, the number of retired persons is also calculated within the model as a proportion of the population aged15 years and over. All the relations of demographic indicators and labour supply included in the Latvian model are given in Figure 2.36.

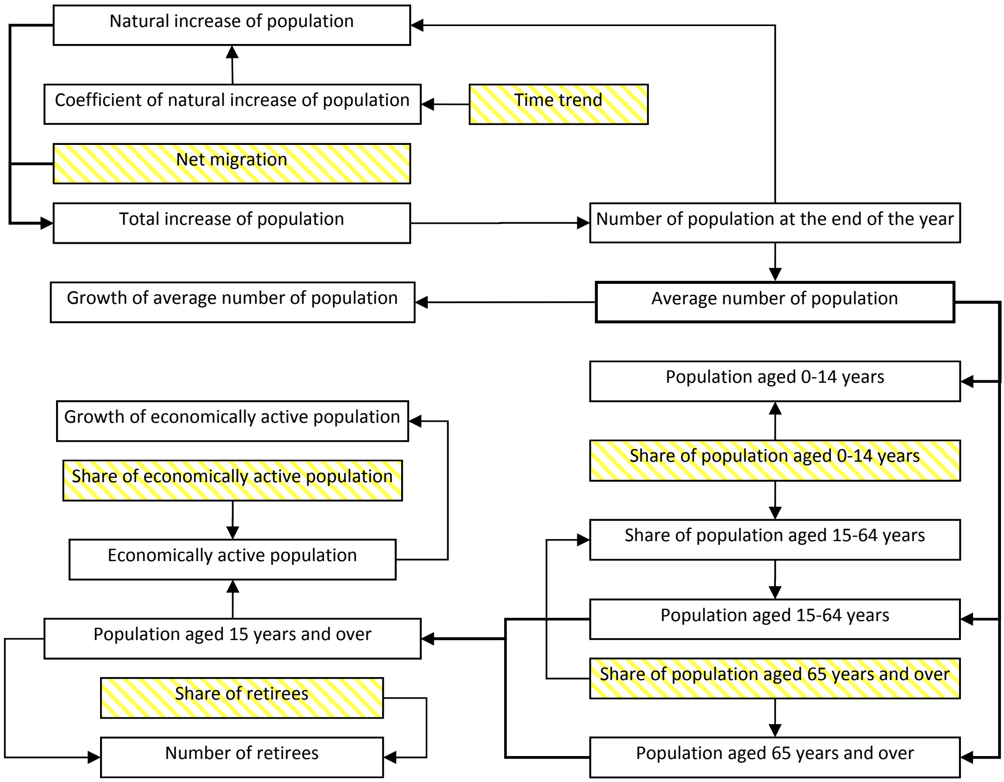


Fig. 2.36. Relations of demographic indicators and labour supply in the Latvian model[19].

The model also contains the identities included in the system of equations (2.62) for the calculation of the total number of resident population.

$$\begin{aligned}
pop\_incr\_nat &= pop\_end(-1) \cdot pop\_k \\
pop\_incr &= pop\_incr\_nat + pop\_migr\_net \\
pop\_end &= pop\_end(-1) + pop\_incr \\
pop\_aver &= (pop\_end(-1) + pop\_end) / 2 \\
pop\_gr\_aver &= (pop\_aver / 2485.056) \cdot 100
\end{aligned} \qquad (2.62)$$

where

pop_incr_nat – natural increase of population;
pop_end – number of population at the end of the year;
pop_k – coefficient of natural increase of population;
pop_incr – increase of population;
pop_migr_net – net international migration of population;
pop_aver – average number of population;
pop_gr_aver – growth rate of the average number of population.

---

[19] See the legend in Fig.2.4

Calculation of the structure of population is included in the system of equations (2.63).

$$\begin{aligned}
\text{pop\_str\_15\_64} &= 100 - \text{pop\_str\_0\_14} - \text{pop\_str\_65\_d}\\
\text{pop\_0\_14} &= \text{pop\_str\_0\_14} \cdot \text{pop\_aver} / 100\\
\text{pop\_15\_64} &= \text{pop\_str\_15\_64} \cdot \text{pop\_aver} / 100\\
\text{pop\_65\_d} &= \text{pop\_str\_65\_d} \cdot \text{pop\_aver} / 100\\
\text{pop\_15\_d} &= \text{pop\_15\_64} + \text{pop\_65\_d}\\
\text{pop\_ea} &= \text{pop\_str\_ea} \cdot \text{pop\_15\_d} / 100\\
\text{pop\_gr\_ea} &= (\text{pop\_ea} / \text{pop\_ea}(-1) - 1) \cdot 100\\
\text{pop\_pens} &= \text{pop\_15\_d} \cdot \text{pop\_str\_pens} / 100
\end{aligned}\tag{2.63}$$

where

pop_str_15_64 – share of the population aged 15-64 years;
pop_str_0_14 – share of the population aged 0-14 years;
pop_str_65_d – share of the population aged 65 years and over;
pop_0_14 – number of population aged 0-14 years;
pop_15_64 – number of population aged 15-64 years;
pop_65_d – number of population aged 65 years and over;
pop_15_d – number of population aged 15 years and over;
pop_ea – economically active population;
pop_str_ea – share of the economically active population in the population aged 15 years and over;
pop_gr_ea – growth rate of the economically active population;
pop_pens – number of pensioners;
pop_str_pens – share of the pensioners in the population aged 15 years and over.

2.8. Fiscal Sector

The section of fiscal sector in the Latvian macro-econometric model contains the calculation of revenues and expenditures of the general government consolidated budget, as well as government debt. The structure of the government budget revenues and expenditures is based on the European System of Accounts (ESA95). Payments of customs duties and value added tax (VAT) in the EU budget are included in the calculation of revenues from VAT, from customs duties and from total taxes on production and imports, because these payments are incorporated in taxes on products for the calculation of GDP. However, they are not included in total tax revenues of the general government consolidated budget.

2.8.1. Revenues of General Government Consolidated Budget

Revenues of the general government consolidated budget are modelled as a sum of indirect and direct taxes, as well as other revenues. In the model, indirect taxes are taxes on production and imports, that is, VAT, excise and customs duties, other taxes on products and other taxes on production. Direct taxes, on the other hand, include taxes on income and capital, which are applied to private persons and enterprises, and social security contributions.

In 2008, tax revenues reached 4,720.5 m LVL. After two years of decrease, in 2011, they increased again, reaching 3,947.0 m LVL. This number is still less than in 2007. In 2011 the sum of the social security contributions, VAT, personal income tax, excise duties and consumption taxes, as well as enterprise income tax formed 73.9% of the total consolidated budget revenues (excluding the payments in the EU budget). The significance of these taxes in total tax revenues has changed with time. The most significant part of the tax revenues – social security contributions – in 1995 accounted for 36.2% of total tax revenues, but in 2011 the share declined to 31.4%. The share of the personal income tax revenues during the same period grew from 16.0% to 20.2%. However, the shares of other significant tax revenues were fluctuating – VAT from 22.8% in 1999 to 27.9% in 2006, excise duties and consumption taxes from 6.4% in 1995 to 13.8% in 2009 and enterprise income tax from 10.8% in 2008 to 3.5% in 2010.

Changes in the structure of tax revenues point at diverse development trends of tax bases and/or tax rates. They have to be taken into account in order to make valid forecasts of tax revenues and to get results of scenario analysis.

One of two approaches can be applied when modelling tax revenues. It is possible to use identities as shown in equation (2.64). In this case tax revenues are calculated by multiplying an effective tax rate or a coefficient characterizing the tax rate by an appropriate tax base.

$$\text{tax\_rev} = (\text{tax\_base}) \cdot (\text{tax\_r}), \tag{2.64}$$

where

tax_rev – tax revenues;
tax_base – tax base;
tax_r – tax rate or tax rate coefficient.

This equation is more appropriate for the calculation of the taxes, which share a common tax rate and precisely enough determinable tax base. Taking into account that the tax base rather characterizes potential and not actual taxable objects, tax rate incorporates also tax relieves and exemptions. Traditionally, the tax base is endogenous, and the tax rate exogenous [179, p. 43]. Usually in this kind of calculation, a proxy of the tax base is used, and the tax rate is calculated as a ratio of tax revenues and the chosen tax base. For example, in AWM model [57, p. 20] these coefficients are calculated as a ratio of tax income to GDP. Disaggregation of tax rate coefficient allows characterizing separately efficiency of tax administration or share of taxes, which is actually collected in a particular period of time. It also allows distinguishing different forms of tax relief and exemptions, if appropriate statistical information is available. Thus, with the help of the model it is possible to evaluate benefits from improved efficiency of tax collection or changes in the system of tax relieves and exemptions.

The second approach is based on the estimation of econometric equations. In most cases estimation of econometric equations of tax revenues includes the tax base as the main factor. Regression equations make it possible to use a wider range of influencing factors, including the use of tax rates stated in legal acts, as well as various forms of tax relief. Econometric equations for the calculation of tax revenues are used in several models, including the Estonian, Slovenian and Austrian models, where tax bases and/or tax rates are used as the factors. For the detailed calculation of tax revenues, it is essential not only to choose between traditional equations for the calculation of tax revenues and econometric equations, but also to choose the most appropriate tax base for each type or group of taxes.

GDP [6, p. 20; 179, p. 43] and private consumption [111, p. 165; 82, p. 76] are used most frequently as a tax base for indirect taxes. Private consumption can be used for calculating excise and customs duties. For calculating taxes on production and imports, which have a broader tax base, GDP is more suitable [7, p. 32]. Nevertheless, such a choice of factors does not always ensure the best results. For instance, in the Austrian model [143, p. 13], the factor used in VAT revenues equation is the private consumption, but fuel tax revenues depend on GDP. In the model for Ireland [106, p. 13], domestic demand, that is, the sum of private consumption, government consumption, investment and exports, is used as a tax base of indirect taxes. In the model for Malawi [32, p. 6], indirect tax revenues include import duties, which are calculated as a product of imports and appropriate tax rate, and the sum of VAT and excise duties, which are calculated by using a similar principle and private consumption as a tax base. Thus, the choice between the use of GDP or private consumption for the characterization of tax base largely depends on the actual data. Imports can also be used as the tax base of customs duties.

Revenues of direct taxes in the models of other countries are calculated both as aggregates and by individual tax types. For example, the sum of wages, transfers and other personal income is used as a tax base for direct taxes in the model for Ireland [106, p. 36], but in the Estonian model [111, p. 165] real GDP is used. Revenues from personal income tax and social security contributions are often modelled as a single variable by using the factor, which is close to disposable income including taxes [179, p. 43] or total compensation of employees [143, p. 13], which is a product of average wages and number of employees, as a tax base. Alternatively, these revenues are modelled separately by using the previously mentioned [103, p. 53] and/or other factors. Taking into account the peculiarities of calculating taxes, in some models the untaxed minimum [33, p. 20] and/or social security contributions [82, p. 76] are deducted from the tax base. Calculation of enterprise income tax revenues is based on gross operating surplus [82, p. 76] or profit of enterprises, which, in the MCM block for Spain [179, p. 43] is calculated as gross operating surplus of enterprises minus depreciation allowances, but in the Slovak model [103, p. 54] it is calculated by deducting total compensation of employees and consumption taxes from nominal GDP. In SLOPOL6 [177, p. 92] tax revenues and GDP in the respective period of the previous year are used as the factors. Thus, the tax base indicator has to be adapted for each group of taxes. In cases, when tax base is not clearly defined or it is too extensive, it is possible to use GDP.

Other budget revenues, which are not connected with tax revenues, are usually exogenous in the models, or they are calculated proportionally to tax revenues or GDP.

During the estimation of VAT equation, the results using both nominal GDP and private consumption were compared. As a result of the analysis equation (2.65) is chosen, where the dummy of 2009 - 2011 is used in addition to the product of private consumption and tax rate. Maximum VAT rate is used in the equation, because there is no enough detailed information for the calculation of appropriate average tax rate. There is also certain lack of substantiation for determination of future values of the average tax rate.

According to the law "On Excise Duties" [102], excisable goods are alcoholic beverages, tobacco products, mineral oils, non-alcoholic beverages and coffee. Statistical data indicate that the share of household expenditures for these goods is comparatively stable. For example, beginning with 2004, 10.0% – 10.8% of household expenditures (per household member) are related to the purchase of non-alcoholic beverages, alcoholic beverages, tobacco, fuels and lubricants. Therefore, in equation (2.66) total private consumption is used for the calculation of excise duties instead of consumption related to excisable goods. Time trend and the dummy of 1998 are also included as additional factors for characterizing the fluctuations of tax revenues. Overall characterization of this equation can be regarded as satisfactory, however, the Durbin-Watson statistic points at possible autocorrelation.

Revenues from customs duties are modelled depending on nominal imports and time trend according to equation (2.67). The relation between customs duties and imports provides better statistical characterization of the equation, comparing with the private consumption and GDP. The choice of this factor is connected with the structure of customs duties, where import duties are the main component.

Other taxes on products include taxes on lotteries, gambling and betting, car registration taxes and other taxes on services. Other taxes on production include taxes on land, buildings and other structures, taxes on pollution and other taxes on production. Taxable object for these tax groups is versatile; therefore nominal GDP is used as a tax base. Econometric equation (2.68) is estimated for modelling of revenues of other taxes on products.

Revenues from other taxes on production are calculated by multiplying GDP by the tax rate coefficient. For the sample period the coefficient is calculated as a ratio of revenues of other taxes on production to the nominal GDP.

$$\mathrm{tax\_vat} = -4.4 + 0.67 \cdot (\mathrm{taxr\_vat} \cdot \mathrm{cons\_cp\_priv}) - 340.2 \cdot \mathrm{d\_0911} \tag{2.65}$$

t-stat (-0.15) (21.0) (-7.1)
mexval (0.1) (468.9) (114.8)

$R^2 = 0.97$; DW = 1.95; P(F-stat) = 0.00 [1995 – 2011],

$$\log(\mathrm{tax\_exc}) = -1.4 + 0.73 \cdot \log(\mathrm{cons\_cp\_priv}) + 0.33 \cdot \log(t) + 0.29 \cdot \mathrm{d\_98} \tag{2.66}$$

t-stat (-2.5) (9.3) (5.8) (3.9)
mexval (21.2) (177.7) (88.7) (46.9)

$R^2 = 0.99$; DW = 1.56; P(F-stat) = 0.00 [1995 – 2011],

$$\log(\mathrm{tax\_cust}) = -0.82 + 0.54 \cdot \log(\mathrm{im\_cp}) - 0.37 \cdot \log(t) \tag{2.67}$$

t-stat (-1.1) (4.9) (-4.0)
mexval (4.2) (65.3) (47.1)

$R^2 = 0.65$; DW = 1.65; P(F-stat) = 0.01 [1995 – 2011],

$$\log(\mathrm{tax\_d21\_oth}) = -17.4 + 2.38 \cdot \log(\mathrm{gdp\_cp}) - 0.11 \cdot t \tag{2.68}$$

t-stat (-7.4) (7.9) (-3.0)
mexval (120.6) (132.6) (28.6)

$R^2 = 0.97$; DW = 1.52; P(F-stat) = 0.00 [1995 – 2011],

where

tax_vat – VAT income;
taxr_vat – VAT rate;
cons_cp_priv – nominal private consumption;
tax_exc – income of excise duties;
tax_cust – income of customs duties;
im_cp – import of goods and services;
tax_d21_oth – income of other taxes on production;
gdp_cp – nominal GDP;
t – time trend (1995 = 1);
d_0911 – dummy variable (1995-2008 = 0, other periods = 1);
d_98 – dummy variable (1998 = 1, other periods = 0).

In the group of direct taxes, a tax base indicator is used as the main factor for modelling of the revenues of personal income tax. The tax rate in 1996 – 2008 was not changed (25%), but tax revenues increased more than sevenfold in 1996 – 2008. However, in order to show the changes in tax rate since 2009, tax rate is multiplied by tax base. For the estimation of the tax base indicator in equation (2.69), the calculation principle of personal income tax on wages is used. According to this principle, the untaxed minimum and the share of social security contributions paid by employees are deducted from the total compensation of employees. The coefficient of the share of social security contributions paid by the employees is obtained by dividing the tax rate applied to employees by the total tax rate of social security contributions (for example, 11% is divided by 35.09% in 2013). Estimation of the tax base indicator does not include personal income from commercial activities or other forms of tax relief (for the care for dependent persons, disabled persons, etc.) and eligible expenditures (for education, health services, etc.). Therefore, the value of the tax base parameter in equation (2.69) is smaller than one. The estimated equation fits the data very well, however, the Durbin-Watson statistic point at possible autocorrelation.

Revenues from enterprise income tax are calculated in equation (2.70) by using profit before taxes in the previous period as a factor. Statistics on gross operating surplus of enterprises is not available for Latvia, but the use of operating surplus and mixed income, which is one of the GDP components by income approach, did not give satisfactory results also in combination with time trend and tax rate coefficient in the previous period.

According to the ESA 95 classification, taxes on capital include annual vehicle duty [162, p. 357], which, according to the Law “On Means of Transport Annual Fees”, has been paid since 1994. However, information about revenues from taxes on capital indicates that in the period of 1995 to 1999 these taxes were not collected; that means that it is possible to estimate econometric equation starting only with 2000. Therefore, the revenues from taxes on capital are calculated as a proportion of GDP.

Revenues from social contributions are modelled in equation (2.71). In this case, the tax base – total compensation of employees – is multiplied by the total tax rate of social contributions. The regression coefficient of the factor can be interpreted as a correction coefficient, which is connected with lower tax rates applied, for example, to income of pensioners and disabled persons.

$$
\begin{array}{lll}
tax\_inc\_pers = & -26.7 + 0.84 \cdot taxr\_iin \cdot (empl \cdot (w\_nom - tax\_nmin))/1000 - tax\_soc \cdot tax\_soc\_e) - & \\
\text{t-stat} & (-2.8) \quad (55.8) & \\
\text{mexval} & (26.7) \quad (1449.8) & \\
 & \\
 & -\ 130.8 \cdot d\_0911 & (2.69) \\
\text{t-stat} & \quad (-9.5) &
\end{array}
$$

mexval (182.0)

$R^2 = 0.99$; DW = 2.74; P(F-stat) = 0.00 [1996 – 2011],

$$\text{tax\_inc\_ent} = 44.8 + 0.20 \cdot \text{prof}\,(-1) + 153.0 \cdot \text{d\_1011} \qquad (2.70)$$

t-stat (4.9) (19.7) (7.6)
mexval (68.9) (455.1) (132.5)

$R^2 = 0.97$; DW = 2.17; P(F-stat) = 0.00 [1995 – 2011],

$$\text{tax\_soc} = 72.6 + 0.65 \cdot (\text{taxr\_soc}/100) \cdot ((\text{empl} \cdot \text{w\_nom})/1000) - 93.7 \cdot \text{d\_09} \qquad (2.71)$$

t-stat (2.8) (29.6) (-1.9)
mexval (26.9) (726.2) (12.5)

$R^2 = 0.99$; DW = 1.95; P(F-stat) = 0.00 [1996 – 2011],

where

tax_inc_pers – income from individual income tax;
taxr_iin – individual income tax rate;
empl – number of employees;
w_nom – gross annual average wage;
tax_nmin – annual untaxed minimum;
tax_soc – income from social security contributions;
tax_soc_e – coefficient of share of social security contributions paid by employees;
tax_inc_ent – income from enterprise income tax;
prof – profit before taxes;
taxr_soc – social contributions rate;
d_0911 – dummy variable (1995 – 2008 = 0, other periods = 1);
d_1011 – dummy variable (1995 – 2009 = 0, other periods = 1);
d_09 – dummy variable (2009 = 1, other periods = 0).

Other government budget revenues include transfers from abroad and capital transfers from the current and capital account of the balance of payment respectively. These elements can be classified as foreign financial help, which mainly take the form of recourses from different EU funds [148, p. 5]. The rest of the government budget revenues is calculated proportionally to the GDP in current prices. Calculation of revenues of general government consolidated budget implies deduction of revenues from customs duties and a part of revenues from VAT, which are paid in the EU budget, from the tax revenues and other revenues. Relations among the government budget revenues are illustrated in Figure 2.37.

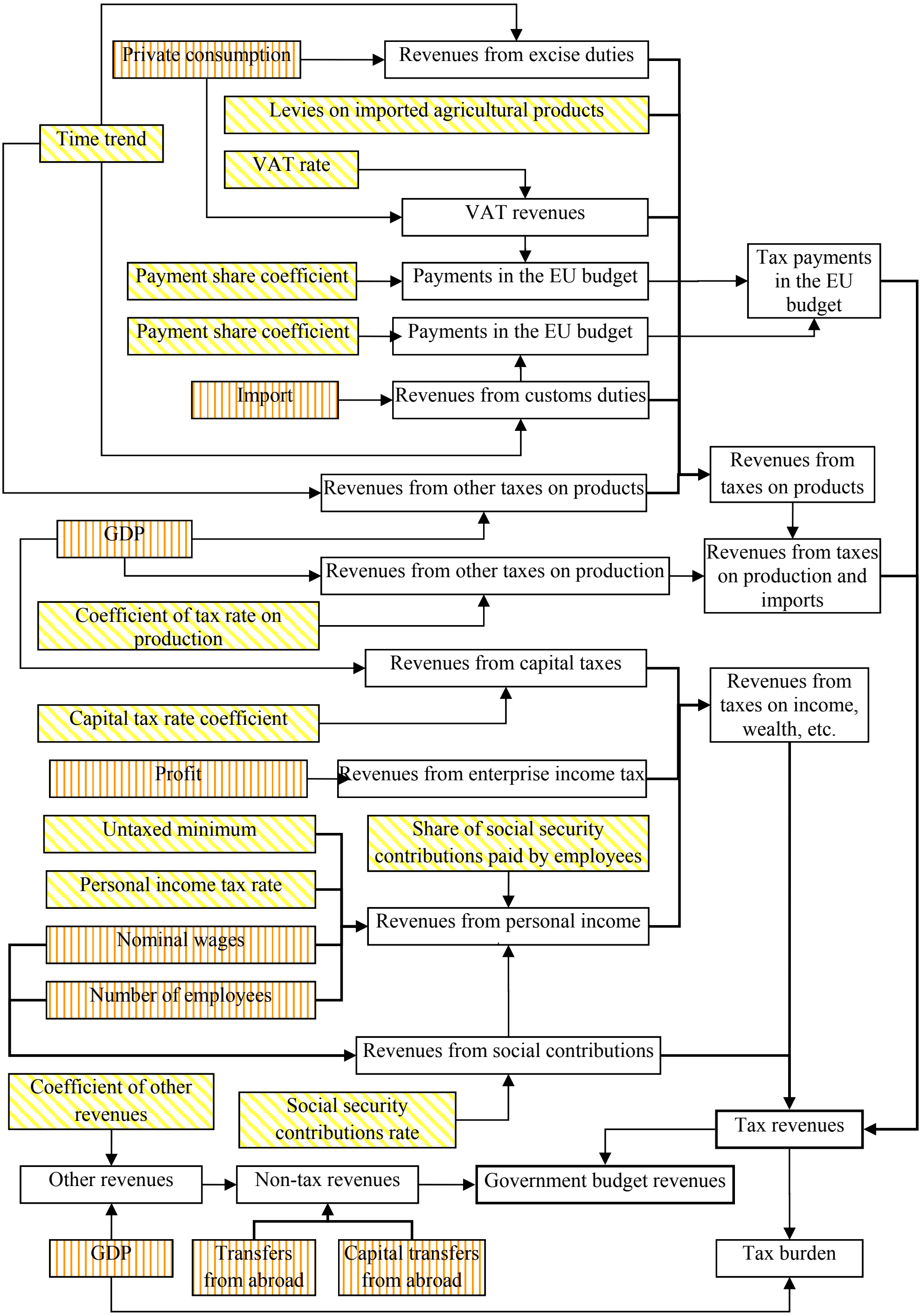


Fig. 2.37. Calculation of government budget revenues in the Latvian model[20].

---

[20] See the legend in Fig.2.4

Calculation of government budget revenues contains also the identities of the system of equations (2.72).

$$
\begin{aligned}
tax\_d21 &= tax\_vat + tax\_exc + tax\_cust + tax\_cust\_a + tax\_d21\_oth \\
tax\_d29 &= gdp\_cp \cdot taxr\_d29 / 100 \\
tax\_d2 &= tax\_d21 + tax\_d29 \\
tax\_vat\_eu &= tax\_vat \cdot taxs\_vat\_eu / 100 \\
tax\_cust\_eu &= tax\_cust \cdot taxs\_cust\_eu / 100 \\
tax\_eu &= tax\_vat\_eu + tax\_cust\_eu \\
tax\_cap &= gdp\_cp \cdot taxr\_cap / 100 \\
tax\_inc\_cap &= tax\_inc\_pers + tax\_inc\_ent + tax\_cap \\
gov\_rev\_tax &= tax\_d2 - tax\_eu + tax\_inc\_cap + tax\_soc \\
gov\_rev\_mb &= mb\_tr\_g\_r + mb\_cap\_tr\_g \\
gov\_rev\_oth &= gdp\_cp \cdot gov\_rev\_coef \\
gov\_rev\_ntax &= gov\_rev\_mb + gov\_rev\_oth \\
gov\_rev &= gov\_rev\_tax + gov\_rev\_ntax \\
tax\_burden &= (gov\_rev\_tax / gdp\_cp) \cdot 100
\end{aligned}
\tag{2.72}
$$

where

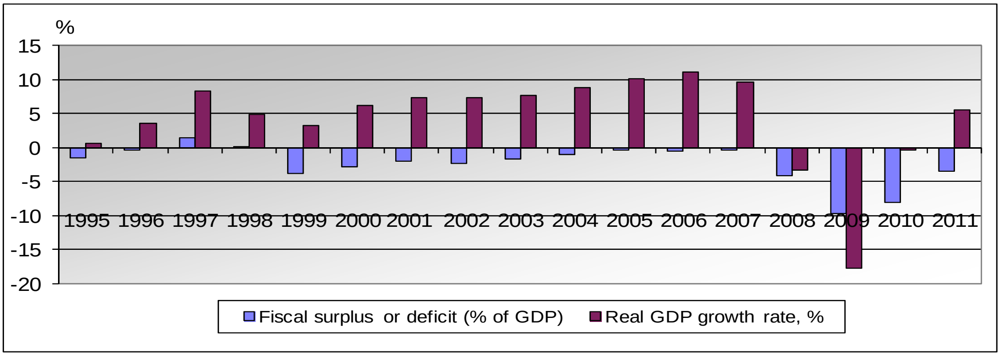
tax_d21 – revenues from taxes on products;
tax_vat – revenues from value added tax (VAT);
tax_exc – revenues from excise duties;
tax_cust – revenues from customs duties;
tax_cust_a – revenues from levies on imported agricultural products;
tax_d21_oth – revenues from other taxes on products;
tax_d29 – revenues from other taxes on production;
gdp_cp – nominal GDP;
taxr_d29 – coefficient of tax rate on production;
tax_d2 – revenues from taxes on production and imports;
tax_vat_eu – revenues from VAT paid in the EU budget;
taxs_vat_eu – share of VAT paid in the EU budget;
tax_cust_eu – revenues from customs duties paid in the EU budget;
taxs_cust_eu – share of customs duties paid in the EU budget;
tax_eu – tax revenues paid in the EU budget;
tax_cap – revenues from capital taxes;
taxr_cap – coefficient of capital tax rate;
tax_inc_cap – revenues from taxes on income, wealth, etc;
tax_inc_pers – revenues from personal income tax;
tax_inc_ent – revenues from enterprise income tax;
gov_rev_tax – tax revenues of general government consolidated budget;
tax_soc – revenues from social security contributions;
gov_rev_mb – government consolidated budget revenues from transfers and capital transfers from abroad;
mb_tr_g_r – transfers received by the government, the balance of payments;
mb_cap_tr_g – net government capital transfers, the balance of payments;
gov_rev_oth – other non-tax revenues of general government consolidated budget;
gov_rev_coef – coefficient of other revenues of general government consolidated budget
gov_rev_ntax – non-tax revenues of general government consolidated budget;
gov_rev – revenues of general government consolidated budget;
tax_burden – tax burden.

2.8.2. Expenditures of General Government Consolidated Budget

Expenditures of general government consolidated budget are often exogenous in the models. However, several models have separate endogenous expenditure positions. For example, in the model of the Slovak Republic [103, p. 25], real government consumption and investments are exogenous. Social benefits are influenced by inflation and unemployment. Interest payments depend on government debt and interest rates. Other expenditures of the government budget grow at the same rate as the nominal GDP. In the Austrian A-LMM model [26, p. 209] subsidies are calculated as a share of budget revenues (total budget revenues minus social contributions). In the MCM block for Spain [179, p. 43], social benefits are calculated by multiplying nominal GDP by implicit rate for transfers, which depends on unemployment rate, and interest payments are calculated as a proportion of government debt. Expenditures on social benefits in the Austrian model [143, p. 13] are calculated in a similar manner. In the model of Lithuania [33, p. 23], the endogenous element of social benefits is the average retirement allowance, which depends on the private consumption price index and the average wage in the private sector. In AWM model [57, p. 48] ratio of social benefits to GDP is modelled depending on unemployment rate.

Budget deficit or government debt is sometimes used as a balancing instrument of revenues and expenditures of the government budget. In MCM model direct tax rate is used as an instrument, with the help of which a desired level of government debt is achieved by increasing or decreasing tax revenues [179, p. 43]. In the Estonian EMMA [82, p. 43] it is assumed that the budget expenditures depend on revenues using government budget deficit or surplus as an instrument. It is determined by a target budget deficit or surplus and ratio of actual and potential GDP. The assumption is that expenditures of the government budget depend on the aims of the fiscal policy, which can be the development of the balanced budget or ensuring the decreased volatility of the output.

For the Latvian model calculation of the government budget expenditures depending on revenues and the target level of budget deficit or surplus appears to be a more suitable approach. As it is not intended to include the calculation of the ratio of actual and potential GDP in the model at present, it is possible to substitute this indicator with the growth rate of real GDP – the larger it is, the smaller should the deficit be or even surplus should be considered. As Figure 2.38 shows, such a relation was comparatively explicit at the end of the 1990s and again during the recent crisis. However, after 2000 the growth rate of GDP demonstrated comparatively larger fluctuations than the budget deficit, and even the GDP growth above 10% per year was not considered as being large enough to form budget surplus. Thus, expenditures of the Latvian government budget cannot to the full extent be characterized as an instrument for smoothing of cyclical fluctuations, but only as a means to achieve a certain level of budget deficit (surplus).



Source: Calculated by the authors on the basis of CSB database [96]

Fig. 2.38. Relation of government budget deficit and GDP growth rate.

Therefore, total expenditures of the general government consolidated budget in the Latvian model are determined on the basis of the previously stated ratio of budget deficit or surplus to GDP and budget revenues. Expenditures of the consolidated budget include gross capital formation, compensation of employees, subsidies, social benefits, interest payments, current transfers paid abroad, EU funds and other expenditures. The chosen disaggregation of expenditures is connected with the main components of budget expenditures according to the information published by the Central Statistical Bureau of the Republic of Latvia. The role of particular components and possibilities to use these components in other relations of the model is also important. For example, subsidies are used in the calculation of GDP. Social benefits are used for determination of personal disposable income. Current transfers paid abroad and EU funds are included in disaggregation because these indicators are also used in the calculation of the balance of payments. Another reason in the assumption that these resources are meant for specific purposes and cannot be associated with other budget expenditure categories.

The most significant element of the general government consolidated budget expenditures in 2003 – 2008 was compensation of employees. In 2011 expenditures for compensation of employees were 1,355.1 m LVL, or 24.5% of all expenditures. Social benefits were the most significant component of budget expenditures till 2003 and again after 2009 amounting to 29.1% in 2011 (1,611.8 m LVL). Since 2002 the share of gross capital formation has increased, and in 2007 it constituted 17.7% of total expenditures, but afterwards it decreased again, comprising 10.7% or 593.6 m LVL in 2011. Other components of government budget expenditures are of comparatively smaller significance. However, the importance of interest payments can increase together with the increase of government debt.

Government budget expenditures on the compensation of employees can be modelled depending on nominal gross wage in the whole economy. However, wage reform in the public sector [101] points at the exogenous character of this indicator. In order to evaluate the dynamics of wages in the government sector more adequately, average monthly gross wages in the public sector are modelled by equation (2.73). In this equation wages depend on the government budget expenditures on the compensation of employees per one employee in the public sector, which is assumed to be the sum of employees in public administration, education and health and social work.

Expenditures of the general government consolidated budget on social benefits are connected mainly with the general government special budget. According to the data of the Treasury [170], in 2011 the total of 83.9% of the general government special budget expenditures for social benefits consisted of pensions. The total of 82.1% of pensioners received old-age pensions [96]. In order to evaluate the expenditures of the social budget in the circumstances of large unemployment level, equation (2.74) is used. In this equation the ratio of social benefits to the number of pensioners and unemployed, which is a proxy of average allowance, depends on real wages and the consumption price index.

$$\begin{array}{llll} \log(w\_m\_gov \cdot 12) = & 6.7 + & 0.79 \cdot \log(gov\_w/empl\_gov) & + 0.027 \cdot t \\ \text{t-stat} & (307.0) & (16.9) & (5.0) \\ \text{mexval} & (8763.9) & (398.4) & (75.8) \end{array} \qquad (2.73)$$

$R^2 = 0.99$. DW = 1.72; P(F-stat) = 0.00 [1997 – 2011],

$$\begin{array}{lll} \log(gov\_tr/(pop\_pens + unempl\_tot)) = & -5.8 + & 0.73 \cdot \log(w\_nom/pi\_cons\_pr) + \\ \text{t-stat} & (-2.9) & (2.8) \\ \text{mexval} & (28.5) & (25.8) \end{array}$$

$$\begin{array}{ll} & + 1.2 \cdot \log(pi\_cons\_pr) \\ \text{t-stat} & (5.2) \\ \text{mexval} & (75.1) \end{array} \qquad (2.74)$$

$R^2 = 0.99$; DW = 1.65; P(F-stat) = 0.00 [1996 – 2011],

where

w_m_gov – gross monthly wage in the public sector;
gov_w – expenditures of general government consolidated budget on salaries;
empl_gov – number of employees in public administration, education and health and social work;
t – time trend (1995 = 1);
gov_tr – expenditures of general government consolidated budget for social benefits;
pop_pens – number of pensioners;
unempl_tot – total number of unemployed;
w_nom – gross nominal wage a year;
pi_cons_pr – consumption price index.

Expenditures on gross capital formation and subsidies are calculated as a proportion of gross fixed capital formation and total general government expenditures, respectively. Interest payments are obtained by multiplying government debt in the previous period by the interest rate coefficient. Other expenditures are calculated as the difference between total expenditures and other elements of expenditures.

Additionally, to analyze the influence of the ageing population on the government budget, indicator of social budget deficit or surplus is included in the model. This variable is calculated in a simplified manner as a difference between revenues of social contributions and expenditures on social benefits.

Calculation of general government budget expenditures and government debt is illustrated in Figure 2.39 and identities included in model calculations are given in the system of equations (2.75).

$$\begin{aligned}
\mathrm{gov\_expend} &= \mathrm{gov\_rev} - \mathrm{gov\_bal} \\
\mathrm{gov\_cap} &= \mathrm{inv\_cp\_fix} \cdot \mathrm{gov\_str\_cap} / 100 \\
\mathrm{gov\_subs} &= \mathrm{gov\_expend} \cdot \mathrm{gov\_str\_subs} / 100 \\
\mathrm{gov\_loan} &= \mathrm{gov\_debt}(-1) \cdot \mathrm{intr\_debt} / 100 \\
\mathrm{gov\_oth} &= \mathrm{gov\_expend} - \mathrm{gov\_cap} - \mathrm{gov\_w} - \mathrm{gov\_subs} - \mathrm{gov\_tr} - \mathrm{gov\_loan} - \\
&\quad - \mathrm{mb\_tr\_g\_pd} - \mathrm{gov\_eu} \\
\mathrm{gov\_bal} &= \mathrm{gdp\_cp} \cdot \mathrm{gov\_bal\_gdp} / 100 \\
\mathrm{gov\_fin} &= -\, \mathrm{gov\_bal} \\
\mathrm{gov\_debt} &= \mathrm{gov\_debt}(-1) + \mathrm{gov\_fin} + \mathrm{gov\_debt\_ch} \\
\mathrm{gov\_debt\_gdp} &= (\mathrm{gov\_debt} / \mathrm{gdp\_cp}) \cdot 100 \\
\mathrm{gov\_bal\_soc} &= \mathrm{tax\_soc} - \mathrm{gov\_tr}
\end{aligned} \tag{2.75}$$

where

gov_expend – expenditures of general government consolidated budget;
gov_rev – revenues of general government consolidated budget;
gov_bal – deficit or surplus of general government consolidated budget;
gov_cap – expenditures of general government consolidated budget for gross capital formation;
inv_cp_fix – fixed capital formation in current prices;
gov_str_cap – government capital share coefficient;
gov_subs – expenditures of general government consolidated budget for subsidies;
gov_str_subs – government subsidy share coefficient;
gov_loan – expenditures of general government consolidated budget for interest payments;
gov_debt – general government debt;
intr_debt – interest rate of government debt;
gov_oth – other expenditures of general government consolidated budget;
gov_w – expenditures of general government consolidated budget for compensation of employees;
gov_tr – expenditures of general government consolidated budget for social benefits;
mb_tr_g_pd – transfers paid by government, the balance of payments;
gov_eu – expenditures of general government consolidated budget for EU funds;
gdp_cp – nominal GDP;
gov_bal_gdp – deficit or surplus of general government consolidated budget in % of GDP;
gov_fin – financing of deficit of general government consolidated budget;
gov_debt_ch – general government debt residual;
gov_debt_gdp – general government debt in % of GDP;
gov_bal_soc – deficit or surplus of general government social budget;
tax_soc – revenues of social contributions.

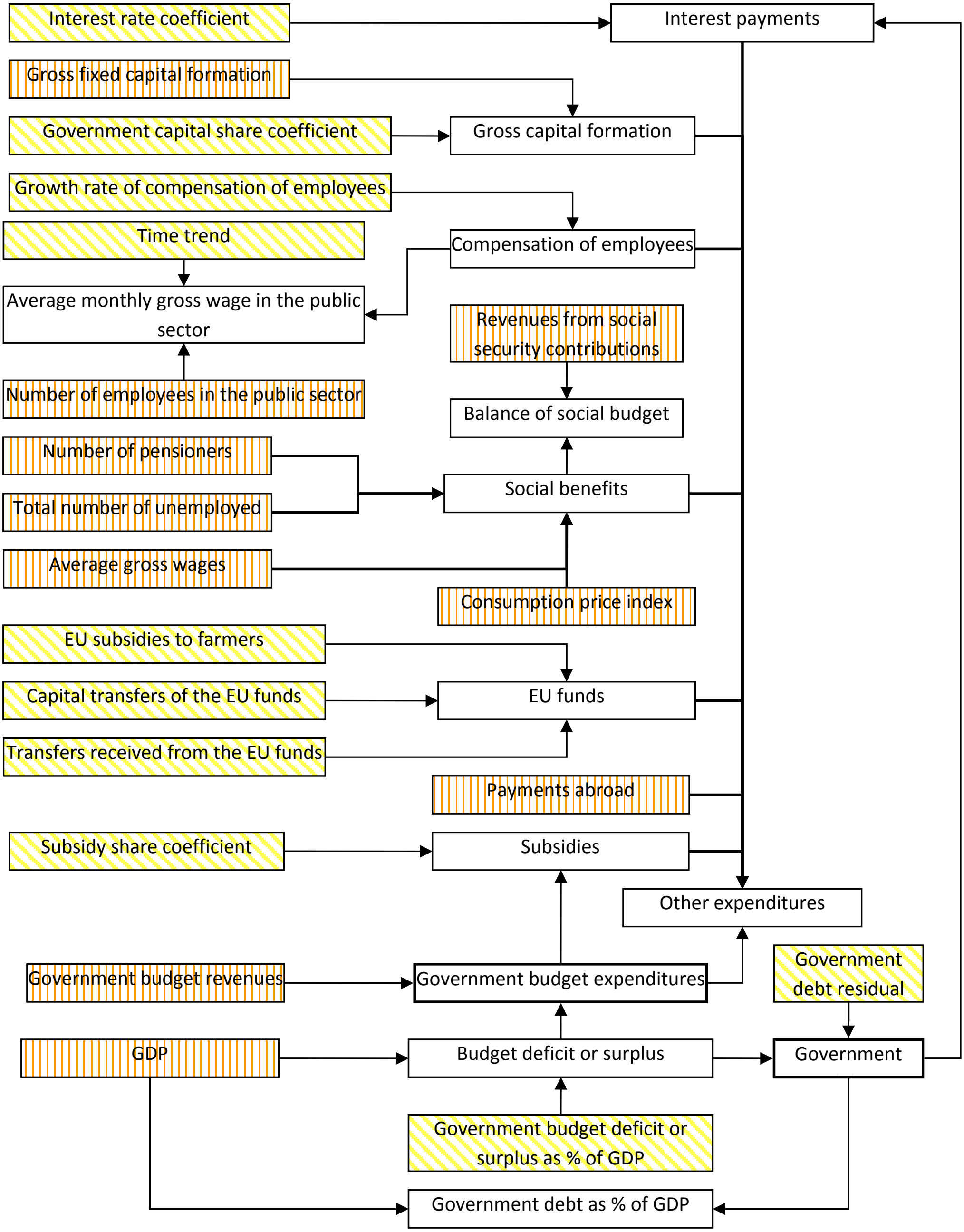


Fig. 2.39. Calculation of government budget expenditures and government debt in the Latvian model[21].

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[21] See the legend in Fig.2.4

2.9. Energy Sector

Analysis of the Latvian Energy Balance in 2011 shows that there are six important energy sources (see Table 2.14). Overall, oil products (about 36%) and fuel wood (about 23%) are consumed most extensively, the consumption of electricity, heat and natural gas is characterized by similar volumes (about 10-13% each). A large share of the necessary energy resources is imported, however, fuel wood is mostly produced in Latvia and 29.2% of the necessary electricity (export, energy sector, losses and final consumption) is produced in Latvia as well. 31.1% of electricity is produced using other energy sources (transformation sector), and the rest 39.7% is imported.

Table 2.14

Latvian Energy Balance in 2011 (thsd toe[22])

	Oil products	Coal	Natural gas	Fuel wood	Heat	Electricity	Total
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Production	-	-	-	1,739	-	254	2,070
Recycled products	1	-	-	-	-	-	4
Imports	1,980	124	1,412	4	-	345	3,957
Exports	472	4	-	546	-	238	1,314
Bunkering	214	-	-	-	-	-	214
Interproduct transfers	0	-	-	-	-	-	-
Stock changes	-47	-3	-121	-77	-	-	-249
Statistical differences	254	-	-	-	-	-	254
Gross energy consumption	1,502	117	1,291	1,120	-	361	4,508
Transformation	-15	-13	-859	-165	597	270	-198
Energy sector	6	-	23	-	13	46	88
Losses	-	-	12	0	82	53	147
Final consumption	1,481	104	397	955	502	532	4,076

– - Magnitude zero

Source: CSB database [96]

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[22] Only the most significant energy types are illustrated

Since electricity is a very important energy resource in final consumption, as well as taking into account that it is possible to obtain electricity both from renewable resources and from other, mostly imported resources, it is essential to elaborate adequate electricity consumption forecasts. Such forecasts would allow planning of further development of the necessary power capacities, inter alia it would be possible to make a choice between imported electricity or other energy resources needed for production of electricity.

Currently, different methods are used in the world for forecasting of electricity consumption, starting with algorithmic methods and ending with systems, which are based on the use of neural network. The most popular are econometric and end-use methods. End-use method can be applied, if detailed information on electricity consumption for various purposes is available. End-use method is based on the assumption that energy is necessary for a particular service, which it provides. End-use method is defined by equation (2.76). The sum of the final consumption of different devices gives total demand for electricity. For determination of the electricity volume, which any particular device needs, the improvements in energy efficiency, utilization indicators of the device and replaceability of different energy sources are also taken into account. One of the pros of this method is the possibility to evaluate the consequences resulting from the introduction of new technologies.

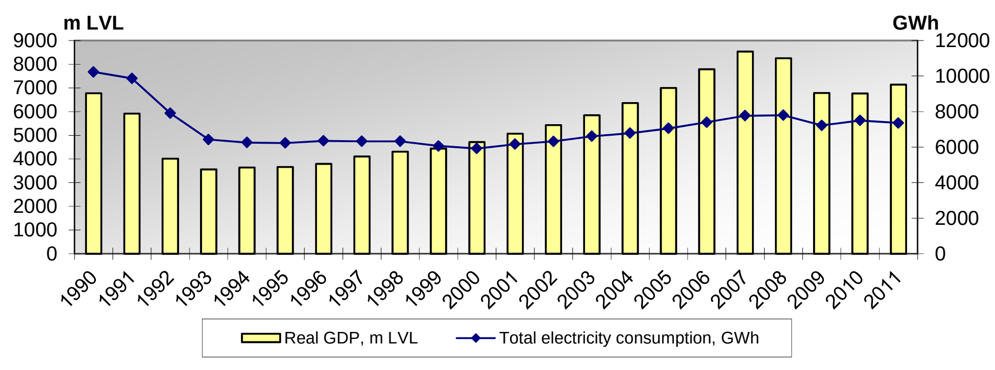
$$E = S \cdot N \cdot P \cdot H \qquad (2.76)$$

where

E – electricity consumption of a device, kWh;
S – average number of devices per one customer;
N – number of clients;
P – electricity amount needed for a device, kWh;
H – duration of the use of a device, hours [108, p. 5].

It is not yet possible to obtain sufficiently detailed information about electricity consumption in Latvia that would be suitable for the end-use method. Therefore, econometric relations are included in the model. Different modifications of econometric modelling methods are used also in the state joint company “Latvenergo”. The World Bank and the European Bank for Reconstruction and Development also recommend using econometric methods for forecasting of electricity consumption [122, p. 96]. Thus, during the development of the model, possibilities to forecast energy consumption depending on macroeconomic indicators is analyzed.

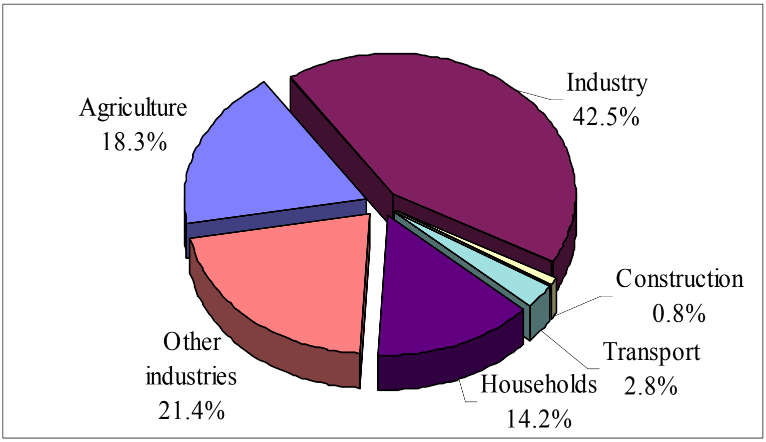
Total electricity consumption is largely determined by the GDP changes. In 1991 – 1993, total electricity consumption sharply decreased together with the decrease in the GDP volume (see Fig. 2.40). In 1993 total electricity consumption volume was by 3,806 GWh or 37.2% smaller than in 1990. The most significant electricity consumption fall was associated with industry – 1,887 GWh or almost 50%, and agriculture – 1,062 GWh or 64.3%. Further electricity consumption volume decreased less rapidly and, beginning with 2001, it slowly increased (by 2.7% – 5.0% per year) till it reached 7,794 GWh in 2008. Together with the decrease of economic activity, electricity consumption also decreased in 2009.



Source: CSB database [96]

Fig. 2.40. Dynamics of the GDP and electricity consumption.

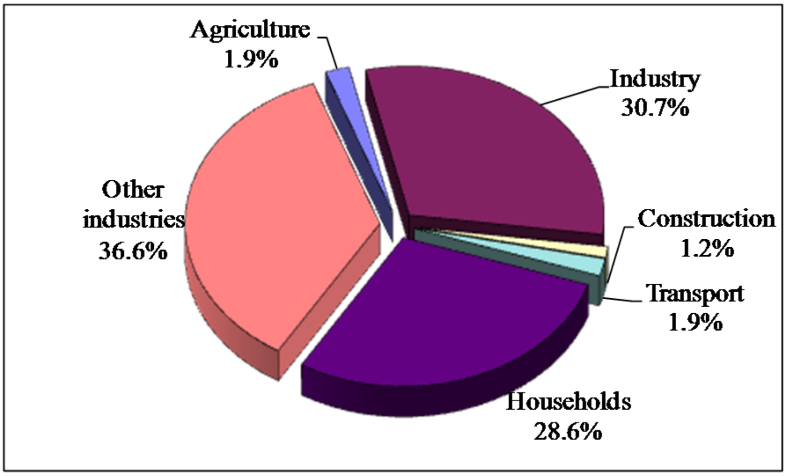
Since 1990 the structure of final consumption of electricity including the energy sector has changed. In 1990 most of electrical power was consumed in industry (42.5%), which is illustrated in Figure 2.41. Significant consumer groups were also agriculture and households (18.3% and 14.2% respectively).



Source: Calculated by the authors on the basis of CSB database [96]

Fig. 2.41. Structure of the final electricity consumption in 1990.

In 2011 the share of industry decreased till 30.7%, the share of agriculture – till 1.9%, but the share of electricity consumed by households increased till 28.6%, as Figure 2.42 shows. Along with the development of construction, electricity consumption volume in this industry also becomes more significant. Nevertheless, in 2011 the share of construction in electricity consumption was only 1.2%.



Source: Calculated by the authors on the basis of CSB database [96]

Fig. 2.42. Structure of the final electricity consumption in 2011.

Taking into account the differences in the dynamics of electricity consumption in different consumer groups, traditional aggregated relation between total electricity consumption and GDP is not used for elaboration of electricity consumption forecasts for Latvia. It is more useful to estimate separate econometric equations for the main consumer groups of electricity, incorporating also specific factors characteristic of each consumer group.

For modelling purposes, electricity consumer groups chosen are the following: agriculture, hunting, forestry and fishing (AB)[23], industry (CDE), construction (F), road transport (60.21), rail transport (60.1), pipeline transport (60.3), other industries (G, H, I – except 60.1, 60.21 and 60.3 – J, K, L, M, N and O) and households. Such a disaggregation corresponds also to the classification of the Central Statistical Bureau of the Republic of Latvia for electricity consumption in Latvia (see, for example, [96]).

Electricity consumption in agriculture, industry, construction and other industries can be related to the output of production. In equation (2.77), which characterizes the dynamics of electricity consumption in agriculture and fishing, time trend is used as an additional factor. Despite the statistical characterization of the equation, which meets all requirements, a growing negative trend together with small changes in the output in comparatively short time gives negative electricity consumption values. Therefore, an alternative equation (2.78) is specified.

There are options to use two output indicators when evaluating electricity consumption in other industries. In the first case it is possible to subtract the output in agriculture and fishing, industry and construction from the total output. In the second case, taking into account that transport is a separate electricity consumer group, which is a part of transport and communications industry, it is possible to use output indicator, which also excludes the output in transport and communications. The relation with output, which excludes transport and communication industry, gives more precise results and is used in equation (2.81).

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[23] Industry codes according to NACE 1.1.rev. classification

$$elect\_ab = 49.0 + 0.37 \cdot out\_fp\_ab - 10.0 \cdot t \qquad (2.77)$$

t-stat (0.8) (2.9) (-4.8)
mexval (2.2) (21.6) (62.2)

$R^2 = 0.80$; DW = 1.60; P(F-stat) = 0.00 [1995 – 2011],

$$\log(elect\_ab) = 5.5 - 0.19 \cdot \log(t) \qquad (2.78)$$

t-stat (154.2) (-11.6)
mexval (3883.8) (215.7)

$R^2 = 0.90$; DW = 1.22; P (F-stat) = 0.00 [1995 – 2011],

$$elect\_cde = 1301.65 + 0.38 \cdot out\_fp\_cde - 39.4 \cdot t + 280.0 \cdot d\_1011 \qquad (2.79)$$

t-stat (5.7) (3.2) (-3.1) (2.9)
mexval (86.8) (34.1) (31.2) (27.6)

$R^2 = 0.52$; DW = 1.92; P (F-stat) = 0.00 [1995 – 2011],

$$elect\_f = 40.2 + 0.054 \cdot out\_fp\_f - 0.92 \cdot t \qquad (2.80)$$

t-stat (10.7) (9.2) (-2.0)
mexval (203.2) (166.1) (13.9)

$R^2 = 0.91$; DW = 1.92; P(F-stat) = 0.00 [1995 – 2011],

$$elect\_oth = 329.5 + 0.22 \cdot out\_fp\_oth_1 + 27.1 \cdot t \qquad (2.81)$$

t-stat (2.6) (5.3) (2.0)
mexval (21.5) (73.5) (13.3)

$R^2 = 0.96$; DW = 1.74; P(F-stat) = 0.00 [1995 – 2011],

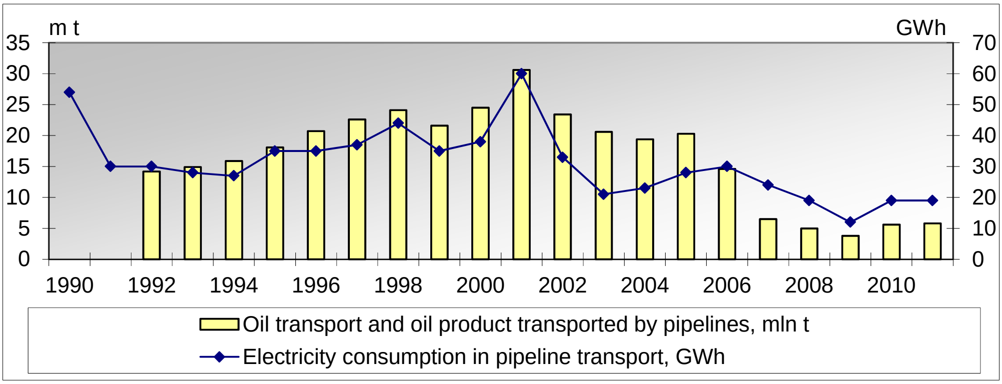
where

elect_ab – electricity consumption in agriculture, hunting, forestry and fishing;
elect_cde – electricity consumption in industry;
elect_f – electricity consumption in construction;
elect_oth – electricity consumption in other industries;
out_fp_ab – real output in agriculture, hunting, forestry and fishing;
out_fp_cde – real output in industry;
out_fp_f – real output in construction;
$out\_fp\_oth_1$ – real output in other industries (all industries except agriculture, fishing, industry, construction and transport, storage and communications);
t – time trend (1995 = 1);
d_1011 – dummy variable (1995 – 2009 = 0, other periods = 1).

Electricity consumption in road transport is closely related to the number of trolley-buses and tramcars, as equation (2.82) shows. In contrast to the road transport, relation between electricity consumption in the rail transport and the number of railway vehicles is not as straightforward. The reason for that might be the fact that road transportation use intensity is comparatively larger – trolley-buses and trams drive more frequently and the total number of these vehicles is much larger than in the railway sector. Moreover, not all vehicles used in the railway transport are electrical vehicles.

Electricity consumption in the rail transport can be related to the number of passengers, taking into account that electric trains are used only in passenger transportation. In 2007 more than 80% domestic passengers were transported using electric trains [127]. Estimated equation (2.83) includes also time trend as an additional factor.

Electricity consumption in pipeline transport can be related to the volumes of transported oil and oil products. Dynamics of these indicators are similar in 1994 – 2005 and then again in 2007 – 2010 (see Fig. 2.43). Therefore, equation (2.84) is estimated.



Source: Calculated by the authors on the basis of CSB database [96]

Fig. 2.43. Electricity consumption and oil and oil products transported by pipeline transport.

$$elect\_tt = -51.4 + 0.21 \cdot tram - 0.60 \cdot t + 5.5 \cdot d\_06 \qquad (2.82)$$

t-stat (-1.7) (4.7) (-3.3) (2.4)

mexval (11.6) (67.8) (38.6) (22.0)

$R^2 = 0.92$; DW = 1.44; P(F-stat) = 0.00 [1996 – 2011],

$$elect\_tdz = 11.8 + 1.1 \cdot pas\_dz + 4.4 \cdot d\_0911 \qquad (2.83)$$

t-stat (3.3) (8.8) (2.2)

mexval (33.6) (156.2) (16.3)

$R^2 = 0.85$; DW = 1.77; P(F-stat) = 0.00 [1995 – 2011],

$$elect\_tc = 10.6 + 1.2 \cdot vads - 14.4 \cdot d\_03 \qquad (2.84)$$

t-stat (3.3) (7.1) (-2.5)
mexval (33.8) (114.2) (19.6)

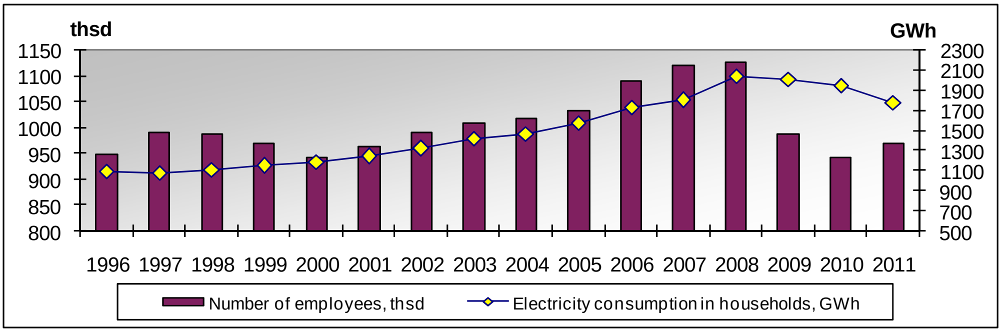
$R^2 = 0.79$; DW = 2.11; P(F-stat) = 0.00 [1995 – 2011],

where

elect_tt – electricity consumption in road transport;
elect_tdz – electricity consumption in rail transport;
elect_tc – electricity consumption in pipeline transport;
tram – number of tramcars and trolley-busses (annual average);
pas_dz – number of passengers in rail transport;
vads – oil transport and oil product transported by pipelines;
t – time trend (1995 = 1);
d_03 – dummy variable (2003 = 1, other periods = 0);
d_06 – dummy variable (2006 = 1, other periods = 0);
d_0911 – dummy variable (1995 – 2008 = 0, other periods = 1).

Electricity consumption in households can be related to the part of residents, who receive wages and salaries or are employed persons. Incorporation of entrepreneurs and self-employed in the number of electricity consumers gives an indicator closer to the number of working-age population (aged 15 to 64), but incorporation of pensioners – the number of population aged 15 years and over. Such a choice of factors is connected with the fact than the largest part of household disposable income per household member in Latvia is formed by wages and salary. According to the CSB data [96], in 2011 the share of wages and salary was 66.3%. The next most significant part of income is related to transfers, mostly pensions. The share of the received transfers in 2011 was 29.6%.

Electricity consumption in households has been increasing since 1998, despite the decrease in total and working-age population, and only in 2009 and 2010 it fell, as Figure 2.43 illustrates. However, starting with 2001, since the number of employees started to increase, electricity consumption has been growing comparatively more quickly. The value of correlation coefficient between electricity consumption in households and the number of employees in 1996 – 2008 was 0.94, which indicates the presence of a very strong relation between these indicators. In 1996 – 2011 it was 0.51, which is still high enough. Incorporation of wages or another indicator characterizing household income (government expenditures for social benefits) was not statistically justified, therefore, time trend is also included in equation (2.85).



Source: CSB database [96]

Fig. 2.43. Electricity consumption in households and the number of employees.

Besides final consumption components, electricity losses also have to be taken into account when calculating total necessary electricity volume. As electricity losses have been gradually decreasing since 1997, trend equation (2.86) is used in the model.

$$\log(elect\_pr) = 1.0 + 0.85 \cdot \log(empl) + 0.041 \cdot t + 0.11 \cdot d\_09 \qquad (2.85)$$

t-stat (0.7) (3.8) (14.6) (2.3)

mexval (1.8) (49.1) (333.8) (19.8)

$R^2 = 0.97$; DW = 2.15; P(F-stat) = 0.00 [1996 – 2011],

$$elect\_zud = 1695.0 - 356.3 \cdot \log(t) \qquad (2.86)$$

t-stat (59.5) (-27.3)

mexval (1494.6) (636.8)

$R^2 = 0.98$; DW = 1.54; P(F-stat) = 0.00 [1996 – 2011],

where

elect_pr – electricity consumption in households,
elect_zud – electricity losses,
empl – number of employees,
t – time trend (1995 = 1),
d_09 – dummy variable (2009 = 1, other periods = 0).

Relations in the energy sector are illustrated in Figure 2.45.

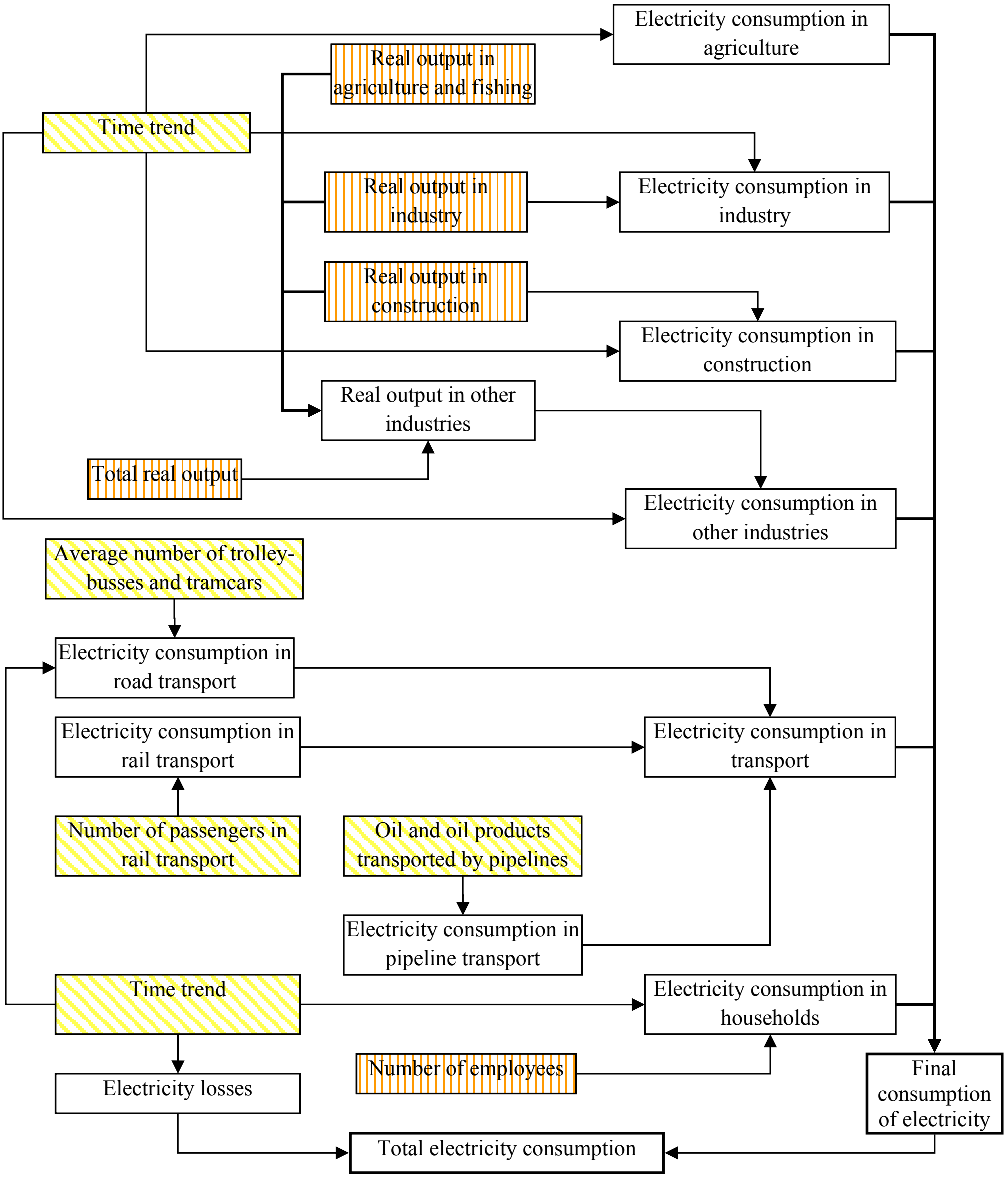


Fig. 2.45. Calculation of electricity consumption in the Latvian model[24].

Identities included in the model are given in the system of equations (2.87).

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[24] See the legend in Fig.2.4

$$\begin{aligned}
\text{elect\_tr} &= \text{elect\_tt} + \text{elect\_tdz} + \text{elect\_tc} \\
\text{elect} &= \text{elect\_ab} + \text{elect\_cde} + \text{elect\_f} + \text{elect\_tr} + \text{elect\_oth} + \text{elect\_pr} \\
\text{elect\_tot} &= \text{elect} + \text{elect\_zud} \\
\text{out\_fp\_oth}_1 &= \text{out\_fp} - \text{out\_fp\_ab} - \text{out\_fp\_cde} - \text{out\_fp\_f}
\end{aligned} \tag{2.87}$$

where

elect_tr – electricity consumption in transport;
elect_tt – electricity consumption in road transport;
elect_tdz – electricity consumption in rail transport;
elect_tc – electricity consumption in pipeline transport;
elect – final consumption of electricity;
elect_ab – electricity consumption in agriculture and fishing;
elect_cde – electricity consumption in industry;
elect_f – electricity consumption in construction;
elect_oth – electricity consumption in other industries;
elect_pr – electricity consumption in households;
elect_tot – total electricity consumption;
elect_zud – electricity losses;
out_fp_oth_1 – real output in other industries;
out_fp – real output;
out_fp_ab – real output in agriculture and fishing;
out_fp_cde – real output in industry;
out_fp_f – real output in construction.

3. APPLICATION OF MACROECONOMIC MODELS IN LATVIA

3.1. Modelling in Latvia

Currently, several macroeconomic models have been developed and applied in Latvia, including macro-econometric, macroeconomic multisectoral and computable general equilibrium (CGE) models. They are used for forecasting, for scenario analysis and for evaluation of the economic policy. The most known macro-econometric models are LMM model of the Bank of Latvia and the Latvian Model of Development (LMD) of the Riga Technical University. This chapter gives a brief insight into the models, which have been discussed in different publications. However, many banks and other organizations maintain their own models without any publicity.

3.1.1. Macroeconomic Models in the Bank of Latvia

LMM model has been built by the Bank of Latvia, which can be considered a macro-econometric model [29]. This model is based on the structure of AWM and MCM models, where the long-term equilibrium is determined by supply, but the short-term dynamics – by the aggregate demand. The Bank of Latvia uses this version of the model only for policy simulations, evaluating the reaction of the national economy to different external and internal "shocks" – monetary policy, exchange rate, oil prices, foreign demand and fiscal policy "shocks". It is planned that the next versions of the model will be suitable also for medium-term forecasting [29]. Specialists of the Bank of Latvia regularly update and publish macroeconomic forecasts, however, without specifying their source or the way they are obtained.

The model is based on quarterly data beginning with 1995 and it contains 87 equations, 19 of which are estimated econometrically (using OLS method). Extrapolation of annual to quarterly data for some indicators has allowed the authors to obtain larger number of observations, which allows estimating the parameters more objectively. However, time series obtained in such a way correspond to the actual situation with a smaller or larger deviation depending on the chosen methodology, which may result in larger errors for the estimated parameters.

The model contains five blocks: supply and demand side, prices, fiscal block and external economic activities. Model blocks are aggregated and include the main macroeconomic indicators, similar to those used in other European central banks. It also makes an emphasis on the monetary policy, which is represented in the model by an interest rate. The whole structure of the model can be evaluated as logical and well-grounded. In certain equations parameter values are calibrated including the values of competitiveness parameter in export and import equations. Effective direct tax rate is related to the government budget deficit in the previous period.

LMM model is additionally applied to evaluate the influence of labour migration on the Latvian economy [141]. Other examples of model applications are not published. Research projects reflected within the Working Papers of the Bank of Latvia show the potential for further applications of LMM. Research is mostly concentrated on monetary indicators, for example, interest rates [3], bank lending [27], inflation [2], Phillips curve relationship [110], as well as other topical indicators and issues like GDP forecasts [28] and productivity issues [56; 109]. However, none of these papers analyzes the possibility to include the estimated equations in a macroeconomic model and therefore to conduct more thorough analysis. Researchers of the Bank of Latvia also employ Dynamic Stochastic General Equilibrium (DSGE) models in different studies [173; 174; 175; 176]

3.1.2. Application of Macroeconomic Models in Ministries of the Republic of Latvia

In Latvia, macroeconomic models are used most extensively in the Ministry of Economics. One of the tasks of the Ministry of Economics is to coordinate the forecasts of the main macroeconomic indicators (official forecasts) with the Ministry of Finance for the elaboration of the government budget project, as well as to maintain and improve the set of modelling instruments for the analysis of the national economy and forecasting [97].

The Ministry of Finance also uses models for a long time. One of the tasks of the Ministry of Finance is to make forecasts of macroeconomic indicators and the main fiscal indicators [98]. In order to make the official government forecasts 1-2 times a year, the Ministry of Economics and Ministry of Finance harmonize their forecasts of 4 main indicators: GDP (% change), PCI (% change), number of employees (% change) and current account (% of GDP) [24].

Regarding the models used in the Ministry of Economics, several models for elaboration of short-, medium- and long-term forecasts are used [23, p. 100; 24]. The quarterly structural model uses the data starting from 1995 to elaborate forecasts for 1-2 years ahead by 16 industries (NACE), based on the assumptions about the dynamics of industries and prices. The annual medium-term model uses the data starting from 1995 to elaborate forecasts for 3-5 years by 8 industries. It includes about 500 variables; the main exogenous indicators are growth rates of industries, prices and government consumption. For long-term forecasting the aggregated model with three-sector disaggregation – agriculture, industry and services – is used, based on the assumptions about investments, technological changes and demographical prospects. The Ministry of Economics also uses Input-Output model, HERMIN model elaborated by the Economic and Social Research Institute of Ireland and Labour Market Forecasting model, which is the dynamic optimization model (DOM) [24, p.41; 75, p.27].

In addition to these models, ministries contract other organizations to carry out research, including elaboration of macroeconomic models or economic-mathematical models of particular industries.

One of the organizations, which elaborate macroeconomic models for the ministries of the Republic of Latvia, is Riga Technical University. Macroeconomic models were used in three research projects of the Ministry of Economics implemented by Riga Technical University. Two projects involve CGE models: 1) for elaboration of forecasts of energy sector development (in cooperation with JSC Latvenergo) [34] and 2) for evaluation of the influence of changes in inflation and labour costs on the structure of the national economy [74]. The third project involves a macro-econometric model in research of the development of the target indicator system and implementation scenarios of the Single Strategy of National Economy, using the set of instruments of modelling, including LMD model [161].

At the basis of both CGE models there is the Australian ORANI-G model [166], and these models are implemented, using software package GEMPACK. The model used for energy sector development forecasting is based on analytically elaborated input-output table of the year 2000 with detalization of 57 industries and 59 product groups [34, p. 7]. According to this research, the necessary amount of electricity output is evaluated by different growth rates of demand. The model helps to evaluate the influence of energy prices on the overall price level and prices in industries. The second model with acronym LAT26CGE is used for the evaluation of influence of changes in inflation and labour costs. The model is based on analytically elaborated input-output table of 2005 with disaggregation of 26 industries. The research shows possibilities to use the model for evaluation of changes in wages, modelling of inflation influence, modelling of influence of changes in productivity and technological progress, as well as for evaluation of changes in tax policy and government expenditures and preferences of final consumers regarding the choice of domestic or imported goods and services [74, p. 63].

The Latvian Model of Development (LMD) used for forecasting of target indicators of the Single Strategy of National Economy is based on annual data staring from 1995. It contains approximately 400 equations included in eight blocks: demographic indicators and labour supply, supply of goods and services and prices, demand of goods and services, income distribution, budget income and expenditures, foreign trade, balance of payments and energy, it also comprises an additional block, which contains input-output relations. Indicators of output, prices, value added and employment are disaggregated in eight industries. Budget block contains the main components of income and expenditures. Foreign trade block contains detailed representation of exports and imports of goods and services. Comparatively large disaggregation of the model allows analyzing different aspects of the national economy. The number of exogenous indicators (about 90) allows examining various economic development scenarios, however, at the same time it demands a lot of additional assumptions regarding the further dynamics of exogenous indicators. The version of the model used in this research [161] has to be updated for several reasons. The first reason is connected with changes in data calculation methodologies (for example, regarding GDP and government budget). The second reason is the presence of more extensive information and changes in separate aspects of economic development, for example, regarding Latvia's accession to the EU.

The Institute of Development of the University of Latvia has built a labour market demand forecasting system for the Ministry of Welfare [40]. This system is now improved as the Labour Market Forecasting Model and is used in the Ministry of Economics [77]. It consists of 3 main blocks – supply, demand and labour market. Its logic is based on the concept of labour market equilibrium – in the long term labour supply and demand reach equilibrium in different segments of labour market.

Stockholm School of Economics in Riga together with the Baltic International Centre for Economic Policy Studies (BICEPS) and Ernst & Young Baltic are elaborating a macro-econometric model for the Ministry of Finance [77; 78] for evaluation of the influence of EU funds on economic development of Latvia. The model contains demand and supply side (five sectors), employment, wages and government budget blocks, 10 exogenous and 87 endogenous indicators.

A number of research projects are connected with the modelling of a particular industry or indicator using econometric or other quantitative methods. In the long term it allows integrating respective relations in a macroeconomic model. Some of the examples are forecasts by industries and predictable restructuring of industries till 2020 elaborated by "Baltic Consulting" [80], research results regarding wages and their influencing factors elaborated by "RS Group" [39], labour demand and supply model elaborated by the University of Latvia [43], imitation model of analysis of Latvia's agricultural policy LAPA for economic evaluation of agriculture and rural development support elaborated by the LVAEI [92] and modelling instruments for analysis and forecasting of development of forestry and related industries elaborated by RTU [113]. These projects are elaborated under the contracts with in the Ministry of Economics, the Ministry of Welfare and the Ministry of Agriculture.

Many research projects in some ministries are potentially connected with macroeconomic modelling, which is not implemented yet. Such issues include the analysis of tourism development, influence of taxes and social transfers on employment, etc.

3.1.3. Macroeconomic Modelling in Universities and Other Organizations

In Latvia, macroeconomic models are developed at Riga Technical University. In cooperation with the specialists from the University of Florence INFORUM type Latvian multisectoral macroeconomic model has been built [16, p. 1]. It contains 55 industries and 7 final consumption components, and is used for long-term forecasting [10; 11; 12; 13; 14; 15; 17; 18]. This model is also used for detailed forecasting of electricity consumption in industrial sectors (according to available statistical data) [93; 121].

With the contribution of the authors, the improvement and use of the macro-econometric Latvian Model of Development in different research projects is continued. These include forecasting of the target indicators of the Single Strategy of National Economy in the research of the Ministry of Economics [161], forecasting the demand for specialists in industries of the Latvian economy [128], forecasting electricity consumption and evaluation of potential electricity deficit [122], forecasting of the number and structure of population [123; 125], as well as analysis of general government consolidated budget revenues and expenditures [124].

For separate industries and aspects of the economy, system dynamic models are developed. These models are used for the analysis of Latvian integration processes in the EU [156] and the EU enlargement [152], for forecasting of development of construction industry [69; 149; 155; 157], for evaluation of influence of labour migration on Latvia’s labour market [150; 153], for analysis of the Latvian energy sector [151], for evaluation of credit burden [154], and for evaluation of regional development [81].

At the University of Latvia mainly individual aspects of economy are modelled or the influence of different factors on significant macroeconomic indicators is evaluated. Labour demand and supply aspects are researched extensively (for example, [40; 43]). Econometric methods are used for analysis of the standard of living of the population (for instance, [19]), for evaluation of the influence of fiscal and monetary policy on the national economy (for example, [49; 142]), and for forecasting of indicators of the Latvian economy [136]. Currently computable general equilibrium model is developed for evaluation of the influence of fiscal policy on the aggregate demand and prices [135].

Economists Association 2010 in cooperation with the Stockholm School of Economics in Riga work on the neoclassical growth model [51], labour market modelling results are published.

In commercial banks of Latvia, macroeconomic models are built and used, but they are not made publicly known. Some exceptions include econometric models built in “Swedbank” for electricity consumption forecasting depending on GDP trends [159] and evaluation of influence of labour migration and GDP [83]. However, none of these models is a comprehensive macroeconomic model.

3.1.4. Overall Evaluation of Latvia’s Macroeconomic Models

Analysis of the situation in the field of development and application of macroeconomic models in Latvia indicates that complex analysis of dynamics of the national economy and industrial structure is carried out rarely. Only in some organizations macroeconomic models are used for this purpose (in the Bank of Latvia, Ministry of Economics and Riga Technical University). However, the situation is gradually improving and the work on macroeconomic model building is carried out also at the University of Latvia and Economists Association 2010 in cooperation with Stockholm School of Economics in Riga. Model building and development is often facilitated by different ministries (mainly the Ministry of Economics), which order particular researches, it is also promoted by the financing available in the form of different grants and the EU co-financing for elaboration of particular projects.

Macroeconomic models are applied regularly for forecasting and planning purposes in the Bank of Latvia, the Ministry of Economics and the Ministry of Finance. Particular models are mainly elaborated in the framework of a single research. Some of the models are used repeatedly, adjusting separate parts or separate equations of the model for examination of other topical problems (LMM model of the Bank of Latvia, Latvian Model of Development of Riga Technical University). It can be noted that exactly the macro-econometric models are used in different researches more often and also repeatedly. It is partly connected with comparatively recent adaptation of other topical types of macroeconomic models (like macroeconomic multisectoral model) for the analysis of Latvia's economy (for example, in Riga Technical University the first elaborations of Latvia's INFORUM type model were made in 2004). At present particular macroeconomic models are used individually, however, elaboration of new models attests the growing potential of the integrated use of different models.

Currently macroeconomic models are mainly used for elaboration of policy and management of general government consolidated budget, which determines the aims of the models. Models are built for forecasting of the main macroeconomic indicators and separate aspects of the national economy. This implies elaboration of different development scenarios, emphasizing different development issues of the national economy. Some examples include possible labour demand problems in different professions [128] or possible deficit of electricity [122]. Models also are used for scenario analysis, including evaluation of the impact of economic policy measures on the development of the national economy, for instance, for evaluation of influence of changes in interest rates, currency exchange rates, oil price, foreign demand and fiscal policy. From the range of the main application areas of macroeconomic models, only counterfactual analysis is not yet carried out in Latvia. These models would allow evaluating the influence of previously made policy decisions on further development of the national economy. This field of analysis demands very precise elaboration of the relationships within a model, which is hindered by comparatively short time series of macroeconomic indicators.

Because of the maintenance needs of the data bases, models are regularly updated or even built from scratch as new data appear. Due to short time series, the choice of frequency of data is also significant. Due to this reason, quarterly data are used in LMM model of the Bank of Latvia. A part of the time series are transformed from annual to quarterly data, which can cause additional imprecision both in specification of equations and in forecasting. However, annual data used in other models limit the number of factors in equations. Therefore, in both cases problems with specification of equations are possible. Development of other types of macroeconomic models is hindered by delayed publishing of input-output tables (the latest officially published information is of 1998, however, Riga Technical University also uses analytically developed input-output tables of the years 2000 and 2005 and input-output tables elaborated within the WIOD project for 2000 – 2009).

Application of econometric methods for elaboration of macro-econometric models, as well as for analysis of separate aspects of the national economy, points at the advantages of development and application of these models.

3.2. Development Scenarios of the Latvian Economy

As in any macroeconomic model, also in the Latvian macro-economic model scenarios have to be developed first.

In order to obtain adequate forecasts, it is necessary to estimate future values of exogenous indicators included in the model. In case of a stable growth of the economy, comparatively simple methods are often used for estimation of future values of exogenous variables. These include the use of the last actual value of the exogenous variable, its average value or a trend. Separate indicators can be estimated according to the expert evaluations. In case of a rapid growth or decrease, especially in cases when statistics on similar dynamics observed previously are not available (as in the case of Latvia), forecasts are elaborated in the form of alternative scenarios. That is, possible future values of macroeconomic indicators are related to the particular assumptions and hypotheses regarding the future development of the economy.

Exogenous indicators included in the Latvian macro-econometric model can be conditionally divided in six groups. The first group contains indicators, which are more or less connected with government policy and legislation (tax rates, ratio of budget deficit to GDP, etc.). The second group consists of indicators, which characterize foreign economy (indicators of the EU-15 countries, Estonia, Lithuania and Russia) and elements of the balance of payments. The third group contains demographic indicators (age structure of the population, share of economically active and retired population in the population aged 15 years and over). The fourth group consists of indicators, which are connected with electricity consumption and production (the number of trolley-busses and tramcars, number of passengers in rail transport, oil and oil products transported by pipelines, volumes of electricity production). The fifth group contains different coefficients and the sixth group – other indicators.

Available information on the changes in legislation and government policy is used for determination of the values of the indicators of the first group. Determination of reliable values of these indicators for the entire forecasting period is hindered by the fact that information on the changes in legislation and government policy is not published timely. Moreover, during the last few years changes are done relatively frequently. Values of the indicators characterizing foreign economies are mostly obtained from the forecasts elaborated by respective countries or international organizations. It is assumed that specialists of these countries and organizations are more experienced and knowing with regard to the peculiarities of economic development of particular countries and groups of countries. Information published by specialists in demography together with the analysis of the latest trends is used for evaluation of possible trends of demographic indicators. Information on the planned/potential electricity production capacities in the next years is used to determine the amount of electricity production. Values of the coefficients are mostly estimated using such forecasting methods as different time series methods (moving average, trend methods, etc.).

3.2.1. The Base Scenario

For the base scenario in the Latvian macro-econometric model, the values of all exogenous variables have to be estimated for the future.

Government budget deficit or surplus as a percentage of GDP, the number of employees in public administration and health and social work, levies on imported agricultural products, which are included in the government budget, annual untaxed minimum for the calculation of personal income tax revenues, different tax rates and the shares of payments of customs duties and VAT in the EU budget are the exogenous indicators, which characterize government policy and legislation.

According to the information of the Ministry of Finance [169], government budget deficit in 2013 will be 1.6% of the GDP, in 2014 and in 2015 it is planned to be 0.9% and in 2016 – 0.8% of the GDP. For the following years it is assumed that the ratio of government budget deficit to GDP will be 0.8%.

Regarding tax rates, it is assumed that the VAT rate will be 21% starting with 2013, personal income tax rate – 24% in 2013 and 2014, 23% in 2015 and 22% in 2016. The rate of social contributions will be 35.09%, including 11% share paid by employees, the rate of other taxes on production and capital tax rate is set to their value of 2011. Due to the lack of information, the value of the levies on imported agricultural products is set to the value of 2011. Untaxed minimum for the calculation of personal income tax revenues is 45 LVL per month or 540 LVL per year. According to the previous trends, 100% of the customs duties and 2% of VAT are paid in the EU budget[25]. The ratio of the other government revenues to tax revenues is set to its value in 2011.

It is assumed that the number of employees in public administration and social work will not change till 2020. But in education employment growth rate will decline from 1% in 2013 to 0.5% in 2020. In order to ensure the target budget deficit, it is assumed that expenditures for compensation of employees will increase by 3% each year. The ratio of government investment to total

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[25] According to ESA95 statistics

investment, the ratio of subsidies to government budget expenditure and the interest rate of government debt is set to their values in 2011.

Future values of the growth rates of foreign GDP are given in Table 3.1. Data in the international databases is a starting point for the authors' estimates of these exogenous variables.

Table 3.1

Estimates of the Growth Rates of Foreign GDP (%)

	2012*	2013	2014	2015	2016	2018	2020
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
EU-15 countries	-0.4	-0.2	1.4	1.5	1.4	1.2	1.0
Estonia and Lithuania	3.6	3.1	3.7	3.5	3.4	3.2	3.0
Russia	3.4	3.4	3.5	3.6	3.8	4.6	4.9

* actual data

Sources: authors' assumptions for 2013-2020 based on Eurostat [54], IMF [181], ИНП РАН [186],

Estimates of the future values of the growth rates of foreign GDP deflators are given in Table 3.2.

Table 3.2

Estimates of the Growth Rates of Foreign GDP Deflators (%)

	2012*	2013	2014	2015	2016	2018	2020
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
EU-15 countries	2.5	1.5	1.6	1.5	1.5	1.5	1.5
Estonia	1.6	1.7	1.7	1.4	1.7	1.8	1.8
Lithuania	2.8	2.5	2.9	2.2	2.2	2.1	2.0
Russia	8.5	7.0	6.6	6.3	5.9	5.2	4.5

* actual data

Sources: authors' assumptions for 2013-2020 based on Eurostat [54], IMF [181], ИНП РАН [186],

According to the National Strategic Reference Framework 2007 – 2013 [50], it is possible for Latvia to use EU funds amounting to approximately 3,184 m LVL during the whole period, which is on average 455 m LVL per year. Information in the Partnership Agreement for the 2014 –2020 EU Funds Programming Period [126] shows that during this period it is possible to attract the EU funding of about 4,070 m LVL; that is approximately 580 m LVL annually. For the next years, it is assumed that the EU subsidies to farmers will be 200 m LVL and received transfers – 140 m LVL (current account), but the remaining 230 m LVL will form capital transfers (capital account). Other transfers received by the government are assumed to be 10 m LVL, but other paid transfers – 16 m LVL (current account), but there will be no other capital transfers (capital account). It is assumed that the government payments in the EU budget will be 1% of GDP and transfers of other sectors will be 1.6% of GDP.

The volume of foreign direct investments is by large connected with the government policy regarding the attraction of investors, for example, providing tax relieves, infrastructure, etc. It is also related to the period of return of investments and potential profit, which is related to economic situation in the country, economic development and its perspectives. At the same time, increase in investment volume cannot be related only to economic development, because in case of large investment objects increase of investments will be comparatively more rapid than in other cases. However, in case of economic recession decrease of investments is more likely as, for example, it was in 1998 and 1999, after the economic crisis in Russia, but in case of rapid growth investments also increase, which was particularly evident in 2005 and 2006, when GDP growth in Latvia was the highest among the EU countries. According to the latest data, growth rate of foreign direct investments in Latvia in 2010 was about 214%, in 2011 around 265%, but in 2012 there was a decrease -26.5%. Average growth rate in the sample is 52%, therefore the growth rate for the future is assumed to be 50% annually. Other exogenous elements of the balance of payments are assumed to be zero or equal to their average value.

In order to forecast the number of population by age groups, research results of P. Eglīte and co-authors [47] was used as the basis, combining the results of the minimum and maximum scenario and adjusting the values according to the latest available data. Age structure of the population used in the model is given in Table 3.3.

Table 3.3

Estimated Age Structure of the Population (%)

Age group	2012*	2013	2014	2015	2016	2018	2020
0 – 14 years	14.4	14.5	14.7	14.9	15.0	15.2	15.4
15 – 64 years	67.0	66.7	66.4	66.1	65.9	65.4	64.9
65 years and over	18.6	18.8	18.9	19.0	19.1	19.4	19.7

* actual data

Source: authors' estimations for 2013-2020

Regarding the share of economically active population (age group 15 – 74 years), it is assumed that 60-61% of the population will be aged 15 years and over, but the share of pensioners will be 35% of the mentioned age group.

For the calculation of electricity consumption in transport, the assumption is used that the number of tramcars and trolley-buses will not change, but new vehicles (see information of Rīgas Satiksme [79; 138]) will replace the obsolete ones, the number of passengers in the rail transport will be 20 m, but the volume of oil and oil products transported by pipelines will be 6 million tonnes

In order to compare electricity consumption forecasts with possible production capacities of electrical energy, the following assumptions regarding electricity production volumes were made:

1) HPPs – average long-term volume of production is 2,900 GWh;
2) CHPs – 1,500 GWh, assuming that CHPs also in the future will not work to full capacity;
3) other producers – taking into account previous trends, it is assumed that the volume of electricity production will increase to 1,400 GWh in 2020.

Coefficients include all dummy variables, including time trend, marginal propensity to consume, ratio of import to output, ratio of value added to output by industries, elasticity coefficients of employment to value added by industries, share of changes in inventories in GDP, coefficients of social contributions and wages in GDP income approach and share of profit in gross operational surplus and mixed income.

Several factors can influence the marginal propensity to consume, for example, government policy and legislation regarding credits, possibilities to make deposits and thus make savings, necessity to use previous savings due to decrease in income, etc. Therefore, when there are few credit restrictions or they do not exist at all, people can consume more than in the situations, when the ratio of credit payments to income, the amount of the first payment, etc. are strictly under control. Economic downturn, which began in the second half of 2008, declarations of the government regarding layoffs, increased tax rates and uncertainty resulted in worries of people about their future. However, since the economy is about to recover, marginal propensity to consume is assumed to gradually increase again.

Import ratio to output characterizes the choice of consumers between domestic and foreign goods. In case of high demand local producers cannot fulfil all the orders, therefore the importance of import increases. However, when demand is decreasing, it is possible to reject imported goods in favour of domestically produced goods, if local population tends to prefer local produce. As the Latvian economy seems to begin to recover, it is assumed that the import share will also start to increase again, reaching 35% in 2015 and then it will decrease again to 34% in 2020.

Values of ratios of the value added to output and elasticity coefficients of employment to value added by industries are set to their average level of the last years. Share of changes in inventories in GDP is set to 0% both in current and constant prices. Values of coefficients of social contributions and wages in GDP income approach and share of profit in gross operating surplus and mixed income are set to their last known values.

Other exogenous indicators in the base scenario include interest rates of government debt and long-term credits, foreign exchange rates, other changes of government debt and growth rates of price indexes.

For the future, values of interest rates and foreign exchange rates are also set to their value in 2011. According to the calculation principle used in the model, other changes in the government debt are used as a correction indicator, therefore their future values are calculated as an average of previous periods.

Values of growth rates of price indexes are assumed to be similar to the forecasts of IMF [181], Eurostat [54] and Swedbank [160].

3.2.2. Scenario of Lower Demand and Tighter Government Policy

The second scenario implies lower values of both domestic and foreign demand as compared to base scenario. For elaboration of this scenario, different values of government budget balance to GDP, government expenditures for compensation of employees, foreign demand (GDPs and foreign direct investments) and marginal propensity to consume are used.

In this scenario government policy is assumed to be stricter, which implies gradual decrease of budget deficit till 0.1% of GDP in 2020. Thus, the compensation of employees in the public sector is assumed to grow at smaller rates than in the base scenario. In 2013 the growth rate will be 2.0% and it will gradually decrease to 1.5% in 2020.

Future growth rates of foreign GDPs used in the second scenario are given in Table 3.4. It is assumed that foreign direct investments after 2012 will grow by 40% annually.

Table 3.4

Estimates of the Growth Rates of Foreign GDP in the Second Scenario (%)

	2012*	2013	2014	2015	2016	2018	2020
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
EU-15 countries	-0.4	-1.2	-0.5	0.5	0.4	0.2	0.1
Estonia and Lithuania	3.6	2.1	2.7	2.5	2.4	2.2	2.0
Russia	3.4	2.5	2.7	2.9	3.1	3.6	4.0

* actual data

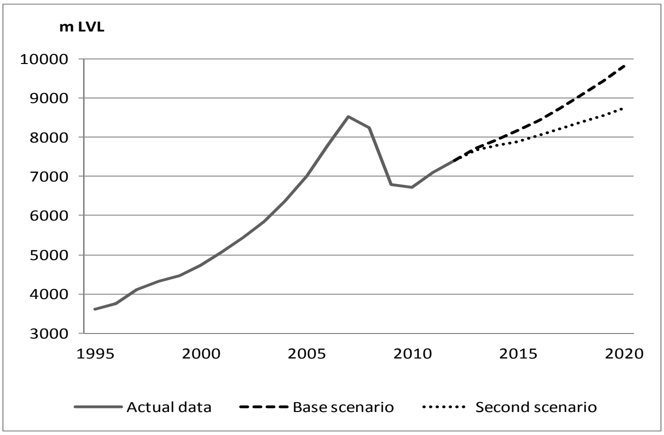
Source: Authors' assumptions

Also different values of marginal propensity to consume are used, which results in a slower increase comparing with the base scenario.

3.3. Forecasts of Macroeconomic Indicators of Latvia

As it was stated before, it is not possible to make plausible forecasts in a comparatively large disaggregation during crises. The main reasons are instability of separate equations and possible influence of specific short-term factors, which might not be taken into account, as well as multiple changes in the government policy. However, aggregated indicators can show plausible trends, if assumptions are made accurately enough. Therefore, only the forecasts of the main macroeconomic indicators are presented in this chapter. All calculations are made using the Latvian macro-econometric model described in Chapter 2.

Using the Latvian macro-econometric model and assumptions of scenarios, it is forecasted that in case of the base scenario real GDP will continue to increase by 3.3% per year on average till 2015 and by 3.7% per year afterwards (see Figure 3.1 and Table 3.5). In case of the second scenario, the growth rates of the real GDP will be comparatively lower – only 2.1%. In this case the value of the real GDP only in 2019 would be larger than its previous maximum in 2007. In case of the base scenario, GDP per person will increase by approximately 2,000 LVL in 2020 comparing with 2012, but in the second scenario the increase is less than 1,000 LVL.



Source: Calculated by the authors, actual data for 1995 – 2012.

Fig. 3.1. Forecasts of real GDP, million LVL.

Highest growth rates of GDP use components are associated with fixed investment and imports, as shown in Table 3.5. Private consumption and exports is also forecasted to grow in both scenarios, but the growth rates of exports in 2013-2015 are comparatively low because of low foreign demand. Only government consumption is forecasted to decrease in constant terms over 2013-2015. Increase in the shares of GDP use components in GDP are changing as well. The share of exports is constantly increasing, the share of government consumption – decreasing. Other share values are similar in 2020 and in 2012.

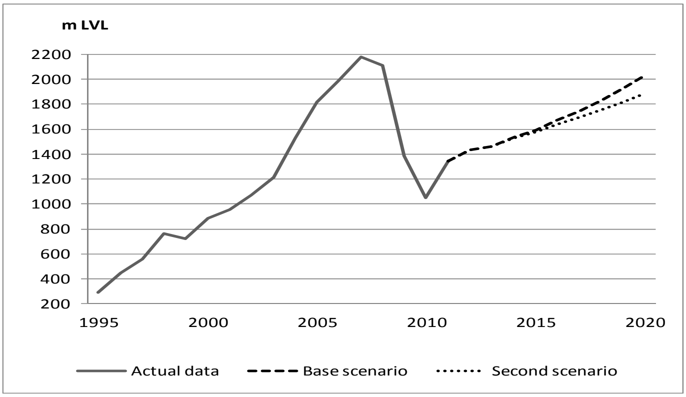
Table 3.5

GDP Use Forecasts, %

	Growth rates (constant prices)			Structure (current prices)		
	2012*	2013-2015	2016-2020	2012*	2015	2020
GDP						
Base scenario	5.6	3.3	3.7	100	100	100
Second scenario	5.6	2.1	2.1	100	100	100
Private consumption						
Base scenario	5.4	3.9	2.6	62.1	66.9	62.9
Second scenario	5.4	2.1	0.5	62.1	64.8	59.2
Government consumption						
Base scenario	-0.2	-2.9	4.3	15.3	14.5	13.8
Second scenario	-0.2	-2.9	1.5	15.3	14.3	12.8
Fixed investment						
Base scenario	12.3	5.9	4.7	23.5	22.4	23.4
Second scenario	12.3	5.3	3.5	23.5	22.4	23.9
Exports						
Base scenario	8.3	1.3	4.8	61.1	62.8	63.5
Second scenario	8.3	0.9	3.5	61.1	62.6	64.1
Imports						
Base scenario	2.9	5.1	4.3	64.4	67.2	65.9
Second scenario	2.9	3.6	2.4	64.4	65.9	63.4

* actual data

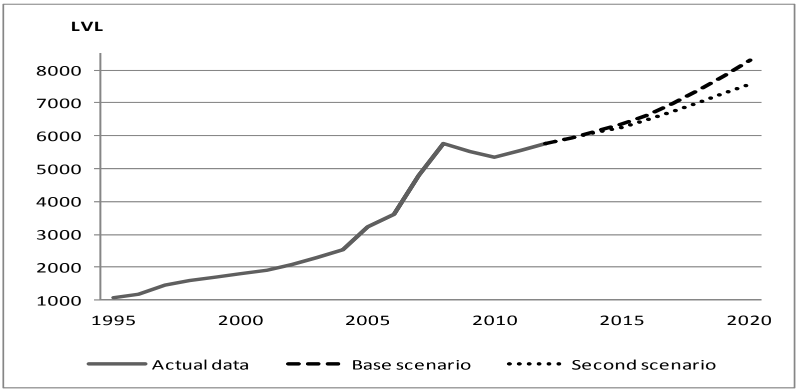
Taking into account the perspectives of the value added and other factors influencing the volume of capital investments, the increase of investments in both scenarios is modest (see Figure 3.2). In the base scenario, the value of capital investment is about 2.0 bn LVL in 2020, in the second scenario – about 2.9 bn LVL.



Source: Calculated by the authors, actual data for 1995 – 2011.

Fig. 3.2. Forecasts of real capital investment, million LVL.

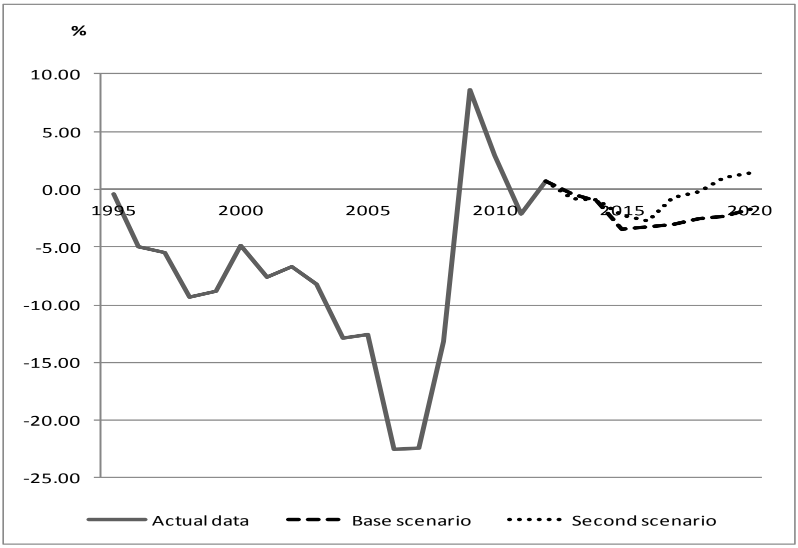
As it is shown in Figure 3.3, annual increase of wages in the base scenario is forecasted at an average rate 3.2% in 2013-2015, and at an average rate 5.5% in 2016-2020. In the second scenario, forecasted growth rates of nominal wages are on average 2.5% in 2013-2015, and afterwards – on average 3.9% a year.



Source: Calculated by the authors, actual data for 1995 – 2012.

Fig. 3.3. Forecasts of nominal annual gross wages, million LVL.

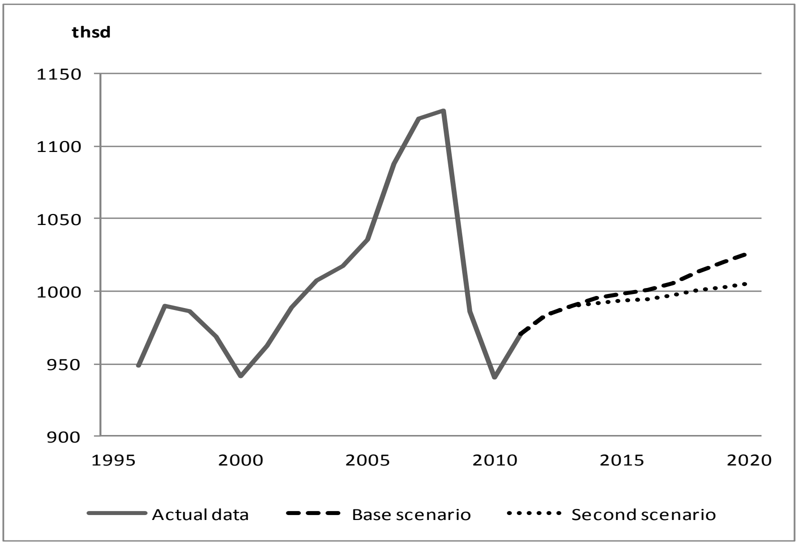
According to the modelling results, current account balance will be mostly negative in the base scenario, as it can be seen in Figure 3.4. Negative value of the current account in percentage of GDP will not exceed 5%. In case of slower economic development, current account balance can turn positive again. In the second scenario positive values are forecasted in 2019 – 2020.



Source: Calculated by the authors, actual data for 1995 – 2012.

Fig. 3.4. Forecasts of the current account of the balance of payments, % of GDP.

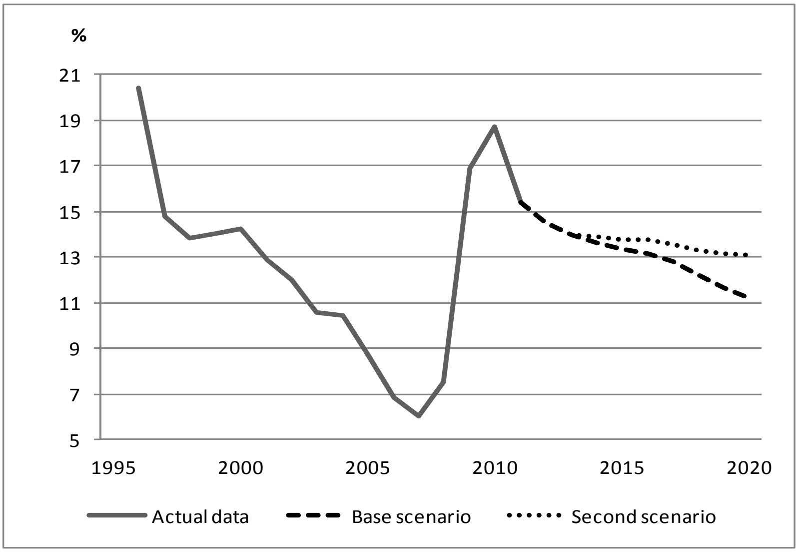
The number of employees will gradually increase in both scenarios (see Fig. 3.5). The number of employees in this case corresponds to the values calculated before the Population Census 2011. According to the census, the number of employees should have been lower at the end of the sample period, therefore the forecasts give slightly larger numbers than they should.



Source: Calculated by the authors, actual data for 1995 – 2012.

Fig. 3.5. Forecasts of the number of employees, thsd.

It is expected that total unemployment rate will decrease, as it can be seen in Figure 3.6. In the base scenario its value in 2020 will be close to 11%, but in the second scenario – 13% of the economically active population.

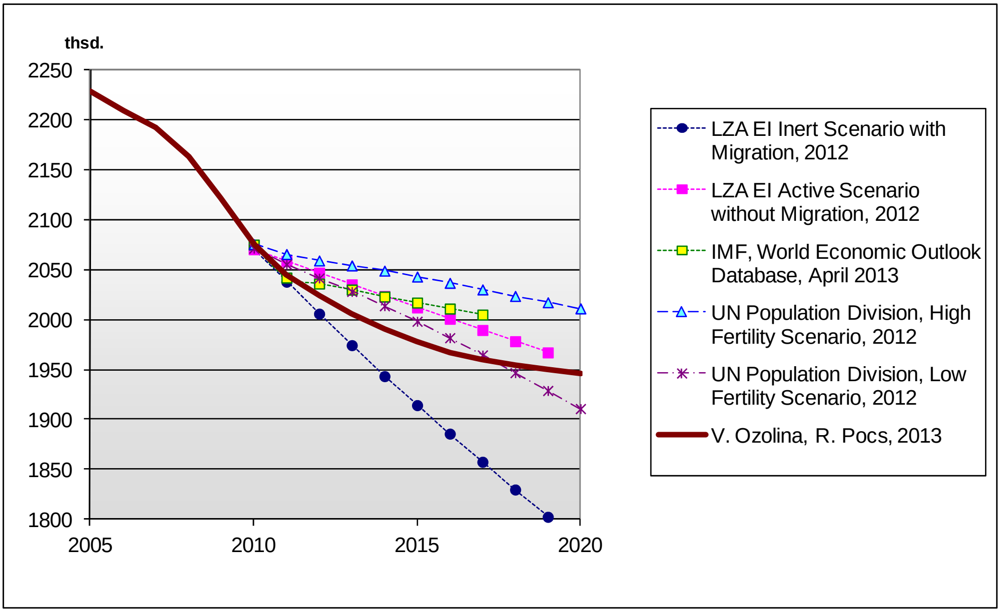


Source: Calculated by the authors, actual data for 1995 – 2012.

Fig. 3.6. Forecasts of total unemployment rate, %.

In compliance with assumptions about further development of the natural increase of population and net migration, total number of resident population during the next years will decrease reaching approximately 1.9 m residents in 2020.

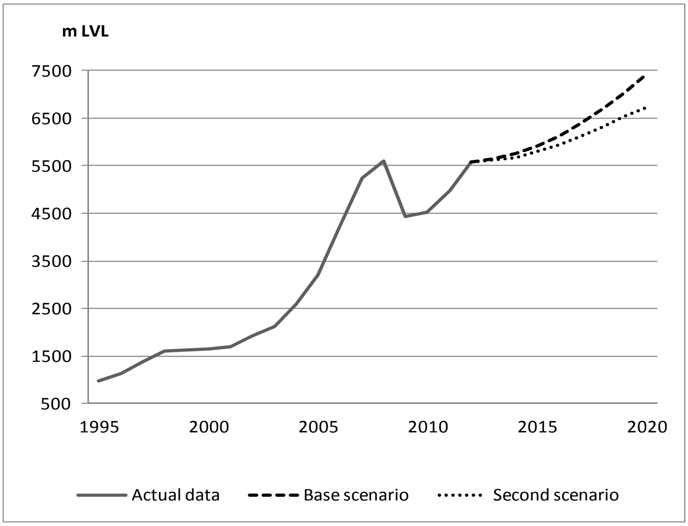
Comparing the obtained forecasts with the forecasts of Latvia's resident population, which are elaborated in other institutions (see Figure 3.7), it is evident that the results in the medium term are mostly in between the extreme cases. Therefore, a conclusion can be made that the Latvian macro-econometric model gives adequate resident population forecasts.



Source: Compiled by the authors.

Fig. 3.7. Forecasts of resident population of Latvia (end of year), thsd.

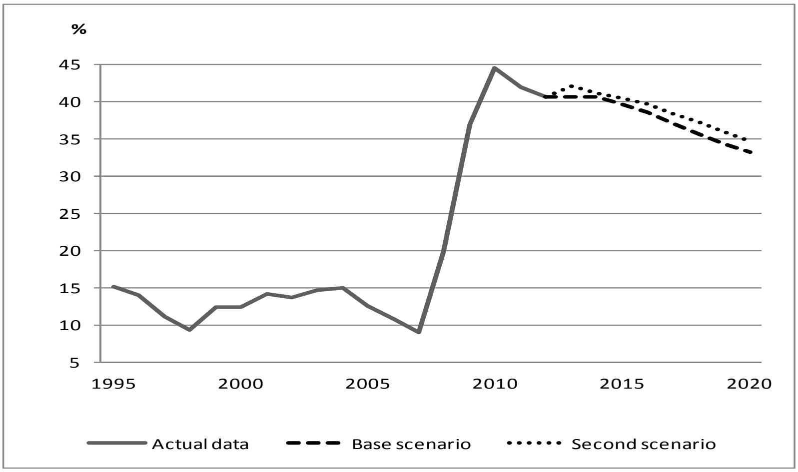
It is forecasted that during the next two years, government budget revenues will be comparatively stable (see Figure 3.8), but afterwards they will begin to increase. In the case of the base scenario, government revenues will increase by an average 4.3% per year. In the case of the second scenario, government revenues will increase approximately by 2.9% annually.



Source: Calculated by the author, actual data for 1995 – 2012.

Fig. 3.8. Forecasts of revenues of general government consolidated budget, million LVL.

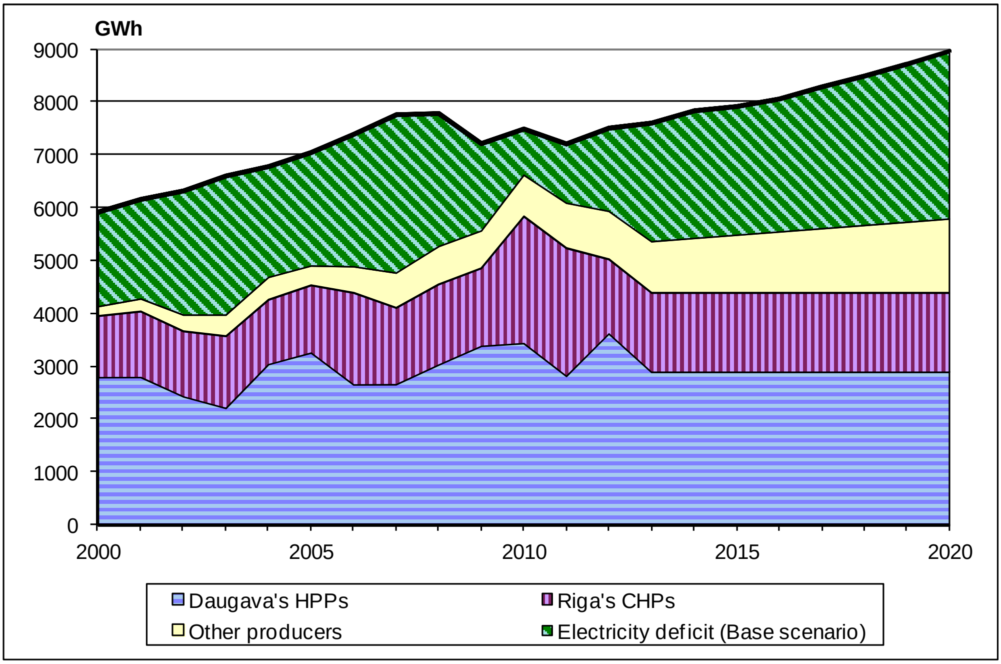
During the next years due to the budget deficit the government debt will also increase (see Figure 3.9). However, in percentage of GDP its volume should not exceed the maximum level stated in the Maastricht Treaty (60% of GDP).



Source: Calculated by the authors, actual data for 1995 – 2012.

Fig. 3.9. Forecasts of the government debt, % of GDP.

According to the assumptions made and the calculations of the model, total consumption of electricity will gradually increase (see Figure 3.10). The obtained electricity consumption forecasts can be used for evaluation of reliability of electricity supply. In the context of research, reliability of electricity supply is seen as the ability of the country to secure domestic electricity consumption with domestically produced electricity. Therefore, the larger share of consumption is secured with domestically produced electricity, the higher is the reliability of electricity supply.



Source: Calculated by the authors, actual data for 2000 – 2012: CSB data base [96], information of Latvenergo [41; 133].

Fig. 3.10. Forecast of the total final consumption of electricity (including losses), GWh.

According to the forecasts of the base scenario presented in Figure 3.10, as well as assumptions about potential electricity production capacities in Latvia, electricity deficit will increase from 11.6% in 2011 (which was at its minimum value in the 21st century) to 35.5% in 2020. It is less than the maximum deficit of 38.6%, which was recorded in 2007.

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Macroeconomic Modelling and Elaboration of the Macro-Econometric Model for the Latvian Economy

Scientific Monograph

Literary editor T. Smirnova

Parakstīts iespiešanai 2013.16.12. Reģ. apl. Nr. 2-0282.
Formāts 60x84/16. Ofseta papīrs. Ofseta papīrs. 12,0 iesp.l.,
8,68 uzsk.izd.l. Metiens 300 eks. Pasūt. Nr. 127.
Iespiests RTU tipogrāfijā, Rīga LV-1658, Kaļķu ielā 1.