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Structural Changes, International Trade and Multisectoral Modelling

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PREFACE

In September 2007 the national team members of the International Inforum (Interindustry Forecasting Project at the University of Maryland) group held the XV annual World Conference in Truijllo, Spain. Such Conferences offer the participants to report their achievements in the different fields concerning the macroeconomic multisectoral modeling approach and data development.

The national partners build their country model based on a common input-output accounting structure and a similar econometric modeling approach for sectoral and macroeconomic variables. In each Conference, the contributions refer to the wide spectrum of research activities carried on within the Inforum system of models. Modeling methodology, improvements of the common software, data management and development, policy analyses supported by model tools based on a bottom-up approach which properly portrays the economic details used by policy makers are all topics of the conferences.

Inforum was founded 40 years ago by Dr. Clopper Almon, now Professor Emeritus of the University of Maryland. The modeling approach, once named 'modern input-output' model and now with the more descriptive 'Macroeconomic Multisectoral Model', is described in a number of papers available on the web site www.inforum.umd.edu.

This book is a collection of selected papers presented at the XV Inforum World Conference. The opening paper is a remarkable example of the complex approach and innovative solutions created within Inforum. **Clopper Almon** and **San Sampattavanija** propose a method to solve a problem that has great practical importance in applied forecasting: the «ragged-end» phenomenon of statistics that must be used from a model builder to obtain results that are both reliable and up-to-date. The paper presents the first systematic attack on this problem for economy-wide, industry-level models: the approach is to use high-frequency – monthly or quarterly – data to produce estimates of current and near-term future values of the annual series used in the long-term model and thus eliminate, from the point of view of its builder, the ragged-end phenomenon. Results show that annual series forecasted with this method are certainly more accurate than using the long-term model to forecast the current year, although they are sensitive to the accuracy of the forecasts of the exogenous variables.

The first section is devoted to multisectoral modeling. **Maurizio Grassini** describes some issue arisen in building the updated version of INTIMO (Interindustry Italian MOdel): the problem of chain indexes, the analysis of labour productivity and the replacement ratio of capital stock. The adoption of chain indexes does not preserve the accounting identities in the models whereas the variables are measured in constant values thus a rescaling procedure is proposed. The analysis of different measures of the employed work force emphasizes that labour market structural reforms in Italy have produced some effects during the last decade, hence the labour productivity time series have to be carefully used in forecasting because past behavior is unlikely to continue in the near future. **Astra Auziņa** and **Remigijs Počs** present a detailed description of the basic structure of an INFORUM-type model for Latvia. The paper shows the most important steps and gives an insight of the difficulties of multisectoral model building for a recent new EU member state and Inforum new partner as well. The design of scenarios in a fast-growing economy with structural changes makes economic forecasting a challenging task. The final paper of this section is by **Alexander Baranov** and **Victor Pavlov**. The authors present forecasts for the Russian economy with a deterministic Dynamic Input-Output Model for the period 2008-2012. The analysis shows that a double level of fixed assets is necessary for the Russian economy to achieve a considerable growth of GDP up to 2017 with a remarkable increase of labour productivity.

Two contributions about the Chinese economy are collected in the second section on data issues. **Mingshuo Fei** and **Shengchu Pan** describe the new features of a databank for the MUDAN multisectoral model of China. In this country, official statistics frequently change their structure to keep up with the fast-growing economy. Therefore it is of outmost importance to understand and use the most recently released data to make the model more accurately reflect the Chinese economy. On the same topic **Li Shantong**, **Ge Xinquan** and **Shao Huiyanx** analyse the input-output data of China at the regional level to compare the similarity between the local industrial structure and the national one through the similarity coefficient. Then the authors investigate how an industry affects its forwards industry and discussed the relationship between the change in trend of an industry's technological density and its capital structure. Finally, the paper analyzes the importance of each sector in the national economy by using an index of backwards linkage and an index of forwards linkage.

The section on domestic demand is devoted to personal consumption. Indeed while the contribution by **Rossella Bardazzi** estimates and compares the behavior of household expenditure in Italy and France, **Jonela Lula**, **Gabrielle Antille Gaillard** and **Jean-Paul Chaze** estimate private consumption in Switzerland with alternative demand systems. In the first paper household consumption is estimated on a similar classification of expenditure functions for the two EU economies with the system of demand equations PADS developed by Almon and widely used within Inforum models. In the second paper this approach is compared with the linear expenditure system and the almost ideal demand system on a set of 12 functions over the period 1980-2005.

International trade modeling is one of the outstanding features of the Inforum system of models. The related section opens with a contribution by **Josef Richter** and **Reelika Parve** on a linkage between a newly built multisectoral model for Austria and a Bilateral Trade Tool for EU27. This is a partial linking since the model is included as a satellite in the trade system, thus this approach is a first step to a full linkage with feedbacks from other countries included in the system. **Douglas Nyhus** uses the MUDAN multisectoral model of China to examine the effects of possible policies that China could do to narrow and/or close its merchandise trade gap over the next ten years. In recent years Chinese growth has been led by exports and this has created a trade surplus and a 'twin' surplus of domestic savings over investment that must be managed with domestic policies. The currency appreciation associated with domestic demand side measures to reduce savings are simulated in the model to investigate the macroeconomic and the industry-level effects. Finally, the paper of **Reelika Parve** presents a theoretical and empirical analysis of the development of a widely used approach to international trade modelling, namely the gravity approach. An extensive review of both theoretical and empirical literature is presented and the gravity model is applied on Italian multisectoral trade flows. Results confirm serious doubts on the applicability of this approach on sectoral data.

The final section concerns energy issues which are ranked very high on the agenda of all model builders. **Michal Przybylinski** presents a new block of foreign trade equations for IMPEC – the multisectoral model of the Polish economy to enable analysis of how changes in world prices of basic energy carriers can influence the domestic economy, especially households. The contribution by **Mariusz Plich** is related to the construction and preliminary use of a very important set of data to join economic and environmental information: the National Accounting Matrix including Environmental Accounts (NAMEA) implemented at the European level. The author develops this accounting framework for Poland from several sources and presents a time-series of NAMEA (1995-2002). Then a decomposition analysis is performed with this data. Finally, **Velga Ozoliņa** and **Remigijs Počs** develop an analysis of electricity consumption building an energy block within the multisectoral model of Latvia. Sectoral equations for electricity consumption are estimated and used in the model to forecast consumption up to 2020: results show that national production of electricity will be insufficient to cover the estimated absorption then this deficit should be covered with net imports or new production facilities.

ROUNDING OUT THE 'RAGGED END' OF HISTORICAL DATA

Clopper Almon, San Sampattavanija[1]

1. The Problem and an Approach to its Solution

Economic forecasts should be based on data that is both reliable and up-to-date. Those two requirements, however, are often contradictory. For example, in a structural model of the U.S. economy with many industries, the most reliable data on the output of the industries comes from the *Census of Manufacturing* and other economic censuses. These censuses, however, are conducted only every five years and processing them requires about two years. Meanwhile, the *Annual Survey of Manufactures* produces sample-based estimates of output with a lag of a little over a year between the end of the reference year and the date of publication. The National Income and Product Accounts (NIPA) appear in full detail at the end of July each year for the previous year. The quarterly version of the NIPA first appears about a month after the end of the quarter. The Federal Reserve Board's indexes of industrial production appear near the end of each month for the previous month. The Census Bureau's *Manufacturers' Sales, Inventories, and Orders* likewise gives monthly data with a slightly longer lag.

For example, if, in November of 2007, we are forecasting to 2020, the last really firm data we have for automobile output is the 2002 Census of Manufacturing, but we have data through 2005 from the Annual Survey of Manufactures, and the full annual NIPA up to 2006, quarterly NIPA for three quarters of 2007, and the industrial production indexes for the first nine or ten months of 2007. From a quarterly macroeconomic model estimated on data through the third quarter of 2007, we may also have quarterly forecasts for the fourth quarter of 2007 and all of 2008 for many series in the NIPA, including consumer spending on automobiles.

[1] Clopper Almon is Professor of Economics Emeritus at the University of Maryland. San Sampattavanija has received a Ph.D. in Economics from the University of Maryland in 2008 with a dissertation based on the study reported here.

We may refer, for short, to this disparity in the end points of the various data series as the 'ragged-end' phenomenon or problem. In view of this ragged end of the data, what values should our forecasts made in November 2007 show for 2006 and 2007? If we choose something other than what the structural model produced, how should the forecasts for 2008 and future years be affected by the difference?

This problem has great practical importance in applied forecasting. The model builder may well take the position that the structural model is meant to capture trends and long-term developments, not short-term fluctuations. The users of the model, however, inevitably look at the recent past and short-term future values. Those working in industry are most likely to look at what the model says about the current *sales* of their industry. Getting sales right requires getting right not only final demands but also input-output coefficients, so it is severe test of the model. If what these users see does not match their own experience or recent statistical data, they are quite prone to discount the model's results or, indeed, to dismiss them altogether. Thus, the credibility of the long-term model can depend heavily on a solution of this short-term problem.

It may be noted that this problem barely exists for builders of quarterly, macroeconomic models. In countries where such models are feasible, the quarterly accounts available regularly from the statistical agency are almost as up-to-date as one can be. If, however, some series are available monthly, they can be used in ways described here to update the quarterly series to one quarter beyond the end of the released data.

The study summarized here is the first systematic attack on this problem known to us for economy-wide, industry-level models[2]. It offers no clever algorithm for a general solution of the problem. Rather, it is a data-intensive procedure to provide an up-to-date starting point for one particular model, the LIFT model of the USA. The approach is to use high-frequency – monthly or quarterly – data to produce estimates of current and near-term future values of the annual series used in the long-term model and thus eliminate, from the point of view of its builder, the ragged-end phenomenon.

In the above example, we would produce 'data' for series in the model up through the end of 2007, even though that year is not yet totally history. The equations of the long-term model would then be estimated through 2007 and forecasts made for 2008 and future years with rho-adjustment for autocorrelated residuals in the regression equations[3]. It

[2] For references to other related studies for relatively small-scale models, see the Ph. D. thesis of San Sampattavanija at the University of Maryland, 2008.

[3] Rho adjustment has long been a standard feature in Inforum software. In the base year of the forecast – a year for which historical data is available – the model calculates the value predicted by an equation. The error is recorded. Then in the first period of

would also be possible to use the forecasts from a quarterly macroeconomic model as exogenous variables in equations to forecast the series of the industry-level model through 2008 and start the long-term forecast from that year as if it were already history. Naturally, one could forecast 2008 in both of these ways and then take some average as the starting point of the long-term forecast.

Although simple in approach, to be effective this solution must include implementation of a computational procedure which quickly and almost automatically acquires the most recent data from the Internet (and other media), processes the data, extends the series, and re-estimates the equations of the structural model, including provision of adjustments for autocorrelated error terms.

This study undertakes to develop such system in the context of the LIFT model of the USA. The model, as it stood at the beginning of this work, had outputs and prices for 97 sectors or products, employment for 97 industries, personal consumption expenditure for 92 categories, and equipment investment for 55 categories. The value-added sectoring is comprised of 51 industries. Most equations in the model are estimated at an industry or product level, and the price and output solution by industry use the fundamental input-output identities. The LIFT model has been producing satisfactory long-term forecasts, but one of its weak spots has long been in short-term forecasting, especially in "forecasting" data that is already "history". A new version of the model is under construction, and we have not felt compelled to follow exactly the structure of the present model, but anticipate that the structure of the new model may, to some extent, be influenced by level of detail that can be supported by the work reported here.

Ideally, all series used in the structural model should be extended to a uniform terminal date, so that the ragged-end problem totally disappears and we have a complete "flat-end" data set. In practice, the system of updating the series must be developed gradually, and the work begun here is not yet totally finished. The flat-ended dataset does, however, now – as a result of this work -- include some of the most important series such as personal consumption expenditures, fixed investment and gross output of industries. Significant series still missing are exports, imports, inventory change, and government expenditures in LIFT detail.

the forecast, this error is multiplied by ρ, the autocorrelation coefficient of the residuals of the equation, and added to the value predicted by the equation. In the second period of the forecast, the error in the base year is multiplied by ρ^2 before adding to the prediction of the equation, and so on. Thus, the model slides onto the equation's forecast rather than jumping on all at once. The methods described here do not replace rho-adjustment. Rather, they give the rho-adjustment process a recent and relatively uniform starting point.

The procedures developed here use monthly or quarterly up-to-date data, such as the industrial production indexes, as indicators of the more basic (but not yet available) annual data for the previous year or two. The higher frequency data can also be used to forecast the basic data for the rest of the current, incomplete year and, towards the end of the year, for the following year.

One of the problems in working with high-frequency data is that it is subjected to revision, especially in the first several periods after the first release. When analysis of revisions began, a predictable pattern was discovered for some series. These patterns have now largely been eliminated by the producers of the series. We will therefore ignore the revision problem in this work, though we still have to keep in mind that we cannot compare models directly without considering the data vintage.

The work of the solution developed here can be divided into six steps.

1. Update all data banks to have the most recent data both for annual data and for higher frequency data.
2. Re-estimate and run the quarterly macroeconomic model, in our case, QUEST. This step includes examination of the exogenous assumptions.
3. Extend high-frequency data to the end of current year and perhaps one year beyond by using time-series analysis and interpolated monthly data from the quarterly macroeconomic model.
4. Use this data to predict the annual series used in LIFT. This step produces the flat-end data set.
5. Re-estimate LIFT equations using this data.
6. Start LIFT with the base year in last or next to last year of the flat-end data set.

The work which will be described here is primarily steps 3 and 4. In Step 3, we work on each high-frequency variable at its original frequency. In Step 4, we move to the annual frequency to get the values we actually introduce into the long-term model.

For example, let us suppose that we were working in early November of 2007 and need values of Gross output by industry for 2006, 2007 and 2008. In late October, the Federal Reserve Board would have published the Industrial Production Index (IPI) through September 2007. We have to calculate the value of the IPI for October 2007 (the current period) and the future values through the end of 2008. Using time-series econometric techniques, more specifically, autoregressive moving average (ARMA) equations seemed to be an appropriate way to begin work on the estimation. Inclusion of moving average error terms, however, complicated the estimation procedure without noticeable improvement in the performance of the equations, so what has actually been used is autoregressive equations with exogenous variables, what we might call AREX. In Step 4, we then make an annual series from the monthly IPI series, estimate annual regressions between the annual Gross product data and the annualized IPI over the years from, say, 1995 to 2005, and use these regressions with the annualized IPI to forecast Gross product for 2006-2008.

Section 2 develops the flat-ended dataset for Personal consumption expenditures; Section 3, for investment in equipment and software by purchasing industry; Section 4, for construction by type; and Section 5, for gross outputs of input-output industries. In each section, we test the method by making forecasts for two full years ahead over years for which we actually have data which we can compare to the forecast. Actually, we make two forecasts, one using the actual values of the exogenous variables and one using values which could have been mechanically calculated at the start of the test period. The first of these is a test of the equations and methods developed here. The second, combines a test of these methods with the errors in the exogenous variables which are likely to be encountered in real-life forecasting. It is to be expected – perhaps even to be hoped – that the errors in the second simulation will be larger. If they were not, it would indicate that the methods are not sensitive to the macro-economic assumptions that go into them. For forecasting two full years ahead, that would be undesirable. Fortunately, we will find that the forecasts are quite sensitive to those assumptions.

These tests are in one important respect 'worst case' tests, namely, the first year is a full-year forecast. Often the method would be used in November or December – the traditional forecasting season – when much more of the high-frequency data would the available for the first year and the second year would not be so far into the future.

2. Personal Consumption Expenditures

The Bureau of Economic Analysis (BEA) of the U. S. Department of Commerce releases monthly Personal Consumption Expenditure (PCE) data in 233 primary series. Some of these, however, come from the same input-output industry in the LIFT[4] model or are so specific or small that little is gained by keeping them separate. From the 233 categories, we therefore created 116 new categories for forecasting. The new categories can be created by simple aggregation without any splitting from the 233

[4] LIFT is an Interindustry Economic Model Based of the Input-Output of the U.S. It is one of the main economic model used by INFORUM <http://www.inforum.umd.edu/Lift.html>.

BEA categories. They can also be simply aggregated, without splits, into the 13 groups called by BEA «Major types of products». The 116 categories include 24 durable products, 41 nondurable products, and 51 services. The large number of service categories reflects the recent trend of U.S. consumer spending to this area. It so happens that each of the 116 categories is either a BEA subtotal or a primary category, so we have BEA-provided series for the price indexes as well as the nominal values.

For each of the 116 categories, we have two monthly regression equations, one for the nominal value of the series and one for the price index. An important source of explanatory variables is the quarterly econometric model QUEST built and maintained by Inforum. For this project, it has been expanded to include all 13 of BEA's series on PCE by Major types of products. QUEST's forecasts of GDP, Personal disposable income, and the rate of inflation in food prices are also available. All QUEST variables are quarterly but, for use in these equations are converted from to monthly frequency by the @qtom() function in the G regression and model building program. For some products, "Refiner Acquisition Cost of Crude Oil, Composite" proved useful. The data comes from the Energy Information Administration[5] (EIA). This data is published monthly with a delay of approximately three months, e.g. the December 2006 number was published in March 2007. A final exogenous variable is the Dow-Jones index of the prices of the stocks of industrial companies.

The estimated equations are then used to forecast the two series for each of the 116 categories at a monthly frequency to the end of the current year and on through the next calendar year. These monthly forecasts are then converted to quarterly and annual frequency by G's @mtoq() and @qtoa() functions.

The method was tested by making forecasts for 2005 and 2006 as if we were in February 2005, with data through the end of 2004. We made two simulations. In the first, we used the actual values of all the exogenous variables in 2005 and 2006. For the second, we used projections made by QUEST estimated through 2005 and given mechanically generated, trend projections of its exogenous variables. Other exogenous variables were given trend projections based on data through the end of 2004. Thus, the first simulation tests the method in an ideal case; the second, in "battlefield" conditions. For concise presentation, the results were aggregated to BEA' s 13 Major Types. Table 1 shows the percentage errors for the aggregates in constant prices. A positive error means that the forecast was on the high side.

With actual values of the exogenous variables, the method worked reasonably well, with an error of 0.38 percent in the total in both years.

[5] <http://www.eia.doe.gov/emeu/mer/prices.html, table 9.1>.

In the more realistic situation of the second simulation, the largest errors were in the over-prediction of expenditures on Motor vehicles and on Gasoline and fuel oil. These errors are easily explained by consumers' reactions to the increased prices of petroleum products, an increase which was not anticipated by the mechanical projections on which the second simulation was based.

Tab. 1. Percentage errors in forecasting PCE categories

Chained Real 2000 dollar

Deviation from the BEA data as of April 2007 in percent		2005 actual exog	2005 predicted exog	2006 actual exog	2006 predicted exog
apce	Personal consumption expenditures	0.38	0.58	0.38	0.93
md	Durable goods	1.42	2.40	2.55	2.75
dmv	Motor vehicles and parts	0.97	5.41	1.51	7.80
dfur	Furniture and household equipment	1.84	1.15	3.46	0.50
doth	Other durable	1.68	-1.69	3.27	-2.79
nd	Nondurable goods	0.42	-0.04	1.19	0.32
nfood	Food	0.28	-1.49	1.04	-3.24
ncloth	Clothing and shoes	1.68	1.07	3.15	0.53
ngas	Gasoline, fuel oil, and other energy goods	-0.38	4.76	-0.11	17.91
noth	Other nondurable	0.35	0.00	1.00	-0.67
sv	Services	0.16	0.52	-0.45	0.85
sho	Housing	-0.98	-0.56	-2.26	-0.71
shoop	Household operation	-1.66	-2.10	-4.21	-1.67
str	Transportation	1.81	1.89	2.65	2.49
smc	Medical care	0.87	1.28	1.39	2.18
srec	Recreation	-0.02	-0.98	0.07	-1.97
soth	Other Services	0.85	1.88	-0.29	2.21

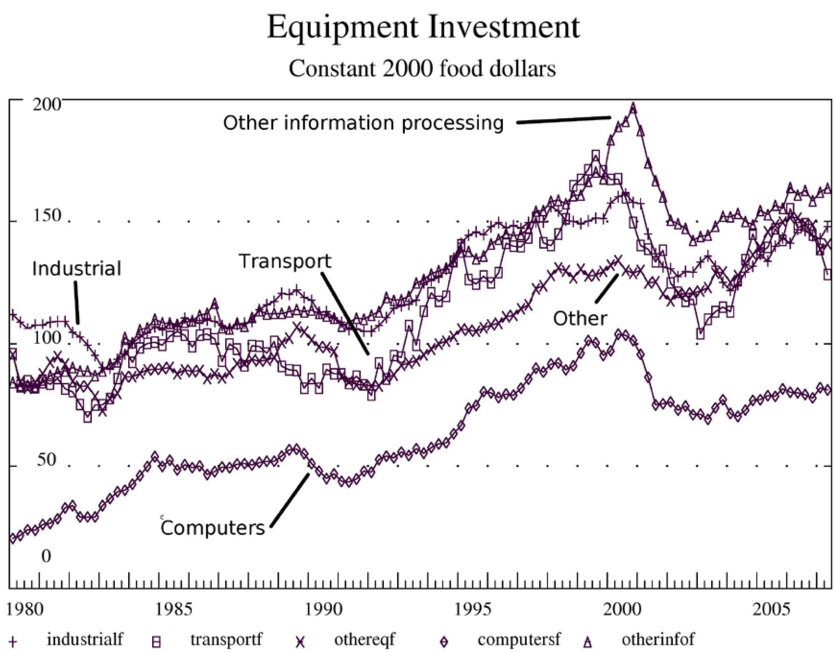
3. Investment in Equipment and Software

Had we shown a graph of the broad aggregates of PCE, it would have been a rather boring display of smooth trends. Equipment investment, as shown in Figure 1, is another story. After steady growth up to 2000, all of the major aggregates plunged downward in 2001 and 2002. This volatility warns us that we make expect larger errors in forecasting here than in PCE.

The data situation for investment is very different from that for consumption. For consumption, we had monthly data in the same detail as that we wanted to use for the annual forecasts. For investment in equipment, there are no monthly data at all. Quarterly, we have six series in the NIPA for investment by type, namely: 1. Computers and peripherals, 2. Software, 3. Other information processing equipment, 4. Industrial equipment, 5. Transportation equipment, 6. Other equipment.

Only at an annual frequency do we find data of the kind we need. The NIPA show series for 27 primary types of equipment plus several subtotals. These series, however, are all by type of equipment, not by purchaser of the equipment. In a model with industry detail, however,it is natural to model investment by purchaser. It is therefore very fortunate that there is now another set of accounts, known as the Fixed Asset Accounts, also prepared by BEA.

Fig. 1. Investment in Equipment and Software



The objective of the FAA is to create series on the capital stocks by industry, but on the way to this objective they produce series on equipment purchases by buying industry. In fact, the FAA include a complete equipment capital flow matrix showing the sales of each type of equipment to each industry. The FAA series on equipment investment by purchaser are made by distributing NIPA investment by type to likely buying industries. In making this distribution, BEA may use various sources of information on investment by purchaser such as the Annual Survey of Manufactures and the economic censuses. The result, Equipment and software investment classified by purchasing industry, has 63 purchasing industries and a complete capital flow matrix showing what types of equipment each of these purchasers buys. Our task, put briefly, is to produce up-to-date estimates of these 63 series for the current year and one ahead. These estimates are, as usual, needed in current and constant prices.

The FAA, it may be noted, appear at about the same time as the annual NIPA, that is, in late July or early August of the year following the year which they describe. The capital flow matrix in current prices[6] can be converted to constant prices using whatever price index one likes on each row and then summing the columns. Because, as the model runs, the capital flow matrix will be used in the other direction, that is, to convert investment classified by purchaser to investment classified by product purchased, we will make the series on constant-price investment by purchaser by simple addition of the components, not by Fisher chained indexes.

Although the FAA capital flow matrix provides important input for the construction of the capital flow coefficient matrix needed for the interindustry model, it does not yield that matrix by simply dividing each column by its total to get a matrix with columns summing to 1.0. The problem is that the interindustry model needs a matrix in producer prices; the FAA capital flow matrix is in purchaser prices. The margins for transportation and trade must be stripped off the sales of equipment and put into the trade and transportation rows. That step, however, is beyond the scope of this study.

As already indicated, our problem is short-range forecasting of the 63 primary series on investment. We need forecasts for both current-price values and constant price values. Our approach is in six steps.

- Step 1. Make quarterly forecasts of both current price values and the price indexes of the six series for which we have quarterly data in the NIPA. These forecasts will be made with inputs from QUEST. They will be in quarterly frequency to make use of the fact that we often have three or even four quarters of a year before the FAA data appear. Convert these quarterly forecasts to annual forecasts.
- Step 2. Make preliminary annual forecasts for two years ahead for each of the 63 primary series which are the target of our work. These equations may use as explanatory variables one or more of the six series forecast in Step 1 or their sum. They may also use their own lagged values.

[6] The BEA name of the file is detailnonres_inv1.xls. To get to it from the BEA main website, <www.bea.gov>, click «Fixed Assets», then under «Fixed assets» to the right of «Interactive tables» click «Fixed assets tables». Then to the right of «Download a spreadsheet of» click «Detailed fixed assets tables». On the screen where that brings you look for « 2. Nonresidential detailed estimates». Under it find «5. Investment, historical cost». To the far right click on «XLS» and download the file. The last tab, called «Datasets» has all of the series in one sheet.

- Step 3. Aggregate the rows of the FAA capital flow matrix to match these six rows and convert to a capital coefficient matrix. (This step might be done with either the matrix of the most recent year or with a (perhaps weighted) average of the last two or three years.
- Step 4. Multiply the coefficients of the matrix made in Step 3 by the forecast of the corresponding investment series made in Step 2.
- Step 5. Scale each of the six rows calculated in Step 4 to sum to the total for the corresponding series forecast in Step 1.
- Step 6. Sum the columns of the matrix found in step 6 to give the current price annual forecast for each of the 63 series.
- Step 7. Convert each row of the matrix found in Step 5 to constant prices using the price indexes found for each of the six series in Step 1. Sum the columns to get the forecasts of the 63 industries in constant prices.

This rather round-about method has the important feature that the information in the six quarterly series is fully used. We test it with two simulations. As with PCE, the first simulation is done with actual, *ex post*, values of the exogenous variables, while the second is made with forecast values of these variables made by running QUEST with mechanical projection of its exogenous variables. Table 2 shows the results aggregated to major industry groups.

Considering the volatility of the investment series, the first simulation, with an error of less than 1.5 percent in the total in both years, looks surprisingly good. The fact that the second simulation overshot by 8 or 9 percent merely means that QUEST was excessively bullish about investment.

4. Construction

We have for construction all the sources we had for equipment plus two more highly important ones. Namely, as in equipment, we have:

- NIPA Quarterly – 5 series;
- NIPA Annual 25 series;
- FAA Annual 15 series.

In addition, we have a monthly survey conducted by the Bureau of the Census on the value of construction put in place (VIP) which is the fundamental source for the NIPA and FAA series. It is available both monthly and annually. Thus we have also:

- VIP Monthly – 12 non-residential series plus 1 residential;
- VIP Annual – 62 non-residential series plus 3 residential.

Tab. 2. Percentage errors in forecasting of Investment in Equipment and Software

Investment in Equipment and Software by Purchasing Industries

	1st Sim		2nd Sim	
Percentage difference from the published nominal value	2005	2006	2005	2006
Total Private fixed assets	1.47%	1.43%	8.72%	8.04%
Agriculture, forestry, fishing, and hunting	4.16%	7.79%	5.98%	6.17%
Mining	2.06%	3.44%	11.72%	6.01%
Utilities	-6.94%	-8.65%	-5.20%	-2.63%
Construction	3.46%	2.06%	-1.02%	-6.46%
Manufacturing	-1.77%	-0.04%	-3.53%	-0.15%
Durable goods	-0.34%	2.75%	-1.54%	4.15%
Nondurable goods	-3.87%	-4.15%	-6.46%	-6.47%
Wholesale trade	-9.46%	-9.69%	-2.76%	-4.48%
Retail trade	8.20%	4.99%	10.85%	8.08%
Transportation and warehousing	2.83%	2.12%	28.73%	26.92%
Information	2.05%	2.09%	28.16%	30.80%
Finance and insurance	8.31%	7.01%	22.21%	22.95%
Real estate and rental and leasing	1.76%	5.58%	25.16%	18.06%
Professional, scientific, and technical services	0.31%	-1.82%	1.75%	0.98%
Management of companies and enterprises\5\	11.66%	6.35%	11.33%	8.25%
Administrative and waste management services	7.02%	3.65%	8.02%	5.90%
Educational services	11.52%	8.12%	11.44%	9.51%
Health care and social assistance	-0.09%	1.11%	-2.70%	-0.68%
Arts, entertainment, and recreation	10.23%	14.04%	12.21%	14.76%
Accommodation and food services	2.13%	-0.62%	4.36%	-1.65%
Other services, except government	8.44%	7.20%	9.14%	9.29%

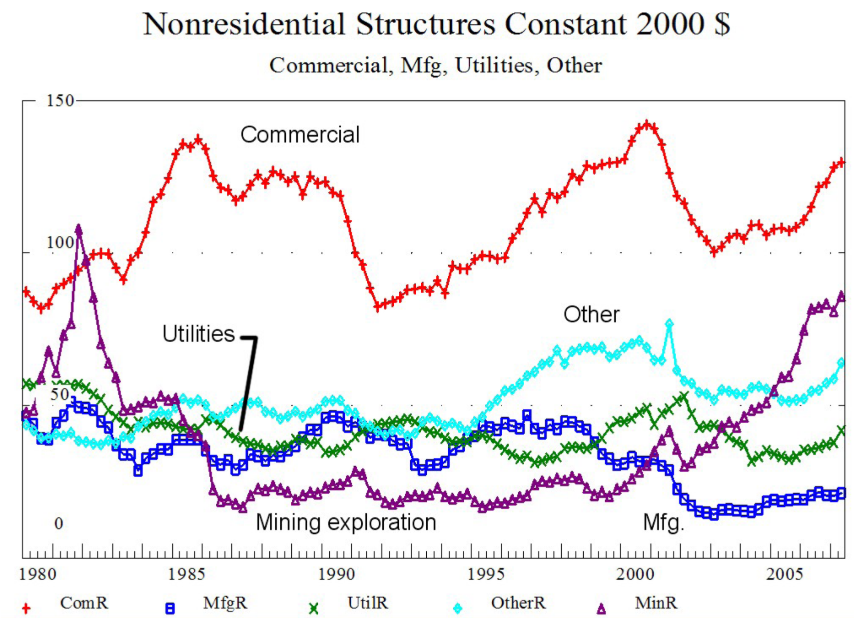
The NIPA include three series not in VIP, namely (1) Mining exploration, shafts and wells, (2) Brokers' commissions, and (3) Net purchases of used structures. Other than in these items, the two series agree closely, as is to be expected since the VIP is the main source for the NIPA series. The Brokers' commissions amount to little for Nonresidential structures but are significant part of NIPA Residential construction.

Because we are going to have to face some fairly large percentage errors in our forecasts, we show in Figure 2 the recent history of the five categories for which the NIPA give quarterly data. The volatile nature of the series is evident, so some fairly large percentage errors may be expected.

For **Non-residential** construction, we proceed in the following steps:

- Step 1. Forecast using time-series methods the 12 VIP monthly series three months ahead and extend the series by as many of these months as necessary to round out the current quarter.
- Step 2. Convert the monthly series developed in Step 1 to quarterly series.
- Step 3. Forecast these 12 quarterly VIP-based series to the end of the following year, relating them to quarterly series from QUEST. Do the same for Mining exploration, for which the quarterly NIPA provide values.
- Step 4. Convert these 13 quarterly series to annual series.

Fig. 2. Investment in Nonresidential Structures, NIPA Quarterly Data. All series deflated by the NIPA deflator for Manufacturing construction



- Step 5. Use the 13 annual series as regressors to forecast the corresponding annual NIPA series.

These should be the series needed by the interindustry model.

Brokers' commissions and Net purchases of used structures need to be projected annually exogenously. No specific data is available on them at a higher frequency.

The plan for **Residential construction** will be significantly different because the quarterly NIPA give important information not contained in the monthly VIP. Namely, whereas monthly VIP gives only one series for all Residential construction, the quarterly NIPA give three series: 1. Single family, 2. Multifamily, and 3. Other. These are distinctions worth keeping because the 2002 benchmark I-O table has two separate columns, one for the sum of the first two series and one for the third. Moreover, by borrowing information from the 1997 table, it should be possible to split the first of those columns so that we would have three columns matching exactly the three quarterly NIPA series. The following plan makes use of all this data.

- Step 1. Forecast with time-series methods the monthly VIP series three months ahead.

- Step 2. Convert this series to quarterly frequency. The converted series will not go past the present quarter.
- Step 3. Regress each of the three NIPA quarterly series on this one and use to forecast the NIPA series through the current quarter.
- Step 4. Forecast these three quarterly series further ahead, through the end of the next year, with exogenous variables from QUEST.
- Step 5. Convert these three series to annual values for use in the annual multisector model.

Application of these procedures in the two simulations already described produced the results displayed in Table 3. The aggregated, calculated by summing up the pieces, is very close indeed in the first simulation while the errors on the low side in the second simulation follow from a low-side error in the QUEST model's forecast. A number of large percentages stand out on first glance at the table, but -- with the notable exception of manufacturing – they are all in small, volatile industries. Manufacturing was reeling from foreign competition in these years.

5. Gross output of industries

Gross output of the various industries in the input-output table – roughly speaking, the sales of the industries – is in the center of the computing sequence of interindustry models. They begin with the final demands, some of which we have already studied, and then go through the input-output computations to reach gross output by industry. They then go on to compute value added, compensation of employees, capital income, taxes, employment and perhaps other variables by industry. Thus, gross output is the key variable linking final demands to industry-specific variables.

Despite the fact that the gross outputs are well down the chain of calculations, users of the models – especially users who work in private industries – almost invariably look first at the gross output forecasts. Indeed, they look immediately at what the model says about gross output in *their* industry for the last year, the current year and the next year, precisely the period they know best from their own recent experience – and the period where, up until now, the model's data base has been the weakest, sometimes two full years out of date.

The strength of interindustry models in forecasting for an industry lies in ensuring consistency among the different industries and in accounting for basic variables, such as demographic changes, and policy variables, such as defense spending. These are long-term considerations and can be easily outweighed in the short term by inventory or exchange rate fluctuations, overcapacity or undercapacity, or even weather. Yet it is precisely the failure to have up-to-date information on gross output

Tab. 3. Percentage errors in forecasting construction by type

Investment in Structures by asset types

Percentage difference from the published nominal value		1st Sim		2nd Sim	
		2005	2006	2005	2006
1	Private fixed investment in structures	-0.03%	0.36%	-7.52%	-3.69%
2	Nonresidential	0.33%	1.02%	-3.24%	-13.50%
3	Commercial and health care	-0.37%	-0.40%	-8.46%	-17.32%
4	Office \1\	0.21%	-0.04%	-13.99%	-27.20%
5	Health care	-0.07%	-0.53%	-2.39%	-8.93%
6	Hospitals and special care	2.56%	-3.17%	-1.15%	-14.12%
7	Hospitals	0.44%	-0.30%	-4.15%	-14.08%
8	Special care	20.10%	-24.95%	23.58%	-14.41%
9	Medical buildings	-6.84%	8.90%	-5.58%	9.56%
10	Multimerchandise shopping	-4.90%	-10.34%	-18.75%	-32.98%
11	Food and beverage establishments	-2.39%	3.96%	-0.99%	6.23%
12	Warehouses	4.09%	7.39%	-5.55%	-12.25%
13	Other commercial \2\	1.08%	7.03%	2.03%	9.03%
14	Manufacturing	8.53%	11.78%	17.58%	12.15%
15	Power and communication	-0.29%	0.41%	3.09%	-6.89%
16	Power	-3.00%	-2.37%	7.73%	-4.18%
17	Electric	0.95%	6.68%	13.10%	3.48%
18	Other power	-13.05%	-23.35%	-5.96%	-21.93%
19	Communication	4.06%	5.46%	-4.37%	-10.76%
20	Mining exploration, shafts, and wells	0.02%	0.06%	-7.81%	-21.43%
21	Petroleum and natural gas	0.43%	-0.10%	-7.41%	-21.58%
22	Mining	-9.27%	4.83%	-16.93%	-17.56%
23	Other structures	-0.45%	1.73%	1.21%	-7.72%
24	Religious	0.14%	-0.36%	9.70%	12.60%
25	Educational and vocational	-1.03%	2.54%	-0.56%	-1.31%
26	Lodging	0.03%	0.03%	-0.64%	-21.28%
27	Amusement and recreation	0.41%	-0.58%	14.62%	-6.20%
28	Transportation	-1.10%	-2.89%	-3.90%	-17.45%
29	Air	15.03%	27.35%	13.99%	20.67%
30	Land \3\	-3.48%	-6.83%	-6.54%	-22.42%
31	Farm	-3.23%	12.84%	-7.78%	1.77%
32	Other \4\	-11.68%	23.07%	-15.35%	13.46%
33	Brokers' commissions on sale of structures	3.66%	-3.18%	-1.90%	-14.28%
34	Net purchases of used structures	-37.34%	9.92%	-22.24%	-11.21%
35	Residential	-0.19%	0.00%	-9.40%	1.57%
36	Permanent site	-0.38%	-1.26%	-12.53%	0.69%
37	Single-family structures	-0.29%	-1.05%	-13.34%	1.60%
38	Multifamily structures	-1.22%	-2.90%	-5.09%	-6.42%
39	Other structures	0.14%	2.06%	-4.00%	3.01%

that can readily discredit the model's results for years further in the future. Thus, this final section of our study has special importance for the model's credibility and acceptance.

Currently, BEA releases gross output data every year. The data are part of the annual industry accounts and have recently been released in December of the year following the reference year. Thus, data for 2006 was scheduled for release in December of 2007. However, BEA (wisely) decided to delay the release until January 2008 in order to be able to use the Annual Survey of Manufactures for 2006. Previously, this Survey would not have been used in the first release of the annual industry accounts, which, consequently, were quite unreliable in manufacturing.

Census has accelerated its production process, and BEA judged the improvement in data quality worth the one month delay in its release. Each release includes gross output by detailed industry of the previous year and a revision of previous releases.

Thus, the official gross output by industry data can be lagged by up to two years. For example, the data for 2005 is still the most up-to-date gross output data available in December 2007. Meanwhile, other economic indicators, such as Census's *Manufacturers' Shipments, Inventories, and Orders*, the Federal Reserve Board's Industrial Production Indexes (IPI) and Census's wholesale trade survey, have been released monthly or quarterly in a timely manner. We will use these other economic indicators to predict the annual Gross output by industry in the period where the BEA has not released the official information and to forecast the gross output into the near future.

Since converting the annual industry accounts to North American Industry Classification System (NAICS) in 2002, BEA has also updated GDP by industry information from 1947 to be consistent with the current definition. However, because of the limited historical source data, there are many NAICS categories that cannot be extended back to 1947. Thus, BEA has published historical data in various degrees of aggregation.

There is not, however, any data on gross output with frequency higher than annual. The situation is thus very different from that for PCE for which we have monthly data in full detail. Even for investment, we have monthly data for construction and quarterly data for some aggregate categories of equipment. With gross output, we have nothing until the first annual estimate appears, so our technique will need to be slightly different from what we have used previously. Namely, we will select high-frequency variables which should be good indicators of gross output, convert them to annual series and regress each gross output on the appropriate annualized version of the high-frequency variable. Then we extend the high-frequency series, annualize the extended series, and put it into the estimated regression equation to get predicted values of gross output. The process will be illustrated below. For the moment, it is sufficient to understand that we need data for gross output and the associated price indexes at an annual frequency and data for similar proxy variables at a high frequency.

BEA releases gross output and the associated price indexes at two levels of aggregation. The more aggregate of the two has 65 primary industry categories and a number of subtotal categories. These are the same 65 categories used in the annual input-output tables. On the BEA website, they are in a file called GDPbyInd_VA_NAICS_1998-2006.xls. (Despite the name, there is no gross ouptut data past 2005.) This same spreadsheet file also contains, for these same industries, series for cost of intermediate inputs, value added, and components of value added added such as wages and salaries, supplements, subsidies, taxes on production and imports, and gross operating surplus. Employment is also available in this classification. Thus, this sectoring is convenient for working with other industry-level data.

On the other hand, the 65-industry aggregation is unfortunately gross in some areas. All construction is in one sector; all utilities – electric, gas, water, and sewer – are in one sector; hospitals and nursing homes are in one sector. However, BEA offers a second set of much more detailed gross product data in 489 primary sectors in a file called GDPbyInd_GO_NAICS_1998-2005.xls . This classification remedies the limitations mentioned, but only gross output in current and constant prices is available, none of the other series.

The present work will be limited to the 65-sector classification, but the availability of data in the more detailed classification should be kept in mind for future work.

A number of sources of high-frequency data were used; they include:

Industrial production index

The monthly industrial production index (IPI) prepared by the Board of Governors of the Federal Reserve System contains more than 300 individual series, classified by market groups and industry groups. It is, however, fairly straight-forward to align the IPI sectors with corresponding sector for gross product. That has been done in the data bank used here, so that IPI series 10 (*ips10*) corresponds to gross output sector 10, namely, Primary metals. All IPI series used here are seasonally adjusted.

Industrial production indexes are used in our model to explain most of the goods-producing industries. In this study, we used the IPI published in February 2007 which contains data through January 2007.

Producer price index

The PPI is the major – though not the only – source of data for BEA's calculation of the price indexes for gross output. Not surprisingly, therefore, PPI is a really good indicator of prices of gross output by industry, especially in the goods-producing industries. In this study, we used PPI published in January 2007 which contains data through December 2006.

Employment, hours, and earnings

For the many industries where there is no index of industrial production, we often need to use as an indicator of output, employment, as reported each month by the Bureau of Labor Statistics (BLS) in *Current Employment Statistics*[7], which is a survey of businesses and government agencies and measures nonfarm payroll employment by industry. As indicators for gross output by industry, we use three of the 19 measures reported in the CES survey, namely, 1. all employees in each industry, 2. average weekly hours of production workers by industry, and 3. average hourly earnings of production workers. CES data is crucial to most of our equations. It is used as a proxy of either production cost (wages per hour) or labor input (employment times hours). In service-producing industries, the CES gives the main explanatory variables used in all the equations, for we have limited information from the IPI or the PPI. The CES information used in this study was published in January 2007 and includes data up to December 2006.

Personal consumption expenditure

Personal consumption expenditure (PCE) information for this study is taken from PCE by product categories published by the BEA in the National Income and Product Accounts (NIPA). This data, which is both detailed and available at a monthly frequency, was described in section 2. For some industries selling primarily to consumers, PCE is useful in estimating real or nominal gross output. Again, PCE information used in this study was published in August 2007.

Wholesale and retail trade

U.S. Census Bureau publishes both annual and monthly wholesale and retail trade data which are used here for estimating the gross output of wholesale and retail trade respectively. The annual wholesale trade[8], the annual retail trade[9], the monthly wholesale trade[10] and monthly retail trade[11] data are each in their separate data files indicated in the footnotes to this sentence. Both monthly surveys were updated to December 2006 for this study.

7 <http://www.bls.gov/ces/home.htm>.

8 <http://www.census.gov/svsd/www/whltable.html>.

9 <http://www.census.gov/svsd/www/artstbl.html>.

10 <http://www.census.gov/mwts/www/mwts.html>.

11 <http://www.census.gov/mrts/www/mrts.html>.

Annual farm labor expense

For farm related industries, CES does not provide any information. We use Annual farm total labor expense data[12] published by the United States Department of Agriculture (USDA). The labor expense data is published as a part of U.S. and State production expenses by expense category, which contains data from 1946. The information used here is updated to 2006.

Other indicators

Two addition indicators, the exchange rate and the crude oil price, are used in estimating both level and price index of gross output by industry.

As in the previous sections, the method was tested in two simulations, but trustworthy Gross output measures were available only through 2004, so the test years were 2003 and 2004. Percentage errors of the forecast are shown in Table 4. Many of the first simulation's results were satisfactory. Among the largest errors were the overestimate of Air travel and the underestimate of Rail travel. These errors were presumably due to changes in consumer behavior in reaction to the 9/11 disaster and the increasing unpleasantness of air travel. Clearly some of the air travelers switched to the trains.

6. Concluding observations

The results of the tests of the methods developed show that they are, fortunately and not surprisingly, sensitive to the accuracy of the forecasts of the exogenous variables. At the same time, the results are certainly more accurate than using the long-term model to forecast the current year, especially near the end of the year.

It is also noteworthy how diverse the data sources are for the four kinds of series we studied. It is necessary to seek out data sources with some diligence and to adapt the method to the nature of the data found. This diversity means that it will remain somewhat time-consuming to prepare the flat-end data set. We believe, however, that the improvement in the accuracy of the current year starting values of the forecasts should make an important contribution to the general credibility of the model.

[12] <http://www.ers.usda.gov/Data/FarmIncome/finfidmuWk4.htm>.

Tab. 4. Percentage errors in Gross output

	Percentage difference from the published real value	1st Sim 2003	1st Sim 2004	2nd Sim 2003	2nd Sim 2004
1	Farms	0.31%	0.70%	0.32%	-0.37%
2	Forestry, fishing, and related activities	-3.23%	-3.50%	-1.65%	-6.25%
3	Oil and gas extraction	-0.41%	-0.23%	-0.48%	-0.96%
4	Mining, except oil and gas	-0.01%	-0.38%	2.09%	0.01%
5	Support activities for mining	-6.11%	-2.57%	3.53%	16.00%
6	Utilities	-2.09%	0.55%	2.84%	11.47%
7	Construction	-0.71%	-1.68%	-1.39%	-7.21%
8	Wood products	0.17%	2.00%	0.37%	1.08%
9	Nonmetallic mineral products	-0.13%	0.84%	-0.56%	-0.13%
10	Primary metals	0.17%	1.13%	0.81%	-3.71%
11	Fabricated metal products	2.36%	-2.97%	4.67%	2.42%
12	Machinery	-0.60%	-0.10%	4.50%	6.76%
13	Computer and electronic products	-2.95%	0.67%	-1.10%	-2.38%
14	Electrical equipment, appliances, and components	-0.23%	1.61%	2.10%	4.47%
15	Motor vehicles, bodies and trailers, and parts	-0.96%	-0.04%	-3.06%	-2.20%
16	Other transportation equipment	-1.95%	-0.56%	1.08%	14.21%
17	Furniture and related products	0.66%	-0.67%	4.60%	1.84%
18	Miscellaneous manufacturing	-0.44%	0.76%	-0.46%	2.61%
19	Food and beverage and tobacco products	-0.02%	-0.31%	-1.15%	1.81%
20	Textile mills and textile product mills	-1.11%	-1.61%	2.25%	2.91%
21	Apparel and leather and allied products	2.59%	2.80%	-2.30%	-13.54%
22	Paper products	-0.44%	0.69%	-0.19%	-6.98%
23	Printing and related support activities	-0.24%	0.63%	-3.15%	-13.48%
24	Petroleum and coal products	1.82%	-0.80%	-11.77%	-35.47%
25	Chemical products	0.99%	0.51%	0.23%	-5.71%
26	Plastics and rubber products	-0.57%	0.63%	-1.00%	1.51%
27	Wholesale trade	-1.70%	3.85%	-1.09%	-1.23%
28	Retail trade	-0.95%	1.13%	-1.32%	-2.55%
29	Air transportation	11.35%	5.29%	10.81%	6.14%
30	Rail transportation	-1.33%	-13.08%	-2.57%	-18.62%
31	Water transportation	-0.29%	-2.76%	3.10%	-1.29%
32	Truck transportation	1.48%	-6.20%	1.41%	-11.87%
33	Transit and ground passenger transportation	-1.83%	-2.01%	-2.98%	-2.77%
34	Pipeline transportation	1.24%	-0.26%	0.71%	1.42%
35	Other transportation and support activities	-0.88%	-1.08%	1.31%	1.14%
36	Warehousing and storage	-0.43%	3.61%	0.53%	2.58%
37	Publishing industries (includes software)	-0.94%	-1.31%	0.44%	-8.61%
38	Motion picture and sound recording industries	-2.60%	-1.04%	-1.36%	-1.05%
39	Broadcasting and telecommunications	1.14%	-1.42%	-0.94%	-0.34%
40	Information and data processing services	-4.21%	-9.37%	-4.43%	-11.92%
41	Federal Reserve banks, credit intermediation, and	3.63%	7.76%	3.40%	5.84%
42	Securities, commodity contracts, and investments	-2.36%	-5.77%	-0.50%	-3.05%
43	Insurance carriers and related activities	1.56%	-1.90%	0.33%	-6.10%
44	Funds, trusts, and other financial vehicles	1.48%	5.25%	-5.35%	-12.48%
45	Real estate /1/	0.43%	-2.35%	-0.04%	-5.46%
46	Rental and leasing services and lessors of intangi	-5.63%	-15.67%	-10.50%	-10.28%
47	Legal services	-1.96%	-0.51%	-2.36%	-1.68%
48	Computer systems design and related services	-6.34%	-8.13%	-5.90%	0.28%
49	Miscellaneous professional, scientific, and techni	-0.17%	0.05%	3.10%	1.19%
50	Management of companies and enterprises	-3.54%	-6.71%	0.97%	-4.80%
51	Administrative and support services	-4.97%	-5.44%	-3.79%	-2.75%
52	Waste management and remediation services	-0.52%	0.75%	-0.59%	-3.02%
53	Educational services	0.21%	1.53%	0.23%	1.39%
54	Ambulatory health care services	-1.88%	-0.57%	-1.90%	-6.42%
55	Hospitals and nursing and residential care facilit	-0.05%	-0.20%	-0.33%	-0.59%
56	Social assistance	-2.19%	-1.12%	-2.15%	-3.89%
57	Performing arts, spectator sports, museums, and re	-4.75%	-3.94%	-4.27%	-1.89%
58	Amusements, gambling, and recreation industries	-0.41%	-0.20%	-0.34%	-1.33%
59	Accommodation	-2.71%	-2.69%	-2.21%	-4.81%
60	Food services and drinking places	0.45%	2.79%	-1.53%	-4.36%
61	Other services, except government	-0.90%	-0.91%	-1.57%	-5.32%
62	General government	-1.70%	-3.39%	-3.05%	-5.39%
63	Government enterprises	-0.48%	-2.01%	-1.38%	-3.28%
64	General government	0.11%	-1.29%	-0.05%	-0.45%
65	Government enterprises	1.41%	3.54%	1.29%	2.73%

MULTISECTORAL MODELS

THREE ISSUES RELATED TO THE CONSTRUCTION OF A MULTISECTORAL MODEL

Maurizio Grassini

1. Introduction

Firstly, this paper deals with the issue of the impact of chain indexing on the database built according to the ESA95 system. Some problems concerning measurement in purchasers prices and basic prices among make and use matrices and available time series related to groups of commodities or to industries are outlined. The size of the loss in the accounting identities due to the introduction of chain indexing is analyzed for Personal Consumption Expenditure by COICOP groups of expenditures and Investments by investors.

Besides the estimation of labour productivity equations, the impact of the European Employment Strategy and reforms in the labour market institutions are analyzed to point out a likely bias in the decline of Italian labour productivity.

Investments and capital stock data are used to investigate the replacement ratios attributed to investors. The replacement ratio time trends and the Istat (the Italian Central Statistical Bureau) Methodological Guide suggest using a non constant replacement ratio while capital stock is computed from investments according to the perpetual inventory principle.

2. Accounting framework

Istat has published a time series of supply, use and import flow matrices for the years 1995-2003. These matrices are built according to the Eurostat format based on ESA95. Details are given for 60 European sectors; the Italian matrices have 59 sectors both for industries and products (the last, which refers to extra-territorial units, is omitted). The supply matrices are built at basic prices; use matrices are available at purchasers' and basic prices.

Istat has made a set of matrices for the year 2000 available. Besides the supply and use matrix at basic prices, a set of other matrices is provided: a matrix of non-deductable VAT, a matrix of excise taxes and a matrix of trade and transport margins. This special windfall of matrices has led to the choice of year 2000 as the base year of the new INTIMO, INTIMO2000.

The supply matrix is moderately sparse. The construction of a product-to-product matrix was obtained by means of Almon's algorithm which applied to domestic and import flow intermediate matrices. The procedure was completed by balancing the value added sector.

The ESA95 framework considers national macroeconomic accounts, institutional accounts and input-output tables as part of a single system of accounts. It makes it easy to construct databases for macroeconomic and, in particular, for multisectoral models which requires aggregate as well as sectoral (industries, commodities and institutions) data.

The maximum detail of Personal Consumption Expenditure, Total Output and Employment time series is available from year 1992; Capital Stock time series begin from 1980; Investments time series show the most detail from 1970. The reconstruction of the time series goes back to the year 1970, but only for a few subtotals. Exports, Imports, Inventory Change (and Total Intermediate Consumption) time series are available for the use matrix in detail (59 sectors) for the time interval of these matrices, precisely years 1995-2003.

Total Output and Employment figures are available for 45 sectors corresponding to industries. Investment and Capital Stock is related to 29 groups of investors. Personal Consumption Expenditure gives details for 56 items. Bridge matrices link the items of Personal Consumption Expenditure and the Investments to the 59 commodities of the corresponding vectors in the final demand of the use matrix.

3. The chain index drawback

Unfortunately, in ESA95 the use of chain indexes does not allow us to preserve the accounting identities whereas the variables are measured in constant values. This is a serious handicap for macroeconomic model builders as far as variables in constant terms are required. Of course, a multisectoral model builder must necessarily tackle the problem concerning the time series used to construct the real side of the model.

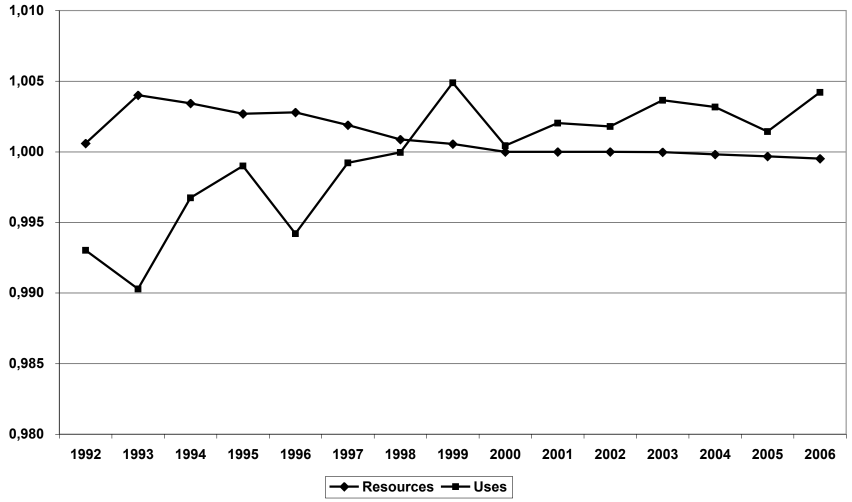
Personal Consumption Expenditure, Investment, Capital Stock , Exports, Imports and Total Output are all used in the real side of the multisectoral model They are required at constant prices. The chain index permits a comparison of the real values of two adjacent years: a variable deflated by means of a price index computed applying weights of the mix of the year before may be compared in real terms only with the variable of the previous year. The idea of the chain index only allows us to compare observations of successive years. However, changes in prices and quantities between nonadjacent periods are obtained by accumulating the «short-term» variations. This procedure leads to the so-called «chain indices». These may be used to deflate the time series in current value obtaining time series in volume within the chain-linking system. Istat has fully adopted the chain-linking system which now replaces the previous fixed-base methodology. Now, the time series in volume are called «chained», no longer «in constant value»; this is to remind us that time series in volume incorporate the pros and contros of the chain index system. Among the disadvantages, the loss of additivity represents a serious drawback for a macroeconomic model builder. Almon (2005) (who already experienced the introduction of the chain index system in the USA National Accounts) showed that there is no elegant analytical method to circumvent the problem. It is up to the model builder to provide a way to overcome the loss of additivity.

First of all, the loss of additivity appears when totals are compared with subtotals. A total may be a subtotal of other aggregated macroeconomic variables. For example, the sum of the 56 «chained» Personal Consumption Expenditure items is not equal to their «chained» total. In turn, total Personal Consumption Expenditure is not equal to the «chained» series in the Resources and Use Account. Furthermore, the «chained» Uses in the Resources and Use Account do not sum up to the corresponding total of the «chained» Uses.

For the purpose of INTIMO2000, in order to recover additivity, a spread procedure is adopted. It is possible to apply a bottom up as well as a top down approach. Here, a top-down procedure is adopted. This choice is suggested by the priority given to the Resources and Uses macroeconomic account as a benchmark of the database. In this account the Total Resource are equal to Total Uses chained values. The total of Resource items, that is to say GDP and Imports, and total of Use items are both different to their common chained total. Moreover, different correction factors are applied to them.

Figure 1 shows the spread factor applied to the aggregates of Resources and Uses account in the years 1992-2006. The Resources correction factor is more constant than the Uses one; while the Resources correction factor ranges between 1.004 and .99995, the Uses correction factor is a bit more erratic and reaches a deviation of about 1 per cent in year 1993, revealing the impact of the heavy currency devaluation which took place the year before. Table 1 contains the percentage values (equal to 100*(correction factor -1)) of the difference between the aggregate values for Resources and Uses (as shown in figure 1), for Personal Consumption Expenditure and Investments.

Fig. 1. Spread Factors



Source: Istat, *Conti economici nazionali 1970-2006*

Tab. 1. Percentage discrepancies between Totals and Sub-totals

Years	Resources	Uses	PCE	CAP
1992	0.059	-0.697	0.010	-0.046
1993	0.401	-0.971	0.013	-0.104
1994	0.344	-0.326	0.008	-0.059
1995	0.269	-0.100	0.005	0.005
1996	0.280	-0.580	0.009	-0.008
1997	0.189	-0.079	0.002	-0.004
1998	0.087	-0.005	0.001	0.003
1999	0.055	0.488	-0.004	-0.005
2000	0.000	0.044	0.000	0.000
2001	0.000	0.202	-0.002	0.000
2002	-0.001	0.179	-0.001	0.006
2003	-0.004	0.364	-0.003	0.000
2004	-0.018	0.318	-0.002	-0.005
2005	-0.032	0.142	0.001	
2006	-0.048	0.420	0.000	

4. Employment, Labour productivity and Labour market structural changes

The sectoral Labour productivity equations largely follow «Verdoorn's Law» which states that empirical evidence supports a «fairly constant relation over a long period between the growth of labour productivity and the volume of industrial production».

This statement may be supported by a number of arguments: a) in a rapidly growing sector, investments may embody technical progress which improves labour productivity; b) an increase of industrial production may make room for economies of scale; c) a sudden important technological innovation can seriously raise competitiveness which in turn leads to an increase in output.

At present, sectoral labour productivity equations are determined by sectoral output dynamics and a time trend. These equations have a very simple analytical structure. Other structures designed to explain total factor productivity indexes (which consider capital stock and labour, at least, as production factors) have been estimated in the past. A good fit and reliable estimated parameter structures at the level of single equation performance put untrustworthy model behaviour out of sight. Gratifying sectoral total factor productivity equation estimates were abandoned and a simple labour productivity equation was maintained where, as mentioned above, the reciprocal of labour productivity (employment over output) was explained by the output rate of growth and a time trend.

In the multisectoral model, labour productivity equations play a double role. On the one hand, they determine the cost of labour (together with capital in the case of total factor productivity) per unit of output; on the other, employment is the by-product of these equations. Two labour statistics are available[1]: labour force and labour employed; the latter has a dual measure: employment and Unit of Labour (UL).

The amount of labour in a unit of time (for example, hours worked per employee per year) is the appropriate input to measure labour productivity. UL, which defines the «number of full time equivalent persons employed by industry», is the closest estimate of the amount of labour in a unit of time available using Italian statistics. The full time equivalent employed person is computed considering the «amount of labour in hours per week» from the prevailing contract in the national labour market. The ratio between «full time equivalent employed person» and «man-hour per unit of time» is not constant over time. It may vary but constantly so that UL can be a good proxy of the labour input related to «employees per industry».

[1] Recently, Istat has published «Total hours worked» for about 30 industries. The labour productivity equations are estimated by using employment statistics available for 45 industries

Employment statistics include overtime, full-time, part-time and a variety of workers who over time may statistically pop up or disappear on account of changing rules in the labour market. Table 2 shows the employment/UL ratio (%) in the market sectors. A ratio above 100 is evidence of a number of employed people greater than their measure in terms of UL. The first row shows the ratio relative to total employment; the second row refers to employees and the third to self-employed workers. From the series relative to the period 1990-2006, employees turn out to be very close to their UL measure. Self-employed workers work about 15-20 per cent more than an employed worker. While self-employed workers show a constant employment/UL ratio over time, this ratio has a constant positive trend for employees.

Tab. 2. Employment to UL in the market sector, (%)
First row: Total; Second row: employees; Third row: self-employed

1990	1991	1992	1993	1994	1995	1996	1997	1998
94.35	94.94	94.91	95.40	94.58	94.30	94.26	94.07	94.01
99.88	100.54	100.88	101.63	100.70	100.42	100.54	100.16	100.10
85.09	85.66	85.04	84.91	84.24	84.04	83.88	83.89	83.74

1999	2000	2001	2002	2003	2004	2005	2006
94.68	94.82	95.31	95.29	95.59	95.73	96.37	96.61
101.02	101.10	101.80	101.64	102.17	102.29	102.84	103.14
83.81	83.99	83.86	83.82	83.87	84.11	84.18	84.13

Source: Istat, Conti economici nazionali 1970-2006

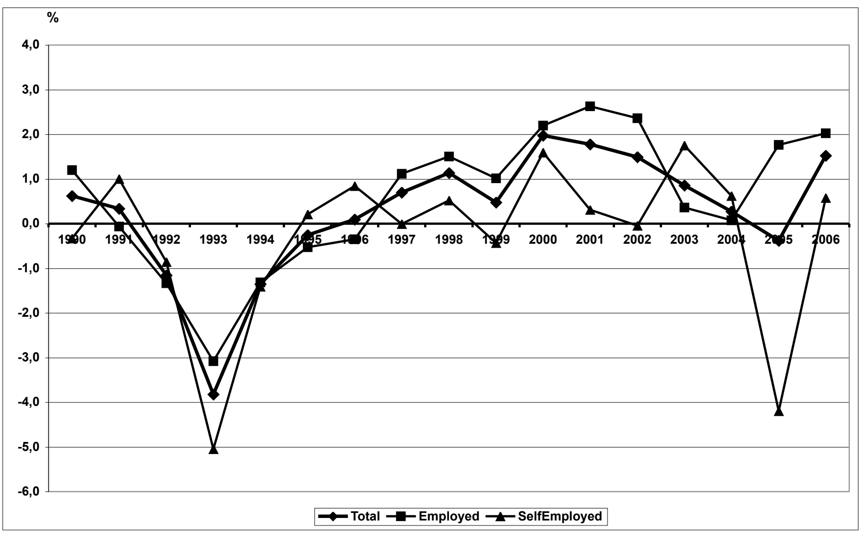
During the early 1990's, as the pace of European integration accelerated in various fields, the European Union realized that it did not have adequate tools to prevent and tackle the persistent high unemployment levels present in many European countries. The real beginning of the examination of employment at a European Union level came about in 1993 with the «White Paper» on Growth, Competitiveness and Employment prepared by the President of the European Commission, Jacques Delors. Inspired by this book in December 1994 in Essen the European Council agreed to five key objectives to be pursued by the Member States to fight unemployment. Two of them concerned the promotion of moderate wage policies and the improvement of efficiency of the labour market institutions.

In Italy, the effect of moderate wage policies is shown in Figure 5. In 1990 and 1991 wages per worker grew much faster than the PCE deflator. In 1992 the Italian currency was hit by a serious financial crisis which led to its devaluation by about 25 per cent. The economy went

Fig. 2. Growth rates of Employment

Source: Istat, *Conti economici nazionali 1970-2006*

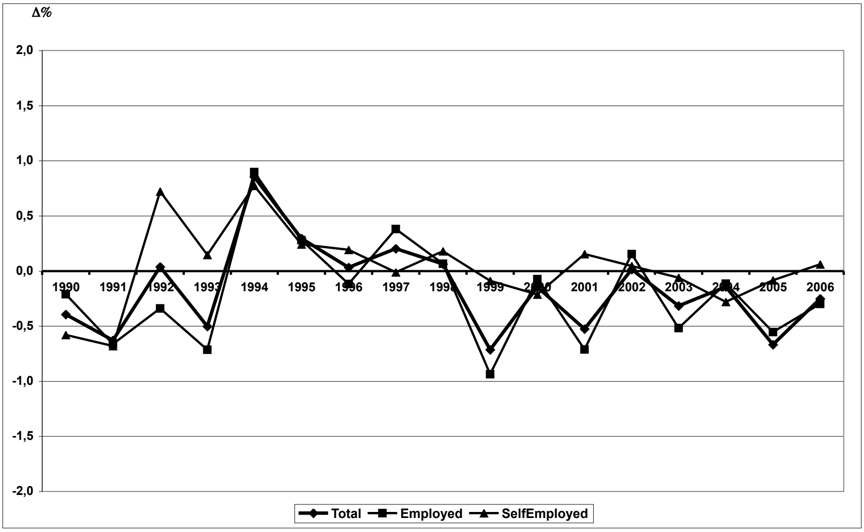
Fig. 3. Growth rates of UL



Source: Istat, *Conti economici nazionali 1970-2006*

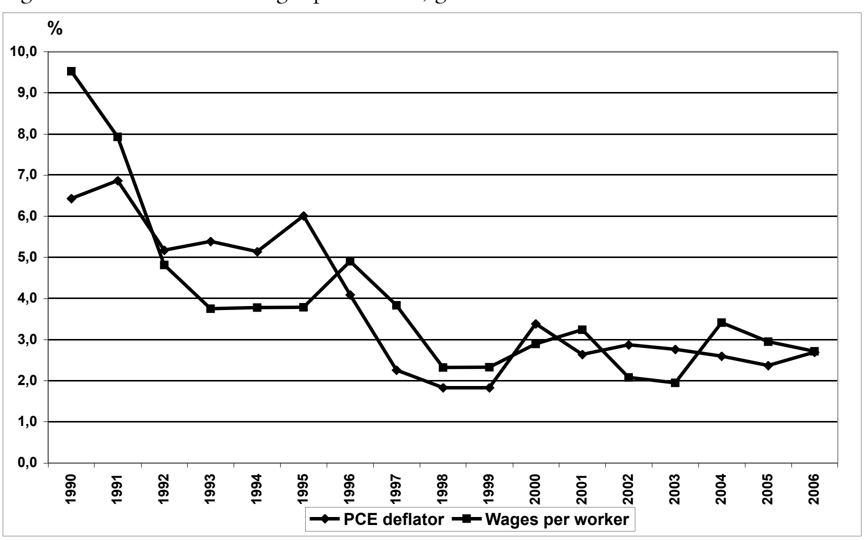
into a recession with a negative GDP rate of growth in 1993. For three years wages grew at a rate of 4 per cent; the PCE deflator grew at 5-6 per cent so that real wages decreased.

Fig. 4. Differences in rates of growth. UL versus Employment



Source: Istat, *Conti economici nazionali 1970-2006*

Fig. 5. PCE deflator and wages per worker, growth rates



Source: Istat, *Conti economici nazionali 1970-2006*

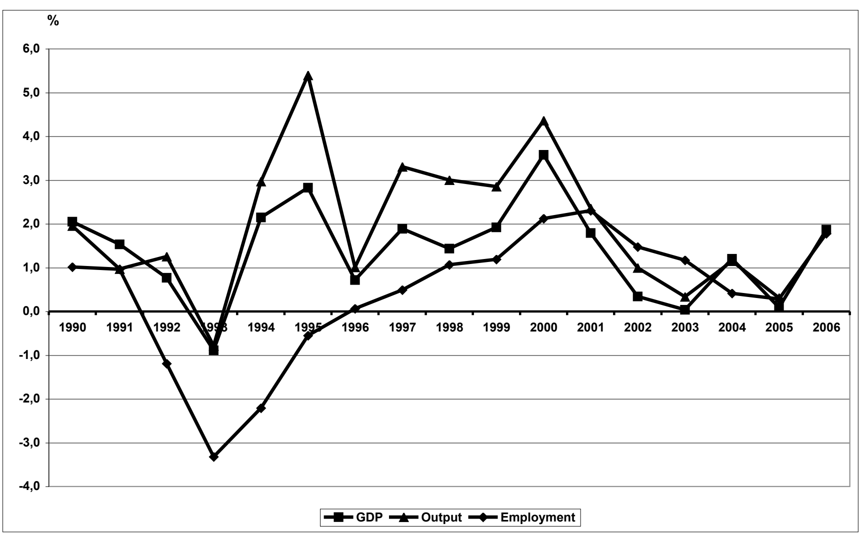
From 1992, the European Member States' economic policies were submitted to multilateral surveillance as defined in the Maastricht treaty. The introduction of a common currency was the objective; a set of indicators were used to monitor the Member States' performance for eligibility to the currency area. The rate of inflation was among these indicators. Surprisingly, Italy, with a history of high inflation, performed very well. Inflation fell rapidly to a rate of 2 per cent. Workers shared the cost of matching the so-called Maastricht criteria. Figure 5 shows that wage dynamics followed the path of inflation over the last decade with no perceivable improvement in real terms.

The path towards a common currency forced European Member States to look for better co-ordination of their social-economic policies. The Treaty of Amsterdam (1995) gives evidence of this concern. It contains a new Title dedicated to actions aimed at fostering employment. In 1996 a permanent Employment and Labour Market Committee was created and in 1997 a European Employment Strategy was launched. The Treaty of Amsterdam emphasized that employment was an issue of common concern and the Member States committed themselves to coordinating their employment policies.

Within this European policy strategy, two reforms of labour market institutions were introduced in Italy: respectively in 1997 and 2003. These reforms basically introduced a variety of new types of labour contract aimed at removing the demand-supply mismatch which was considered the main cause of the high level of unemployment. The effect of these reforms can be seen in Figure 6.

The recession provoked by the 1992 Italian financial crisis was anticipated by negative growth of employment rates. Despite a remark-

Fig. 6. Growth rates of GDP, output and employment



Source: Istat, *Conti economici nazionali 1970-2006* able increase in total output, the recovery in 1994 and 1995 took place with declining employment. In 1997, with the introduction of the first reform, employment began to grow and the rates of growth remained positive for a decade. In this period, GDP (and total output) and employment dynamics do not show any production function approach in their background. In other words, the reduction of the unemployment rate worsened labour productivity. Figure 4 shows that the UL rates of growth were largely greater than employment growth rates and Figure 6 shows employment growth rates generally greater than output growth rates from 2001 onwards.

However, the sectoral employment over sectoral output ratio shows in general the expected negative trend and the Verdoon's law-inspired model still performs quite well as regards fit. The impact of the labour market reforms certainly contributed to lower labour productivity which will be able to follow a better trend when the «new» structural unemployment rate is achieved

5. Capital stock and capital investment

Within the ESA95 system, Istat has recently published a new time series of investments, capital stock and amortization. These time series cover the time interval 1970-2003 for investments and 1980-2003 for capital stock (gross and net) and amortization. The time series are available for 29 investors. A bridge matrix to link these investors to producers is available for the year 2000. The row sum and column sum of this matrix match the investments in the time series and in the use matrix in the year 2000.

Capital stock and investments time series for 29 investors enabled a simple investigation of the replacement rates which relate them.

By using the formula $K_t = I_t + (1 - \alpha) * K_{t-1}$, the replacement rate applied to the perpetual inventory system turns out to be rather variable among the investors and over time as shown in Table 3. Figure 7 shows some investors who faced a replacement rate with a positive trend (Agriculture, Fishery, Mining non energetic materials, Food and Beverages industry and Textile and clothes industry); Figure 8 shows replacement rates which are more or less constant over time for Chemicals, Construction, Health services, Real Estate and Government; in Figure 9 two sectors (Mining of energetic raw materials and Coke and oil products) present a declining replacement rate but well over the average value of the aggregate.

Table 4 shows the composition of capital stock at the beginning and at the end of the time interval and, in the third column, the differences between them. Real estate, Financial services and Government declined from over 46 per cent of total investment in 1980 to 37 per cent in 2003.

Tab. 3. Replacement Rates

INVESTORS	YEARS																						
	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1 Agriculture	4.9	5.0	5.1	5.2	5.2	5.3	5.4	5.4	5.4	5.5	5.5	5.6	5.6	5.7	5.7	5.8	5.8	5.9	5.9	6.0	6.0	6.1	6.1
2 Fishery	9.0	9.1	9.2	9.4	9.6	9.7	9.9	10.2	10.2	10.3	10.4	10.5	10.6	10.7	10.7	10.9	10.8	10.8	10.8	10.8	11.0	11.0	10.6
3 Energetic mineral	11.3	11.1	10.8	10.5	10.7	10.9	10.5	10.3	10.1	10.0	10.4	10.5	10.4	9.9	10.0	9.7	9.8	9.7	9.7	10.0	10.1	10.1	10.6
4 Non energetic mineral	7.4	7.5	7.6	7.7	7.8	7.9	8.0	8.2	8.5	8.7	8.8	8.8	8.7	8.8	9.0	9.3	9.2	9.2	9.4	9.3	9.3	9.5	9.5
5 Food beverage industry	7.8	7.8	7.9	8.1	8.2	8.3	8.5	8.7	8.8	8.9	9.0	9.1	9.0	9.0	9.2	9.0	9.1	9.1	9.2	9.0	9.0	8.9	8.9
6 Textiles & Clothes	7.2	7.3	7.4	7.7	7.8	8.0	8.2	8.4	8.5	8.7	8.7	8.5	8.5	8.8	8.9	8.9	8.9	9.0	9.0	9.0	9.1	9.1	9.1
7 Leather and products	7.4	7.5	7.7	7.8	8.0	8.2	8.4	8.6	8.8	8.9	9.1	9.2	9.2	9.5	9.7	9.7	9.6	9.8	9.7	9.8	9.7	9.7	9.3
8 Wood and furniture	6.7	6.9	7.0	7.2	7.4	7.6	7.8	7.9	8.0	8.1	8.2	8.3	8.3	8.4	8.6	8.6	8.7	8.7	8.8	8.7	8.6	8.7	8.6
9 Paper, paper products	7.3	7.4	7.6	8.0	8.2	8.5	8.7	8.8	8.9	9.0	9.2	9.2	9.2	9.4	9.7	9.5	9.5	9.6	9.4	9.6	9.4	9.3	9.3
10 Coke, oil products	10.3	10.1	9.9	9.6	9.8	9.9	9.5	9.3	9.3	9.1	9.4	9.5	9.2	9.0	9.0	9.3	9.3	9.6	9.3	9.5	9.3	9.2	9.4
11 Chemicals	8.2	8.5	8.8	9.1	9.4	9.6	9.9	10.1	10.2	10.2	10.2	10.2	10.1	10.1	10.1	10.3	10.2	10.1	9.9	9.8	9.8	9.8	9.8
12 Rubber & Plastic	7.4	7.6	7.7	8.0	8.1	8.5	8.7	8.9	9.0	9.0	9.1	9.1	9.1	9.3	9.5	9.4	9.4	9.5	9.5	9.5	9.4	9.4	9.4
13 Non metallic minerals	7.3	7.4	7.6	7.8	7.9	8.1	8.4	8.6	8.8	8.8	8.8	8.9	8.8	8.9	9.2	9.1	9.2	9.1	9.2	9.1	9.1	9.2	9.1
14 Metal products	7.4	7.6	7.8	8.0	8.2	8.4	8.7	9.0	9.1	9.1	9.2	9.2	9.1	9.4	9.6	9.7	9.5	9.6	9.7	9.6	9.5	9.3	9.1
15 Mechanical machinery	7.1	7.3	7.4	7.7	7.9	8.1	8.3	8.6	8.8	8.8	8.8	8.7	8.7	9.0	9.2	9.1	9.0	9.1	9.0	9.1	9.1	9.2	9.1
16 Electrical machinery	8.3	8.4	8.6	8.9	9.0	9.3	9.5	9.7	9.9	10.0	10.0	9.8	9.8	10.0	10.3	10.2	10.2	10.1	10.2	10.8	10.6	10.2	10.2
17 Motor vehicles	8.3	8.6	8.6	8.7	8.7	9.0	9.5	9.6	9.5	9.7	9.8	9.9	9.7	9.5	9.6	9.5	9.6	9.7	9.8	10.0	10.0	10.1	10.1
18 Other industries	6.2	6.4	6.6	6.8	7.0	7.2	7.4	7.6	7.9	8.1	8.2	8.4	8.6	8.7	9.0	9.0	9.1	9.1	9.2	9.3	9.2	9.2	9.0
19 Electricity, gas, water	5.5	5.5	5.4	5.4	5.4	5.4	5.4	5.4	5.5	5.6	5.9	6.2	6.2	6.3	6.4	6.5	6.6	6.8	6.9	7.0	7.2	7.3	7.5
20 Construction	8.9	8.9	8.9	9.1	9.4	9.5	9.7	9.9	10.0	10.1	10.2	10.2	10.0	10.0	10.2	10.2	10.1	10.0	9.8	9.8	9.8	9.5	9.2
21 Trade	5.9	6.0	6.1	6.2	6.2	6.3	6.3	6.5	6.6	6.6	6.7	6.6	6.6	6.6	6.7	6.8	6.8	6.9	6.9	7.0	7.1	7.2	7.0
22 Hotels & Restaurants	4.0	4.1	4.2	4.3	4.4	4.5	4.6	4.7	4.8	4.8	4.8	5.0	5.0	5.1	5.2	5.2	5.3	5.5	5.6	5.7	5.7	5.7	5.8
23 Transport, Communic.	8.0	8.1	8.2	8.4	8.4	8.5	8.7	8.8	8.9	9.1	9.2	9.3	9.3	9.4	9.5	9.7	9.9	9.9	10.0	10.0	9.9	9.8	9.7
24 Financial services	3.3	3.5	3.7	3.9	4.0	4.2	4.4	4.5	4.7	4.8	4.8	4.8	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.7	4.8	4.9	5.0
25 Real Estate	2.0	2.1	2.1	2.1	2.1	2.2	2.2	2.2	2.2	2.3	2.3	2.3	2.3	2.4	2.4	2.4	2.4	2.4	2.5	2.5	2.5	2.6	2.6
26 Government	2.7	2.7	2.8	2.8	2.9	2.9	2.9	2.9	3.0	3.0	3.0	3.0	3.1	3.1	3.1	3.2	3.2	3.2	3.3	3.3	3.4	3.4	3.4
27 Education	4.3	4.3	4.3	4.3	4.3	4.4	4.4	4.4	4.4	4.3	4.3	4.3	4.2	4.2	4.2	4.3	4.3	4.4	4.4	4.5	4.4	4.6	4.6
28 Health services	8.8	8.9	9.0	9.2	9.4	9.4	9.5	9.5	9.5	9.4	9.2	9.0	8.8	8.7	8.9	9.0	9.1	9.2	9.1	9.1	9.0	8.9	8.8
29 Other personal services	6.0	5.9	5.8	5.8	5.8	5.8	5.9	5.9	5.9	6.0	6.0	6.0	6.0	6.1	6.2	6.3	6.4	6.4	6.5	6.5	6.6	6.6	6.6

Fig. 7. Growing Replacement Rates

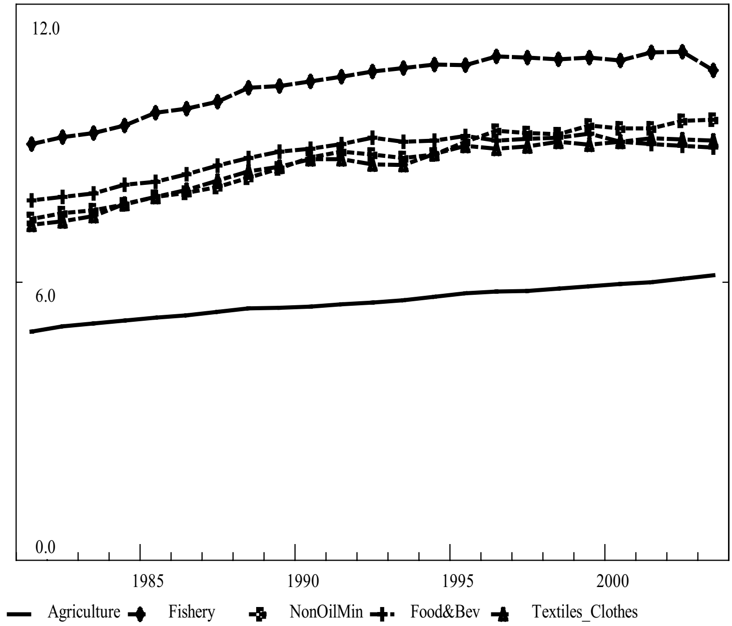


Fig. 8. Relatively Constant Replacement Rates

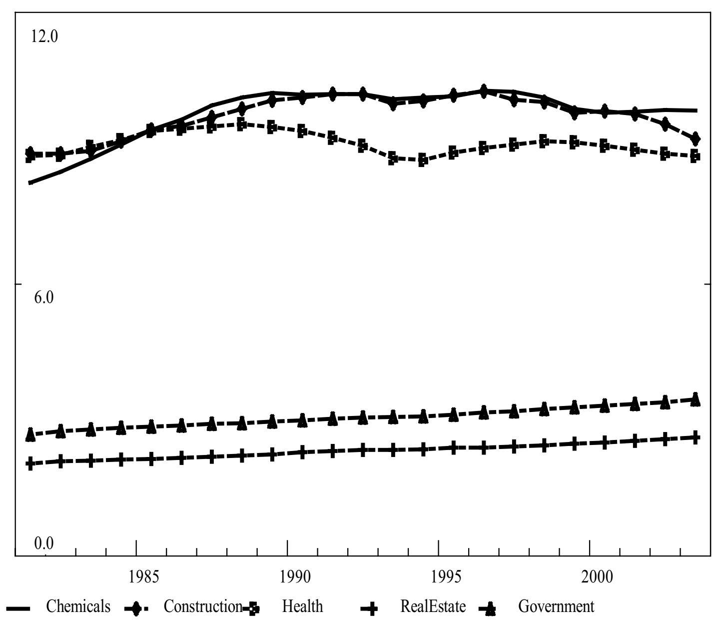


Fig. 9. Declining Replacement Rates

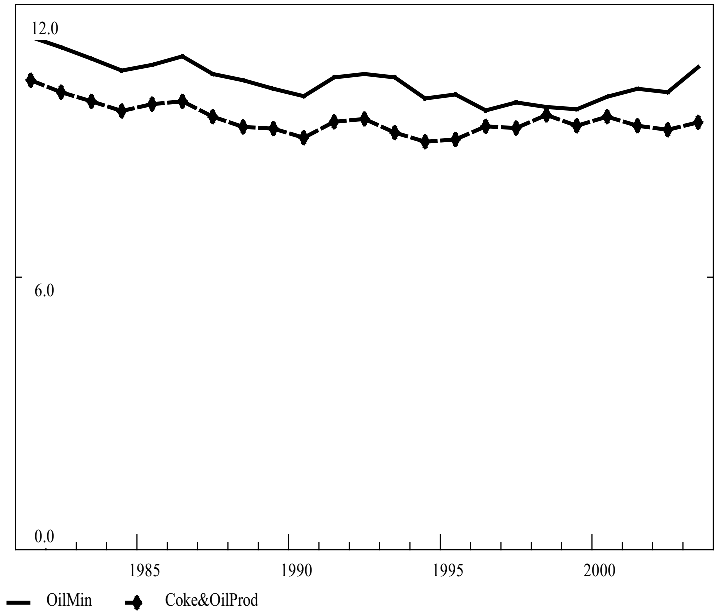
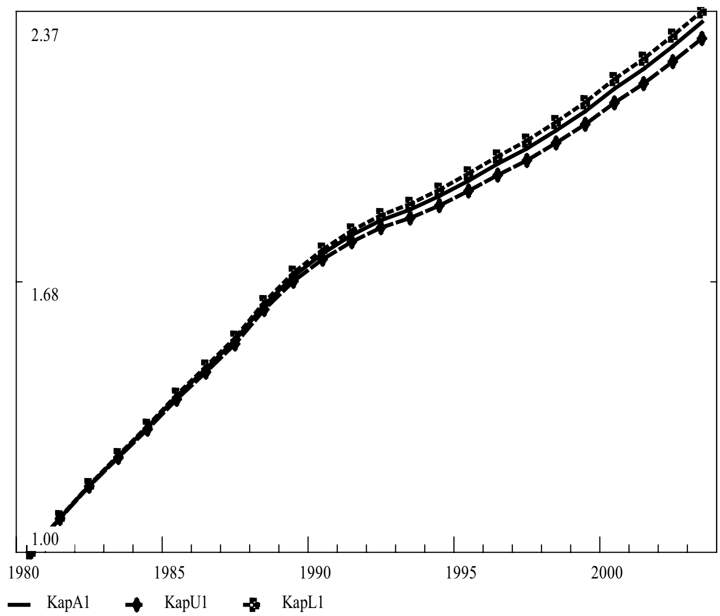


Fig. 10. Education – Replacement Rates: Lower .042, Average .044, Upper .046



Tab. 4. Capital Stock composition and Replacement Rates

	Investments			Replacement rates			
Years	1981	2003	diff	period 1981-2003			
				average	min	max	diff
Agriculture	4.84	4.00	-0.84	5.57	4.93	6.14	1.21
Fishery	0.21	0.14	-0.07	10.27	8.97	10.97	2.01
Mining of energetic Raw Mat	0.13	0.42	0.29	10.31	9.67	11.28	1.61
Mining non energetic materials	0.32	0.19	-0.13	8.60	7.36	9.50	2.14
Food beverage industry	2.17	2.19	0.01	8.72	7.76	9.20	1.44
Textiles & Clothes	2.29	1.47	-0.82	8.46	7.24	9.10	1.86
Leather and products	0.49	0.34	-0.15	8.92	7.41	9.77	2.36
Wood and furniture	0.90	0.53	-0.37	8.07	6.71	8.79	2.09
Paper, paper products	0.86	1.45	0.59	8.90	7.28	9.66	2.38
Coke, oil products	0.41	0.46	0.05	9.47	8.98	10.33	1.35
Chemicals	2.06	1.79	-0.28	9.76	8.24	10.26	2.02
Rubber & plastic	1.15	1.25	0.11	8.90	7.43	9.51	2.08
Non metallic minerals	1.32	1.69	0.37	8.62	7.31	9.21	1.90
Metal products	4.12	3.71	-0.41	8.95	7.42	9.66	2.24
Mechanical machinery	2.75	2.16	-0.59	8.58	7.13	9.21	2.08
Electrical machinery	1.38	1.66	0.28	9.74	8.26	10.75	2.50
Motor vehicles	1.61	1.61	0.00	9.45	8.30	10.10	1.80
Other industries	0.93	0.73	-0.19	8.13	6.20	9.32	3.12
Electricity, gas, water	4.29	4.42	0.13	6.14	5.37	7.46	2.09
Construction	3.38	4.06	0.67	9.71	8.87	10.25	1.38
Trade	4.75	8.04	3.29	6.60	5.91	7.17	1.26
Hotels & Restaurants	1.65	2.61	0.96	4.96	4.02	5.80	1.77
Transport, comunic.	7.39	12.73	5.34	9.16	8.01	10.01	2.00
Financial services	4.22	1.92	-2.31	4.43	3.26	4.99	1.72
Real Estate	31.39	27.01	-4.38	2.31	2.04	2.61	0.57
Government	10.77	8.11	-2.66	3.05	2.68	3.45	0.77
Education	0.86	0.74	-0.13	4.35	4.20	4.57	0.38
Health services	1.49	1.74	0.25	9.10	8.74	9.53	0.79
Other personal services	1.86	2.84	0.98	6.13	5.79	6.65	0.85
Total	100.00	100.00					

Investment in Transports and Communications reached a share of 12.73 per cent in 2003 starting from 7.39 per cent in 1980.

The far right column in Table 4 shows the average replacement rates. These averages range from 2.31 per cent of Real estate up to 10.27 per cent for Fishery. The replacement rate used to compute capital stock from capital investment (applying the perpetual inventory criterion and using it as an explanatory variable in the shares equations in BTM) is (or was) 8 per cent. This replacement rate was considered to have much more weight than the one «behind» the capital stock time series and it was used to emphasize the influence of the younger capital investment and hence the content of embodied technical progress. Unexpectedly, 20 out of 29 replacement rates in Table 4 are greater than 8.00 per cent. This means that the decay of capital stock is higher than the depreciation used in the BTM share equations. The replacement rate applied to each investor is determined by the capital investment mix and by the capital investment average life used by Istat (see Table 5).

In Table 4, the average value and the maximum and minimum value of the replacement rates are shown. The last column shows the difference between the maximum and the minimum replacement rates per investor. Real Estate, Government, Education, Health services and Other services show a difference of less than 1; since the replacement rates appear to be quite constant over time, we can assume that the variability may be duly considered just a random component. This is not the case for Fishery, Mining of non energetic materials, Leather and leather products, Wood and furniture, Paper and paper products, Chemicals, Rubber and plastic, Metal products, Mechanical machinery, Electrical machinery, Other industries, Electricity, gas, water and Transport and communication, which show differences of not less than 2 percentage points. Large differences together with regular trends may generate significantly different capital stock forecasts. While Education capital stock shows different but common trends according to lower, average and maximum replacement rates, Other manufacturing industries may even have positive or negative trends within the range of the observed sectoral replacement rate.

6. Concluding remarks

Accounting identities play a crucial role in the construction of econometric models. Tackling practical problems, Klein (1983) admitted that «model building took an unfortunate doctrinal turn» when economic theories were formulated side-by-side with mathematical equation systems. This «doctrinal turn» was mostly made at the Cowles Foundation where the first and influential paradigms of the statistical approach to econometrics were dictated. Then Klein realised that a fruitful approach

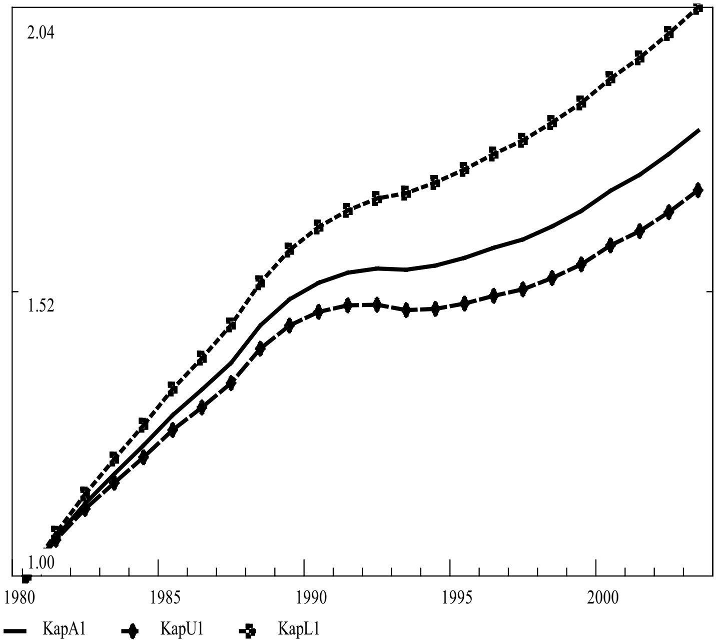
Tab. 5. Average life of Capital stock

INVESTORS	INVESTMENT GOODS								
	Machinery and equip.	Office machinery	Telecomu-nication equip.	Furniture	Land transport	Other transport	Construc-tion	Software	Other goods and services
Agriculture	18	7	7	16	10	18	51	5	34
Fishing	18	7	7	16	10	18	35	5	34
Mining Energetic Raw Material	18	7	7	16	10	18	35	5	34
Mining non Energetic Materials	18	7	7	16	10	18	35	5	34
Food, Beverages and Tobacco Industries	18	7	7	16	10	18	36	5	34
Textiles and Clothes	18	7	7	16	10	18	35	5	34
Leather and Leather products	18	7	7	16	10	18	35	5	34
Wood and wood products	18	7	7	16	10	18	35	5	34
Paper, paper products and printing	18	7	7	16	10	18	35	5	34
Coke and oil products	18	7	7	16	10	18	35	5	34
Chemicals and synthetic fibers	18	7	7	16	10	18	35	5	34
Rubber and Plastic products	18	7	7	16	10	18	35	5	34
Non metallic products	18	7	7	16	10	18	35	5	34
Metal products	18	7	7	16	10	18	35	5	34
Machinery and equipment	18	7	7	16	10	18	35	5	34

INVESTORS	INVESTMENT GOODS								
	Machinery and equip.	Office machinery	Telecomunication equip.	Furniture	Land transport	Other transport	Construction	Software	Other goods and services
Electrical machinery and optical instruments	18	7	7	16	10	18	35	5	34
Transport equipment	18	7	7	16	10	18	35	5	34
Other manufactured goods	18	7	7	16	10	18	35	5	34
Electrical energy, gas, steam and hot water	18	7	7	16	10	18	40	5	34
Construction	18	7	7	16	10	18	35	5	34
Trade	18	7	7	12	10	18	65	5	34
Hotels and Restaurant	18	7	7	12	10	18	65	5	34
Transport, storage and communications	18	7	7	16	10	18	50	5	34
Financial intermediation services	18	7	7	16	10	18	65	5	34
Real estate services, renting, computer services, research and development, other business services	18	7	7	16	10	18	79	5	34
Government	18	7	7	16	10	18	60	5	34
Education	18	7	7	16	10	18	57	5	34
Health services	18	7	7	16	10	18	35	5	34
Other services	18	7	7	16	10	18	56	5	34

Source: Istat

Fig. 11. Other Manufacturing – Replacement Rates: Lower .062, Average .081, Upper .093



to the definition of the structure of a model and its estimation might be founded through the accounting structure. Lately, Almon (1996) clearly showed that the Standard National Accounts (the accounting system used in the United States) involves some 150 items connected to 40 identities; since these represent a set of equations, they may be used as the cornerstone for the so called *identity-centred* modelling. Unfortunately, the adoption of the chain indexes does not preserve the accounting identities whereas the variables are measured in constant values. This loss is common to all the European Member States. The discrepancies due to the chain indexes have been evaluated for the Italian «chained» time series. Firstly, these statistics reveal common features of the chain indexes effect: the discrepancies are much more modest after the base year than before it. Secondly, the discrepancies turned out to be very modest; in other words, the «departure» from the exact accounting identity may be considered negligible. Rescaling the partial items over their total does not introduce noticeable changes to the original «chained» time series. The top-down approach has been applied to the Italian statistics: totals drive the rescaling of the subtotals.

According to previous experience, Verdoorn's law will be the cornerstone model for estimating labour productivity equations. The measurement of labour productivity is derived from the ratio of gross output to the work force employed. The latter has a dual measure: the number of people employed and the number of full-time employed persons. The comparison of these two measures gives evidence of the impact of the structural reforms of the labour market occurring over the last decade. A trade-off between labour productivity and job creation has taken place. Structural reforms have constantly spread their effect over time not signalling any instantaneous structural break. Hence, the labour productivity time series have to be carefully used in forecasting because the leeway observed in the last decade is unlikely to continue in the near future.

From investment and capital stock sectoral time series, replacement rates have been computed applying the perpetual inventory formula. These rates are not constant over time. The Istat «Methodological Notes» related to these time series tell us which factors influence the evolution of each sectoral replacement rate. Two issues may be underlined within the framework of the Inforum model system. First, the replacement rate trends must help to design the scenarios of these exogenous variables. Second, the spread of each capital stock replacement rate poses a two-fold choice: a) in estimating the import share equations; b) in forecasting import shares in the Bilateral Trade Model (BTM) which links the Inforum country models. Since in BTM capital stock is computed from investment flows, the perpetual inventory principle should be applied using sector specific and time varying replacement rates. Furthermore, although chosen within the observed spread, different replacement rates may generate extremely different trends in capital stock.

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BASE-SCENARIO FORECASTS USING THE LATVIAN MULTISECTORAL MACROECONOMIC MODEL: THEORETICAL STRUCTURE AND RESULTS

Astra Auziņa, Remigijs Počs

The Latvian economy experiences extremely high annual growth rates compared to the EU member states. This determines a great need for modelling tools that are able to capture and reflect both macro and sectoral changes.

The activities aimed at updating and improving the Latvian multisectoral macroeconomic model have not stopped and the process is still ongoing. At the current stage, the model developed can be applied to various and diverse modelling needs. The Latvian multisectoral macroeconomic model has been developed and applied to forecast long-run sectoral development till 2020. However, special attention has been paid to the manufacturing industry and its relative importance in the economy. Year-by-year, the service industry is squeezing out the manufacturing sector.

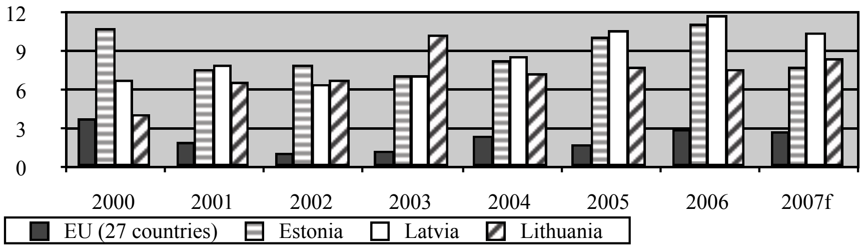
1. Analysis of trends

The Latvian economy has considerably higher growth rates than the overall EU economy and even the neighbouring EU member states. The annual growth rate of 11.9% was the highest growth rate in the EU in 2006. Figure 1 illustrates the growth rate differences between the Baltic States (Latvia, Estonia, and Lithuania) and the average EU-27 level.

Some Latvian industries have developed extremely fast. In 2006, the fastest growing industries (according to the NACE group classification) were real estate (K) (17.4%), wholesale and retail trade (G) (17.4%), financial intermediation (J) (15.4%), and construction (F) (13.6%). However, the product manufacturing - manufacturing industry only grew by 6.2%, and was one of the lowest growth rates amid industries (see table 1).

In 2006, fishing and agriculture, including forestry, did not share the value added increase trend of the rest of the economy. Despite the increase in subsidies and new market opportunities, agriculture lowered its position year-by-year.

Fig. 1. GDP growth rates in the EU and the Baltic States (%)



Data source: Eurostat
f – Eurostat forecast.

Tab. 1. Gross domestic product by kind of activity (growth indexes)

	2001	2002	2003	2004	2005	2006
TOTAL	1.080	1.065	1.072	1.087	1.106	1.119
Agriculture, hunting and forestry (A)	1.082	1.056	1.000	1.032	1.095	1.000
Fishing (B)	0.854	0.874	0.559	1.091	1.056	0.908
Mining and quarrying (C)	1.679	1.213	1.287	1.115	1.310	1.094
Manufacturing (D)	1.102	1.089	1.060	1.067	1.059	1.062
Energy (E)	1.058	1.043	1.044	1.050	1.018	1.040
Construction (F)	1.061	1.108	1.137	1.133	1.155	1.136
Wholesale, retail trade (G)	1.106	1.127	1.100	1.124	1.174	1.174
Hotels and restaurants (H)	1.137	0.998	1.255	1.164	1.146	1.143
Transport, storage and communications (I)	1.095	1.034	1.089	1.101	1.137	1.093
Financial intermediation (J)	1.073	1.051	1.033	1.083	1.114	1.154
Real estate, renting and business activities (K)	1.139	1.057	1.067	0.345	3.515	1.176
Public administration and defence; compulsory social security (L)	1.027	1.035	1.025	1.044	1.042	1.052
Education (M)	1.012	1.013	1.064	1.025	1.041	1.034
Health and social work (N)	0.999	1.013	1.033	1.022	1.021	1.039
Other community, social and personal service activities (O)	1.035	1.046	1.049	1.080	1.091	1.144

Data source: CSB data base

Since 2000, the structure of the national economy has also changed. Table 2 illustrates the structure of value added from 2000 to 2006. The share of the service industries (G-O) continued to increase and, in 2006, was 74.8%. The service sector industries with the largest share in val-

Tab. 2. Structure of value added by kind of activity (%)

	2000	2001	2002	2003	2004	2005	2006
TOTAL	100	100	100	100	100	100	100
Agriculture, hunting and forestry (A)	4.3	4.3	4.4	4.0	4.3	3.8	3.6
Fishing (B)	0.4	0.3	0.2	0.1	0.1	0.1	0.1
Mining and quarrying (C)	0.1	0.2	0.2	0.3	0.3	0.3	0.3
Manufacturing (D)	13.7	13.9	13.7	13.3	13.2	12.6	11.8
Energy (E)	3.6	3.4	3.3	3.2	3.0	2.5	2.5
Construction (F)	6.1	5.6	5.5	5.6	5.8	6.1	6.8
Wholesale, retail trade (G)	16.8	17.4	17.8	17.9	18.9	20.1	20.9
Hotels and restaurants (H)	1.1	1.2	1.2	1.4	1.6	1.7	1.8
Transport, storage and communications (I)	14.0	15.3	15.2	15.3	14.8	13.9	13.0
Financial intermediation (J)	4.9	4.4	5.0	4.9	5.1	6.0	6.2
Real estate, renting and business activities (K)	14.0	14.0	13.9	13.7	13.8	14.2	14.8
Public administration and defence; compulsory social security (L)	8.2	7.8	7.9	7.8	7.1	6.9	6.6
Education (M)	5.3	5.1	4.9	5.6	5.2	4.8	4.4
Health and social work (N)	3.4	3.2	3.0	3.0	2.9	3.0	3.1
Other community, social and personal service activities (O)	4.1	3.9	3.8	3.9	3.9	3.9	4.0

Data source: CSB data base

ue added are trade (wholesale and retail trade (G)), real estate and other business services (K), transport (I). These service industries accounted for 48.7% in 2006. From 2000 to 2006 the share of wholesale and retail trade increased faster than any other industry – by 4.1 percentage points and, in 2006 was 20.9%.

The manufacturing sector lost a part of its share in the economy despite its positive, and considerably high, annual growth rates. Manufacturing growth rates are considerably high in comparison with the average EU rates, but lower than the average growth rates of the total Latvian economy. Over the past years, the manufacturing share decreased by 1.9 percent point and, in 2006, was below 12 percent.

Employment trends represent the growing need for labour force, and, since 2000, the number of employed persons has increased on average by 2.4% annually. The sharpest increase, of 5%, was observed in 2006. (see table 3).

Tab. 3. Employed persons by kind of activity (thsd)

	2000	2001	2002	2003	2004	2005	2006
TOTAL	941	962	989	1007	1018	1036	1088
Agriculture, hunting and forestry (A)	134	143	147	135	132	122	118
Fishing (B)	2	2	6	3	2	3	2
Mining and quarrying (C)	2	2	3	2	2	2	4
Manufacturing (D)	170	166	167	174	163	154	170
Energy (E)	21	19	22	22	25	23	22
Construction (F)	56	68	60	74	87	91	104
Wholesale, retail trade (G)	145	151	148	153	151	158	170
Hotels and restaurants (H)	22	22	24	25	26	28	29
Transport (I)	79	78	86	95	96	95	101
Financial intermediation (J)	12	14	13	16	18	20	25
Real estate, renting and business activities (K)	45	41	39	42	40	49	61
Public administration and defence; compulsory social security (L)	71	68	68	67	73	82	88
Education (M)	87	88	88	79	83	91	88
Health and social work (N)	48	50	60	59	54	58	51
Other community, social and personal service (O)	44	49	53	57	60	58	49

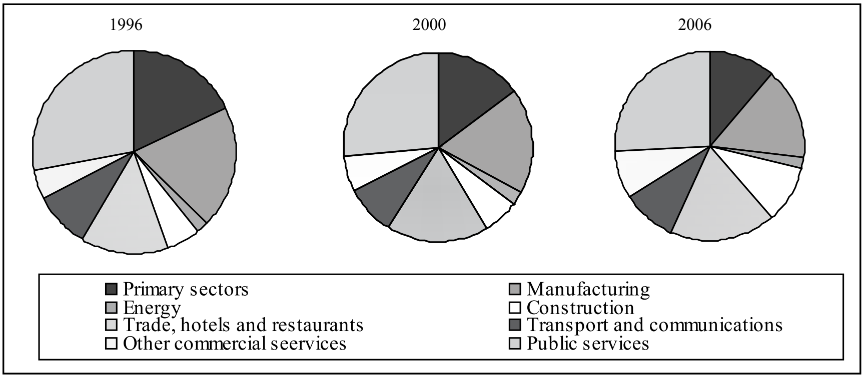
Data source: CSB data base

Figure 2 shows changes in the structure of employment from 1996 to 2006. Agriculture is the only industry where the number of employed persons has decreased. Since 2000, the construction sector has almost doubled the number of employees, due to the notable shifts in the housing market, real estate prices, and mortgage market (caused by considerably low mortgage rates).

The unemployment rate and number of unemployed are the indicators which illustrate changes in the demand for labour. As a result of the high economic growth the demand for labour has significantly increased and since 2002 the unemployment rate has almost halved (see figure 3.) – from 12.0% in 2002 to 6.8% in 2006. The decreasing unemployment rate trend is steady and according to the State Employment Agency was estimated at 4.9% in November 2007.

The imports and exports of goods and services have considerably increased, however the ratio of exports to GDP has only increased slightly – from 41.6% of GDP in 2000 to 44.2% of GDP in 2006,while the ratio

Fig. 2. Unemployment indicators

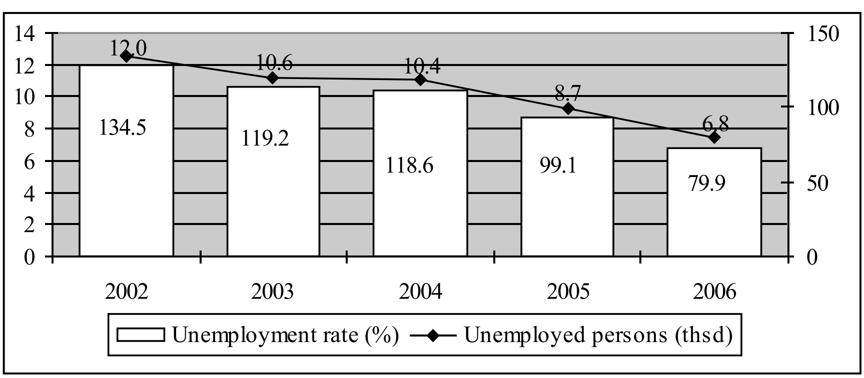


Data source: Eurostat

of imports to GDP has grown dramatically – from 48.7% to 64.4%. As a result, the foreign trade deficit has also increased substantially. The current account balance as a percentage of GDP increased from -4.8% in 2000 to -22.3% in 2006. However, in 2005, it was considerably lower (-12.5%) and even decreased a little, by 0.3 percent points, compared to the level of the previous year (see figure 4).

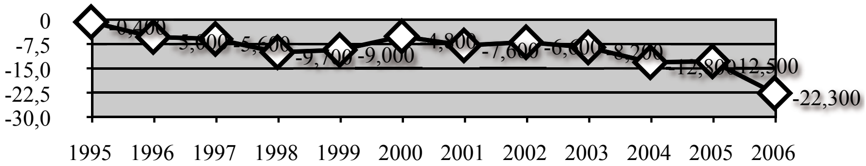
According to estimates by the Bank of Latvia the gap between exports and import growth rates continued in 2007, and reached -26.4% and -23.5% in the first and second quarters of 2007. The European Commission forecasts that the current account deficit will decrease slightly in coming years reaching -23.8% in 2007, -21.6% in 2008, and -19.8% in 2009.

Fig. 3. Unemployment indicators



Data source: CSB data base

Fig. 4. Current account balance, % of GDP



Data source: Bank of Latvia

2. The main features of the Latvian multisectoral macroeconomic model

Description

The Latvian multisectoral, macroeconomic model is based on the INFORUM philosophy, based on input-output accounting principles and identities, integrated using the bottom-up approach and applying INFORUM software. There have been significant achievements, improvements and upgrades compared to the development and condition of the model in previous years.

As the model development process encountered a number of problems regarding data endowment and availability, structural changes in the economy and future perspectives, experts' forecasts and other issues are still very problematic and require an appropriate solution.

Sectoral disaggregation is based on the NACE classification (dual code system) with some exceptions. The mining and quarrying sector (C group) presents two branches – coal and peat mining (C10) and aggregate other mining and quarrying industries (C11-C14). This aggregation has been carried out so as to omit the industries that have zero values (according to geographical location, natural resources endowment and existing manufacturing, these branches are not presented in the economy, however, some branches consume the imported products of these branches).

Other disaggregation has not yet been performed. However, several initiatives concerning the energy sector, financial intermediation, real estate and some other industries are being considered as potential model elements. Specifically, the disaggregation of the energy sector and its logical integration in the model is a topical and necessary issue, as a considerably large share of the electricity consumed domestically is imported. The construction sector has also experienced very fast and diverse growth, therefore, a detailed and disaggregated analysis of this sector would contribute considerable valuable information.

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

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

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

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

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

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

Household consumption

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

Household consumption according to the consumption item ($pce_{h,t}$) is forecast using different forms of functions (see Equations 2.1 - 2.2).

$$\log(pce_{f,t}) = a + b * \log(totpce_t) + c * dummy05, \tag{2.1}$$

$$pceio_{i,t} = pce_{h,t} * BM_t, \tag{2.2}$$

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

$dummy05_t$ – dummy ($dummy05_{2005,...2020}$=1);
h – consumption item (h=f+g).

The choice of the form of relation in the model depends on the result of econometrical estimation of historical behaviour of the time-series. Modelling household consumption by consumption item, the total household-consumption is econometrically estimated and forecast beforehand. Household consumption by branch according to the industry disaggregation level is acquired using a bridge matrix. This practice is also common to some INFORUM models. The German INFORUM model (INFORGE model) generates forecasts of household consumption by consumption item (43 groups) and by the bridge matrix obtains household consumption by branch (59 branches) (see Lutz, Distelkamp, Meyer, Wolter 2003).

By means of the bridge matrix household consumption by branch is obtained according to the level of disaggregation in the model (see Formula 2.3).

$$pceio_{i,t} = pce_{h,t} * BM_t, \tag{2.3}$$

where $pceio_{i,t}$ – household consumption (constant prices) for products of branch i in the time period t (I = 1, 2,.., 55; t=2000, 2001,…, 2020);
$pce_{h,t}$ – household consumption (constant prices) by item h, time period t;
BM_t – bridge matrix.

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

Final consumption of non-profit institutions serving households

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

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

$$ccp_{i,t} = ccp_{i,2005} * ccp\_index_t, \tag{2.4}$$

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

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

Exports

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

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

Exports of goods by branches are forecast by Formula (2.5).

$$\exp_{g,t} = \exp_{g,2005} * \exp\_index_{g,t}, \qquad (2.5)$$

where $\exp_{g,t}$ – export of goods (constant prices) by branch g at the time period t;
$\exp\_index_{g,t}$ – export index of branch g (2005=1).

The base year of the BTM export indexes is 2000, they have been recalculated to use 2005 as the base year.

In the Latvian model, an assumption is launched that the exports of services grow at the same growth rate as the total exports of goods in the long-run. The exports of services are modelled according to the following Formula:

$$\exp_{s,t} = \exp_{s,t-1} * \exp\_d_t, \qquad (2.6)$$

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

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

Due to these motives the approach mentioned has been used in the Latvian model:

- This approach is used to gradually integrate into the INFORUM modelling system and make forecasts obtained by taking into account the development trends in other countries (especially in-countries importing Latvian goods and services).

- Insufficient length of detailed time series;
- Exports are determined more by external factors than by domestic production capacity and historical development trends.

Imports

Imports of goods and services by branches are modelled using a single method compared to exports. Imports are modelled using import shares. Latvia integrates with the EU and other markets, and the importance of imports in the Latvian economy has increased because of free trade and the trade barrier liberalization process.

Import shares are modelled in the model using Formula (2.7):

$$impsh_i = \frac{imp_i}{imp_i + out_i}, \tag{2.7}$$

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

In the Latvian model, firstly the import shares of branches are modelled. Each branch has its import shares equation (see Formula 2.8).

$$impsh_{i,t} = impsh_{i,t-1} + a * trend_t, \tag{2.8}$$

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

On the basis of the modelled import share values, using the Seidel procedure imports and outputs of branches are modelled simultaneously. By transforming the Formula (2.8), the result is Formula (2.9), which is used in the model.

$$imp_{i,t} = impsh_{i,t} * ds_{i,t}, \tag{2.9}$$

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

Some branches especially in the service sector produce products which cannot be exported to Latvia; hence there are zero imports for the products in some sectors.

Government expenditure

Government expenditure by branches is modelled using exogenous growth trends (see Formula 2.10).

$$gov_{i,t} = gov_{i,t-1} * gov\_d_{i,t}, \tag{2.10}$$

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

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

Fixed capital formation

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

$$pde_{i,t} = pde_{i,2005} * pde\_index_{i,t}, \tag{2.11}$$

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

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

Changes in stocks

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

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

Output

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

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

Value added

Since sufficient, long-term disaggregated time series of value added according to its elements are not available, the value added is modelled as a single vector in the model. Value added by sector is modelled by using growth indexes (see Formula 2.12).

$$vad_{i,t} = vad_{i,2005} * vad\_index_{i,t}, \tag{2.12}$$

where $vad_{i,t}$ – value added by sector i at time period t (constant prices); $vad\_index_{i,t}$ – value added index by sector i at time period t.

Using output and value added by branch, value added coefficients are calculated (see Formula 2.13).

$$unitva_{i,t} = \frac{vad_{i,t}}{out_{i,t}}, \tag{2.13}$$

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

The value added coefficient is important in the further calculations in the model, especially as regards the price side of the model.

Prices

Prices by branch are modelled using the PSeidel procedure. The Leontief price equation is based on this procedure.

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

$$p_{i,t} = A_t * p_{i,t} + unitva_{i,t}, \qquad (2.14)$$

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

The PSeidel procedure is an essential part of the INFORUM model and it is one of the characterising and widely-used features of this type of model.

Productivity and employment

There are two indicators which characterize sectoral productivity in in the model. One of these indicators is output per employed person in branch i. The second indicator is the ratio between employed persons and the output of branch i (see Formulas (2.15) and (2.16)).

$$labpro_i = \frac{out_i}{emp_i}, \qquad (2.15)$$

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

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

$$empro_i = \frac{emp_i}{out_i}, \qquad (2.16)$$

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

In the Latvian model, output per employee is obtained using exogenously given growth rates. Output per employee $labpro_{i,t}$ is modelled using Formula (2.17).

$$labpro_{i,t} = labpro_{i,t-1} * labpro\_d_{i,t}, \qquad (2.17)$$

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

Both indicators ($labpro_{i,t}$ and $empro_{i,t}$) are related and on the basis of Formulas (2.16) and (2.17), can be expressed as Formula (2.18).

$$empro_{i,t} = \frac{1}{labpro_{i,t}}. \qquad (2.18)$$

Employment is modelled in absolute numbers, this means employed persons by branch. The number of employed persons is calculated using the following Formula:

$$emp_{i,t} = labpro_{i,t} * out_{i,t}, \qquad (2.19)$$

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

It is assumed that it is not significant whether a person works more or less hours in the future compared to the base year, the only important issue is the amount of output produced by one employed person (person equivalent).

Macroeconomic indicators

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

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

3. Modelling results

The forecasts generated by the model illustrate the potential pace of development of the Latvian economy in the long-run. Taking into account the structural and sectoral changes and shifts in the economy, the model is developed and used more as an indicative instrument revealing potential future levels and problems. At the current stage, the model results must be interpreted with reserve and scepticism. As the model deals with many sectors some of them perform illogically and require close investigation and examination, especially the branches that have developed rapidly over past years, with both trends and experts suggesting that this growth will continue.

A base modelling scenario has been developed. It represents the potential sectoral and total development until 2020. The base-scenario illustrates the economic development within the present and provisional trends and shifts. It is neither optimistic nor pessimistic.

Table 4 illustrates average annual growth rates by branches. Most of the sectors behave according to pre-simulation assumptions, however some branches require detailed analysis to separate scenario assumption mistakes or errors from fundamental and model-size errors or problems.

Exports of goods were forecast on the basis of export indexes for Latvia computed by Grassini and Parve. However, some modifications and extensions have been carried out because the time model horizon is longer. These activities are carried out using trend analysis and experts' evaluations mainly.

As imports of goods and services are forecast using equations – imports share equations are integrated in the model. At the current stage, according to the model, imports behave optimistically from the overseas point of view and very pessimistically from the domestic producers' position. According to the forecasts the foreign trade deficit will continue to grow and it seems too dramatic and destructive for domestic production. Additional analysis and studies are required to estimate whether it is possible, and how, to improve the model.

Figure 5 illustrates the imports and exports of goods and services in constant prices till 2020.

The model also included employment modelling possibilities. At present, employment is forecast using the relation between output and productivity. Productivity according to category is exogenous at the current stage of the model. This block also requires both detailed and diverse analysis of results and theoretical improvements. As a result, employment (in persons) mainly depends on output according to category.

According to modelling results, the average annual growth rate of total employment is 1.2%, and in 2020 total employment is forecast to be 1, 305,000 persons. Analysing the structure of employed persons, the share of the service sector will stop increasing and stabilize.

4. Modelling problems and solutions

There are several problems concerning the model's forecasts at the current stage. Firstly, the problems regarding the model's incompleteness, in other words, the results are out of line because of the structure,

Tab. 4. Output growth rates forecasts by branch (indexes)

	Code	Shortened description	2007-2010	2011-2015	2016-2020	2007-2020
1	A 01	AgriProd	1.046	1.036	1.030	1.037
2	A 02	ForestProd	1.111	1.083	1.068	1.085
3	B 05	Fish	1.053	1.038	1.029	1.039
4	C 10	CoalPeat	1.109	1.106	1.099	1.105
5	C 11- C 14	OthMining	1.109	1.106	1.099	1.105
6	D 15	FoodBever	1.053	1.044	1.034	1.043
7	D 16	Tobacco	1.134	1.089	1.066	1.093
8	D 17	Textiles	1.109	1.078	1.060	1.080
9	D 18	Clothing	1.093	1.068	1.054	1.070
10	D 19	Leather	1.148	1.100	1.074	1.104
11	D 20	Wood	1.080	1.060	1.047	1.061
12	D 21	PulpPaper	1.096	1.070	1.055	1.072
13	D 22	PrintRecor	1.091	1.071	1.057	1.072
14	D 23	Coke	1.058	1.048	1.045	1.050
15	D 24	Chemicals	1.062	1.055	1.048	1.054
16	D 25	RubPlast	1.064	1.062	1.062	1.063
17	D 26	OthNMetPro	1.071	1.064	1.059	1.064
18	D 27	BasicMet	1.081	1.068	1.054	1.067
19	D 28	MetalProd	1.070	1.067	1.064	1.067
20	D 29	MachEquipm	1.090	1.077	1.070	1.078
21	D 30	MachOffice	1.086	1.077	1.072	1.078
22	D 31	MachElectr	1.079	1.065	1.056	1.066
23	D 32	CommEquipm	1.097	1.080	1.071	1.082
24	D 33	MedOptInst	1.083	1.066	1.056	1.067
25	D 34	Vehicles	1.279	1.174	1.129	1.187
26	D 35	OthTransp	1.099	1.073	1.060	1.076
27	D 36	FurnitOhte	1.087	1.068	1.061	1.071
28	D 37	SecRawMate	1.065	1.056	1.047	1.055
29	E 40	ElEnergyGa	1.048	1.048	1.047	1.048
30	E 41	Water	1.090	1.097	1.094	1.094
31	F 45	Construct	1.069	1.067	1.065	1.067
32	G 50	VehRepairS	1.064	1.051	1.042	1.051
33	G 51	WholesaleT	1.041	1.037	1.034	1.037

(continued)

	Code	Shortened description	2007-2010	2011-2015	2016-2020	2007-2020
34	G 52	RetailTrS	1.023	1.023	1.022	1.023
35	H 55	HotelRstnt	1.059	1.047	1.038	1.047
36	I 60	LandTransp	1.052	1.044	1.037	1.044
37	I 61	WatTranspS	1.252	1.118	1.073	1.138
38	I 62	AirTranspS	1.082	1.061	1.048	1.062
39	I 63	SuppTransp	1.031	1.029	1.026	1.029
40	I 64	PostTlcmS	1.054	1.046	1.040	1.046
41	J 65	FinIntermS	1.047	1.043	1.040	1.043
42	J 66	InsuranceS	1.063	1.054	1.047	1.054
43	J 67	AuxFinIntS	1.052	1.041	1.032	1.041
44	K 70	RealEstate	1.033	1.034	1.036	1.035
45	K 71	MachRentS	1.074	1.071	1.067	1.070
46	K 72	ComputerS	1.067	1.062	1.059	1.062
47	K 73	ResearchS	1.063	1.052	1.045	1.052
48	K 74	OthBusinS	1.056	1.049	1.044	1.049
49	L 75	PublAdminS	1.029	1.029	1.029	1.029
50	M 80	EducationS	1.036	1.034	1.032	1.034
51	N 85	SocialS	1.042	1.038	1.035	1.038
52	O 90	RefuseDisp	1.055	1.067	1.073	1.066
53	O 91	MemberOr	1.089	1.068	1.056	1.070
54	O 92	RecrCultur	1.030	1.026	1.023	1.026
55	O 93	OtherServ	1.051	1.044	1.038	1.044
		Total	1.057	1.051	1.047	1.051

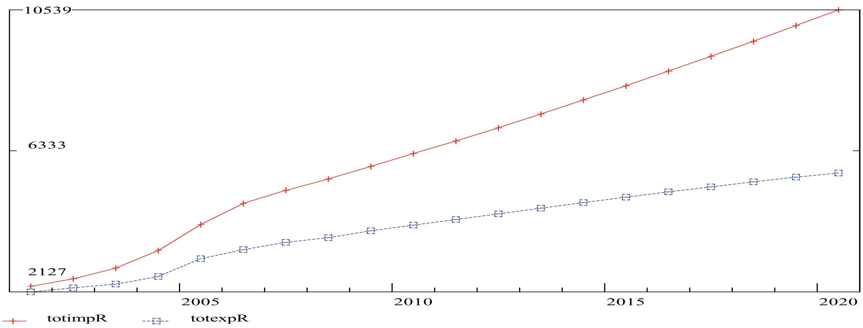
elements, coefficient values, etc. This is mainly seen in the forecasts for small (or even tiny) and specific branches that perform differently from year to year.

Secondly, the issues of how effectively and fast the above-mentioned problems are caught are some of the most difficult problems and issues. Detection of these problems is the first step and it may occur within a short period of time, but what is a far more complicated task is to find an appropriate solution.

Thirdly, the model requires new input-output information. Some action has been taken to elaborate an input-output table for 2005 for analysis requirements and with a lower level of disaggregation.

At first glance it seems that the model behaves more optimistically than expected. However, comparing the model's results to other Latvian

Fig. 5. Imports and exports forecast, mln lats



economy model results, this is not so – other models present even more optimistic values. For instance, compare the model's real GDP level in 2020 with the Latvian labour demand forecast system results (Frolova, 2004), and the result is that the level of GDP in the latter is approximately 15% higher.

Comparing employment forecasts, the results are opposite; the Latvian multisectoral, macroeconomic model generates larger numbers than the Latvian labour demand forecast system. It requires additional study to find out the cause of the difference and whether any changes should be made to the model.

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<http://epp.eurostat.ec.europa.eu/> – Eurostat data base

<www.bank.lv> – Bank of Latvia (Balance of payment statistics)

FORECASTING OF RUSSIAN ECONOMY DEVELOPMENT WITH USE OF THE DYNAMIC INPUT-OUTPUT MODEL WITH FUZZY PARAMETERS[1]

Alexander O. Baranov[2], Victor N. Pavlov[3]

Estimates for projecting the development of the Russian economy for the period 2008-2012 were carried out in two stages.

1. A forecast was carried out with the help of a Deterministic Dynamic Input-Output Model.
2. Calculations based on the Dynamic Input-Output Model with fuzzy parameters were made which took into account the results of forecasting the development of the Russian economy using the Deterministic Dynamic Input-Output Model.

1. Hypotheses underlying various estimates based on the Dynamic Input-Output Model for the years 2008-2012

The forecasting estimates for the years 2008-2012 were carried out with the help of the Dynamic Input-Output Model based on the information data of 2007. At the same time, all the estimated parameters were defined in the comparative prices of 2003.

The main goal of the forecasting estimates was to investigate whether it would be possible for Russia to achieve the level of per capita GDP output close to that of the lesser developed countries of Western Europe, Greece and Portugal in the course of the next decade (2008-2018). In

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2002, taking into account the parity of the purchasing power of the national currency, GDP per capita in Russia was approximately two times lower than in these countries (Russian Yearbook of Statistics 2006: 769,771). Given that in the course of ten years, GDP at least doubles, its average annual growth rate should account for not less than 7.2%. In the period 2008-2012, due to this average annual growth rate, GDP should grow by at least 41%.

The possibilities of attracting additional workforce into the production process being limited, the main source of production growth in Russia is in raising its efficiency. Indeed, in the period of economic recovery (1999-2006), employment in the Russian economy grew by 7.9%, while the productivity of labour grew by 53.7% (see table 1). The growth of productivity was the crucial factor that provided the increase of GDP by about two-thirds in the given period.

The main source of productivity growth is simple and extended reproduction of fixed assets is carried out through investments. Investments in fixed assets which provide for the replacement of the morally and physically outdated active part of fixed assets, permits the "entrance" of new technologies into the production process. The comparison of the fixed capital investment growth rate and the rate of labour productivity growth in 1999-2006 (see table 1) shows that 1% of growth of the first index accounted for 0.46% of growth in the second. (53,7/117,5 = 0,46).

As we can see, the most important condition for achieving the goal of doubling GDP per capita in 10 years when labour resources are limited, is to considerably increase fixed capital investments. If we proceed from the above ratio of the correlation between the increase in the rate of investments in fixed capital and the growth of productivity and suppose that the size of labour resources in the Russian economy does not grow, it will be possible to forecast that in five years the essential fixed capital investment growth rate will account for not less than 90% (41%/0.46 90%) or 13.7% per year on average.

Another justification for high rates of investment in fixed capital in the projected period is connected with the need for the substantial renewal of basic assets that should be carried out over the next few years.

The need for such research is well-founded since the moral and physical depreciation of fixed assets in Russia over the last decades has reached such a degree that only a rapid increase in the production of asset-building industries will be able to provide considerable growth of production and raise the living standard of the population. This paper continues the research in this field carried out earlier (Baranov 1994).

In the period 1999-2006, fixed capital investment growth rates accounted for 218%, while the rates of putting fixed assets into operation was 212% (see table 1). However, in spite of the considerable growth of investments in fixed assets and the input of fixed assets, the absolute

Tab. 1. Major macroeconomic indices growth rates in the Russian economy from 1999-2006, %

Index	Growth rates in 1999-2006
Gross Domestic Product	165.8
Expenditures for Final Consumption	170.0
Employment in the Economy	107.9
Fixed Assets	105.5
Labour Productivity with respect to GDP	153.7
Capital Productivity	157.1
Fixed Capital Investments	217.5
Fixed Assets Put in Service	211.5
Average annual growth of GDP per 1% of investment in fixed assets, %	0.56
Average annual growth in labour productivity per 1% of fixed capital investments, %	0.46
Average annual growth of final consumption per 1% of fixed capital investments, %	0.6

References: Russian Federal State Statistics Service 2006; Russian Federal State Statistics Service 2007; Internet: site of Russian Federal State Statistics Service <http://www.gks.ru>.

value of these indices in the comparative prices of 2006 remained equal to about 50% of the level of 1991. As a result, the Russian economy did not experience any important positive changes in the age composition of fixed assets and the degree of their depreciation.

In general, the degree of fixed assets depreciation in the national economy in 1998 was equal to 40.1%, in 2005 – 44.3% (see table 2), and in 2006 – 45.3%. The degree of wear and tear of machinery and equipment in 2006 was 52.5%. The degree of fixed assets depreciation in industry in 1998 accounted for 53.3% and in 2005 it was 49.7%. Due to an increased input of fixed assets in recent years, the ratio of fixed assets renewal in the economy in general, according to the estimates of the Federal Statistics Service of the Russian Federation, grew from 1.1% in 1998 to 2.2% in 2005; in industry it grew from 0.9% to 2.6% correspondingly (see table 2). At the same time, the ratio of fixed assets retirement in the Russian economy in general remained the same (1.1%), while in industry it actually fell from 1.3% in 1998 to 1.0% in 2005.

Note that in the USA, which has an enormous production mechanism, the ratio of fixed assets renewal at the end of the 90s (1998-1999) was considerably higher than in Russia and accounted for 5.2% (estimated on the basis of official American data – US Department of Commerce 2001).

Tab. 2. Dynamics of indices characterizing the state of fixed assets in Russia in 1998-2005, %

Indices	1998	1999	2000	2001	2002	2003	2004	2005	Percentage changes in 2005 compared to 1998
Fixed assets depreciation rate in the country's economy as a whole	42,2	41,9	42,4	45,8	47,9	49,5	42,8	44,3	2,1
Fixed assets renewal ratio in the country's economy as a whole	1,1	1,2	1,4	1,5	1,6	1,9	2,1	2,2	1,1
Fixed assets retirement ratio in the country's economy as a whole	1,1	0,9	1,0	1,0	1,0	1,1	1,1	1,1	0
Fixed assets renewal ratio in industry	0,9	1	1,3	1,5	1,5	1,7	1,8	1,9	1
Fixed assets retirement ratio in industry	1,3	1	1,2	1,1	1	1,0	1,0	1,0	-0,3
Fixed assets depreciation rate in industry	52,9	55,1	51,6	52,3	51	52,9	51,4	49,7	-3,2
Share of equipment less than 10 years old in industry	24,2	19,3	15,3	13,3	12,5	12,7	No data	No data	-11,50[1]

[1] Difference in data for 2003 and 1998

Reference: Russian Federal State Statistics Service 2006: 327-329.

The information given above testifies that in the years of the economic recovery *there were no noticeable positive qualitative changes in the condition of the fixed assets.* A high depreciation level of fixed assets is still one of the main reasons for unstable economic development and uneven increases in the living standards of the population in the medium and long-term.

The size of investments made in recent years cannot lead to radical shifts in the age composition of the production mechanism. The state share in the pattern of fixed capital investment capitalization is still insignificant. In the last seven years (1998 -2006) the share of consolidated budget in fixed capital investment capitalization accounted for approximately 20% (Russian Federal State Statistics Service 2001). If we consider taxation, in 2002 profit tax privileges for enterprises investing their financial resources in renovating and expanding fixed assets were abolished. Consequently, in the years of the economic recovery, no active fiscal policy was conducted that could contribute to a rapid renewal of fixed assets.

It seems that in a situation of crisis of fixed assets, the state should conduct a more active economic policy that would stimulate a rapid renewal of fixed assets. In the area of monetary policy a package of measures aimed at lowering the real interest rate for crediting business should be introduced. In fiscal policy, investments should be stimulated through tax incentives as was done before. However, in our opinion, the application of indirect regulation instruments only in the investment process seems insufficient in the present situation. In the condition of a balanced and profitable budget the state, represented by the Federal Center and the administrative bodies of the subjects of the Russian Federation, may directly finance priority, innovative, investment projects in the sphere of creating infrastructures (construction of roads, airports and sea ports etc.) This variant of the economic policy in the area of investments would promote the transition of the economy to the path of innovative development that is stipulated in one of the versions of the economic development plan for Russia in 2008-2010 in accordance with the forecasts of the Government of the Russian Federation[4]. State financing should be carried out mainly on a competitive basis. The mechanism of decision-making should be as transparent as possible and be controlled by society.

[4] Internet: *On Preliminary Results of Socio-Economic Development of the Russian Federation in the 1st Quarter of 2007. Projection of Socio-Economic Development of the Russian Federation for 2008. Forecast parameters by 2010 and limit level of prices (tariffs) on the products (services) of the subjects of natural monopolies for 2008 and for the period up to 2010. April 2007*, Report of G. Gref, the Minister of Economic Development and Trade, at the meeting of the Government of the Russian Federation on 19.04.2007. Site of the Ministry of Economic Development and Trade of the Russian Federation <http://www.economy.gov.ru/wps/portal>. (In Russian).

In this connection, it seems appropriate to further research the possibilities of greater direct financing by the state, represented by a consolidated budget for some part of the investments for renewing fixed assets.

Considerable growth of investments in fixed capital, especially in its active part, is also possible in terms of a fuller utilization of production capacities. The level of utilisation of production capacities in machine building in Russia remains low. In 2005 production capacities in machine building fluctuated from 3.9% (production of bridges and electric cranes) to 68% (production of automobiles). According to our estimates, on average, the degree of utilizing production capacities in industry in 2002 accounted for about 42% (the estimates are based on the data collected by the Federal State Statistics Service of the Russian Federation). It opens up new possibilities for considerably improving the production of the means of labour due partly to an increased utilization of production capacities in industry. However the most important question, concerning the possibility of actual utilization of these production capacities and the production of competitive products on such basis, remains open. Another opportunity for a large-scale renewal of fixed assets is to import large amounts of machinery and equipment but this would have a negative effect on the value of current account operations and balance of payments in general.

Given the rapid growth of investments in fixed assets, their replacement rate should grow considerably. According to our estimates, in order to provide stable economic growth via the path of innovative development, the fixed assets retirement compensation rate should at least triple. For this reason, the estimates were based on the hypothesis that in 2012 this macroeconomic parameter would amount to approximately 3.3%. At the same time, the retirement compensation rate for the active part of fixed assets (machines and equipment) should grow from 1.6% in 2007 to 4.8% in 2012, while for the passive part (structures) it should increase from 1% to 1.5% accordingly. In addition, the value of fixed assets was supposed to grow at approximately the same rate as in recent years. In other words, investments in fixed assets should provide for their rapid renewal in conditions where the average annual rate of fixed assets growth is equal to 1%. Under the specified conditions of a rising retirement compensation ratio, the growth rates of investments in fixed assets was determined endogenously in the course of solving the problem using the Dynamic Input-Output Model for the years 2008-2012.

The third aspect reflected in developing different variants of forecasting estimates with the help of the Dynamic Input-Output Model with fuzzy parameters implied the need to increase end consumption by the population by not less than twice during the projected period. In 1999-2006, 1% of GDP growth accounted for 0.94% growth in end consumption (see table 1). On the basis of this ratio, the GDP growth rate in ten years should account for about 206% (100 % + (100%/0,94)). During the forecasting period (2008-2012) the GDP growth rate should reach 43%. In 1999-2006 the ratio characterizing the correlation between the growth rate of GDP and growth rate of investments in fixed assets was 0.56% (see table 1). Consequently, in 2008 – 2012, investments in fixed assets should grow by not less than 78% (43,50,56 ≈78%).

The above estimates resulting from the need to provide the required growth of end consumption and labour productivity make it possible to draw a conclusion that *the attainment of target indices in the development of the Russian economy in 2008-2012 will require an increase in investments in fixed assets of at least 80%-90%.*

The present parameter was adjusted in the course of forecasting estimates with the help of the Dynamic Input-Output Model.

The following assumptions are made in all the estimated alternatives.

1. It is assumed that by 2012 the size of net exports of the Russian economy will fall. In the optimistic scenario it is expected to fall by 33% and in the pessimistic one by 8%.

A greater decrease of balance in the optimistic scenario is justified by the fact that according to this scenario there will be a much higher rate of GDP growth and, consequently, a much higher rate of import growth. On the whole, the specified net export dynamics is much more optimistic compared to the scenario of development of the economy of the Russian Federation prepared by the Ministry of Economic Development and Trade of the Russian Federation. According to the projection made by the Ministry, net exports will already approach the zero value by 2010. Such development of events seems too pessimistic.

2. The size of labour resources and the population of Russia remain constant during the whole forecasting period and are equal to the values of these indices in the base year. In other words, it is assumed that the measures taken by the Government of the Russian Federation to stimulate the birth rate and reduce the death rate as well as to resettle compatriots from abroad will quickly achieve the desired effects.

3. The rates of gross output and GDP growth are taken to be equal.

4. The sectoral coefficients of labour-intensiveness, capital-intensiveness and per unit consumption of material are determined endogenously on the basis of calculated gross output and size of labour resources.

The following scenarios of the development of the Russian economy were studied.

The following assumptions were made in the **first (optimistic) scenario**.

1. On the basis of the hypothesis that GPD in Russia will double in ten years and the living standard of the population will grow correspondingly, it was concluded that the growth rate of expenditure on final consumption in 2008-2012 should be equal to at least 41%.

Tab. 3. Projected growth rates of certain major indices of the Russian economy in 2008–2012, %

Index	2008	2009	2010	2011	2012	2012/ 2007
Total Gross Output and GDP						
Optimistic Scenario	107,5	107,5	107,5	107,5	107,5	143,6
Pessimistic Scenario	105,4	105,4	105,4	105,4	105,4	130,1
Gross output of the 1st subdivision						
Optimistic Scenario	109,2	106,9	107,0	107,4	107,6	144,4
Pessimistic Scenario	106,8	104,6	104,6	104,9	105,0	128,7
Gross output of the 2nd subdivision						
Optimistic Scenario	104,4	108,6	108,5	107,7	107,2	142,0
Pessimistic Scenario	102,8	106,8	107,0	106,4	106,1	132,7
Total Fixed Assets						
Optimistic Scenario	101,6	101,8	102,0	102,3	102,7	110,8
Pessimistic Scenario	101,5	101,6	101,6	101,7	101,8	108,6
Including						
Active Part of Fixed Assets (machines and equipment)						
Optimistic Scenario	102,0	102,0	102,1	102,4	102,7	111,8
Pessimistic Scenario	102,0	102,0	102,0	102,0	102,0	110,3
Passive Part of Fixed Assets (structures)						
Optimistic Scenario	101,4	101,6	101,9	102,3	102,6	110,3
Pessimistic Scenario	101,3	101,4	101,5	101,6	101,7	107,6
Total Fixed Capital Investments						
Optimistic Scenario	114,6	113,9	114,4	114,7	115,0	196,9
Pessimistic Scenario	106,7	106,5	106,6	106,8	106,9	138,3
Including						
Investments in Machines and Equipment						
Optimistic Scenario	117,5	115,9	116,2	116,3	116,2	213,7
Pessimistic Scenario	109,1	108,0	108,1	108,0	107,9	148,4
Investments in Structures						
Optimistic Scenario	112,3	112,3	112,8	113,4	113,9	183,8
Pessimistic Scenario	104,9	105,3	105,4	105,7	106,0	130,4
Total Fixed Assets Replacement Rate, %						Replacement Rate in 2007, %
Optimistic Scenario	1,5	1,8	2,2	2,5	2,8	1,2
Pessimistic Scenario	1,4	1,5	1,7	1,8	2,0	1,2

(continued)

Index	2008	2009	2010	2011	2012	2012/ 2007
Including						
Replacement Rate of Machines and Equipment, %						
Optimistic Scenario	2,3	2,9	3,6	4,2	4,9	1,6
Pessimistic Scenario	1,9	2,3	2,6	2,9	3,3	1,6
Replacement Rate of Structures, %						
Optimistic Scenario	1,1	1,2	1,3	1,4	1,5	1,0
Pessimistic Scenario	1,0	1,1	1,1	1,2	1,2	1,0

Note: Results of estimates for the Russian economy are based on the Dynamic Input-Output Model

In this scenario it is assumed that the Russian economy will choose an innovative line of development, making it possible to provide considerable growth in the living standards of the population, and to diversify exports (get rid of dependence on world market prices of energy carriers) and provide more stable economic growth.

2. During the whole projected period the fixed assets put in service will grow by at least 90%. The growth rate of investments in fixed assets will at least double.

3. During the whole forecasting period replacement rates for the active (machines and equipment) and passive (structures) parts of fixed assets in the Russian economy as a whole will grow 3 and 1.5 times respectively (see table 3). The scenario of considerable renewal of the production mechanism makes it possible to accelerate the introduction of new technologies into production processes and raise the efficiency of production.

The second (pessimistic) scenario is based on the following assumptions.

1. The GDP and gross output of the Russian economy in 2008-2012 will grow at the rate of approximately 30% corresponding to an average annual growth rate of 5.2%. This rate conforms to the inertial scenario for the development of the economy of the Russian Federation included in the forecast of the Russian Ministry of Economic Development and Trade for the period 2008-2012 [11].

2. The scenario assumes a slower replacement of machines and equipment. The replacement rate for the active part of fixed assets (machines and equipment) will grow gradually from 1.6% in 2007 to 3.2% in 2012; for the passive part of fixed assets (structures) it will increase from 1% to 1.2% correspondingly (see table 3). Fixed capital investments will grow

approximately 38% (97% in the optimistic scenario), while investments in the active part of fixed assets will increase by 48% (214% in the optimistic scenario).

As we can see from the above brief description of the hypotheses underlying the estimates for different scenarios, they investigate different versions of accelerated renewal of fixed assets in the Russian economy, primarily their active part.

It is important to note that during the period under review, within the frameworks of the first and second projections, there is considerable growth of production in capital-building engineering industry. At the same time it is assumed that in all the industries of the economy the utilization of fixed assets will become more intensive: there will be growth of capital productivity or a decrease in capital intensiveness. The growth of capital productivity in the forecasting estimates is explained by introducing into production, as it expands, a considerable part of production capacities not utilized at present and by using new, more effective fixed assets that are put into operation during the period investigated.

An important condition for achieving the rates of production growth assumed in the scenarios is the growth of fixed capital investments; with priority investments in capital-building and adjacent industries.

2. Results and interpretation of forecasting estimates based on the Dynamic Input-Output Model with fuzzy parameters

The second stage of forecasting the development of the Russian economy consisted in making estimates with the help of the Dynamic Input-Output Model with fuzzy parameters (see Appendix). These estimates were based on the results of forecasting the Russian economy using a Deterministic Input-Output Model.

In the course of the estimates, several experiments were carried out. The degree of plausibility of a particular assumption was calculated in the following way (Pavlov, Pavlov 2006).

Namely, fuzzy set A in space X is understood as a geometrical object having the following property: for each $x \in X$, number $\chi_A(x){:}0 \leq \chi_A(x) \leq 1$ is determined, that is interpreted, as the degree of plausibility of the statement that $x \in A$.

If $\chi_A(x)=0$, statement $x \in A$ is absolutely implausible; if $\chi_A(x)=1$, then statement $x \in A$ is absolutely plausible. Function $\chi_A{:}X \to I$ is called the function of membership of a (fuzzy) set A. Here $I=[0;1]$, I^X is the domain of measurable images $f{:}X \to I$.

In fact, a fuzzy assignment of parameters in the Dynamic Input-Output Model and the computation of fuzzy values of economic indices leads to a new understanding of macroeconomic stability. The methodology of assessing the reliability of forecast indices proposed earlier (*ibidem*) can be also interpreted as the assessment of stability of computed fuzzy indices in relation to a fuzzy description of model parameters.

The geometric characteristic of stability is the ratio of the intersection area of the forecasting index membership function's sub-graph and the standard index membership function's sub-graph (see cross-hatch area in fig. 1) to the total area of standard index membership function's sub-graph.

In order to build the membership function of computed indices a stochastic algorithm described in the paper was applied (Pavlov, Pavlov 2007). In each experiment, particular parameters of the Dynamic Input-Output Model were assigned within the framework of particular constraints indistinctly; 200 estimates based on the Dynamic Input-Output Model were carried out. Their results, in terms of studied parameters, were processed with the help of a stochastic procedure of building membership function and are illustrated with the help of the diagrams below. For instance, figure 1 shows a fuzzy representation of a projected growth rate of gross output of the Russian economy between 2008 and 2012.

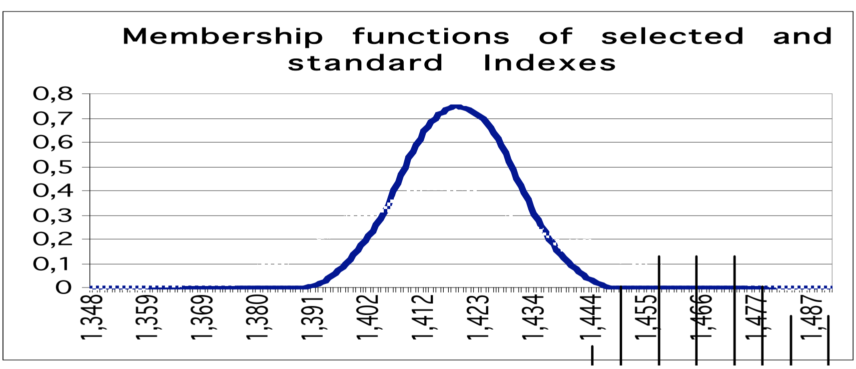
In the estimates given below, the degree of fuzziness of parameters varied within the limits of 10 to 25 per cent from the values of parameters defined on the basis of retrospective information analysis.

In order to estimate the level of stability, each selected index (for instance, gross output of the national economy) was compared with a standard fuzzy description of its most plausible value calculated on sample basis. In order to calculate the most plausible value x_0 the problem of maximizing the function of membership χ_p of index p was solved:

$$\chi_p(x_0) = \max_{x \in R} \chi_p(x),$$

where R is a real line.

Fig. 1. The geometric characteristic of computed fuzzy indices stability



A standard fuzzy presentation of value x_0 was calculated with the help of a stochastic procedure where the degree of fuzziness was equal to half the amplitude of sampling of a studied parameter, with the degree of fuzziness of variable parameters equal to 10%.

Of course, measuring the degree of stability of forecasting indices relative to the standard index leads to dependence of the degree of stability on the choice of this standard index. However it is easy to prove that the degree of stability of the value of the forecasting indices will proportionally decrease or increase when changing from one standard index to another. In that case the ratio between stability levels of different indices will remain the same.

Let us briefly describe some results of experimental estimates.

1. It was determined whether an event was plausible, that is whether the growth rate of gross output of the Russian economy would be equal to 143.6% (the most plausible index value in the optimistic scenario) in the conditions when the most important parameters of the Dynamic Input-Output Model are presented fuzzily, within the limits specified earlier. The plausibility degree of achieving the growth rates of gross output of the 1st (144.4%) and 2nd (142.0%) subdivisions was determined in the same way. At the same time, the following parameters were set in a fuzzy way: 1) the growth rates of employment in the economy over five years; 2) the value of fixed assets put into service in each year of the projected period; 3) the growth rate of net exports over five years; 4) the growth rate of each element of the materials output ratio matrix over five years; 5) the sectoral structure of fixed assets put into service; 6) the labour productivity growth rate (the rate of growth of each element of the vector was specified in a fuzzy way). The "excitation" of the parameters enumerated above was conducted within a wide range of values; here we mean their deviation from the projected value determined through expertise by analyzing retrospective data: ±10%, ±15%, ±20%, ±25%. The deviation of the variable parameters grew from year to year, which complied with the hypothesis that fuzziness in their values increases as we move away from the base year. For example, for the option of parameter variation of ±10%, the dynamics of deviation increases growth were given as: ±2% in 2008, ±4% in 2009, ±6 % in 2010, ±8% in 2011, ±10% in 2012. The growing deviations dynamics for other ranges of parameter deviations were assigned in a similar way. Examples of the results of estimates in the first experiment are given in figs. 2 and 3. The results of the first experiment are summarized in table 4.

   From the results of the calculations given above a conclusion can be drawn that the gross output of the second subdivision of the Russian economy appeared the least stable in the case of variations in 6 major parameters.

Tab. 4. Dependence of the gross output stability level of the Russian economy on the degree of variation of 6 groups of parameters

Index	±10%	±15%	±20%	±25%
Stability level for gross output as a whole	95,6	79,1	69,0	50,5
Stability level for gross output of the 1st subdivision	94,8	77,0	63,1	49,2
Stability level for gross output of the 2nd subdivision	93,9	74,1	61,6	47,4

Fig. 2. Membership function of a fuzzy gross output growth rate of the Russian economy according to the optimistic development scenario, with a fuzzy assignment of 6 major parameters within the variation range of ±10%. The level of stability is equal to 95.6% (plausibility degree of coincidence of sample and standard indices)

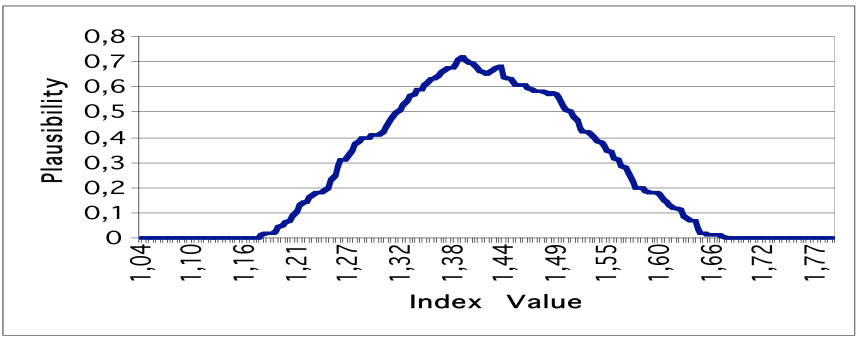
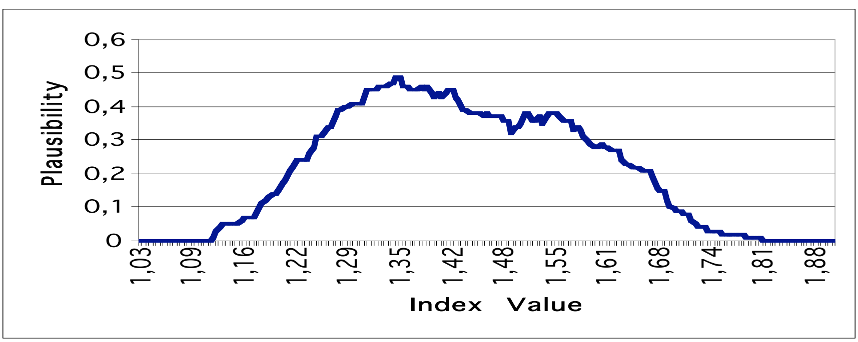


Fig. 3. Membership function of a fuzzy gross output growth rate of the Russian economy according to the optimistic development scenario, with a fuzzy assignment of 6 major parameters within the variation range of ±15%. The level of stability is equal to 79.1% (plausibility degree of coincidence of sample and standard indices)



2. It was determined whether an event was plausible, that is whether the growth rate of gross output of the Russian economy would be equal

to 143.6% (the most plausible index value in the optimistic scenario) in conditions where the size of fixed assets put into operation and labour productivity in the Dynamic Input-Output Model are presented fuzzily within the limits specified earlier. The "excitation" of the parameters grew from year to year as in the first experiment. Cases of a fuzzy input of fixed assets and labour productivity were studied when these parameters deviated from the standard value by ±10% and ±20%. Similarly, the plausibility degree of achieving the growth rates of gross output of the first (144,4%) and second (142,0%) subdivisions was determined. The results of the second experiment are summarized in table 5.

Tab. 5. Dependence of the gross output stability level of the Russian economy on the degree of variation in the description of fixed assets put in service and labour productivity

Index	±10%	±20%
Stability level for total gross output	93,9	56,0
Stability level for gross output of the 1st subdivision	95,0	68,1
Stability level for gross output of the 2nd subdivision	97,2	38,2

From the data given in table 5 it can be seen that the Russian economy is very sensitive to changes in fixed assets put in service and the fluctuations in labour productivity connected with them. Enormous instability in the dynamics of the output of the 2nd subdivision against the fluctuations of variable parameters deserves special attention.

Based on the preliminary forecasting estimates using the Dynamic Input-Output Model with fuzzy parameters, we can draw a conclusion that *sustainable economic growth providing a considerable improvement in the living standard of the population is only possible in conditions of the stable renewal of fixed assets by providing high rates of introduction of fixed assets put in service leading to a considerable growth of labour productivity.*

3. Basic Conclusions

1. For the Russian economy to join the path of stable economic growth with a considerable growth of GDP in 10 years (at least double in level) (2008-2017) it is necessary to double investments in fixed assets in 2008-2012, including investments in machines and equipment of a little over double.
2. The quantitative assessment of parameters of rapid renewal of fixed assets show that the retirement compensation rate of fixed assets should grow from 1.2% in 2007 to 2.8% in 2012, while for the active part of fixed assets (machines and equipment) it should increase from 1.6 in 2007 to 4.9 in 2012.

3. The results of estimates based on the Dynamic Input-Output Model show that in the period 2008-2012 the gross output of asset-building sectors of the engineering and construction industry should grow at the rate of approximately 210 % and 180 % correspondingly. If it is not possible to provide such growth rates of asset-building sectors, there should be a considerable growth in imports of machines and equipment, which will have negative consequences on balancing the balance of payments.
4. A fuzzy assignment of parameters for the Dynamic Input-Output Model and the computation of fuzzy values of projected indices can be interpreted as the assessment of stability of the computed fuzzy indices (gross output, fixed assets etc.) in the conditions of a fuzzy description of exogenous model parameters.
5. A fuzzy description of the size of fixed assets put into service and labour productivity in the Dynamic Input-Output Model showed that in the projected period the Russian economy demonstrates high instability if these parameters vary. It implies that sustainable economic growth ensuring a considerable improvement of the living standard of the population is possible only in the conditions of a stable renewal of fixed assets by means of providing high rates of input of fixed assets leading to a marked increase in labour productivity.

Appendix

Optimization Intersectoral Dynamic Model with Fuzzy Parameters

A distinctive feature of constructing the Dynamic Input-Output Model is splitting the production sphere into two subdivisions. In accordance with the methodology of national accounts, the sphere of production includes both material and non-material production, as well as, partly, housekeeping. Thus, the first subdivision of the gross output production sphere comprises the production of the means of production and services (both material and non-material) included in intermediate consumption. The second subdivision consists of the production of commodities and services (both material and non-material involved in final consumption[5].

The model uses the following parameters which are described in terms of fuzzy sets.

n – number of sectors in the economy;

m – number of sectors in the first subdivision ($m<n$);

[5] A.O. Baranov, *Economy of Russia in the Period of Reforms: Money, Budget, Investments*. Novosibirsk State University, Novosibirsk 2004. (In Russian).

k – number of asset-building sectors ;
T – number of forecasting time periods;
l – number of labour resource types specified in the model;
$a_{ij}(t)$ – ratios of direct material costs of sector i per unit of production j in the t time period;
$c_{hj}(t)$ – ratios of labour intensiveness of a sector j for the h type of labour resource in the t time period;
$b_{ij}(t)$ – ratios of capital intensiveness of a sector j for the i -type of fixed assets in the t time period ;
ϑ_{ij} – construction lag in sector j for the i type of fixed assets;
$k_{ij}(t,\tau)$ – retirement rate of fixed assets of i type in sector j aged τ in the t time period ;
$B_{ij}(t,\tau)$ – fixed assets of i type in sector j put in service in the t time period;
$K_{ij}(t,t+\tau)$ – investments of type i in sector j in year t in the facilities put into operation in $t + \tau$ time period;
$K^*_{ij}(t)$ – total investments of type i in sector j in the t time period;
$\mu_{ij}(t,\tau)$ – ratio showing which part of fixed assets input in sector j in time period $t + \tau$ is formed due to investments of type i in the t time period so as

$$\mu_{ij}(t,\tau) = K_{ij}(t,t+\tau) \Big/ \left(\sum_{i=1}^{k} \mathrm{B_{ij}}(t+\tau) \right);$$

$L_h(t)$ – size of h- type of labour resources that can potentially be employed in the economy in t time period;
$F_{ij}(t,t\text{-}\tau)$ – fixed assets of i - type of sector j introduced in the period t - τ by the end of year t,
$F^*_{ij}(t)$ – fixed assets of i – type of sector j by the end of time period t;
$N_{ij}(t)$ – construction-in-progress of fixed assets of type i in sector j by the end of time period t;
$f_j(t)$ – weighting coefficients of j production sector in the functional target of the economic system.

It is assumed that all the parameters introduced are fuzzy multitudes.

Let the economic system embrace n sectors, where $l \le i \le k$ are asset-building sectors, are not-asset-building sectors of the first subdivision, and $m < i \le n$ are the sectors of the second subdivision.

As the model parameters are fuzzy multitudes, all further arithmetic transformations made in accordance with the rules of fuzzy arithmetics will also constitute fuzzy sets.

Let us mark a fuzzy produced gross output as $x_j(t)$, and a fuzzy utilized gross output as $\bar{x}_j(t)$ - of sector j, a fuzzy net export of j product as $S_j(t)$, a fuzzy growth of reserves as $\Delta z_j(t)$ and fuzzy losses of output as $\ddot{I}_j(t)$ of sector j during t period of time. By analogy with [18], the equation of product balance of sector j will be presented as:

$$x_j(t) = \overline{x}_j(t) + S_j(t) + \quad z_j(t) + \ddot{I}_j(t). \tag{1}$$

The reproduction of fixed assets in the model of dynamic intersectoral balance with lags is described as the process of exchange of a utilized output of asset-building sectors of *t* period with the introduction of fixed assets of *t* period mediated by the change in the volume of construction in progress.

The application of lag indices makes it possible to tie the process of output production by asset-building sectors of machine-building and construction as well as export and import of the output of these sectors in each time period with preceding and subsequent periods. Part of the output produced by asset-building sectors of the economic system in each period ensures the continuation of construction begun before and part of it is exported. It provides the connection of investments and, consequently, the dependence of their volume, industrial and technological structure on the previous investments and on the size of imports of asset-building sectors output. In each period of time, the fixed assets input differs in its physical composition due to the output of machine-building and construction industries utilized during preceding and present periods. During *t* period, construction-in-progress of *j* sector ($l \le j \le n$) receives the output of asset-building sector *i* in volume $K^*_{ij}(t)$, which is distributed among diffeent layers of construction-in-progress. Investments are determined by the formula

$$K^*_{ij}(t) = \sum_{u \ge 0} K_{ij}(t, t+u). \tag{2}$$

The input of fixed assets $B_{ij}(t)$ in sector *j* during *t* time period is formed from the used product of *i* asset-building sector according to the formula

$$B_{ij}(t) = \sum_{u \ge 0} K_{ij}(t-u, t). \tag{3}$$

The size of investments $K_{ij}(t,t+u)$ in the layer of construction-in-progress introduced during $t + u$ time period is calculated through the input of fixed assets in this period by the formula

$$K_{ij}(t, t+u) = \mu_{ij}(t,u) \cdot \sum_{i=1}^{k} \mathrm{B_{ij}}(t+\tau). \tag{4}$$

Coefficients $\mu_{ij}(t,u)$ are the integral characteristic of fixed assets input and depend on the technology and intensiveness of construction in sector *j*. At the same time, the technology of construction consists of a finite number of stages. Then investments are determined by the formula

$$K_{ij}(t,t+u)=\sum_{v}\left(\xi_j(t,t+u,v)\cdot\eta_{ij}(t+u,v)\cdot\sum_{i=1}^{k}\mathrm{B_{ij}}(t+\tau)\right),\tag{5}$$

where $\eta_{ij}(t+u,v)$ is the share of input of fixed assets of *i-type* in branch *j* in $t+u$ time period that is formed during *v* stage of construction; $\xi_j(t,t+u,v)$ is part of stage *v* performed during *t* time period (*u* periods before the introduction of the present layer). Depending on the size of expected investments in fixed assets several successive stages can be performed during one period or one stage that can last several periods. Formulas (4) and (5) are the basic ones for determining the size of investments in fixed assets in different sectors of the economic system through the anticipated input of fixed assets. Additional control parameters $\xi_j(t,t+u,v)$ in formula (5) make it possible to forecast coordinated input of fixed assets and fixed capital investments in the conditions of changing construction periods. For this purpose, standards $\xi_j(t,t+u,v)$ take into account the acceleration or deceleration of capital construction rates.

Recurrent ratios for re-computing construction-in-progress are described by the formula

$$N_{ij}(t)=N_{ij}(t-1)-\sum_{u=1}^{ij-1}K_{ij}(t-u,t)+\sum_{u=1}^{ij-1}K_{ij}(t,t+u).\tag{6}$$

Recurrent ratios for determining the size of fixed assets of *i* type in branch *j* aged *u* by the end of time period *t* are specified by the formula

$$F_{ij}(t,0)=B_{ij}(t),\quad F_{ij}(t,u)=F_{ij}(t-1,u-1)\cdot\left(1-\kappa_{ij}(t,u)\right).\tag{7}$$

The model of fixed assets reproduction (2)-(7) is used for evaluating fixed capital investments and their technological structure by sectors through the anticipated introduction of fixed assets adjusted for the construction lag and $\xi_j(t,t+u,v)$ operation regime of investment package.

The gross output $x_j(t)$ of *j* asset-building sector during *t* time period is determined by the formula

$$x_j(t)=\sum_{j=1}^{n}K_{ij}^{*}(t)+S_i(t)+\ddot{\imath}_i(t).\tag{8}$$

The balance between production and utilization of the output of non-asset-building sectors of the first subdivision looks like this

$$x_j(t)=\sum_{j=1}^{n}a_{ij}(t)\cdot x_j(t)+S_i(t)+\ddot{\imath}_i(t),\quad k<i\le m.\tag{9}$$

Correlations for forming the output of the second subdivision sectors are presented as

$$x_i(t) = Q_i\left(x_i(t-1), S_i(t-1), \lambda, t\right) + S_i(t), \quad m < i \le n, \tag{10}$$

where Q_i is images synthesizing the structure and dynamics of needs (normally these are monotonously growing functions of λ parameter.)

Labour resources limits are described by the system of inequalities

$$\sum_{j=1}^{n} c_{hj}(t) \cdot x_j(t) \le L_h(t), \quad h = 1,\dots,l. \tag{11}$$

Fixed assets constraints are described by the system of inequalities

$$b_{ij}(t) \cdot x_j(t) \le F_{ij}(t), \quad 1 \le i \le k, \quad 1 \le j \le n. \tag{12}$$

Let Ω be the set of fuzzy paths of the development of the economic system $x_j(t)$ that complies with constraints (2)-(3), (5)-(12) in each time period t and let us formulate the problem of fuzzy optimization

$$\sum_{t=1}^{T} \sum_{j=1}^{n} f_j(t) \cdot x_j(t) \quad \max, \quad x \in \Omega, \tag{13}$$

where the set of possible paths Ω and the coefficients of the maximized function $f_j(t)$ are fuzzy.

The solution of the problem (13) under the input of fixed assets put in service $B_{ij}(t)$, labour resources $L_k(t)$, as well as standards $\eta_{ij}(t+u,v)$, $\xi_j(t,t+u,v)$, $K_{ij}(t,u)$, $a_{ij}(t)$, $S_i(t)$, $c_j(t)$ for each time period from $[0;T]$, gives a fuzzy system of development indices of the economic system, including gross output $x_j(t)$, fixed capital investments $K^*_{ij}(t)$, input of fixed assets $B_{ij}(t)$ and fixed assets by the end of each time period $F_{ij}^*(t) = \sum_{u \ge 0} F_{ij}(t,u)$.

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DATA ISSUES

NEW DATABANK OF THE MUDAN MODEL BASED ON THE 2002 I-O TABLE OF CHINA

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The 2002 I-O table for China was published in August 2006 because we had to wait for the results of the first national economic census. After that, we planned to develop a new databank for the Mudan model based on the 2002 I-O table.

The first-generation of Mudan was completed in June 1993. The Model, which we called MUDANI,was based on the 1987 33-sector I-O table. The model we are running now is Mudan IV, which is based on the 1997 59-sector I-O table. The sample range is from 1985 to 2000.

The reasons for updating the Mudan databank are as follows.

1. The sample range needs to be expanded to the nearest year we can get data for. China's national economy has changed a lot both as regards total figures and structurally in recent years.
2. New national standards of industrial classification, which we call GB2002, were issued and implemented, and the sector statistical measures were different between the year 2002 and previous years.
3. The first national economic census was carried out in 2004. Following the issue of census data, some statistical data for previous years were adjusted in 2006.
4. The 2002 I-O table of China was published in 2006.

All of these provide us with a better database to update the MUDAN model. Therefore, in order to make the model more accurately reflect the Chinese economy, we began to work on the new databank of the MUDAN model in April 2007.

We redefined the sector classification of Mudan based on GB2002. Although the model is still in a framework of the 59 I-O sectors, the 59 sectors based on 2002 I-O table is not exactly the same as that in Mudan IV. On the basis of the framework of the 59 I-O sectors, time series

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data were collected and processed. The sample range was expanded to 2005 (from 1985 to 2005).

This paper describes the work we have done on the new databank of the Mudan model.

1. The new sector classification of the Mudan model based on GB2002

1.1 New National Standards of Industrial Classification (GB2002)

Two national standards of industrial classification were issued in the 1980s and 1990s. The first was issued in 1984, we shall call it GB84 (national standard 84 of industrial classification). The second was issued in 1994, we shall call it GB94 (national standard 94 of industrial classification). These were widely used in statistics, planning, financial accounting, business, tax management and other fields. But along with the continuous development of the economy and industrial structure adjustments, many new tertiary industries emerged, such as information technology, resources and environmental protection, intellectual property rights, and so on. The old standards were unable to classify these sectors.

There are two main deficiencies in the old national standards of industrial classification: firstly, the statistical standard is unsuitable. There are many differences between China's current industrial classification and international standards, which greatly affect the international comparability of statistical data. Secondly, the system of statistical indicators is unsuitable. Some of China's statistical indicators differ from those of international standards in name, definition, coverage and method of calculation. These differences significantly influence the utility and comparability of China's statistical data.

To solve these problems, a new national standard of industrial classification, which we shall call GB2002, was issued on May 10, 2002, and implemented in the 2002 statistical yearbook.

There are 20 categories, 95 large sub-categories, 396 medium sub-categories and 913 small sub-categories in the new industrial standard. Compared to GB94, 4 categories, 3 large sub-categories, 28 medium sub-categories and 67 small sub-categories were added. The new standard basically reflects the current industrial structure in China. The paragraphs below illustrate the main differences between the new and old standards of industrial classification in detail.

- The adjustment of categories

According to the status of national social and economic development, the new standard added six categories. These were «telecommunication, computer services and software», «accommodation and food serving services», «rental and business services», «water conservancy, environmental resources and public facilities management», «education services» and «international organizations».

There were also some changes both in the name and the content of categories. Those affected were «mining», «transport, storage and post services», «wholesale and retail trade services», «finance», «resident and other services», «health, social security and welfare», «cultural, sporting and recreational services» and «public administration and other sectors».

With reference to international industrial classification, the new standard removed two categories: «geological, geophysical and other prospecting services, water conservancy» and «other business».

According to the principle of homogeneity, the category «geological, geophysical and other prospecting services» and «scientific research, technical services» were combined as «scientific research, technical services and geological prospecting».

The following are the 20 categories of the new standard (GB2002):

A. Agriculture, forestry, animal husbandry, and fishery
B. Mining
C. Manufacturing
D. Electricity, gas, water production and supply
E. Construction
F. Transport, storage and post services
G. Telecommunication, computer services and software
H. Wholesale and retail services
I. Accommodation and food serving services
J. Finance and insurance
K. Real estate
L. Rental and business services
M. Scientific research, technical services and geological prospecting
N. Water conservancy, environmental resources and public facilities management
O. Residents services and other services
P. Educational services
Q. Health, social security and welfare
R. Cultural, sporting and recreational services
S. Public administration and other sectors
T. International organizations

- The adjustment of large sub-categories

According to the principle of homogeneity, there were some changes in the large sub-categories of the new standard. The «logging and transport of timber and bamboo» category moved from its original position in «mining» to «agriculture, forestry, animal husbandry and fishery»; the «city public transport» category moved from its original position in «social services» to «transport, storage and post services».

In the old GB94 standard, «social services» included many heterogeneous large sub-categories. But in the new GB2002 standard, «hotel», «travel agency, tour operator and tourist guide services», «rental and business services», «recreational services», «information, counseling services» and «computer services» were transferred to the «accommodation and food serving services», «rental and business services», «cultural, sporting and recreational services», «telecommunication, computer services and software» categories respectively.

Considering that some high-tech, environmental protection, financial services and marketing services have developed rapidly in recent years, the new standard added some large sub-categories, such as «recycling of waste resources and waste materials», «information transmission services», «software», «securities», «business services», «technology exchange and promotion of the service» and «environmental management».

- The adjustment of medium and small sub-categories In order to transfer from GB2002 to the international standard ISIC, some medium and small sub-categories were added. At the same time, some were combined and adjusted.

1.2 The 59-sector classification of the new databank

As explained above, national standards of industrial classification had been revised several times in the past 20 years, so the existing input-output tables were based on different national standards of industrial classification. For example, the 1987 and 1992 tables were based on national standards 84 and the 1997 table was based on national standard 94. While the 2002 table was based on national standard 2002. There is therefore an inconsistency of sector classification among these input-output tables.

This situation greatly influences the development of the model's databank. There are three industrial classification standards across the model's sample period (1985-2005), so the original data of each sector may not be consistent even if we use the same 59-sector classification for the whole period. We had to solve this problem and the approach was to build series input-output tables (Pan Shengchu, Feng Yuan, Zhou Lingyao, 2005).

Our objective was to adjust and transfer the 1987, 1992, 1997 and 2002 tables to series input-output tables with the same sector classification. We called them series input-output tables of base years. In order to make series input-output tables more valuable, we followed two principles in adjusting and transferring the tables:

1. To ensure a sector classification that was as detailed as possible in the series tables, we used the original tables where sector classification was most detailed (117 sectors in the 1987 table, 118 sectors in the 1992 table, 124 sectors in the 1997 table, 122 sectors in the 2002 table).

2. Sector classification of the series tables had to be based on the Industrial Classification of the National Standard 2002. This way, we could ensure the series tables were consistent with sector classification according to the newest standard.

On the basis of this, we got a 59-sector classification for the Mudan model. Then according to the 59-sector classification, we converted the time series data of three different ranges (1985-1993, 1994-2001 and 2001-2005) to 59-sector data. Finally we got time series data which was consistent throughout the whole sample period. The new 59 sector classification is shown in Table 1.

Compared with the databank of Mudan IV based on 1997 I-O table, there are a lot of changes in the new databank. Below are the sectors of the model which underwent relatively big changes.

- Textiles (14)

Sector 14 corresponds to the large sub-category 17 of GB2002 except for the medium sub-category 171 (fiber preliminary processing) which was transferred to «technical services of agriculture forestry, livestock and fishing».

In GB94, sector 14 corresponded to the medium sub-category 17 and small sub-category 2851 (fishing gear using wire manufacturing), small sub-category 2852 (fishing gear using wire building industry), small sub-category 2851 (fishing gear using rope manufacturing), small sub-category 2852 (fishing net manufacturing) of the large sub-category 28 and the small sub-category 1890 (other fiber products manufacturing) belonging to the large sub-category 18.

- Metal products (31)

The sector corresponds to large sub-category 34 of GB2002.

In GB 94, it corresponded to the large sub-category 34, but the small sub-categories 3486 (skilled manufacturing), 3487 (gas appliances manufacturing), 3434 (mold manufacturing) and 3420 (cast iron pipe manufacturing) were transferred to sectors 29, 32 and 38 respectively.

- Machinery (32)

There were quite big changes in this sector. The sector corresponds to large sub-categories 35 and 36 of GB2002.

In GB94, it corresponded to the large sub-categories 35, 36 and 39, and the small sub-categories 4243 (weighing instrument manufacturing), 3434 (mold manufacturing), 4091 (welding machine manufacturing) and 4092 (industrial furnace manufacturing), but did not include the small sub-category 3532 (AIDMO vehicle manufacturing) or 3654 (medical materials and medical supplies manufacturing).

In GB84, it corresponded to the large sub-categories 53, 54, 55, and the small sub-categories 6370 (weighing instrument manufacturing), 5134 (mold manufacturing), 5891 (Machine Manufacturing), 5892 (industri-

Tab. 1. The new 59 sectors of the Mudan Model

1 Farming	31 Metal products
2 Forestry	32 Machinery
3 Livestock	33 Railroad equipment
4 Fishing	34 Motor vehicles
5 Coal mining	35 Shipbuilding
6 Crude petroleum and natural gas production	36 Aircraft
7 Ferrous ore mining	37 Transportation equipment, n.e.c.
8 Non-ferrous ore mining	38 Electric machinery and equipment
9 Non-metal minerals mining and mining, n.e.c.	39 Electronic and communication equipment
10 Logging and transport of timber and bamboo	40 Instruments, meters and other measuring equipment
11 Food processing and manufacturing	41 Manufacture, n.e.c.
12 Beverages	42 Electricity, steam and hot water production and supply
13 Tobacco manufacture	43 Gas production and supply
14 Textiles	44 Production and supply of water
15 Wearing apparel	45 Construction
16 Leather, fur and their products	46 Railway transportation
17 Sawmills and bamboo etc. products	47 Highway transportation
18 Furniture	48 Water transportation
19 Paper and paper products	49 Air transportation
20 Printing industries	50 Transport, n.e.c.
21 Cultural, education, sports articles	51 Communications
22 Petroleum refineries and coke products	52 Commerce
23 Chemical industries	53 Restaurants
24 Medicines	54 Finance and insurance
25 Chemical fibres	55 Real estate, and social services
26 Rubber products	56 Health care, sports and social welfare
27 Plastic products	57 Education, culture, arts, radio, film and television
28 Building materials and non-metallic mineral products, n.e.c.	58 Scientific research and polytechnic services
29 Primary iron and steel manufacturing	59 Public administration and others
30 Primary non-ferrous metals manufacturing	

al furnace manufacturing), but did not include the small sub-categories 5333 (AIDMO vehicle manufacturing), part of 546 (medical equipment manufacturing) 547 (cultural and office machinery manufacturing), 5481 (bicycle manufacturing), 5483 (manufacture of watches) or 5484 (camera manufacturing).

- Real estate, utilities and residents services (55)

The sector corresponds to large sub-categories 66, 72, 73, 74, 80, 81, 82, 83 of GB2002.

In GB94, it corresponded to the large sub-categories 72, 73, 74, 75, 76, 77, 78, 79, 80, 82, 84, and the medium sub-categories 991 (business management), 936 (Environmental Protection), part of 939 (other integrated technical services), small sub-categories part of 3582 (auto repair services), 4280 (instrumentation and Cultural office equipment repair services), part of 3783 (motorcycle repair industry), and 4243 weighing instrument manufacturing), but the small sub-categories part of 7590 (Other public services), small sub-category 7560 (scenic area management services), medium sub-category 751 (city public transport services) and small sub-category part of 7550 (municipal project management industry) were not included.

- Scientific research and integrated technology services (58)

The sector corresponds to large sub-categories 05, 61, 62, 75, 76, 77, 78, 79 of GB2002.

In GB 94, it corresponded to the large sub-categories 05, 50, 51, 83, 92, 93 and the medium sub-categories, 019, 171 (initial fiber raw materials processing industry), small sub-category 4183 (electronic computer repair services), part of 7590 (other public services), 7560 (Scenic Area Management) and 8560 (drug testing, Room), but the medium sub-categories 936 (Environmental Protection), part of 939 (other integrated technical services) and small sub-categories part of 9340 (technical supervision) and 8330 (databank services) were not included.

- The executive (59)

The sector corresponds to large sub-categories 93, 94, 95, 96, 97 of GB2002.

In GB94, it corresponded to the large sub-categories 94, 95, 96, 97, 98, 99 and the small sub-categories part of 9090 (other cultural and arts industry), part of 9340 (technical supervision) and part of 7590 (Other public total services), but the medium sub-category 991 (business management) was not included.

2. Time series data collection and processing

The next step was collecting and processing time series data, including output, consumption, investment, imports and exports employment, wages, price index data and so on. The sample range was from 1985 to 2005.

Output

The output data is 59-sector data, all of it taken from the *China Statistical Yearbook* and the *China Statistical Yearbook of the industrial economy.* As there are differences between the industrial classification standards, we needed to carry out some processes such as aggregating and dividing. Below are some examples.

- The output of food processing and manufacturing

For the period 1985 to 1993, the output of «cold beverage manufacturing goods» was transferred to «food processing and manufacturing».

For the period 1985 to 2001, the output of «additives manufacturing» was transferred to «food processing and manufacturing».

- The output of beverage manufacturing

For the period 1985 to 1993, the output of «cold beverage manufacturing goods» was transferred to «food processing and manufacturing».

- The output of textiles

For the period 1994 to 2001, the output of «fishing gear using wire manufacturing», «fishing gear using the wire building industry», «fishing gear using rope manufacturing», «fishing net manufacturing» and «other fiber products manufacturing» was transferred to this sector, while the output of «fiber preliminary processing» was transferred to «scientific research and integrated technical services».

For the period 1985 to 1993, the output of «other sewing» was transferred to this sector, but the output of «fiber preliminary processing» was transferred to «scientific research and integrated technical services».

- The output of wearing apparel
- For the period 1994 to 2001, the output of «other fiber products» was transferred to «textiles».

For the period 1985 to 1993, the output of «other sewing» was transferred to «textiles».

- The output of logging and the transport of timber and bamboo

For the period 1985 to 1993, part of the output of «forestry chemical products manufacturing» was transferred to this sector.

- The output of printing

For the period 1985 to 2001, part of the output of «cultural sporting goods manufacturing» was transferred to this sector.

- The output of cultural sporting goods manufacturing

For the period 1994 to 2001, part of the output of «cultural sporting goods manufacturing» was transferred to «printing», and part of the output of «sports equipment manufacturing» was transferred to «ship manufacturing», but the output of «other fishing gear manufacturing» was transferred to this sector.

For the period 1985 to 1993, part of the output of «cultural sporting goods manufacturing» was transferred to «printing», and part of the output of «sports equipment manufacturing» was transferred to «ship manufacturing».

- The output of petroleum processing, coke and nuclear fuel processing

For the period 1985 to 2001, the output of «radiotherapy chemical products manufacturing» was transferred to this sector, and part of the output of «other rare metal smelting» was transferred to this sector.

- The output of nonferrous metal smelting

For the period 1985 to 2001, part of the output of «other rare metal smelting and other rare metal rolling» was transferred to «petroleum processing, coke and nuclear fuel processing».

Consumption

The original consumption data was classified according to consumer goods and services, in which the consumption of rural residents was divided into 10 categories; and the consumption of urban residents was divided into 24 categories. All the consumption data comes from the *China Statistical Yearbook*. Through the consumption bridge matrix, they were transferred to 59-sector data. There are 206 consumption time-series in the databank.

As the change of sector classification does not influence original consumption data, what we need to do is to extend the sample range of consumption time series data to 2005. However, it should be noted that the change in sector classification does influence the consumption bridge matrix, so we should re-estimate the consumption bridge matrix based on the 1987, 1992, 1997 and 2002 I-O tables.

Fixed investment

The fixed investment data was classified according to investor sectors, in which fixed investment was divided into 52 sectors. All investment time series data comes from *China Statistical Yearbook*, *China's fixed asset investment statistics Code 1950-2000*, and *China fixed assets investment Yearbook*. Through the investment bridge matrix, they were transferred to 59-sector data. There are 1015 investment time-series in the databank. As the changes of sector classification do not influence the original investment data, what we need to do is to extend the sample range of investment data to 2005. However, it should be noted that the change of sector classification does influence the investment bridge matrix, so we should re-estimate the investment bridge matrix based on the 1987, 1992, 1997 and 2002 I-O tables.

Import and export

There are 145 time-series of import and export data in the databank. All of the import and export data comes from *China Customs Statistics Yearbook*. The data is classified according to types of products, not sectors, so we have to integrate different products into the 59 sectors. The collection and processing of import and export data is ongoing.

Employment and wages

The employment and wages data is 52-sector data, and the data sources processing methods are the same as the Mudan IV.

Macroeconomic data

In the new databank, the macroeconomic data includes GDP, final consumption expenditures, gross capital formation, net exports of goods and services, household consumption expenditures, consumption of rural residents, consumption of urban residents, government consumption, gross fixed capital formation, changes in inventories, output of primary industry, output of industry, output of construction, output of tertiary industry, output of transport, storage and post, output of wholesale and retail trades, output of finance and insurance according to the expenditure approach, and their deflator index. We have done the work of data collection. It should be noted that part of the macroeconomic data was adjusted after the first national economic census in 2004.

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CHINA: REGIONAL INPUT-OUTPUT ANALYSIS (2002)

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1. Data in China

1.1 IO Tables in China

There are five Input-Out tables for the Chinese Economy which include the 1982, 1987, 1992, 1997 and 2002 IO tables, based on large-scale, input-output surveys across the country. Apart from these five formal IO tables, the National Bureau of Statistics (NBS) derived three extension tables, including the 1990, 1995 and 2000 tables. Although input-output tables account for the structures of production sectors and industries, they have been compiled only once every five years since 1982 in China. These extension tables are compiled by modifying the coefficients of the IO tables and also have a five year duration, but start from 1990. So in other years there is no description of production sectors or industrial structures.

1.2 2002 Input-output table

The 2002 Input-output table is the latest input-output table for China's economy. This table was constructed based on large-scale, input-output survey across the country and the 1st Economic Census of China in 2004. Some characteristics were shown in the 2002 IO table: (1) the basic structure of the 2002 IO table is the same as the 1997 table. In the table, Final demand includes household consumption, government con-

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sumption, capital formation and changes in stock and exports; value added includes depreciation of fixed capital, compensation of employees, net taxes on production and operation surplus; (2) the sectional classification for the 2002 IO table. The economy is divided into 122 sectors, of which there are 5 sectors for agriculture, 81 sectors for mining, manufacturing, electricity generation, and construction, 36 sectors for services; (3) some new service sectors have been introduced, for example Information communication and Service, Computer service and software.

2. Eight Regions

Based on the location on the map, we divided China into 8 regions: the Northeast region (NE), the Northern coastal region (NC), the Southern coastal region (SC), the middle reaches of the Yangtze River (YZ), the Eastern coastal region (EC), the middle reaches of the Yellow River (YE), the Southwest region (SW) and Northwest region (NW).

The Northeast region (NE) consists of the Liaoning, Jilin, and Heilongjiang provinces covering 8.5% of the national area, and with 8.4% of the national population. These areas are provided with similar natural conditions and resource structures, and are closely related historically. At present, they face many common problems such as exhausted resources and upgrading of industrial structures.

The Southern coastal region (SC) consists of the Fujian, Guangdong, and Hainan provinces, covering 3.5% of national area, and with 9.5% of the national population. This region is adjacent to Hong Kong, Macao and Taiwan, has rich overseas social resources, and is more open to the outside world.

The middle reaches of the Yangtze River (YZ) includes the Hubei, Hunan, Jiangxi, and Anhui provinces, covering 7.3% of the national area, and with 18.2% of the national population. This region has sound farming conditions and a dense population. But it has not yet fully opened up to the outside world. It is under considerable pressure from changing industrial structures.

The Eastern coastal region (EC) consists of the city of Shanghai, the Jiangsu and Zhejiang provinces, covering 2.3% of the national area, and with 10.7% of the national population. These areas started modernising earlier and historically have close foreign economic ties, leading the way in many fields as regards national reform and opening up to the outside world. They are rich in human resources and have tangible development advantages.

The middle reaches of the Yellow River (YE) includes the Shaanxi, Shanxi, Henan provinces and the Inner Mongolia Autonomous Region, covering 17.2% of the national area, and with 14.9% of national population. This region abounds in natural resources, is rich in coal and natural gas reserves in particular, and is located in the interior in an important strategic position. However, it has not yet opened up sufficiently to the outside world, and has a difficult task in adjusting its structure.

The southwest region (SW) consists of the Yunnan, Guizhou, Sichuan provinces, Chongqing Municipality, Guangxi Zhuang and Autonomous Region, covering 14.4% of the national area, and with 19.4% of the national population. The region is located in a remote area with poor soil and people. However, it is well situated to open up to Southern Asia.

The Northwest region (NW) consists of the Gansu, Qinghai provinces and Ningxia Hui, Tibet and Xinjiang Uygur autonomous region, covering 42.8% of the national area, and with 4.6% of the national population. Given its adverse natural conditions, this region has a vast territory with a scarce population and limited market. It has good opportunities for opening up to the west.

3. Regional IO Analyses

3.1 Regional Industrial Structure (2002)

Table 1 shows that China's regional industrial structure is distinctly different. Evidently, the percentage of agriculture in total output in NE, YE, YZ, SW and NW is higher than the average level of the country, but the share of secondary industry in total output of EC and SC is higher than that of the rest of the country; the percentage for EC in particular is 6.7% higher than the national average Among the secondary industries, the share of output accounted for by mining in NE, NC, YE and NW is relatively high. For the EC, its low and medium technical industries' output percentage is clearly higher than that of other regions, respectively 5.8% and 6.8% higher than the national average. On the other hand, for the eight regions, the share of output accounted for by tertiary industry is very similar, for each being less than one-third of its total output.

Table 1 also shows that most regions' share of output on medium technological industry is the highest of all industries, except for YE's resources-based industry and NW's other service industry. In general, the more developed the regional economy, the higher the percentage of output in medium technological industry, for example, in EC, the percentage of medium technological industry is about 26.7%. This reflects how important the medium technological industry is in each regional economy. More attention should also be paid to the fact that the share of low tech is highest in EC, while the highest percentage of high tech is in SC and resource-based and other service industries are relatively higher in the other provinces.

Tab. 1. Regional Industrial Structure (2002) (%)

	National	NE	NC	EC	SC	YE	YZ	SW	NW
Agriculture	8.4	9.2	7.3	4.8	6.1	12.3	12.2	13.4	12.3
Secondary Industry	60.5	59.0	59.4	67.2	63.1	59.7	55.4	52.9	51.7
Mining	2.8	5.9	3.7	0.4	1.5	6.1	2.5	2.6	6.1
Resources based	12.8	14.3	15.4	9.6	11.0	16.1	13.8	12.7	12.6
Low Tech.	9.2	5.0	7.0	15.0	13.0	7.5	7.2	3.4	2.5
Medium Tech.	19.9	20.8	19.3	26.7	17.3	15.5	17.8	17.3	11.1
High Tech.	4.4	1.7	3.9	6.0	11.0	1.0	1.2	1.4	0.3
Electricity	2.8	3.1	1.9	2.5	2.7	3.4	3.0	3.2	4.8
Construction	8.5	8.1	8.0	7.0	6.4	9.9	9.9	12.3	14.4
Tertiary Industry	31.1	31.9	33.3	28.0	30.9	28.0	32.4	33.7	36.1
Transportation	4.2	4.4	4.2	3.2	4.4	5.9	4.1	4.2	5.8
Trade and restaurant	4.3	3.7	5.2	4.4	4.6	2.5	4.5	4.3	3.8
Finance and real estate	7.6	9.2	7.2	7.1	7.2	7.2	8.6	8.2	8.6
Other Service	14.9	14.6	16.7	13.4	14.6	12.4	15.2	17.0	17.9

By calculating each region's different industry output percentage in relation to China's total output (not shown in the table), the following results can be observed: (1) Agriculture is concentrated in the NC,YZ and SW; (2) Mining is concentrated in NE, NC and YE; (3) Manufacturing (including resources-based, low Tech., middle Tech. and high Tech) are drawn into BC, EC and SC; (4) Most finance and real estate is distributed in NC and EC, (5)the other service is mainly focused in NC, EC and SC.

3.2 The analysis of regional similarity of the industrial structure (2002)

The similarity between regional industrial structure and national industrial structure can be compared using the similarity coefficient. The range of its value is between 0 and 1. The larger the similarity coefficient, the more similar the regional industrial structure is to the national industrial structure.

$$r_k = \frac{\sum_{i=1}^{n}(x_i^k \bar{x}_i)}{\sqrt{\sum_{i=1}^{n}(x_i^k)^2}\sqrt{\sum_{i=1}^{n}(\bar{x}_i)^2}}$$

$$(i = 1,2,\cdots,n; k = 1,2,\cdots m)$$

Where x_i^k is the ^{i}th sector's percentage of output for region k; $\bar{x}_i$ is the i^{th} sector's percentage of output for the country.m is the number of regions, n is the number of sectors in the IO table.

In China, both for each province and for the country's industrial structure, the similarity coefficient has decreased in the past years. In 2002 each province's similarity coefficient was lower than in 1997. The similarity coefficient was about 0.78-0.98 in 1997, but it fell to 0.49-0.73 in 2002.

Compared to the other provinces, the four cities (including Beijing, Shanghai, Tianjing and Chongqing) and some provinces which have advantages in terms of resources have a low similarity coefficient. In 1997, Beijing and Shanghai were below 0.8, then in 2002, Beijing, Tianjing and Shanghai were all less than 0.6. Shangxi, Qinghai, Xinjiang, Heilongjiang, Guizhou and Yunnan provinces have their particular advantages in resources, so there is a distinct difference between their industrial structure and the rest of the country's, their similarity coefficient is relatively small. However, the middle region is very similar to the whole of the country in industrial structure. For example, in YZ, Hubei, Anhui, Jiangxi and Hunan have a high similarity coefficient, in addition, the other provinces are very similar to the country's similarity coefficient, including Hebei in NC, Henan, Shananxi in YE and Liaoning.

3.3 The analysis of Location Quotient

The location quotient is a good index which shows the comparable industrial advantages of a region. The following formula shows how it has been calculated.

$$Q_{ij} = \frac{L_{ij} \Big/ \sum_i L_{ij}}{\sum_j L_{ij} \Big/ \sum_i \sum_j L_{ij}}$$

i ith region;

j jth sector;

L_{ij} output for ith region and jth sector.

If $LQ_{ij}>1$, it means that the i^{th} region has an advantage in industry J, that is to say, the i^{th} region not only satisfies local needs, but can also export production to others. On the contrary, if $LQ_{ij}<1$, the industry J cannot satisfy local needs for region i, it needs help from other regions.

If LQ_{ij}=1, this means that the aggregate supply is equal to the aggregate demand for industry J in the i^{th} region.

The analysis of each region's economy can be based on the value of LQ in two ways. Firstly, analyzing each region's LQ by means of the column in table 2; secondly, analyzing regional distribution of each industry by means of the row in table 2.

By analysing the column, we can see the three top sectors with strong advantages in each region. Of course, we can easily see which sectors have weaknesses in this region.

Below each region's top sectors are shown:

- NE: Mining, Retail and Whole Sale, Restaurant, Electricity;
- NC: Mining, Finance, Real Estates, Other service;
- EC: Low Tech., Medium Tech., High Tech.;
- SC: High Tech., Low Tech., Finance, Real Estates;
- YE: Mining, Agriculture, Transportation;
- YZ: Agriculture, Construction, Retail and Whole Sale, Restaurant;
- SW: Agriculture, Construction, Electricity;
- NW: Mining, Electricity, Construction.

Tab. 2. Location Quotient (2002)

	NE	NC	EC	SC	YE	YZ	SW	NW
Agriculture	1.09	0.87	0.58	0.72	1.44	1.45	1.59	1.45
Mining	2.07	1.33	0.14	0.55	2.14	0.88	0.92	2.15
Resource Based	1.00	1.09	0.91	1.05	1.15	1.01	0.85	0.79
Low Tech.	0.50	0.86	1.67	1.22	0.78	0.80	0.38	0.35
Middle Tech.	1.04	0.98	1.34	0.87	0.77	0.90	0.87	0.55
High Tech.	0.39	0.89	1.34	2.49	0.23	0.27	0.33	0.07
Electricity	1.12	0.71	0.92	1.00	1.21	1.09	1.17	1.71
Construction	0.95	0.95	0.82	0.76	1.14	1.17	1.45	1.68
Transportation	1.03	1.02	0.76	1.05	1.38	0.97	1.01	1.37
Retail and Whole Sale, Restaurant	1.20	0.95	0.93	0.95	0.92	1.12	1.07	1.12
Finance, Real Estates	0.85	1.19	1.01	1.06	0.58	1.04	1.00	0.87
Other Service	0.98	1.12	0.90	0.98	0.83	1.02	1.14	1.20

If analyzing according to industry (row), we can see which regions have strong advantages in each industry.

1. Agriculture

The regions that have evident advantages are NE, YE, YZ, SW and NW, SW, especially, is at the top, its LQ reaches 1.59, YZ and NW's LQ is 1.45. However, the lowest LQ of agriculture is that of the EC, which is only 0.58.

In general, the provinces which have strong advantages are Jilin, Hainan, Henan, Neimeng, Anhui, Jiangxi, Guangxi, Sichuan, Guizhou, Xinjiang (see table 3). Beijing, Tianjin and Shanghai do not have any advantages in agriculture.

2. Mining

In mining, the most advantaged regions are NE, NC, YE and NW, with the LQ of NW the highest at 2.15.YE and NE follow at 2.14 and 2.07. But we should notice that EC is very weak in mining, its LQ is only 0.14.

The provinces which have advantages in mining are distributed as shown in table 4.

Tab. 3. Agriculture (LQ)

NE: Jilin (1.50), H.L.J. (1.12)
NC: Hebei (1.21), Shandong (1.02),
SC: Hainan (3.02),
YE: Henan (1.56), Shaanxi (1.16), Neimeng (2.01),
YZ: Anhui (1.72), Hubei (1.11), Hunan (1.47), Jiangxi (1.76)
SW: Guangxi (1.87), Sichuan (1.63), Guizhou (1.71), Yunnan (1.76)
NW: Gansu (1.44), Qinghai (1.00), Ningxia (1.20), Xinjiang (1.60)

Tab. 4. Mining (LQ)

Coal mining and processing	NE: Liaoning (1.05), Hei.L.J (1.71) NC: Hebei (1.18), Shandong (1.71) YE: Shanxi (11.38), Henan (2.02), Shaanxi (1.48), Neimeng (3.79) YZ: Anhui (1.85), Hunana (1.47), Jiangxi (1.33) SW: Sichuan (1.34), Guizhou (2.45) NW: Gansu (1.03), Ningxia (4.12), Xinjiang (1.02)
Crude petroleum and natural gas products	NE: Liaoning (1.76), Hei.L.J (10.21) NC: Tianjin (3.20), Shandong (2.56) YE: Shaanxi (3.72) NW: Qinghai (4.90), Ningxia (3.11), Xinjiang (7.03)
Metal ore mining	NE: Liaoning (1.22), NC: Hebei (3.33), Shandong (1.39) SC: Fujian (3.12), Hainana (1.21) YE: Shanxi (1.69)Henan (2.18), Shaanxi (1.69), Neimeng (1.61), YZ: Hubei (1.00), Hunan (1.61), Jiangxi (1.70) SW: Guangxi (2.73), Yunnan (1.95) NW: Gansu (1.72), Qinghai (1.33), Ningxia (3.25)
Non-ferrous mineral mining	NE: Liaoning (1.21), Hei.L.J (1.14) SC: Fujian (1.31), Guangdong (1.00) YE: Shanxi (1.47), Henan (1.99), Neimeng (1.57), YZ: Anhui (2.29), Hubei (2.08), Hunan (1.30), Jiangxi (1.35) SW: Guangxi (1.19) Sichuan (2.87) Guizhou (1.62) Yunnan (1.43) NW: Ningxia (2.47)

3. Resources-Based industry

The regions with resources-based advantages are mainly YE, NC, YZ and NE, their LQs are 1.15, 1.09, 1.05, 1.01 and 1.00. However, other regions have no advantages in resources.

The LQ of some provinces are relatively high, for example, Shandong's LQ for the manufacture of food products and tobacco processing is 2.18, while that of, Yunnan is equal to 2.36; in petroleum processing and coking, Liaoning reaches 3.47 and Xinjiang 3.16; Non-metal mineral products in Henan reach 2.44. As these industrial advantages are benefits from local endowments, other provinces have difficulties in modelling their own industry on them and surpassing them.

Tab. 5. Resources based industry (LQ)

Manufacture of food products and tobacco processing	NE:Jilin (1.46), H.L.J (1.42) NC:Shandong (2.18) SC:Fujian (1.02) YE:Henan (1.59), Neimeng (1.02) YZ:Anhui (1.19), Hubei (1.33), Hunan (1.20) SW:Guangxi (1.09) Sichuan (1.18) Guizhou (1.32) Yunnan (2.36)
Petroleum processing and coking	NE:Liaoning (3.47), Jilin (1.28), H.L.J (2.20) NC:Beijing (1.64), Tianjin (1.52), Shandong (1.51) YE:Shanxi (2.31), Shaanxi (1.09) NW:Gansu (4.02), Ningxia (1.36), Xinjiang (3.16)
Nonmetal mineral products	NE:Liaoning (1.06) NC:Hebei (1.84) YE:Shanxi (1.26), Henan (2.44 ((Shaanxi (1.04), Neimen (1.13), YZ: Anhui (1.39), Hubei (1.12) Hunan (1.21), Jiangxi (1.24), SW:Guangxi (1.36) Sichuan (1.38)

4. Low Tech. Industry

Most of the regions with advantages in low tech. are situated in in EC and SC, their LQ is about 1.67 and 1.22, and the other six regions do not have this advantage. Low tech. industry is labour-focused. Table 6 shows that Zhejiang, Jiangsu, Fujian and Guangdong have a distinct advantage in this sector.

5. Medium Tech

It is evident that EC has the advantage as regards middle tech., its IQ is about 1.34. NE also has certain advantages, its IQ is a little more than 1.0, the other six regions do not have any advantages in this industry, especially NW which is only 0.55. The LQ of each province can be seen in table 7.

6. High Tech. Industry

High tech. industry is mainly focused in the coastal regions, including EC and SC, it developed especially quickly in SC where its LQ has

Tab. 6. Low Tech. Industry (LQ)

Textile goods	NC: Hebei (1.12), Shandong (1.15) EC: Jiangsu (2.15), Zhejiang (2.84), SC: Fujian (1.03), YZ: Hubei (1.32)
Wearing apparel, leather, furs, down and related products	EC: Shanghai (1.15), Jiansu (1.54), Zhejiang (2.59) SC: Fujian (1.28), Guangdong (1.94), YE: Henan (1.02)
Paper and products, printing and record medium reproduction	NC: Hebei (1.34), Shandong (1.03) EC: Shanghai (1.05), Zhejiang (1.55) SC: Fujian (1.29), Guangdong (1.71), SW: Guangxi (1.46)
Other manufacturing products	EC: Jiangsu (1.03), Zhejiang (1.60) SC: Fujian (1.96), Guangdong (1.49), YE: Shanxi (1.09), Henan (2.49), YZ: Hunan (1.50), Jiangxi (1.16) SW: Guangxi (1.32)
Sawmills and furniture	NE: HeiL.J. (1.69), EC: Zhejiag (1.10), SC: Fujian (3.01), Guangdong (1.41) YE: Henan (2.10), YZ: Anhui (1.34) Hubei (1.03) Hunan (1.05) Jiangxi (1.09) SW: Guangxi (1.35)

Tab. 7. Medium Tech. Industry (LQ)

Chemicals	NC: Tianjin (1.13), Hebei (1.09), Shandong (1.14) EC: Shanghai (1.14), Jiangsu (1.59), Zhejiang (1.35) SC: Guangdong (1.05) NW: Ningxia (1.01)
Metals smelting and pressing	NE: Liaoning (1.98) NC: Tianjin (1.53), Hebei (1.79) EC: Shanghai (1.22), Jiangsu (1.36) YE: Shanxi (2.24), Neimeng (1.57) YZ: Hubei (1.23), Hunan (1.16), Jiangxi (1.06) SW: Sichuan (1.16), Guizhou (2.20), Yunnan (1.32) NW: Gansu (1.83), Qinghai (2.10), Ningxia (2.09)
Transport equipment	NE: Liaoning (1.13), Jilin (4.11) EC: Shanghai (2.27), Zhejiang (1.01), Hainan (1.23), YE: Shaanxi (1.19) YZ: Anhui (1.02), Hubei (2.05), SW: Chongqing (5.04)
Electric equipment and machinery	NC: Tianjin (1.32), Shandong (1.03), EC: Shanghai (1.51), Jiangsu (1.22), Zhejiang (2.01) SC:Guangdong (2.04)

reached 2.49. Here there is an interesting phenomena wherein both NW and YE have no any advantages in high tech. overall but the two prov-

inces: Chongqing and Shaanxi have maintained their advantage in high tech. Table 8 shows that Beijing, Tianjin and Guangdong have absolute advantages in electronic and telecommunication equipment, their IQs are 2.47, 3.09, 3.14. However electric equipment and machinery are mostly in Zhejiang and Guangdong.

Tab. 8. High Tech. Industry (IQ)

Electronic and telecommunication equipment	NC:Beijing (2.47), Tianjin (3.09) EC: Shanghai (1.69), Jiangsu (1.61), SC: Fujian (1.05), Guangdong (3.14)
Instruments, meters, cultural and office machinery	NC:Beijing (1.69), EC: Shanghai (1.65), Jiangsu (1.04), Zhejiang (2.28), SC: Fujian (1.95), Guangdong (2.23), YE: Shaanxi (1.03), SW:Chongqing (1.46)

7. Analysis of the regional intermediate input rate

The intermediate input rate is the rate of each industrial sector's intermediate input to aggregate input, it expresses the rate of materials which need to be bought from other industry for the industrial sectors' output. It reveals the direct effect of an industry which provides inputs when the final demands of this industry increase by one unit. The intermediate input rate (l_i) can be expressed as follows:

$$l_i = \frac{\sum_{j=1}^{n} x_{ij}}{x_i}$$

Where x_i is aggregate input and x_{ij} is the intermediate input of industry *j*. The intermediate input rate can reflect the extent of direct backwards linkage. The lower the intermediate input rate, the lower the input rate from forwards industry, meaning that the industry depends less on that industry, and therefore that the forwards industry contributes little to this industry. By analysing the intermediate input rate, we can also see how an industry affects its forwards industry. From the changes in the intermediate input rate trend, we can see the trend of change in an industry's technological density and capital structure.

Table 9 shows that the differences between each region's intermediate input rate is not very big; they are close to the national average level. The rates for EC and SC are above the national average, but are relatively low for SW and NW. However there is big difference between the provinces. For example, the highest is Guangdong, with a rate of 0.691; but it is 0.541 in Neimeng.

Tab. 9. Intermediate input rate

	Intermediate input rate	
	1997	2002
National Average	0.62	0.64
NE	0.61	0.60
NC	0.63	0.64
EC	0.66	0.68
SC	0.63	0.67
YE	0.60	0.59
YZ	0.61	0.60
SW	0.58	0.58
NW	0.58	0.59

Tab. 10. Intermediate input rate and per capita GDP

	Per capita GDP	Intermediate input rate		Per capita GDP	Intermediate input rate
Guangdong	15030	691	Hubei	8319	603
Zhejiang	16838	683	Hunan	6565	603
Jiangsu	14391	681	Gansu	4493	594
Tianjin	22380	678	Shanxi	6146	59
Shanghai	40646	677	Shaanxi	5523	59
Shandong	11645	646	Jiangxi	5829	574
Chongqing	6347	64	Sichuan	5766	574
Fujian	13497	634	Xinjiang	8382	574
Ningxia	5804	633	Guizhou	3153	573
Liaoning	12986	631	Guangxi	5099	572
Beijing	28449	623	Qinghai	6429	567
Hebei	9115	622	HeiL.J.	10184	55
Anhui	5817	618	Yunnan	5179	549
Jilin	8334	617	Hainan	7803	546
Henan	6436	603	Neimeng	7241	541

Table 10 shows the relationship of intermediate input rate and per capita GDP. In general, the better the province's economy, the higher the provinces' intermediate input rate, such as Beijing, Tianjin, Shanghai, Zhejiang and Guangdong. Inversely, the worse the provinces' economy, the lower the provinces' intermediate input rate, such as Yunnan, Guangxi, Guizhou and Gansu.

5. Index of backwards linkage (e_j) and index of forwards linkage (e_i)

The importance of each sector in the national economy can be analyzed using an index of backwards linkage and an index of forwards linkage. The index of backwards linkage reflects the extent of effect on the demand for other industrial products when a sector increases its final input. If the index $e_j>1$,it means that the industry's backwards linkage is above average for all industries; otherwise, if $e_j<1$, it means that the industry's backwards linkage is below average in all industries. The index of forwards linkage can reflect the output provided by one industry to the other industries when each industry increases one unit of final input. If $e_j>1$, it means that the forwards linkage of industry i is larger than the average of all industries, on the contrary, if $e_j<1$,it means that the forwards linkage of industry I is less than the average of all industries. The higher the index of forwards linkage, the more likely it is that the industry is in a weak sector. Based on Hirschman's rule, all industries can be classified into four categories: 1. sectors mainly producing intermediate products, they have a higher index of backwards linkage and lower index of forwards linkage; 2. sectors mainly producing final products, they have a higher index of backwards linkage and lower index of forwards linkage; 3. sectors mainly producing intermediate primary products, they have a lower index of backwards linkage and a higher index of forwards linkage; 4. sectors mainly producing final intermediate primary products, they have a lower index of backwards linkage and a lower index of forwards linkage.

According to the index of backwards and forwards linkage, all sectors can be divided into 4 kinds; they are distributed into four different quadrants: 1. In the first quadrant, all industries' indexes of backwards and forwards linkage are above 1, the characteristics of these industries are their strong influence and severe restriction; 2. In the second quadrant, all industries' index of backwards linkage are above 1,but their index of forwards linkage is below 1, the characteristics of these industries are a strong influence and weak restriction; 3. In the third quadrant, all in-

index of backwards linkage>1 **index of forwards linkage<1**	**index of backwards linkage>1** **index of forwards linkage>1**
index of backwards linkage<1 **index of forwards linkage<1**	**index of backwards linkage<1** **index of forwards linkage>1**

dustries' index of backwards and forwards linkage are below 1, the characteristics of these industries are weak influence and weak restriction; 4. In the fourth quadrant, all industries' index of backwards linkage is below 1, but their index of forwards linkage is above 1, the characteristics of these industries are weak influence and strict restriction.

Based on the indexes of backwards linkage and index of forwards linkage, all industries' positions can be expressed by the following quadrants.

Electric equipment and machinery(1.334, 0.937)	Electronic and telecommunication equipment (1.395, 1.707)
Instruments, meters, cultural and office machinery(1.299, 0.677)	Transport equipment(1.263, 1.1)
Wearing apparel, leather, furs, down and related products(1.207, 0.657)	Metal products(1.228, 1.001)
Construction(1.184, 0.56)	Textile goods(1.223, 1.11)
Other manufacturing products(1.183, 0.683)	Metals smelting and pressing(1.205, 2.219)
Nonmetal mineral products(1.152, 0.935)	Chemicals(1.178, 3.197)
Gas production and supply(1.126, 0.484)	Paper and products, printing and record medium reproduction(1.161, 1.342)
Sawmills and furniture(1.125, 0.724)	Petroleum processing and coking(1.069, 1.353)
Metal ore mining(1.054, 0.767)	Manufacture of food products and tobacco processing(1.047, 1.044)
Non-ferrous mineral mining(1.027, 0.568)	
Tourism(1.001, 0.74)	
Eating and drinking places(0.926, 0.993)	Coal mining and processing(0.932, 1.048)
General technical services(0.89, 0.508)	Transport and warehousing(0.915, 1.963)
Water production and supply(0.879, 0.508)	Electricity, steam and hot water production and supply(0.888, 1.644)
Other social services(0.878, 0.592)	Wholesale and retail trade(0.834, 1.959)
Scientific research(0.86, 0.498)	Finance and insurance(0.798, 1.374)
Education, culture and arts, radio, film and television(0.776, 0.423)	Agriculture(0.77, 1.704)
Real estate(0.737, 0.687)	Crude petroleum and natural gas products(0.676, 1.175)
Scrap and waste(0.38, 0.502)	

DOMESTIC DEMAND

WHAT DRIVES HOUSEHOLD PRIVATE EXPENDITURE IN ITALY AND FRANCE?

Rossella Bardazzi[1]

1. Introduction

Private consumption is the main demand component in all capitalist economies making its behaviour of utmost importance for all policymakers. As economic model builders, estimating and forecasting household spending is a task the result of which substantially affects the performance of the overall macroeconomic model. INFORUM models have many years of experience in this field, as several approaches have been designed and tested in the past in different economic environments. This study is aimed at making a contribution to this cumulated knowledge as it applies a demand system to a highly disaggregated consumption function classification of two European countries: Italy and France. These economies belong to the Euro area thus sharing not only the same currency but also some economic policies shaped by European directives in terms of market reforms, regulations, taxation, and other fields. Therefore it's significant to verify to what extent household behaviour shares some common features in these countries and reacts in similar ways to symmetric and asymmetric shocks. Finally, we aim to test the suitability of a specific demand system designed by Almon (1996) to interpret private spending behaviour in different institutional settings.

The paper is organized as follows: Section 2 presents an aggregate interpretation of recent private consumption trends in the European economy with a special focus on Italy and France, then an analysis of tendencies by functions is presented in Section 3. The data and the model used are described in Section 4 while the estimation results for both countries are commented on in Section 5. Finally Section 6 concludes.

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2. Private consumption in Europe: an aggregate interpretation

Since 2001, growth in private consumption in the Euro area has been persistently sluggish and has been much weaker than in some other EU countries or in the USA. Although these economies have been subject to largely similar shocks, household spending seems to have been recently a less effective cyclical stabilising force in the euro area than elsewhere (EC 2006; Bank of Italy 2007). This evidence has promoted a renewed interest in empirical analyses to understand the causes of this trend and to suggest possible solutions with alternative policies. Indeed, understanding the behaviour of private consumption is crucial for the assessment of the economic situation in the short and medium term. As the largest expenditure component of GDP, household spending plays a central role in the cyclical fluctuations of activity around its long-term growth path.

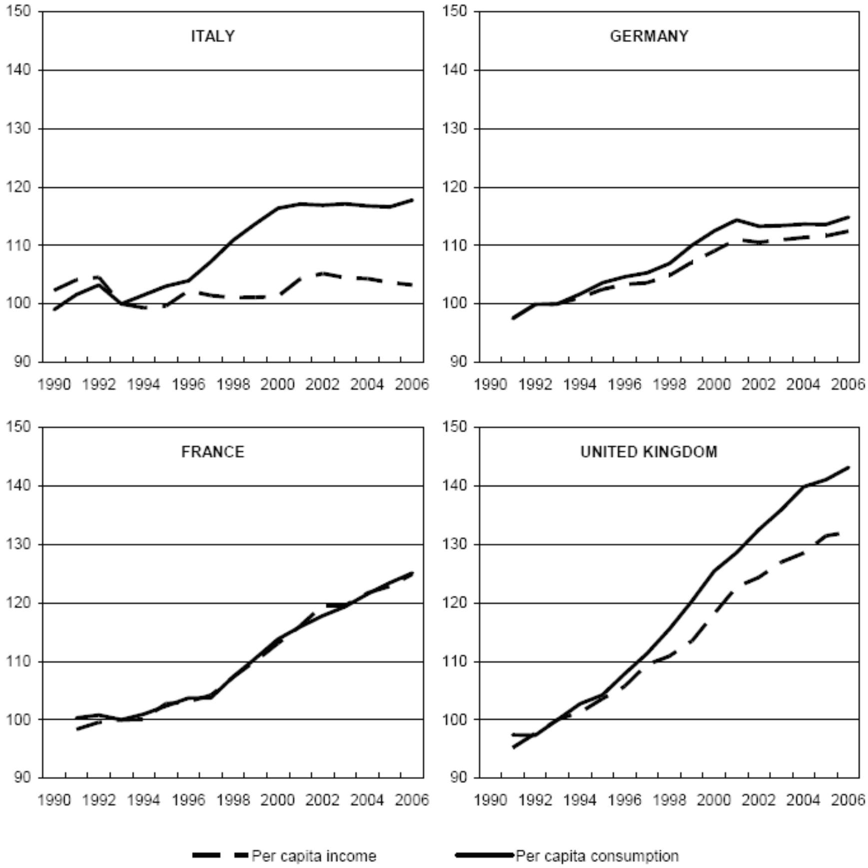
The traditional theory used to explain household spending behaviour is the life-cycle model: according to this model, over time households even out their consumption on the basis of their intertemporal budget constraint, which is the sum of current income, the discounted flow of future, expected income and the current endowment in wealth. Unexpected, permanent increases in income or wealth will expand consumption as they ease the budget constraint. This theory has been used to design the empirical model applied in a study commissioned by the European Commission to investigate the resilience of private spending in the Euro area (European Commission 2006). The main conclusions of the aggregate analysis presented in the first part of this study for all Euro countries show that it is possible to explain consumption behaviour using traditional determinants (disposable income and net financial wealth) and that demographic developments and fiscal policy innovations contribute to the explanation. A pervasive role of house prices has also been found at least for some countries[2]. However, the diversity of the European economies is significant, therefore assessing the driving determinants of private consumption is better done using country-specific equations.

Indeed looking at the dynamics of disposable income and household consumption in the largest euro economies – France, Germany and Italy – we may observe very different situations (figure 1). While in Italy the behaviour of consumption has been more dynamic compared with the sluggish performance of disposable income since 1990, the opposite behaviour is observed in Germany where consumers' loss of confidence lies behind the stagnation of per capita household consumption and in

[2] This result is particularly relevant for understanding the potential consequences of the more recent developments of the housing markets after the subprime mortgage crisis originated in the US.

France the private spending trend follows that of disposable income very closely and both have been rising for the last 15 years.

Fig. 1. Per capita household disposable income and consumption (indices 1993 = 100, chain-linked volumes)



Source: Bank of Italy on Eurostat data

Therefore the patterns of aggregate consumption across Europe are not easily identified by means of a common model specification. Varying institutional factors and structural changes may help to explain why spending and saving decisions are diverse across these countries. As in this paper we present an empirical estimation of personal consumption equations for Italy and France, in the following we have restricted our interest to these countries and surveyed the recent explanations for their performance in economic literature.

2.1 Italy

Looking at the graph for Italy in Figure 1 may help one to appreciate the effect of two major economic events that happened within the period analysed in the empirical study presented in this paper. In 1992-1993 a confidence crisis in the Italian currency (that forced the Lira out of the ERM, Exchange Rate Mechanism) generated a deep recession: for the first time in recent Italian history both household disposable income and consumption in real terms dropped for several quarters in a row. Consumer spending decreased less and recovered more rapidly than disposable income. This event called for changes in government policies with restrictions on social security, freezes on public employment and wages, cuts in public expenditures: these changes plausibly affected the permanent income of Italian households (Grant, Miniaci and Weber 2002).

A second important event happened a few years later when Italy joined the European Monetary Union: mortgage interest rates almost halved between 1997 and 1999 alleviating liquidity constraints for Italian consumers and causing their plans to shift from saving to consumption albeit facing increased economic uncertainty after a sequel of reforms in social security and labour market rules. A recent study based upon a new set of data on the wealth of households developed by the Bank of Italy (Bassanetti, Zollino 2007) estimates the link between consumption, financial and housing wealth on aggregate time series (1980-2006). This estimated long-term relationship shows a marginal propensity to consume out of disposable income to the order of 60 cents per one euro increase, while the MPC resulting from a similar change in financial and housing wealth are 6 cents and 1.5 cents respectively. The latter increase is smaller than those found by similar studies for the Anglo-Saxon economies, while the MPC with respect to financial wealth is about the same as in the other countries and the one with respect to income is slightly higher. These results are explained in several ways[3]. Firstly, Italian households own relatively little financial wealth as the consequence of a financial system which is essentially bank-based, thus limiting the size and participation in the stock market[4]. Secondly, although property is by far the largest and most widespread component of household wealth, the lower tendency to consume out of real wealth is due both to the large non-liquidity of

[3] Paiella (2007) finds similar results in her empirical analysis based on Italian household individual data covering the period 1991-2002.

[4] In 2005, financial assets in Italy were almost 4 times disposable income, a slightly lower ratio than in the United States and the UK. As far as dwellings are concerned, household wealth was 4 times disposable income, a figure similar to that of the UK, lower than France, and higher than Germany or the United States (see Bank of Italy 2007).

real assets[5] and to the prevailing bequest motive for holding onto their tangibles to pass on to their children. Besides, housing wealth is not only a store of value but also a consumer good in that it provides housing services: more than 70 per cent of Italian households own their principal residence with a consequent preference for consuming its services.

Notwithstanding the reduced tendency to consume out of wealth, according to the aggregate consumption function for Italy (Bassanetti, Zollino 2007) since the early 1990s disposable income has made a modest contribution to growth in consumption while the increase in household spending can be ascribed mainly to the growth in financial wealth. This growth can be essentially explained by savings and capital gains. In the 1990s savings contributed to accumulation nearly as much as capital gains, while in recent years capital gains became predominant. The same relevant role for financial wealth is found in the country-specific equation of the EC study, along with a strong effect of the real interest rate. However, this empirical model leaves some Italian consumption behaviour unexplained: disposable income, financial wealth and interest rates are the only significant variables but one-off dummies are often needed to improve the results. In the Bank of Italy analysis, a better set of data and, perhaps, a better specification of the aggregate equation suggests a more convincing interpretation of private spending: beside wealth effects (both financial and real), this aggregate model takes into account the economic shocks described above, checking for changes in real interest rates and real public consumption which are found significant. These results are interpreted by the authors as a Ricardian mechanism at work: in correspondence with the stringent restriction of public deficit in the first half of the 1990s there was a step-up in households' spending plans. On the other hand, the fall in real interest rates, connected with Italy's entry into the EMU, was presumably also perceived by households as permanent and contributed to shift their decisions from saving to consumption.

2.2 France

In France per capita consumption growth has been closer to disposable income behaviour (figure 1). Sustained dynamics of real disposable income drove private spending throughout the 1990s while the EC study findings account for a significant role of demographic factors too which

[5] High costs of mortgage refinancing and the lack of reverse annuity mortgage markets increase transactions costs for Italian households and prevent them from transforming changes in the value of real estate into purchasing power.

build slowly over time and hence add little to the understanding of recent patterns in French consumption while they might become relevant for long-term forecasting. Growth in financial wealth and in housing prices have supported consumption in more recent years. This strong relationship between consumption and disposable income is confirmed by other studies (Lollivier 1999) where income elasticity is measured with several econometric models and it is too high to confirm the life-cycle model where the consumer should aim to smooth his consumption aside from short-term income fluctuations.

Boissinot (2007) estimates life-cycle profiles for consumption in France using repeated cross-sections of the INSEE Budget Survey and finding the typical hump-shaped pattern of both total and non-durable consumption: consumption culminates at the age of 40 and declines evenly afterwards. This profile can be attributed not only to the life-cycle explanation but also to changes in the demographic composition of the population.

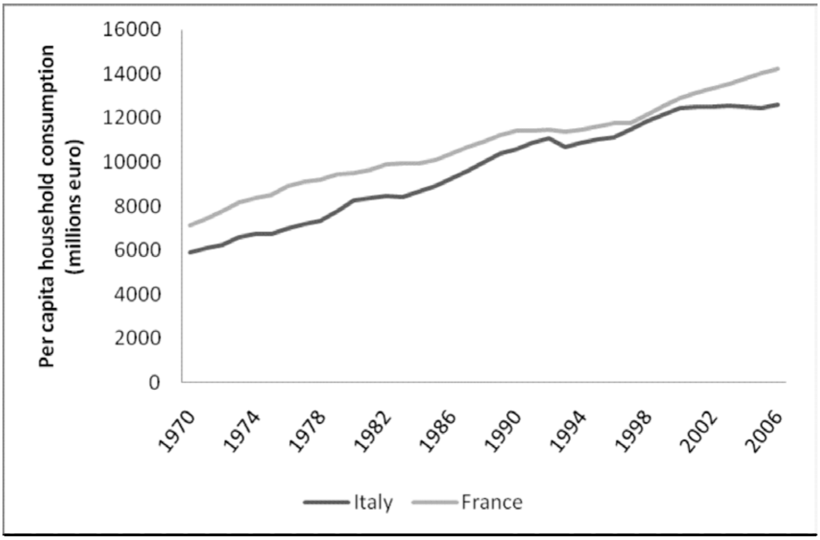
2.3 France and Italy: a comparison of descriptive evidence

This study is aimed at investigating whether a disaggregated system of demand is flexible enough to interpret the behaviour of consumption in different countries. As briefly described above the profile of private spending has developed very differently in these two countries. A long term perspective of this evidence is represented in figure 2. A progressive reduction of the distance between the French and Italian levels of per-capita consumption took place up to the end of 1990s although the event of the 1992 currency crisis in Italy is clearly visible. Since 2000 the growth of per-capita spending in constant terms is around zero, while the French consumer increases his consumption at around 1.5 percentage points every year.

In 2006 economic activity accelerated in all the major euro-area countries, although for different reasons. Looking at the contributions of various demand components to GDP growth (table 1), Italy and France show similar growth rates of overall economic activity but the determinants of this result are very different: in France the main contribution is from private spending which is double compared to Italy (1.9 against 0.8%), while the role of net exports is negative. The Italian final consumption result is similar to the German case where economic growth is faster and generated mainly by an exceptional rise in exports which strongly boosted investment. Finally, domestic demand was the main stimulus behind Spain's accelerated economic growth (3.9%).

This recent evidence confirms that although the overall economic growth in Italian and French economies is proceeding at a similar pace, the role of private spending in this result is very different. Thus it is worth investigating the possible explanations of this evidence at a more disaggregated level of spending functions.

Fig. 2. Per capita household consumption (chain-linked, reference year 2000)



Source: Eurostat data.

Tab. 1. Contributions of demand components to GDP growth – Main EMU countries 2006 (% values)

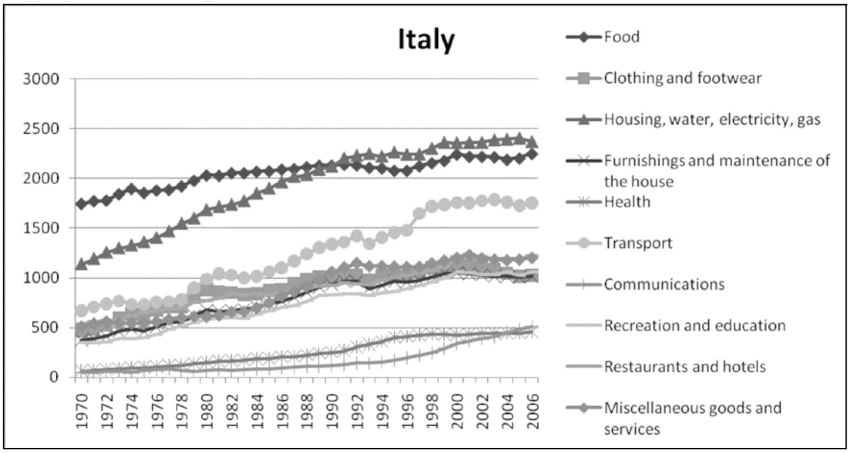
	Italy	*France*	*Germany*	*Spain*	*EMU*
Final consumption	0,8	1,9	0,8	2,9	1,4
Fixed Investments	0,5	0,8	1	1,8	1
Inventories	0,3	-0,3	-0,2	0,1	0
Net Exports	0,3	-0,4	1,1	-1	0,3

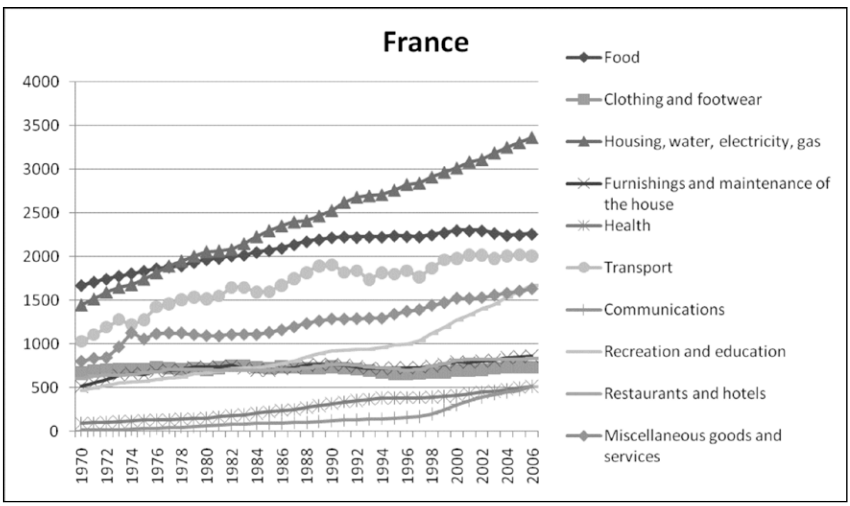
Source: Eurostat data.

3. Household consumption by functions: a long-term perspective

An analysis of household spending by function is useful for understanding the long-term dynamics of different expenditures within household budgets. Figure 3 shows private expenditures in Italy and France classified according the two-digit level COICOP (Classification Of Individual Consumption by Purpose) guidelines. Since 1970 both for Italy

Fig. 3. Final consumption expenditure of households by consumption purpose - COICOP 2 digit - aggregates at constant prices (1970-2006)





Source: Eurostat data

and France housing expenditures (including water, electricity, gas) have increased steadily and represent, with actual and imputed rents, almost one-third of annual consumption. In both countries the real per-capita expenditure for transport is also growing at a steady pace and it follows the expenditure for food in terms of budget share. At the bottom of both graphs are the lines for communication expenses and health[6], which in-

[6] This refers to health expenditures paid directly by households, not including the

deed represent the smallest shares in the average household budget but which are both growing as a result of the development of new technologies and the increasingly ageing population.

These disaggregated dynamics depend on the determinants we have already analysed for the aggregate consumption level but they are also affected by changes in tastes, relative prices, demographics and other factors. In the following sections we will show that these variables have been very influential on disaggregated private demand and that, particularly after the introduction of the common currency, the change in relative prices is very different according to consumption item. To perform this empirical analysis a disaggregated demand system was applied to both economies over a very detailed dataset.

4. The demand system and the dataset

4.1 The functional form

Although the estimation of demand functions on time-series data was certainly the dominant concern in demand analysis in the Eighties, with the design of new theoretical demand systems, in more recent years fewer contributions have been found in related literature. From the theoretical point of view, there is a widespread consensus for the most popular system demand, the Almost Ideal Demand System (AIDS) designed by Deaton and Muellbauer (1980), which indeed has supplanted nearly all other systems in applied work. As to the empirical studies on consumption by detailed expenditure functions the evidence on this issue including the period after the adoption of the euro is virtually nil both for the Italian and for the French economies.

The time-series system of consumer demand equations used in this study is the PADS model developed by Almon (1979, 1996)[7]. This demand system has already been used for forecasting Italian (Bardazzi and Barnabani 2001) and US consumption (Dowd *et al.* 1998). In another chapter of this book a comparison of PADS with AIDS and the Linear Expenditure System for Switzerland is also presented. As explained by Almon, the PAD system is favoured when desirable long-run properties – such as non-negative budget shares in the long-term – are required as in a long-run forecasting macromodel. As summarized by its author,

goods and services consumed by families but provided for by the public administration (these are included in a new concept introduced by SEC95 and defined as «effective consumption»).

[7] The 1996 paper was re-published in Almon C., The Craft of Economic Modelling, Volume 3, available on the website inforumweb.umd.edu.

the basic requirements for a market system of demand include at least the following:

- It should allow for complementarity and substitution effects between different goods;
- It should be homogenous of degree zero in income and prices;
- It should add up, i.e. the sum of the expenditures of all products should be equal to total expenditure;
- As income rises, marginal propensities to consume should be different for each good and depend upon relative prices;
- It should take into account the effect of other variables besides income and prices (time, demographic factors, interest rates etc.);
- It should not be too complicated to be estimated and suitable for large system of goods also.

The PAD system satisfies these requirements and, in its basic form, specifies that the demand for a good depends, linearly, on income, a cyclical variable and a time trend, and, non-linearly, on the prices of all other goods. The analytical form of the system is the following:

$$\frac{q_{it}}{Pop_t} = \left(a_i + b_i\, y_t + c_i\, \Delta y_t + d_i\, time \right) \left(\frac{p_i}{P} \right)^{-\lambda_i} \prod_{k=1}^{n} \left(\frac{p_i}{p_k} \right)^{-\lambda_k s_k} \left(\frac{p_i}{P_G} \right)^{-\mu_G} \left(\frac{p_i}{P_g} \right)^{-\nu_g}$$

where:
q_{it}/Pop_t is consumption per-capita in constant prices of product i,
y_t is income (total expenditure) per-capita in constant prices,
Δy_t is equal to $(y_t - y_{t-1})$,
time is time trend,
s_k is the budget share of product k in the base year,
p_k is the price index for product k, equal to 1 in base year,
a, b, c, d, λ, μ, and v are parameters to be estimated (λ is the individual good price response parameter, μ is the group price parameter and v is the subgroup price parameter),
and P, P_G, P_g are over-all, group, and subgroup price indexes given by:

$$P = \prod_{all\,k} p_k^{s_k} \qquad P_G = \left(\prod_{k \in G} p_k^{s_k} \right)^{1/\sum_{k\in G} s_k} \qquad and \quad P_g = \left(\prod_{k \in g} p_k^{s_k} \right)^{1/\sum_{k\in g} s_k}$$

In this model, consumption products are organized into economically relevant groups and subgroups: a commodity can be a strong complement/substitute for other items in its own group while interacting less strongly with the prices of goods in other groups. Similarly, the functional form allows subgroups within which we suppose even greater sensitivity of the demand for one product to the price of others in the same subgroup. This specification serves two purposes: it economizes on the number of parameters, making this an empirically estimable system; and it divides consumption up into natural functional categories of human needs. This method is almost the only sensible way to deal with very large systems.

The system satisfies the following constraints:

$$\sum_{i=1}^{n} b_i = 1 \quad [1] \qquad \sum_{i=1}^{n} a_i = 0 \quad [2] \qquad \sum_{k=1}^{n} c_{ik} = 0 \quad [3]$$

The first two constraints ensure constant-price adding up: as we move away from the base year, a spreader is employed. The spreader adjusts expenditure for each commodity by allocating the difference between total expenditures (y) and the sum of expenditures in proportion to the marginal propensities to consume with respect to y at the current prices[8]. The third constraint imposes homogeneity of degree zero in all prices and income in the system. However, this system has a lot of price parameters to be estimated depending on the number of years and on the expenditure categories. To reduce this number, Slutsky symmetry at the base year prices is assumed. Therefore, we assume that:

$$c_{ij} . q_i / p_j = c_{ji} . q_j / p_i$$

Multiplying both sides by $(p_i \, p_j / y)$, we obtain

$$c_{ij} / s_j^o = c_{ji} / s_i^o$$

where s_i^o is the base year share of total expenditures for commodity *i*. If we now define $\lambda_{ij} = c_{ij} / s_j^o$, we have the symmetry condition

$$\lambda_{ij} = \lambda_{ji}$$

which reduces the number of price parameters by half. A further restriction is imposed by combining commodities into groups and sub-groups. This grouping technique was introduced by Almon (1979) and improved by the same author (Almon, 1996) with a specification where every product has its own-price elasticity. We will have as many price-exponent parameters as there are commodities plus groups plus subgroups. Estimation will be simplified by the following definitions:

[8] The amount to add up is usually very small (2% of the total expenditure) as it has been tested both in the US and in the Italian model.

$$\lambda_{ij} = \lambda_i + \lambda_j$$

if product *i* and product *j* are not in the same group or subgroup;

$$\lambda_{ij} = \lambda_i + \lambda_j + \mu_G$$

if products *i* and *j* are in the same group *G* but not in the same subgroup;

$$\lambda_{ij} = \lambda_i + \lambda_j + \mu_G + \nu_g$$

if they are in the same subgroup *g* of the same group *G*.

In fact, when household data are available, results from the cross-section work may be incorporated within a modified-version of the demand system described above as presented in Bardazzi and Barnabani (2001). Moreover, this system can benefit from interaction with a Demographic Projection Model as show in Bardazzi (2003) and Dowd *et al.* (1998). However, in this paper the cross-section stage of analysis was not performed and we only applied the time-series model. Instead, some specific product equations have been enriched with variables other than price, income and time. In fact, other factors such as interest rates, demographics, dummy variables for some regime changes may be relevant to the demand for some specific commodities. Therefore we will experiment some of these additional variables in consumption equations for selected categories.

The PAD system means that parameters can be constrained if they show implausible values – such as positive price elasticities or negative income elasticities offset by positive time coefficients – and it is the responsibility of the model builder to provide the soft constraints to obtain reasonable parameters coherent with economic theory: this step is quite difficult since it is a trade-off between the model's fit and the forecasting performance of the system[9].

4.2 The data

The Italian data used for estimating the demand system is the personal consumption expenditures in constant 2000 Euros produced by the National Statistical Institute according to a classification based up-

[9] The mathematics of estimation including soft constraints is explained by Almon (1996) and, for the Italian case, by Bardazzi and Barnabani (2001).

on the COICOP classification at 3-digit level adapted to Italian households preferences. The number of expenditure categories used here is 56 as shown in table 2[10]. For France, household consumption by function produced by INSEE is more detailed and was aggregated to match the Italian data since it was based on the same statistical concepts as defined by SEC95. This allowed us to compare the results of the regressions run from 1992 to 2006.

Tab. 2. Groups and subgroups of commodities for PADS estimation

Consumption categories	*Group*	*Subgrp*	*Consumption categories*	*Group*	*Subgrp*
1 Cereals and Bakery Products	1		29 Drug Preparation, Sundries and orthopedic eq.		
2 Meat	1	1	30 Physicians, Dentists, Other Medical Professionals		
3 Fish	1	1	31 Hospitals, Nursing Homes		
4 Dairy Products	1	1	32 Vehicles	4	2
5 Fats & Oils	1		33 Operation of Motor Vehicles (excluding fuels)	4	2
6 Fruit	1		34 Fuels and oil	4	2
7 Fresh vegetables	1		35 Public Transportation	4	
8 Sugar, marmelade, syrups, honey	1		36 Postal services		
9 Other Food n.e.c.	1		37 Telephone and communication equipment	6	3
10 Coffee, Tea and Cocoa	1		38 Telephone and communication services	6	3
11 Nonalcoholic Beverages	1		39 TV, Radio, Photo, Computers	6	
12 Alcoholic Beverages			40 Other recreational durables	6	
13 Tobacco			41 Recreational equipment	6	
14 Clothing	2		42 Flowers, plant, pets		
15 Footwear and Repair	2		43 Recreational and cultural Services		
16 Rents			44 Books		
17 Tenant Occupied Rent			45 Magazines and Newspapers		
18 House maintenance			46 All-inclusive holidays		
19 Water and other household services			47 Education		
20 Electricity, gas, and other fuels			48 Bar and Restaurants		
21 Furniture	3		49 Hotels & motels		
22 Household Linen	5		50 Personal Care equipment		
23 Kitchen and Household Large Appliances	3		51 Personal care items n.e.c.		
24 Kitchen and Household small Appliances	5		52 Personal Care services		
25 China, Glassware and Tableware	5		53 Social services		
26 Household and garden utensils	5		54 Insurance		
27 Other Non-Durables			55 Financial Services		
28 Domestic Services			56 Other Services n.e.c.		

Other variables used in the system are consumption price deflators computed from the series at current and constant prices, total expenditure used as a proxy variable of disposable income and total population. Moreover, for some commodities interest rates are used as explanatory variables (Treasury bill rate at 3 months)[11] as well as other demographic indicators produced by ISTAT and INSEE.

According to the approach used here, groups and subgroups of commodities are designed so as to estimate price interactions between specific expenditure categories. Thus in the 56-item classification 6 different groups were created — as shown in table 2 – (1 is Food, 2 Clothing and Footwear, 3 Household Durables, 5 Minor Household Durables,

[10] The official ISTAT classification is 58, we have excluded 2 items (narcotics, personal services n.e.c.) because these cells are empty.

[11] Italian Ministry of Treasury, Eurostat, Agence France Trésor.

4 Transportation, 6 Recreational Durables) and within some of them 3 subgroups (1 Protein Food, 2 Vehicles and operation, 3 Communication eq. and services). Within these groups a commodity can be either a complement or substitute for other items in its own group while having weaker price interactions with goods in other groups.

5. Estimation results

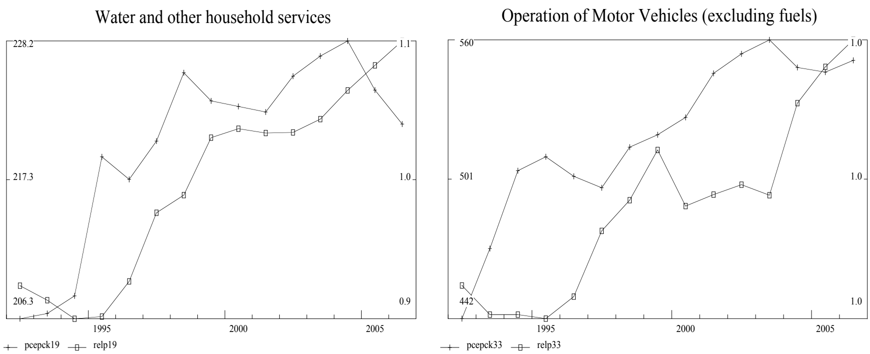
The estimation of the program was done with a computer program designed for this system by Almon and improved by Horst (2002). The demand system for both countries was run initially without any constraint on the parameters but did not produce satisfactory results. In fact, in the Italian case there were 12 consumption categories with positive own (compensated) price elasticities and the income elasticities of the same number of categories (some of which are the same) were negative. Therefore, we investigated the relationship between the relative price and the real expenditure by commodity to understand the strong positive price elasticities and found some interesting evidence. Indeed some items – as shown in Figure 4 for two illustrative cases – had rising relative prices but the amount spent on them in real terms has also been going up, thus causing trouble in the system as their price parameters affected demand for all other goods. Therefore, some of these commodities were treated as insensitive to prices while for others soft constraints were imposed. Finally, it can be shown that some expenditure categories were characterised by a sort of 'euro effect' as their relative prices accelerated after the introduction of the new currency (for instance Bar and Restaurants, Fresh vegetables in Figure 5).

In the French case, these problems were slightly less severe, with 11 out of 56 positive price elasticities and only 5 wrong income elasticities and were similarly treated with soft constraints.

Selected results of groups and subgroups of commodities are presented in table 3 for the Italian case. In each panel several parameters are reported: the own price parameter (lambda), the share of total expenditure for each good, income and price elasticities, the time trend, and the group and any subgroup price parameters. Finally, cross price elasticities are shown at the bottom of each panel: in general, positive values of price elasticities imply substitutability and negatives suggest complementarity.

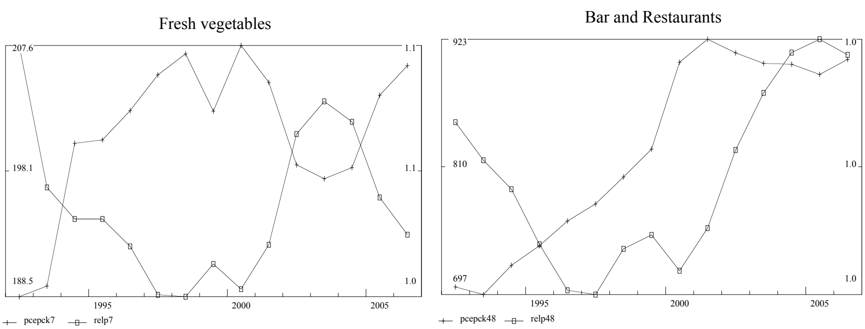
In the first group – Food – income elasticities are positive but very low, there is a negative time trend both for fats and oils (5) consumption and for coffee and tea (10) while price elasticities are all negative. Price interaction within the group goes in the direction of substitutability: cross price elasticities are mostly positive especially for meat (2), while the prices of fats and oil (5) and of coffee and tea (10) do not affect purchases of other goods

Fig. 4. Relative price and expenditure in real terms



Source: author's calculations.

Fig. 5. The 'Euro effect'



Source: author's calculations.

in this group. Within the protein subgroups we find a weak complementarity while these goods are substitutes to other food items in the group.

Clothing and footwear are complements in Group 2 as expected, income elasticity is positive and high while the time trend coefficient is negative and very high. An alternative specification of the equation, not shown here, including as an explanatory variable the share of people over 65 years old improves the results, capturing part of the negative trend of this commodity.

For Group 3, Household Durables, a different specification of the basic equation was used: since interest rates have been proven to explain the behaviour of Italian household aggregate consumption, we tried to verify if some commodities benefited from the fall in interest rates due to the convergence process towards the common currency. Indeed, easier access to consumer credit had a detectable though weak effect on the

Tab. 3. Italy: Results of Demand System Estimation by Group and Subgroup

Group 1: Food

Equation	Subgroup	lambda	share	IncEl	OwnPrEl	Time	Mu	Nu
1 Cereals and Bakery Products	0	0,55	0,028	0,79	-0,8	0,5	0,4	
2 Meat	1	0,15	0,034	0,25	-0,36	0,51		-0,05
3 Fish	1	0,07	0,01	0,48	-0,24	-0,02		-0,05
4 Dairy Products	1	-0,01	0,021	0,7	-0,19	-0,82		-0,05
5 Fats & Oils	0	-0,19	0,008	0,95	-0,1	-1,13		
6 Fruit	0	0,05	0,011	0,25	-0,33	0,27		
7 Fresh vegetables	0	-0,01	0,016	0,21	-0,28	0,54		
8 Sugar, marmelade, syrups, honey	0	0,22	0,01	0,64	-0,5	0,55		
10 Coffee, Tea and Cocoa	0	0,8	0,002	0,35	-1,09	-0,65		
11 Nonalcoholic Beverages	0	0,24	0,009	0,93	-0,53	0,24		

Cross Price Elasticities

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**10**	**11**
1	-0,8	0,04	0,01	0,02	0	0,01	0,01	0,01	0,01	0,01
2	0,04	-0,36	-0,01	-0,04	0	0,01	0,01	0,01	0	0,01
3	0,04	-0,04	-0,24	-0,04	0	0	0,01	0,01	0	0,01
4	0,04	-0,05	-0,02	-0,19	0	0	0	0,01	0	0,01
5	0,03	0,01	0	0	-0,1	0	0	0,01	0	0
6	0,04	0,02	0	0,01	0	-0,33	0	0,01	0	0,01
7	0,04	0,02	0	0,01	0	0	-0,28	0,01	0	0,01
8	0,05	0,03	0,01	0,01	0	0,01	0,01	-0,5	0	0,01
10	0,06	0,05	0,01	0,02	0,01	0,01	0,02	0,02	-1,09	0,01
11	0,05	0,03	0,01	0,01	0	0,01	0,01	0,01	0,01	-0,5

Subgroup 1: Protein food

Group 2: Clothing and Footwear

Equation	Subgroup	lambda	share	IncEl	OwnPrEl	Time	Mu
14 Clothing	0	0.25	0.07	1.84	-0.46	-16.8	-0.01
15 Footwear and Repair	0	0.23	0.019	1.36	-0.46	-3.1	

Cross Price Elasticities

	14	**15**
14	-0.46	0.01
15	0.04	-0.46

Group 3: Household Durables

Equation	Subgroup	lambda	share	IncEl	OwnPrEl	Time	IntRates	Mu
21 Furniture	0	0.23	0.034	0.31	-0.52	0.09	-0.1	0.26
23 Kitchen and Household Large Appliances	0	0.27	0.009	1.38	-0.72	-1.05	-0.09	

Cross Price Elasticities

	21	**23**
21	-0.52	0.06
23	0.23	-0.72

purchase of furniture (21) and of large household appliances (23). The same effect was found in Group 4 (Transportation) for the purchase of vehicles (32) and in Group 6 for Recreational Durables.

The price interaction of transportation commodities indicates substitutability both within the group and the subgroup of vehicles and op-

Group 4: Transportation

Equation	Subgroup	lambda	share	IncEl	OwnPrEl	Time	IntRates	Mu	Nu
32 Vehicles	2	1.11	0.043	1.3	-1.63	-0.01	-0.2	0.25	0.29
33 Operation of Motor Vehicles	2	0.24	0.041	1.06	-0.83	1.54			0.29
34 Fuels and oil	2	0.29	0.036	1.73	-0.91	3.44			0.29
35 Public Transportation	0	0.24	0.018	0.47	-0.7	1.39			

Cross Price Elasticities

	32	**33**	**34**	**35**
32	-1.63	0.25	0.22	0.06
33	0.33	-0.83	0.19	0.05
34	0.33	0.22	-0.91	0.05
35	0.18	0.1	0.09	-0.7

Subgroup 2: Vehicles and operation

Group 5: Minor Household Durables

Equation	Subgroup	lambda	share	IncEl	OwnPrEl	Time	Mu
22 Household Linen	0	0.14	0.005	0.28	-2.9	0.39	3.51
24 Kitchen and Household small Appliances	0	0.3	0.002	1.23	-3.56	-1.55	
25 China, Glassware and Tableware	0	0.21	0.006	1.59	-2.66	-0.5	
26 Household and garden appliances	0	0.17	0.003	1.39	-3.21	0.28	

Cross Price Elasticities

	22	**24**	**25**	**26**
22	-2.9	0.49	1.31	0.72
24	0.99	-3.56	1.31	0.72
25	0.99	0.49	-2.66	0.72
26	0.99	0.49	1.31	-3.21

Group 6: Recreational Durables

Equation	Subgroup	lambda	share	IncEl	OwnPrEl	Time	IntRates	Mu	Nu
37 Telephone and communication equipment	3	0.46	0.006	3.56	-0.91	1.37	-0.1	0.18	0.07
38 Telephone and communication services	3	0.86	0.019	2.62	-1.2	3.51			0.07
39 TV, Radio, Photo, Computers	0	0.59	0.011	1.81	-0.97	-0.04	-0.19		
40 Other recreational durables	0	0.24	0.004	1.6	-0.65	-0.85			

Cross Price Elasticities

	37	**38**	**39**	**40**
37	-0.91	0.18	0.06	0.02
38	0.06	-1.2	0.06	0.02
39	0.04	0.12	-0.97	0.02
40	0.03	0.11	0.06	-0.65

Subgroup 3: Communication eq. and services

eration. Income elasticity is particularly high for purchase of fuels in a framework of rising world oil prices and stagnant disposable income.

Minor household durables in Group 5 did not turn out to be necessities especially small china and glassware (25) and household and garden appliances (26) and they are strong substitutes for household linen (22) and small appliances (24).

Finally, recreational durables (Group 6) are luxuries showing very high income elasticities and are weak substitutes for each other both within the group and the subgroup of communication equipment and services.

Estimation results for France are shown in table 4 without cross price elasticities values, which are summarized by the mu and nu parameters. Some differences compared to the Italian results are worth stressing:

Tab. 4. France: Results of Demand System Estimation by Group and Subgroup

Group 1: Food

Equation	Subgroup	lambda	share	IncEl	OwnPrEl	Time	Mu	Nu
1 Cereals and Bakery Products	0	-0.28	0.02	0.02	-0.05	0.72	0.22	
2 Meat	1	-0.2	0.038	0.1	-0.2	-1.18		0.21
3 Fish	1	-0.21	0.011	0.25	-0.31	0.2		0.21
4 Dairy Products	1	-0.11	0.02	0.26	-0.37	0.79		0.21
5 Fats & Oils	0	0.22	0.004	0.15	-0.57	-0.59		
6 Fruit	0	-0.09	0.009	0.78	-0.25	-0.05		
7 Fresh vegetables	0	-0.01	0.014	0.41	-0.32	-0.19		
8 Sugar, marmelade, syrups, honey	0	-0.15	0.01	0.54	-0.19	0.61		
10 Coffee, Tea and Cocoa	0	-0.01	0.003	0.06	-0.34	-0.01		
11 Nonalcoholic Beverages	0	0.2	0.007	0.52	-0.55	2.59		

Subgroup 1: Protein food

Group 2: Clothing and Footwear

Equation	Subgroup	lambda	share	IncEl	OwnPrEl	Time	Mu
14 Clothing	0	-0.84	0.044	1.18	-0.38	-3.4	2.64
15 Footwear and Repair	0	-0.44	0.009	1.51	-4.34	-0.65	

Group 3: Household Durables

Equation	Subgroup	lambda	share	IncEl	OwnPrEl	Time	Mu
21 Furniture	0	0.25	0.016	0.61	-0.23	-2	-0.44
23 Kitchen and Household Large Appliances	0	1.18	0.008	1.96	-1.01	-2.99	

Group 4: Transportation

Equation	Subgroup	lambda	share	IncEl	OwnPrEl	Time	Mu	Nu
32 Vehicles	2	0.25	0.043	1.34	-0.04	-4.1	0.23	-1.02
33 Operation of Motor Vehicles	2	0.25	0.051	0.85	-0.07	1.34		-1.02
34 Fuels and oil	2	0.4	0.038	0.18	-0.15	-3.04		-1.02
35 Public Transportation	0	0.24	0.019	1.82	-0.81	-1.31		

Subgroup 2: Vehicles and operation

Group 5: Minor Household Durables

Equation	Subgroup	lambda	share	IncEl	OwnPrEl	Time	Mu
22 Household Linen	0	0.23	0.003	1.93	-0.55	-1.29	0.51
24 Kitchen and Household small Appliances	0	6.56	0.001	3.46	-6.89	-2.96	
25 China, Glassware and Tableware	0	0.24	0.007	0.55	-0.51	-0.19	
26 Household and garden appliances	0	0.24	0.004	1.58	-0.54	-0.57	

Group 6: Recreational Durables

Equation	Subgroup	lambda	share	IncEl	OwnPrEl	Time	Mu	Nu
37 Telephone and communication equipment	3	2.03	0.003	3.41	-2.08	-5.78	0.26	-0.35
38 Telephone and communication services	3	0.18	0.019	6.54	-0.43	-2.98		-0.35
39 TV, Radio, Photo, Computers	0	0.5	0.022	2.91	-0.77	0.11		
40 Other recreational durables	0	0.23	0.003	3.36	-0.61	-0.37		

Subgroup 2: Vehicles and operation

goods in the subgroup of protein food (Group 1) are substitutes for each other and in general within the group. The same price interaction is estimated in Group 2 for Clothing (14) and Footwear (15). An alternative specification with interest rates for durables was tested but rejected as the coefficients all had the wrong positive sign.

Tab. 5. Housing expenditures estimation: Italy and France

ITALY Equation	Included	lambda	share	IncEl	OwnPrEl	Time
16 Rents	0	0	0.018	-0.12	0	0.36
17 Tenant Occupied Rent	0	0	0.103	0.3	0	8.65
18 House maintenance	1	0.23	0.012	1.28	-0.48	-2.77
19 Water and other household services	1	0.21	0.017	0.52	-0.45	1.66
20 Electricity, gas, and other fuels	1	0.21	0.034	0.07	-0.45	3.37
FRANCE						
16 Rents	0	0	0.039	0.51	0	6.94
17 Tenant Occupied Rent	0	0	0.128	0.39	0	21.51
18 House maintenance	1	0.23	0.013	0.07	-0.36	1.65
19 Water and other household services	1	0.21	0.014	0.09	-0.34	3.51
20 Electricity, gas, and other fuels	1	0.23	0.035	0.71	-0.35	0.4

As a final point, table 5 presents the estimation results for some consumption categories both for Italy and France. These are the functions with rising importance within the household budget as already shown in Figure 3, as related to contract tariffs for household utilities, rents and house maintenance. These consumptions are somewhat subtracted from arbitrage and represent a constraint within the budget with fewer substitutes – at least in highly regulated markets as in these countries –, and therefore less price sensitive. This is the main reason why rents (16) and tenant occupied rent (17) are not considered as part of the system and their prices do not affect the prices of other goods. On the other hand, house maintenance (18), water and other services (19), and electricity gas and other fuels (20) are weakly price and income elastic. For Italian households, house maintenance expenditures are decreasing with time and are very sensitive to income dynamics. Relative prices of these goods have been rising in recent years and their equation results may help to explain the difference between high perceived inflation and the overall price dynamics as reported by the national statistical offices.

6. *Conclusions*

In this paper we have estimated a system of consumption functions for two European countries: Italy and France. The results of this highly disaggregated system (56 functions) broadly confirm the conclusions of other studies performed on aggregate data. In the Italian case, financial conditions have shown a certain influence on expenditure decisions, particularly for durable goods. On the one hand, we may observe that some goods have become luxuries within a budget constraint where some necessary and non-reducible expenditures (such as housing expenditures) have been rising since the year 2000. On the other, households did not react appropriately to the rising relative prices[12] of some services (such as Bar and Restaurants) after the Euro cash changeover: the new currency made it more difficult for the consumer to distinguish a price increase from an exchange rate effect especially for items which are seldom bought, thus allowing firms to take advantage of this confusion. This specific event causes difficulties in estimating consumption at a detailed level because of price interactions among goods: however the flexibility of the PAD system makes it possible to tackle the problem by isolating the problematic items from the rest of the system. Finally, estimation results were more reliable in the French case where in most cases disposable income is the main driver behind consumption decisions, whereas for Italian household demand other factors (such as demographic changes, financial conditions, labour market reforms) seems to be at work in influencing consumer behaviour thus requiring additional future work on some equations.

As a final remark it should be remembered that the empirical, disaggregated analysis presented here as the aggregate estimates of other studies commented on at the beginning of the paper, is designed to find an interpretation for the past behaviour of private consumption. However, model builders are well aware that perfectly fitting equations do not guarantee a similar performance when they are inserted into a general equilibrium model like Inforum models. Furthermore in forecasting some explanatory variables which were found significant in the system they may create problems and a change in the specification may be required (see Horst 2002).

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ESTIMATION OF CONSUMPTION FUNCTIONS FOR SWITZERLAND

Jonela Lula, Gabrielle Antille Gaillard, Jean-Paul Chaze[1]

1. Introduction

In demand analysis two systems of consumption functions are often used: the Linear Expenditure System (LES) and the Almost Ideal Demand System (AIDS). LES is fully compatible with consumer behaviour theory and therefore satisfies all the hypotheses like additivity, homogeneity and the Slutsky relations. However, unwanted restrictions on elasticities are also imposed, ruling out inferior or complementary goods. AIDS adds flexibility in that there are no restrictions on the sign of the income and price elasticities, and theoretical restrictions may be imposed or tested. Despite the flexibility of AIDS, these systems are often criticized for being insufficiently realistic and this is the origin of the Perhaps Adequate Demand System (PADS)[2]. Our interest relies on the comparison of these systems both from a theoretical point of view and from an empirical one. We thus first mention some specificities of each system and then present the results of estimations for Switzerland over the period 1980-2005. The classification of goods and services with respect to the values of their income and price elasticities are discussed and a comparison is made between the three models.

2. The theoretical models

2.1 The Linear Expenditure System

The demand functions of the LES

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[2] See Almon C. (1979) and Almon C. (1996).

$$q_i = a_i + \frac{b_i}{p_i}\left(y - \sum_{i=1}^{n} p_i a_i\right), \qquad i = 1,2, \quad ,n$$

where q_i is the quantity of good i per capita
p_i is the price of good i, and
y is the total expenditure per capita,

result from maximisation of the following utility function:

$$U = \sum_{i=1}^{n} b_i \cdot Log\left(q_i - a_i\right)$$

with $b_i > 0$

$$\sum_{k=1}^{n} b_k = 1$$

and $q_i - a_i > 0$

under the constraint:

$$y = \sum_{i=1}^{n} p_i q_i$$

This system satisfies adding up, homogeneity and Slutsky conditions. Unfortunately some unwanted restrictions appear concerning the sign of the elasticities. First, given $b_i > 0$, all income elasticities are positive, ruling out inferior goods and second, all compensated cross-price elasticities are positive so that all commodity groups are substitutes according to the Hicksian definition.

The LES is useful if we are interested to obtain a first description of consumer behaviour as it gives us some information about consumption, although its structure is largely imposed. The constraint on the sign of income elasticities is not overly restrictive as long as we consider rather broad categories, since inferior goods are rarely observed at this level. To a lesser extent, the same argument applies to the fact that the LES does not allow pure complements. Of course, if we work with more disaggregated consumption functions, a necessary feature if we want to introduce consumer expenditures detailed by product into a macroeconometric model for long term forecasting, the LES is not the most appropriate model. The benefit of having a limited number of parameters for estimation is then overruled by the fact that the system is unable to express complementarity and/or substitutability between goods and services.

2.2 The Almost Ideal Demand System

$$Log\left(c\left(u,p\right)\right) = a_0 + \sum_k a_k \cdot Log\left(p_k\right) + \frac{1}{2}\sum_k \sum_j \gamma^*_{kj} \cdot$$
$$\cdot Log\left(p_k\right) \cdot Log\left(p_j\right) + u \cdot b_0 \cdot \prod_k p_k^{b_k}$$

In the AIDS, demand functions are not given in volume but in budget shares. These budget shares w_i are obtained applying Shephard's Lemma to the following cost function:

The AIDS demand functions in budget share are thus:

$$w_i = a_i + \sum_{j=1}^{n} \gamma_{ij} \cdot Log\left(p_j\right) + b_i \cdot Log\left(\frac{y}{P}\right) \qquad i = 1,2,\ldots,n$$

where P is an overall price index, which may be approximated by Stone's price index:

$$Log\left(P\right) = \sum_{i=1}^{n} \pi_i Log\left(p_i\right)$$

π_i being the observed budged shares.

The restrictions on AIDS parameters are given by the following sets:

$$\sum_{i=1}^{n} a_i = 1$$
$$\sum_{i=1}^{n} \gamma_{ij} = 0 \qquad \sum_{j=1}^{n} \gamma_{ij} = 0 \qquad \gamma_{ij} = \gamma_{ji}$$
$$\gamma_{ij} = \frac{1}{2}\left(\gamma^*_{ij} + \gamma^*_{ji}\right)$$
$$\sum_{i=1}^{n} b_i = 0$$

These restrictions are imposed in order to satisfy all hypotheses from consumer behaviour theory, except negativity of the Slutsky matrix, which cannot be imposed (and may thus only be satisfied locally).

This system does not impose any restrictions to the sign of the elasticities, so that theoretically all types of goods and services could appear: inferior, normal or luxury, and these goods and services can be either substitutes or complements depending on the sign of the compensated price elasticity.

The AIDS is thus very flexible since it allows complementarity as well as substitutability between goods. It is suitable for interpreting consumption behaviour and analyzing income and price elasticities. When using this system in a macroeconometric model for long term forecasting, we have to be careful since very large increases in real income might lead some budget shares to become negative. Furthermore, as pointed out by Almon[3], partial derivatives of budget shares with respect to real income do not depend on relative prices, which may prove overly restrictive.

2.3 The Perhaps Adequate Demand System.

The PADS which has been introduced by Almon[4] is more suited in the context of macroeconometric models for long term forecasting than the two previous systems, which are derived from microeconomic consumer theory. It satisfies most criteria considered important for such models[5], including the possibility to express either substitutability or complementarity between goods and dependency of the marginal propensity to consume on relative prices. On the other hand, while all three systems are homogeneous of degree zero in prices and income, additivity and Slutsky symmetry are satisfied only for the base year in the PADS.

The PADS shows a multiplicative link between income and prices. It can be written as follows:

$$q_i = \left[a_i(t) + b_i \cdot \left(\frac{y}{P_0} \right) \right] \prod_{k=1}^{n} p_k^{c_{ik}} \qquad i = 1,2,\ldots,n$$

where $a_i(t)$ is a function of time
b_i is a positive constant
y is the nominal per capita income

[3] See Almon C. (1996)

[4] See Almon C. (1979)

[5] *Ibidem.*

p_k is the price index of product k
P_0 is an overall price index defined by

$$P_0 = \prod_{k=1}^{n} p_k^{s_k}$$

where s_k is the budget share of product k for the base year.

In this system the adding-up hypothesis is satisfied only for the base year if

$$\sum_{i=1}^{n} b_i = 0$$

For the other years we have to introduce a 'spreader' which distributes the difference between the sum of all expenditures and income. Slutsky symmetry is also satisfied only for the base year and under additional restrictions on the parameters, such as

$$c_{ik} = \lambda_{ik} s_k ,$$

where

$$\lambda_{ij} = \lambda_{ji} .$$

3. Application to Switzerland

3.1 The data

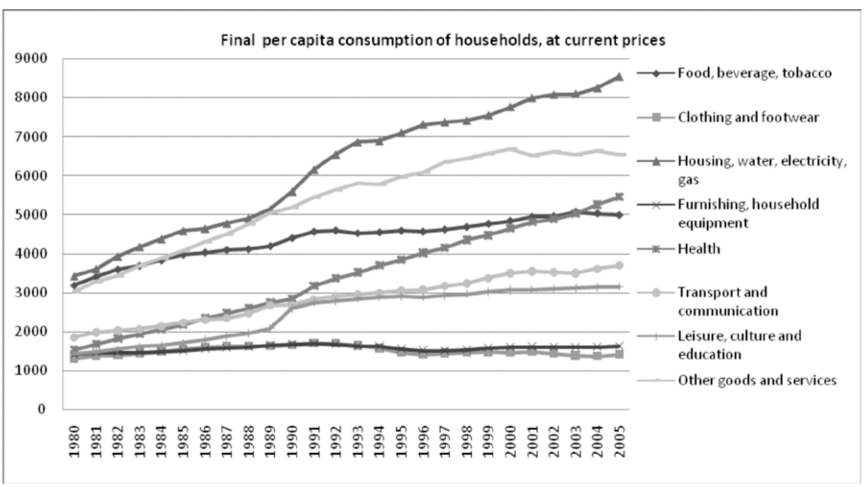
The data on personal consumption expenditures come from the Swiss national accounts; they are available for 12 consumption functions in the COICOP classification over the period 1980-2005, at current prices. We also have expenditure by consumption function evaluated at prices of the previous year. These data allow us to calculate a series of price indices for which we choose 2001 as base year. The consumption expenditures are then divided by the resident population.

The definition of private consumption is the national concept, which means that expenditures from residents abroad are included in the function. Such is also the case for the price index which takes into consideration both the evolution of prices in Switzerland and outside the country. In the latter case, Swiss Statistics consider the price index from the 12 most visited countries by Swiss residents.

To facilitate estimation (notably for the PADS system), we aggregate the twelve positions of the Swiss national accounts into eight positions, as follows:

1.1 Food, non alcoholic beverages	1. Food, beverages, tobacco
1.1 Alcoholic beverages and tobacco	
2. Clothing and footwear	2. Clothing and footwear
3. Housing, water, electricity, gas	3. Housing, water, electricity, gas
4. Furnishing, household equipment	4. Furnishing, household equipment
5. Health	5. Health
1.1 Transport	6. Transport and communication
1.1 Communication	
7.1 Leisure and culture	7. Leisure, culture and education
2.2 Education	
1.1 Hotels and Restaurants	8. Other goods and services
1.1 Other goods and services	

Fig. 1. Final per capita consumption of households, at current prices



Studying the evolution of household expenditures over the period (figure 1) we notice that two functions have been growing very fast:

- «Housing, water, electricity and gas» for which per capita expenditure has been multiplied by 3.5 over the period,
- «Health», with a multiplier of 2.5,

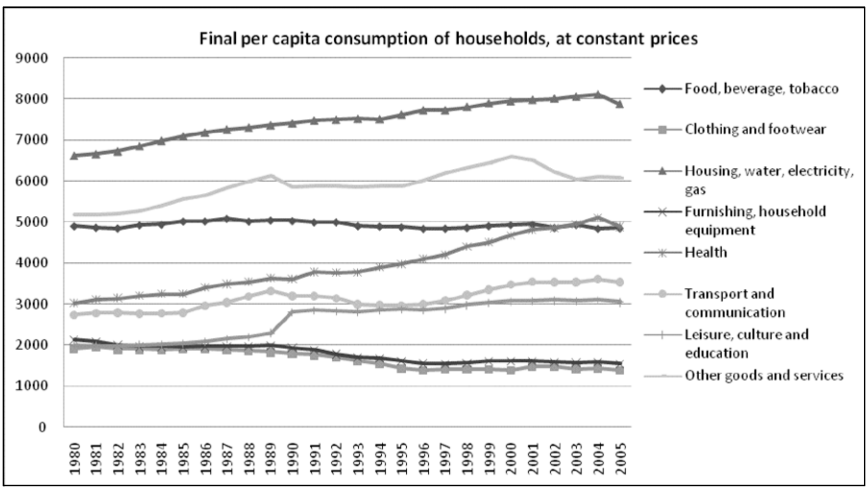
whereas two functions are very stable:
- «Furnishing, household equipment»,
- «Clothing and footwear»,

At constant prices (figure 2), we notice the following results: stability in consumption for:
- «Food, beverages, tobacco»,

an increase in consumption for:
- «Housing, water, electricity, gas»,
- «Health»,

and finally a decline in consumption for:
- «Clothing and footwear»,
- «Furnishing, household equipment».

Fig. 2. Final per capita consumption of households, at constant prices



3.2 Estimation of the systems of consumption functions

For our estimations, we introduce a time *trend (t)*, and an error term ε is added to all equations.

The additivity restriction implies that the covariance matrix is singular. Therefore, one of the demand equations is dropped from the system, the remaining ones are estimated by maximum likelihood and then the parameters of the last equation are recovered using the constraints.

1. Linear Expenditure System

$$d_{it} = p_{it}a_i + p_{it}\gamma_i t + b_i\left(y_t - \sum_{i=1}^{n} p_{it}\left(a_i + \gamma_i t\right)\right) + \varepsilon_{it}$$

In this system the error terms follow a first order autoregressive process (AR1)

$$\varepsilon_{it} = \rho\varepsilon_{i,t-1} + e_{it} \quad \text{with} \quad \varepsilon_t \sim N\left(0,\theta\right) \text{ and } \quad e_t \sim N\left(0,\Omega\right)$$

and the covariance matrix $\theta = \rho\theta\rho + \Omega$

2. Almost Ideal Demand System

$$w_{it} = a_i + \gamma_i t + \sum_{j=1}^{n} \gamma_{ij} Log\left(p_{jt}\right) + b_i Log\left(\frac{y_t}{P_t}\right) + \varepsilon_{it}$$

with $\varepsilon_t \sim N\left(0,\Omega\right)$

3. Perhaps Adequate Demand System

$$q_{it} = \left[a_i + \gamma_i\left(t\right) + b_i \cdot \left(\frac{y_t}{P_t}\right)\right] \prod_{k=1}^{n} p_{kt}^{\lambda_{ik}s_k} + \varepsilon_{it}$$

with $\varepsilon_t \sim N\left(0,\Omega\right)$

For the estimation of these systems we use the TSP software.

3.3 Results

In order to analyse the results we first consider income elasticities and then compensated price elasticities.

The income elasticity η (Table 1) allows classifying the goods into three categories with respect to its value:

η < 0 inferior goods
0< η < 1 normal good (necessity)
η > 1 superior good (luxury)

Tab. 1 Income Elasticities

Consumption functions	LES	AIDS	PADS
Food, beverage, tobacco	Normal	Normal	Normal
Clothing and footwear	Superior	Normal	Normal
Housing, water, electricity, gas	Normal	Normal	Normal
Furnishing, household equipment	Superior	Superior	Normal
Health	Normal	Normal	Inferior
Transport and communication	Superior	Superior	Superior
Leisure, culture and education	Superior	Superior	Superior
Other goods and services	Superior	Superior	Superior

As we see from Table 1, no good except one are considered as inferior, even with the AIDS and PADS which allow such a classification. The inferior good in the PADS concerns «Health», a result which seems rather confusing from an economic point of view, especially since health expenditures in the National Accounts rely to the full cost of consumption. On the other hand, «Health» is considered as normal with either LES or AIDS. As mentioned, the other goods are either necessities or luxuries. A similar classification is obtained for these functions with all three demand systems, with two exceptions: «Clothing and footwear» which is a luxury in the LES and a necessity in the other two systems and «Furnishing, household equipment» which is a luxury in the LES and AIDS and a necessity in the PADS.

When looking at compensated price elasticities (tables 2, 3 and 4), we have to distinguish between direct and cross price elasticities.

Compensated direct price elasticities have to be negative with respect to the law of demand. As we can see from the tables, compensated direct price elasticities have the expected sign for the LES (as imposed); while in the other two systems the sign of three direct compensated price elasticities is in contradiction with theory. These elasticities concern the functions

- Food, beverages and tobacco
- Housing, water, electricity, gas,

for the AIDS and PADS and

- Furnishing, household equipment, for the AIDS.

Compensated cross price elasticities ξ allow classifying goods into three categories with respect to their values:

$\xi_{ij} > 0$ *i* and *j* are pure substitutes,

Tab. 2. Compensated Price Elasticities for LES

	1	2	3	4	5	6	7	8
1	**-0,2026**	0,0288	0,0428	0,0326	0,0037	0,0061	0,0037	0,0480
2	0,0963	**-0,3897**	0,1535	0,0004	0,0583	0,0585	0,0421	0,1434
3	0,0006	0,0287	**-0,1378**	0,0320	0,0117	0,0021	0,0094	0,0274
4	0,0896	0,0065	0,1400	**-0,3384**	0,0559	0,0548	0,0405	0,1297
5	0,0671	0,0007	0,1077	0,0010	**-0,2394**	0,0407	0,0290	0,1010
6	0,0854	0,0209	0,1522	0,0256	0,0418	**-0,4245**	0,0295	0,1486
7	0,1101	0,0010	0,1768	0,0019	0,0657	0,0667	**-0,4123**	0,1658
8	0,0768	0,1285	0,0347	0,1413	0,0996	0,0574	0,0762	**-0,3727**

Tab. 3. Compensated Price Elasticities for AIDS

	1	2	3	4	5	6	7	8
1	0.1567	0.7972	-0.0852	0.4393	0.0978	-0.1105	0.0031	-0.3242
2	0.2444	-0.5857	-0.0509	-0.1072	0.0674	-0.2661	0.0828	0.0853
3	-0.1185	-0.2283	0.0031	-0.5699	0.3897	0.1760	0.1933	-0.2065
4	0.1590	-0.1103	-0.1303	-0.2737	-0.1257	0.0185	0.3917	0.0160
5	0.0951	0.2479	0.2512	-0.3183	-1.1783	-0.3549	0.5461	0.4545
6	-0.0540	-0.6147	0.0559	0.0626	-0.2964	-0.5506	0.8097	0.2100
7	0.0340	0.2014	0.0463	0.7761	0.3042	0.7036	-2.4812	0.2168
8	-0.4027	0.3889	-0.1946	0.0679	0.5809	0.3711	0.4369	-0.4215

Tab. 4. Compensated Price Elasticities for PADS

	1		2		3		4	
	AIDS	PADS	AIDS	PADS	AIDS	PADS	AIDS	PADS
1	+	+	Substitute	Substitute	Complement	Complement	Substitute	Substitute
2	Substitute	Substitute	-	-	Complement	Complement	Substitute	Complement
3	Complement	Complement	Complement	Complement	+	+	Complement	Complement
4	Substitute	Substitute	Substitute	Complement	Complement	Complement	+	-
5	Substitute	Substitute	Substitute	Substitute	Substitute	Substitute	Complement	Complement
6	Complement	Complement	Complement	Complement	Complement	Substitute	Substitute	Substitute
7	Complement	Substitute	Substitute	Substitute	Substitute	Substitute	Substitute	Substitute
8	Complement	Complement	Complement	Substitute	Substitute	Complement	Complement	Substitute

$\xi_{ij} = 0$ i and j are independent,
$\xi_{ij} < 0$ i and j are pure complements.

For the LES all compensated cross price elasticities are > 0 as expected. For the other two systems, the classification obtained with respect to substitutability or complementarity is the same, except for the links between:

- functions 1 and 7 (complements with the AIDS and substitutes with the PADS)
- functions 2 and 4 (substitutes with the AIDS and complements with the PADS)
- functions 3 and 6, (complements with the AIDS and substitutes with the PADS)
- as well as for function 8 which shows opposite classifications with almost every other function except 1, 5 and 7.

Table 5 gives a summary of these results.

Tab. 5 Substitutability or complementarity of the goods

	5		6		7		8	
	AIDS	PADS	AIDS	PADS	AIDS	PADS	AIDS	PADS
1	Substitute	Substitute	Complement	Complement	Complement	Substitute	Complement	Complement
2	Substitute	Substitute	Complement	Complement	Substitute	Substitute	Complement	Substitute
3	Substitute	Substitute	Complement	Substitute	Substitute	Substitute	Substitute	Complement
4	Complement	Complement	Substitute	Substitute	Substitute	Substitute	Complement	Substitute
5	-	-	Complement	Complement	Substitute	Substitute	Substitute	Substitute
6	Complement	Complement	-	-	Substitute	Substitute	Complement	Substitute
7	Substitute	Substitute	Substitute	Substitute	-	-	Substitute	Substitute
8	Substitute	Substitute	Complement	Substitute	Substitute	Substitute	-	-

4. *Conclusion*

In this paper, we applied three demand system specifications – the LES, AIDS and PADS – to eight consumption functions derived from the Swiss National Accounts data on personal consumption expenditures. Results confirm that each specification has some advantages and drawbacks, and none of the three systems is entirely satisfactory from all points of view. The choice of specification should therefore rely on the research focus, which may be to build a fairly aggregate model for computable general equilibrium modelling, to analyze income and price elasticities with sufficient degrees of freedom or to develop a detailed macroeconometric model for long-term forecasting.

The main advantage of the LES is the regular structure of consumption it imposes, notably with respect to negativity conditions that the other systems are only able to satisfy locally. To illustrate this, for mean values of income and prices, the law of demand does not apply for «Food» and «Housing» in both AIDS and PADS (plus «Furnishing» in AIDS).

Regularity with respect to consumer theory in LES is however obtained at the expense of flexibility in the income and price elasticities. The fact that the LES rules out inferior goods should not be seen as a major problem at this level of aggregation. In fact, no inferior good is identified by the AIDS, while the fact that «Health» appears as an inferior good in the PADS seems rather unsatisfactory, as it contradicts results generally obtained at the micro or macro level, where «Health» is often identified as a superior good.

The fact that the LES rules out pure complements appears to be more problematic, even at this level of aggregation. In fact, among the 28 pairs of goods that may be considered, 13 are identified as pure complements by the AIDS and 10 by the PADS.

If we compare compensated price elasticities between AIDS and PADS, we notice that 8 pairs of goods are considered as pure complements and 13 are considered as pure substitutes by both models, while only 7 pairs of goods change classification, among them 4 involving the residual «other goods and services» category. These results in terms of complementarity or substitutability may therefore be considered as fairly robust towards the choice of specification (LES is of course ruled out from this comparison).

Moving to income elasticities, we notice that the classification of goods is the same in the three models for five goods over eight, which is rather satisfactory. Of the remaining goods, «Clothing» is identified as a luxury by LES only, «Furnishing» as a necessity by PADS only and, as mentioned, «Health» as an inferior good by PADS only, and no other difference is present.

To conclude, as the Swiss Statistical Office is preparing new series with more disaggregated date, we plan to re-estimate the three systems to see if some non-satisfactory results, notably with respect to the law of demand, are due to the data.

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INTERNATIONAL TRADE

LINKING A SIMPLE INFORUM MODEL AS A SATELLITE TO THE BTM. THE CASE OF AEIOU

Josef Richter[1], *Reelika Parve*[2]

1. Introduction

The models of the INFORUM family are linked together with a Bilateral Trade Model (BTM) via foreign demand and prices. This linking mechanism on commodity detail is one of the outstanding features of the international consortium of INFORUM models. It guarantees that the results of model simulations are not only consistent on the national but also on the international level.

This paper gives a short description on how the simple Austrian INFORUM model AEIOU was linked to the BTM as a kind of satellite. Information on demand for Austrian exports and on Austrian import prices was derived from the BTM system for arriving at scenarios for Austria, without considering any feedback from the Austrian economy to the BTM system.

This exercise was carried out on the basis of experience gained with linking a previous Austrian INFORUM model to the INFORUM consortium of models (s. Richter 1991). Similar experience was available in Italy: in its early stage of development INTIMO (Interindustry Italian Model), the INFORUM model for Italy, also started as a satellite. In this phase, Italy took the advantage of being ready to be hosted in the INFORUM international link model. Import and export prices as well as sectoral foreign demand, incorporating the forecast generated by the country models, were made available to the Italian team so that INTIMO could start on as a 'stand alone' model on the basis of very meaningful exogenous variables for foreign trade relationships.

The paper gives a very short outline of the present stage of the Austrian model and describes the linking process in some detail. The description of this semi-final stage seems necessary to underline why the option 'satellite' was chosen instead of 'full linkage'. The final chapter is devoted to a discus-

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sion of the advantages and limitations of a satellite approach. We hope that model builders in other countries – and in small open countries in particular – might benefit from the experience gained with the Austrian model.

2. AEIOU in its present stage

AEIOU is a typical INFORUM model in its infant stage of development. It is based on a bottom-up philosophy and makes utmost use of all empirical evidence available in Austria.

Work on the new Austrian model started in 2005 and was made possible by grant 11,144 from the *Oesterreichische Nationalbank* (Austrian National Bank). This phase of the development was finished early in 2007[3].

2.1 Accounting framework

The disaggregation is by 56 industries and 56 groups of commodities. The clear distinction between industries and commodities is made throughout the entire model.

In final demand three categories of private consumption, two of government consumption and 15 categories of capital formation are distinguished explicitly[4]. Value added is broken down into six components.

Empirically the starting point for AEIOU is the Austrian input-output table according to the make-use system for the year 2001. The valuation concept takes care of the distinction between basic prices and purchasing prices. This implies that equations for components of final demand must be formulated in purchasing prices and the estimated results transformed into basic prices. This procedure guarantees that trade and transport margins, commodity taxes and commodity subsidies are all properly accounted for. Institutional accounts have been aggregated into three sectors: households, enterprises, and government.

AEIOU takes economic data very seriously. Much attention was paid to the theoretical foundations on which the data generating process (and the compilation of the national accounts in particular) are based.

[3] In this stage the Institute for Industrial Research, Vienna, provided the organizational background. Bernhard Böhm (University of Technology, Vienna) was the project leader, Josef Richter (University of Innsbruck) the continuous element in the work. Without the substantial contributions of Clopper Almon and Maurizio Grassini it would have been impossible to get started. Reelika Parve offered so much advice and wrote so many substantial parts of the computer code, that she has to be considered co-author of the project.

[4] The considerations which led to this specific form of disaggregation are described in some detail in Böhm, Richter (2007).

The essential set of product-to-product tables was derived relying on hybrid technology assumptions, but primarily using a slightly modified version of the Almon purification approach (Almon 2000)[5].

Because Statistics Austria provided no time series at constant prices of a given base year, such series (base year 2001) had to been calculated starting from chain-linked indices. Unfortunately (and quite surprisingly) Austrian national accounts do not provide price data by groups of commodities (CPA). The only time series for domestic prices can be derived indirectly from the times series of total output in current and the ones at constant prices.

If calculated in a correct way, the 'price' of the output of an industry can be seen as the weighted sum of the prices of the commodities produced by this specific industry. In matrix notation the relation can be written as:

$$pdm * C = pind \quad (1)$$

pdm stands for the vector of domestic prices by groups of commodities (CPA) and C is the product-mix matrix derived from the make-matrix V by:

$$C = V' * Outdiag^{-1} \quad (2)$$

by dividing the elements of the transposed make-matrix by the output vector. *Outdiag* stands for the diagonalized output vector by industries.

In the Austrian case time series for output prices *pind* by industries (NACE) were available. They were transformed by using the relations of the C matrix of 2001 by:

$$pdm_t = pind_t * C^{-1} \quad (3)$$

In this process C was assumed to remain constant over time, which is of course a simplification. To have domestic prices by commodities was an important step for the estimation of relative prices and their use in the import share equations.

2.2 Behavioral relationships

At the moment, private consumption, capital formation, employment and imports are endogenized by means of econometrically estimated sets

[5] For a detailed description of the estimation of a consistent set of matrices, see Koller (2007).

of equations. For most of the equations time series covering the period 1976 to 2004 were available. In the following paragraphs a very short description is given for some of the blocks[6].

2.2.1 Private consumption

In the underlying input-output table private consumer expenditures (PCE) are shown according to a domestic concept. Consumer expenditures of foreign tourists in Austria are included while consumer expenditures of Austrians abroad are excluded.

For modelling purposes domestic PCE are broken down by three different categories:

- National residents (Austrians in Austria);
- Foreigners (Tourism);
- Private non profit institutions.

Two main considerations stand behind the distinction between PCE by Austrian residents and PCE by tourists. Disposable income of Austrian residents is the main driving force behind consumer expenditures of Austrian in Austria and abroad. The expenditures of foreign tourists in Austria however are affected by the income situation in the countries of their origin and by the competitive position of Austria compared to other destinations of tourists. The other motivation behind this distinction is the entirely different commodity composition of these two categories.

At the moment, behavioral equations exist for private household consumption of Austrian residents only. They are estimated in a disaggregation by 37 COICOP groups of expenditures. In addition consumption expenditures of Austrian residents abroad (no distinction by commodities) were estimated as a complementary item. The estimation was done in purchasers' prices, the only relevant valuation concept for consumer decisions. The main explanatory variables are:

Total consumer expenditures including expenditures of Austrian residents abroad;

Prices of the individual COICOP categories relative to the price of total consumer expenditures;

Prices of the individual COICOP categories relative to the price of subgroups of competitive consumer expenditures.

The resulting vector of consumer expenditures in purchasers' prices by COICOP categories is then transformed into a vector of consumer expenditures in purchasers' prices by commodities (CPA). In a sec-

[6] For a more detailed version, see Böhm, Richter (2007).

ond step, the vector in purchasers' prices is transformed into a vector in producers' prices, allocating the commodity specific trade margins to the three trade commodities (CPA 50 «Trade and repair services of motor vehicles etc», CPA 51 «Wholesale and comm. trade services, ex. of motor vehicles» and CPA 52 «Retail trade services, repair services, ex. of motor vehicles»), five commodities of transport services (CPA 60 and 61 «Land and water transport and transport via pipeline services», CPA 62 «Air transport services», CPA 63 «Supporting transport services and travel agency services», CPA 64 «Post and telecommunication services» and CPA 66 «Insurance and pension funding services» because of transport related insurance) commodity taxes and commodity subsidies, compatible with the valuation concept of the basic input-output identities.

At the present, the consumption expenditures of foreign tourist in Austria and those of private non profit institutions are treated exogenously.

2.2.2 Capital formation

For each of the 15 categories of capital formation mentioned before a specific investment equation was estimated. The main explanatory variables are:

- Total output of the investing industry (or groups of industries);
- User costs of capital;
- Output prices.

The resulting global demand for investment is then split up into commodity specific demand (valued at purchasers' prices) using 15 specific bridge matrices. Then six specific valuation transformation matrices (for residential buildings, for other buildings, for machinery and for equipment, for transport equipment, for livestock and one for intangible fixed assets) are applied to arrive at a valuation in producers' prices.

2.2.3 Exports of merchandise goods

The future demand for Austrian exports for the 29 commodity groups (CPA)[7] was directly taken from the BTM results after aggregating the available 120 BTM categories (see Chapter 3).

[7] In fact there are only 28 groups of merchandise exports, since there are no merchandise exports of «Recovered secondary raw materials».

The valuation of merchandise exports is the same as in the foreign trade statistics. A specific transformation matrix is applied to arrive at a valuation in producers' prices.

2.2.4 Exports of other commodities (services)

The (very small) statistical discrepancies between foreign trade statistics and the base tables were allocated to exports of services.

Calculation starts from an exogenously given total which is disaggregated by means of a specific bridge matrix in order to arrive at the commodity detail in producers' prices.

2.2.5 Imports of merchandise goods

As already mentioned, a distinction is made between merchandise imports and imports of services. The 29 commodity groups of merchandise imports are modelled with the help of 27[8] import share equations.

In order to integrate AEIOU as quickly as possible into the international consortium of INFORUM models, imports by groups of commodities are modelled in a way which is already used in many INFORUM models. The basic consideration behind this approach is to model the development of the import share (the share of imports in total demand) as a function of relative prices (prices of imported goods\prices of domestic goods) and a specific trend, called the «Nyhus-trend» (Nyhus, Wang 1996).

In a later stage, a more detailed approach could be considered in analogy to the procedure already chosen in previous Austrian INFORUM models (Richter 1991). In this approach, use is made of the information contained in the detailed import matrices for intermediate demand and final use.

The import shares imps (i) of commodity group i (CPA) are defined as:

$$imps_i = \frac{imp_i}{Supply_i + imp_i} \tag{4}$$

The standard specification of the import share equations is:

[8] Only 27 import equations because there are no merchandise imports of «Recovered secondary raw materials» and import of electricity is treated exogenously.

$$imps_i = f\left(\frac{pim_i}{pdm_i}, NT_i\right) \qquad (5)$$

NT (i) stands for the logistic Nyhus-trend.

In a few cases, soft constraints were added into the estimation process of the parameters. For some commodity groups it was necessary to fix the level of domestic output and to treat import demand as a residual. This approach was chosen for the following commodity groups: CPA 10 «Coal and ores», CPA 11 + CPA 13 «Crude oil» and CPA 30 «Office machinery and computers». In all three cases the import share imps (i) as defined in equation (4) is 80% or even more. Domestic production in Austria is very low and there are obvious capacity constraints. All additional domestic demand has to be met by imports.

As mentioned before, consumption expenditures of Austrian residents abroad do not show up in the input-output table (and AEIOU). Consequently there was no need to model them in the import block.

2.2.6 Imports of other commodities (services)

The (very small) statistical discrepancies between foreign trade statistics and the base tables were again aggregated with imports of services.

The exogenously given total is disaggregated by means of a specific bridge matrix in order to arrive at the commodity detail in producers' prices.

Since domestic supply is a function of the technology matrix A and final demand minus imports, imports and supply have to be calculated simultaneously. The standard INFORUM software offers a version of the Seidel process that computes in an iterative way imports simultaneously with supply (Almon 1996).

2.3 Major deficits

In its present stage, many components of final demand are already explained by econometrically estimated equations. Only total expenditures of tourists in Austria, total consumption of private non profit organization, total government consumption, inventory changes, and exports of services and imports of services are treated exogenously. These exogenous assumptions can easily be replaced by either simple global behavioral equations or sets of equations on the level of commodity detail.

Some work has been devoted to the estimation of a simple accountant to link private consumer expenditures of Austrian households to the income generated in the various industries, taking the process of redistribution of income into account. A lot of work remains to be done in this respect.

What has not yet been implemented is the price side of the model although some steps in order to arrive at a well elaborated price model have however already been taken. The estimation of wage equations by industries is the most important one in this context.

Currently domestic prices are treated exogenously. Future prices are based on simple trend extrapolations. The lack of a price model and the absence of other relevant variables like investment by industries or capital stock by industries are the main reasons why it was by far too early to consider full linking with the help of the BTM model.

3. Adapting the BTM Scenario

3.1 Bridge BTM classification – European Standard Product Classification CPA

The Bilateral Trade Model of INFORUM uses its own 'special' classification where products classified according to the United Nation's SITC (Standard International Trade Classification) Revision 3 are aggregated into 120 groups of products using Ma's (1996) scheme. This wide sectoral disaggregation is suitable to make deep trade analysis at commodity level. As this information had to be linked to an EU country model based on the European standard classification, CPA (Classification of Products by Activity) with 'only' 60 groups of merchandises and services[9], we had to aggregate 120 trade groups in some reasonable way providing a concordance between BTM trade groups and CPA.

Given that no correspondence table exists between Ma's classification and European Union's CPA, we had to produce it by ourselves going through several steps. As already mentioned the BTM uses Statistics Canada trade data classified by SITC. So the first step was quite natural one: the Ma's table on the «Concordance between Trade Sector and SITC Revision 3» was used to find out a corresponding CN (Combined Nomenclature) code for each single commodity code by SITC Rev.3. As the second stage, the conversion table between CN and CPA permitted us to obtain the definitive table at desired aggregation level[10].

The only major problem involved was that no direct correspondence in the BTM classification was found for CPA 37 «Secondary raw mate-

[9] A half of these commodity groups concerns goods.

[10] These last two correspondence tables are available on the Eurostat's Metadata Server, RAMON: <http://ec.europa.eu/eurostat/ramon/relations/index.cfm?TargetUrl=LST_REL>.

Fig. 1. Aggregation Scheme

BTM (120 trade groups) ↔ SITC Revision 3
↓
CN (8 digits)
↓
CPA (6 digits)
↓
CPA (2 digits)

rials» (commodity group 28 in AEIOU). This group includes the following goods:

- CPA 371010 Metal secondary raw materials;
- CPA 371020 Ship-breaking services;
- CPA 372010 Non-metal secondary raw materials.

With the exception of the second one (CPA 371020 ↔ BTM103 «Shipbuilding and repairing») no correspondence was found.

The export forecast and prices for the AEIOU come from the BTM run of September 2006.

Goods

Exports and imports of goods are aggregated according to the correspondence table BTM120-CPA60 in order to get 29 product groups instead of the original 120. In the Austrian model, there are 29 commodity groups instead of the usual 32:

- CPA 11 «Crude petroleum and natural gas», CPA 12 «Uranium and thorium ores», CPA 13 «Metal ores» are aggregated into one group;
- CPA 05 «Fish products» are added to CPA 01 «Products of agriculture», as the fish products do not represent a relevant order of magnitude in the Austrian economy.

Prices

In order to get import prices, the first step was to calculate nominal and real values for the 29 CPA groups we were interested in. It means that, as the forecasts are expressed in constant USD, we had to calculate nominal values of the traded goods at detailed level by multiplying each BTM commodity group by its price.

4. Linking AEIOU as a satellite to BTM. Necessary adaptations and indexing

As already mentioned in the introduction, the 'satellite status' is characterized by the fact that information on demand for Austrian exports and on Austrian import prices are derived from the BTM system, without considering any feedback from the Austrian economy to the BTM system. The following paragraphs describe the technical aspects of this linking process.

4.1 Merchandise exports

The time series for Austrian exports in constant US $ from the adapted BTM run were indexed to 2004 = 1. 2004 is the last year for which historical data for Austrian exports by CPA categories are available. The indices were then linked to the historical series and led directly to exogenous estimates for Austrian exports by CPA categories.

4.2 Merchandise imports

Merchandise imports were estimated on the basis of the import share equations mentioned above. The time series for the import prices *pim* (i) for the forecasting period were again derived from the BTM simulation. Because import prices in the BTM are expressed in US $ whereas the import prices in the Austrian model are expressed in EURO, an adaptation for the exchange rate US $/EURO became necessary. After this adjustment, the series for import prices were again indexed to 2004 = 1 and linked to the historical time series for Austrian import prices.

With the exception of the exchange rate adaptation, the procedure was analogous to the one for merchandise exports.

5. Is the assumption of a one – way dependency justified? Empirical evidence from the BTM

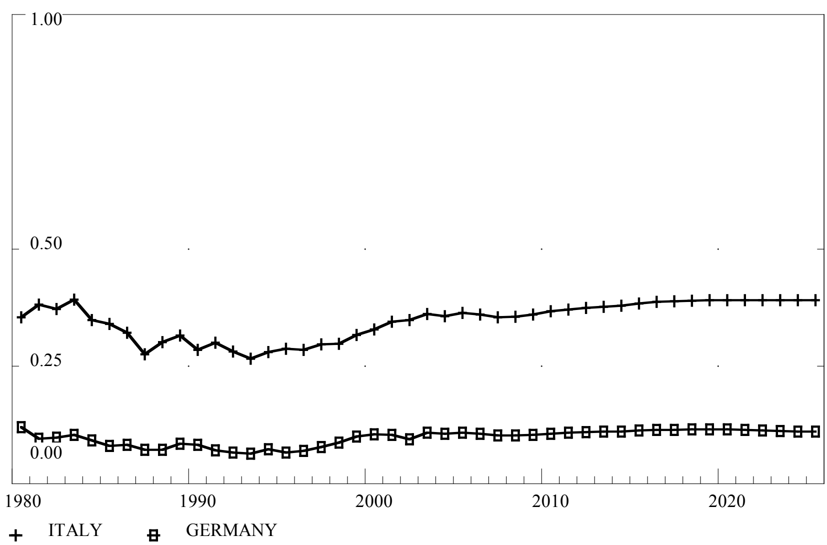
5.1 The case of Austria

The omission of feedback effects can be justified if a pronounced one-way dependency can be assumed, i.e. if Austrian exports are dependent on import demand of the countries in the BTM system, whereas the exports of no country in the BTM system depend on Austrian import demand in a significant way. The same one-way dependency should be given with respect to prices.

Empirical evidence can be derived from the data in the BTM system to illustrate to which extent this set of assumptions is acceptable. The first way for doing this is just looking at the Austrian shares in the imports in countries included in the BTM system. In order to investigate the Austrian market shares, the latest BTM forecast was aggregated into 29 CPA merchandise categories.

The only two countries where Austrian goods play a significant role are Germany and Italy. But even in this case we have to bear in mind that the Austrian share in their home market is likely to be very small, of course with some exemptions. Two product groups where Austria appears to be a relevant trading partner are CPA 02 «Products of forestry» and CPA 20 «Wood and Wood products».

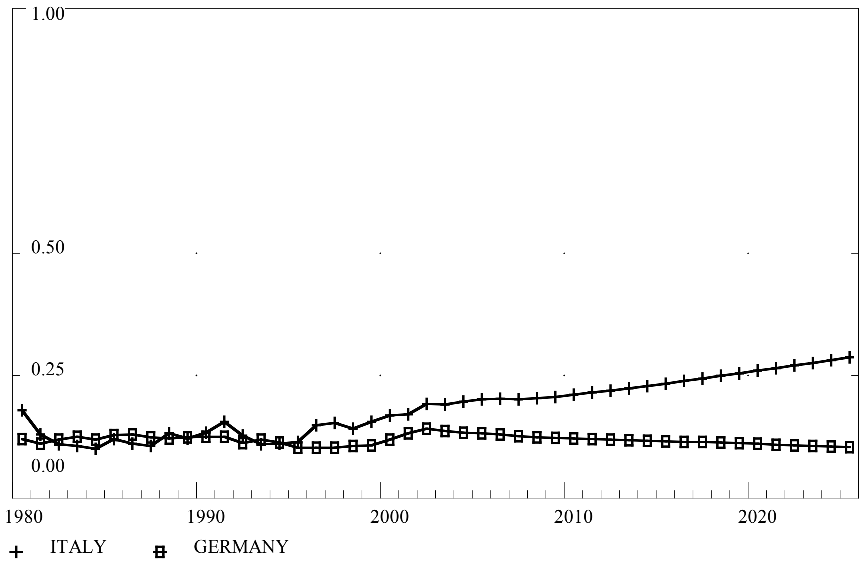
Fig. 2. The share of Austria on the Italian and German markets of Forestry products (CPA 02)



For some other products only Germany seems to be an important destination for Austrian goods: CPA 21 «Pulp, paper and paper products», CPA 22 «Printed matter and recorded media», CPA 40 «Electrical energy». As can be seen from Table 1 from an Austrian perspective the shares of these commodity groups in total exports are quite low.

Another important aspect is that the production of forestry products and the production of wood and products of wood are primarily based on inputs produced in Austria, i.e. the total import content of these com-

Fig. 3. The share of Austria on the Italian and German markets of Wood and Wood products (CPA 20)



Tab. 1. The most important commodity groups of Austrian exports in 2001 seen from the perspective of imports in countries included in the BTM system

CPA		Share in total Austrian exports (in %)
02	Products of forestry	0.11
20	Wood and products of wood	3.34
21	Pulp, paper and paper products	4.88
22	Printed matter and recorded media	2.08
40	Electrical energy	1.25

modities is very low. Consequently, any increase or decrease in exports of these commodities only will lead to a very small change in the import demand of Austria, which therefore can be neglected.

On the other hand, the most important commodity groups for Austrian exports (see Table 2) play only a little role seen from the perspective of the importing countries represented in the BTM system.

The production of these commodities in Austria relies on imported inputs considerably, both directly (imported parts, components) and indirectly. Even if the production of Austrian machinery or Austrian vehicles is based on domestically produced steel, this steel was manufactured on the

Tab. 2. The most important commodity groups of Austrian exports in 2001

CPA		Share in total Austrian exports (in %)
29	Machinery and equipment n..c.	13.76
34	Motor vehicles, trailers and semi-trailers	13.40
24	Chemicals, chemical products	8.78
27	Basic metals	7.38
32	Radio, TV and communication equipment	6.70

basis of imported ore and coal. Any change in the export performance of commodities such as machinery will thus – in reality – lead to a change in the Austrian import demand. The Austrian share in import demand of vehicles in the BTM system (see Figure 5) is quite low, so no big distortions must be expected. More serious effects can result in the case of machinery. As might be seen from Figure 4 Austria is one of the most important German trading partners (after Italy) with a market share approximately equal to 10%. In all the other BTM countries, the Austrian share appears to be low. The omission of feedback effects of the Austrian-German trade in machinery may cause serious limitations for the use of the Austrian model especially for some specific kinds of policy simulations.

Fig. 4. The share of Austria on the Italian and German markets of Machinery and Equipment (CPA 29)

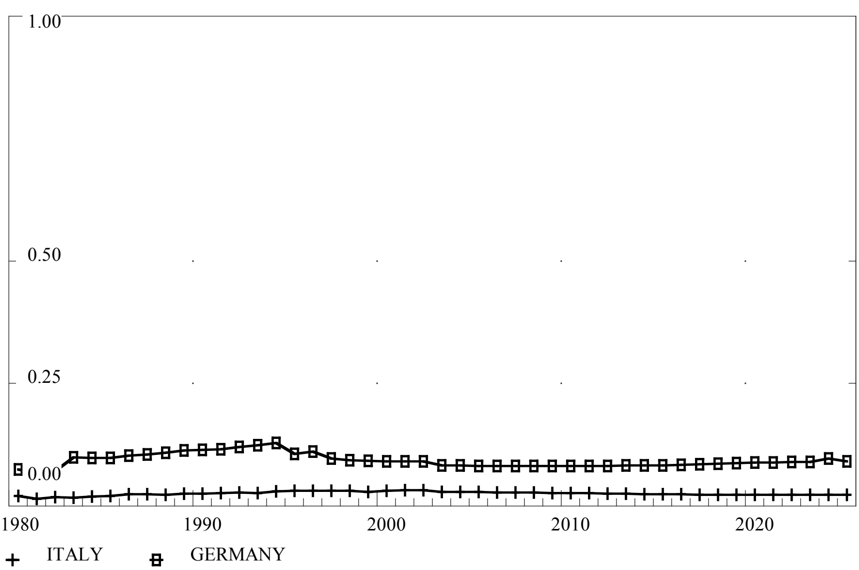
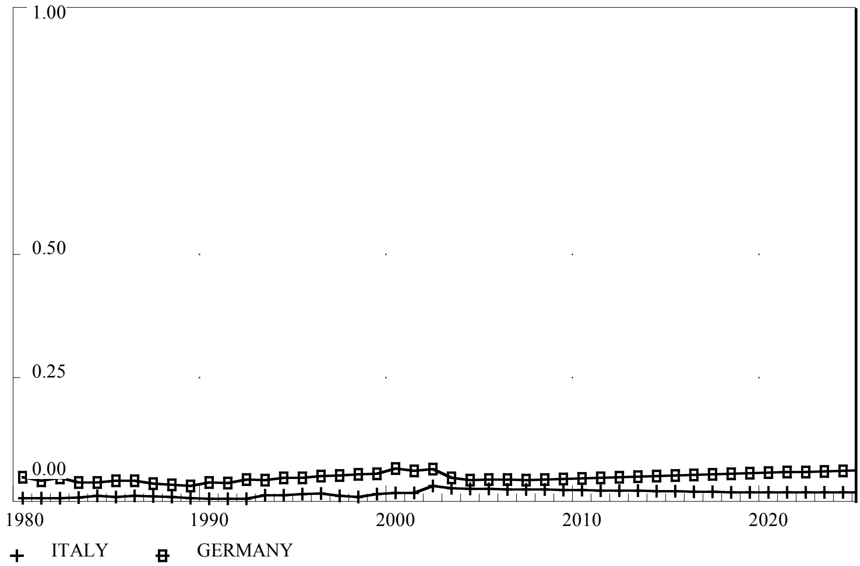


Fig. 5. The share of Austria on the Italian and German markets of Vehicles (CPA 34)



To conclude, it seems that the only countries able to 'distort' to some amount our results because of the lack of any feedback from other countries are, mainly, Germany and, to some extent also Italy. The size of these distortions produced by lacked consideration of changes in foreign demand depends clearly on the pattern of Austrian specialization, i.e. whether or not those merchandises absorb a significant amount of the Austrian total foreign trade.

5.2 The case of other small countries

The satellite approach can fruitfully be adopted for other small countries, like Estonia, Latvia, Poland as well as other new European Union member States, which are able to influence the global trade even less than Austria. Please note that the following empirical examples come from the bilateral trade database for the European Union while the forecasts for Austria are taken from BTM. For a detailed description see Grassini, Parve (2006).

For example, we can look at Estonia[11] and observe its market shares in

[11] Last May, the model for Estonia was updated to the base year 2000. Its current stage is definitely more infant than the present version of AEIOU. The data situation in Estonia is certainly better as in Latvia, even if some time series are still missing (private

the countries of BTM system. As Estonian exports are primarily oriented to the European Unions' markets, we can ignore US and other extra-European countries. Currently, Estonian market shares do not reach 1 per cent in any EU country of BTM system, with the exception of CPA 20 «Wood and wood products» which account for approximately 3 per cent in Denmark (see tables 4a-4e)[12]. Latvia faces almost the same situation.

Tab. 3. Estonian 5 most important export articles (by CPA, in % on total merchandise exports)

32	Radio, TV and communication equipment	26.0
20	Wood and products of wood	10.5
15	Food products and beverages	8.1
17	Textiles	6.9
18	Wearing apparel; furs	6.9
	Total	58.4

Tab. 4. Estonian market shares for its most important export articles in the BTM European countries (%)

a)		CPA 32 - Radio-TV and Telecommunication Equipment										
		1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	at	0.001	0.000	0.000	0.001	0.003	0.000	0.001	0.016	0.041	0.005	0.003
2	be	0.000	0.000	0.000	0.012	0.000	0.000	0.005	0.002	0.029	0.007	0.018
5	de	0.001	0.010	0.017	0.009	0.085	0.213	0.040	0.150	0.222	0.199	0.105
6	dk	0.028	0.045	0.035	0.027	0.033	0.050	0.051	0.052	0.021	0.041	0.042
8	es	0.000	0.000	0.000	0.000	0.041	0.029	0.002	0.000	0.006	0.003	0.008
10	fr	0.000	0.000	0.004	0.002	0.000	0.004	0.005	0.003	0.039	0.002	0.000
11	gb	0.000	0.000	0.001	0.004	0.003	0.008	0.028	0.006	0.018	0.023	0.006
15	it	0.000	0.000	0.000	0.002	0.000	0.007	0.000	0.000	0.017	0.005	0.001
b)		CPA 20 - Wood and Wood products										
		1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	at	0.047	0.023	0.035	0.025	0.009	0.026	0.052	0.128	0.176	0.120	0.082
2	be	0.004	0.089	0.082	0.117	0.245	0.214	0.233	0.193	0.188	0.240	0.269
5	de	0.340	0.378	0.397	0.375	0.563	0.579	0.684	0.843	1.005	0.876	0.844

(continued)

consumption at constant prices, output at constant prices) and some other series are extremely short. However, there is good chance to improve the current version thanks to a partnership with a Central Banks team working on some special issues, like labor demand and so on.

[12] Main trading partners of Estonia are Finland and Sweden.

6	dk	0.449	1.082	2.202	1.583	1.744	2.249	2.914	2.799	3.281	3.088	2.743
8	es	0.000	0.000	0.012	0.060	0.025	0.079	0.084	0.099	0.123	0.147	0.187
10	fr	0.051	0.115	0.186	0.220	0.229	0.203	0.173	0.236	0.252	0.222	0.153
11	gb	0.416	0.361	0.346	0.347	0.327	0.245	0.272	0.335	0.295	0.403	0.552
15	it	0.110	0.148	0.334	0.357	0.386	0.234	0.285	0.326	0.419	0.316	0.343
c)		CPA 15 – Food and beverages										
		1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	at	0.002	0.001	0.001	0.000	0.002	0.004	0.007	0.015	0.010	0.020	0.017
2	be	0.001	0.002	0.008	0.007	0.006	0.011	0.003	0.010	0.010	0.050	0.007
5	de	0.013	0.013	0.035	0.028	0.024	0.042	0.054	0.093	0.136	0.096	0.109
6	dk	0.030	0.052	0.043	0.040	0.110	0.153	0.162	0.177	0.173	0.181	0.165
8	es	0.000	0.000	0.000	0.000	0.000	0.007	0.013	0.026	0.015	0.034	0.019
10	fr	0.002	0.003	0.007	0.005	0.005	0.008	0.013	0.010	0.014	0.037	0.021
11	gb	0.002	0.001	0.013	0.016	0.003	0.000	0.003	0.001	0.004	0.001	0.015
15	it	0.000	0.000	0.000	0.001	0.000	0.001	0.002	0.001	0.002	0.024	0.048
d)		CPA 17 – Textiles										
		1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	at	0.000	0.000	0.005	0.026	0.052	0.118	0.086	0.060	0.096	0.091	0.064
2	be	0.089	0.242	0.299	0.215	0.136	0.190	0.172	0.143	0.121	0.126	0.100
5	de	0.109	0.157	0.182	0.215	0.233	0.273	0.309	0.336	0.389	0.263	0.218
6	dk	0.212	0.310	0.402	0.364	0.383	0.482	0.682	0.685	0.734	0.617	0.547
8	es	0.003	0.016	0.081	0.039	0.024	0.042	0.019	0.151	0.055	0.017	0.013
10	fr	0.010	0.027	0.077	0.076	0.059	0.058	0.051	0.039	0.047	0.097	0.118
11	gb	0.066	0.133	0.164	0.237	0.299	0.449	0.594	0.632	0.528	0.397	0.356
15	it	0.037	0.080	0.080	0.073	0.078	0.121	0.151	0.173	0.213	0.153	0.069
e)		CPA 18 – Wearing apparel										
		1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	at	0.001	0.007	0.014	0.056	0.015	0.008	0.009	0.008	0.006	0.013	0.014
2	be	0.001	0.001	0.000	0.001	0.000	0.001	0.000	0.000	0.000	0.001	0.000
5	de	0.058	0.052	0.047	0.033	0.027	0.038	0.049	0.056	0.074	0.059	0.046
6	dk	0.024	0.017	0.022	0.078	0.111	0.166	0.237	0.204	0.252	0.169	0.101
8	es	0.000	0.000	0.000	0.001	0.000	0.002	0.000	0.000	0.000	0.000	0.000
10	fr	0.000	0.000	0.000	0.004	0.000	0.001	0.001	0.000	0.000	0.002	0.002
11	gb	0.006	0.016	0.022	0.023	0.017	0.028	0.038	0.037	0.041	0.034	0.018
15	it	0.006	0.018	0.008	0.015	0.022	0.023	0.022	0.017	0.033	0.015	0.004

The case of Poland (see tables 5 and 6a–6d) is somewhat different. In a number of product groups (Coal, Textiles) Poland appears to be a relevant trade partner for several European countries: for example, about 20 per cent of German total coal imports come from Poland. In some trading groups country-specific relationship can be found: for instance this is the case of Polish-Italian intensive trade activity in the commodity group CPA 34 «Motor vehicles» due to industry specific investments[13]. Similarly to Austria, the main source of distortion becomes the omission of Polish-German trade relations. However, even in this case, a 'satellite approach' can be a useful starting-point for a country-model construction and first simulation exercises.

Tab. 5. The 5 most important export articles in Poland, in 2000 (by CPA; % on total exports of merchandises)

34	Motor vehicles, trailers and semi-trailers	11.9
27	Basic metals	8.4
15	Food products and beverages	7.1
36	Furniture; other manufactured goods n.e.c.	7.0
17	Textiles	6.5
	Total	40.9

Tab. 6. Polish market shares in the European BTM countries (%)

a)		CPA 02 - Forestry										
		1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	at	2.42	2.59	2.00	1.80	1.54	1.95	1.87	3.51	4.75	4.16	2.90
2	be	1.60	1.07	1.10	1.09	0.97	1.02	1.11	1.43	1.94	1.92	2.01
5	de	6.77	5.70	5.96	6.10	6.05	5.63	5.56	5.82	7.26	5.84	4.38
6	dk	3.06	1.85	1.73	2.02	2.08	1.75	2.12	2.40	3.13	3.25	3.76
8	es	0.33	0.45	0.59	0.47	0.81	1.19	1.04	1.54	1.61	1.32	1.60
10	fr	0.29	0.41	0.32	0.40	0.61	0.91	0.92	0.89	0.78	0.88	0.93
11	gb	0.45	0.10	0.26	0.17	0.17	0.19	0.16	0.21	0.35	0.43	0.50
15	it	0.80	1.13	1.12	1.20	1.23	1.22	0.98	0.91	1.01	0.83	0.95
b)		CPA 10 - Coal, lignite; peat										
		1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	at	29.25	32.56	41.82	43.93	44.09	49.18	50.95	50.48	46.94	51.80	43.12
2	be	2.85	2.60	1.76	2.41	1.85	0.99	3.28	3.50	0.20	3.14	3.91
5	de	16.28	15.95	16.17	16.91	19.89	19.39	22.41	19.91	20.22	17.62	17.75

(continued)

[13] FIAT, Italian Automobile industry, invested a lot in Polish automobile sector: and as a matter of fact, some types of FIAT cars are now produced only in Poland ('new' Panda, Fiat500).

6	dk	24.84	20.98	19.16	30.68	35.29	33.49	29.99	35.23	8.83	10.70	10.56
8	es	0.45	0.47	2.52	2.18	2.68	1.44	1.56	1.21	0.19	1.15	0.96
10	fr	4.72	6.58	5.06	8.29	3.94	4.93	3.43	3.81	2.51	2.64	4.68
11	gb	7.65	1.32	1.76	0.71	3.27	4.32	3.62	4.80	4.65	3.05	1.53
15	it	1.53	1.09	1.15	0.72	2.19	4.03	1.20	2.42	0.26	0.01	2.11
c)		CPA 20 - Wood and wood products										
		1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	at	1.71	1.57	1.61	1.58	2.19	3.25	3.96	4.86	5.49	4.03	3.03
2	be	2.70	2.69	2.76	2.76	2.78	2.74	3.04	3.47	4.67	4.25	3.52
5	de	9.65	9.90	10.89	11.81	13.33	13.07	14.35	14.69	16.03	12.97	11.02
6	dk	5.77	5.00	4.23	4.44	6.17	5.97	6.14	8.35	9.32	9.43	9.85
8	es	0.32	0.72	1.09	1.11	1.47	1.28	1.33	2.19	2.53	2.97	3.49
10	fr	2.13	2.15	2.54	2.74	3.01	3.41	3.23	3.57	3.51	3.68	5.45
11	gb	0.79	1.09	1.26	1.79	2.33	2.63	2.68	2.81	2.76	3.25	3.40
15	it	1.01	1.15	1.41	1.84	2.36	2.06	1.91	1.79	1.95	2.12	2.59
d)		CPA 36 - Furniture; Other manufactured goods n.e.c.										
		1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	at	1.36	1.41	1.35	1.35	1.54	1.50	1.59	1.94	2.32	1.86	1.63
2	be	0.11	0.18	0.30	0.40	0.49	0.68	1.11	1.08	1.22	0.94	0.99
5	de	5.27	5.34	5.69	5.90	6.96	3.52	7.81	7.93	9.33	8.77	7.83
6	dk	1.87	1.94	2.28	3.03	2.66	3.15	4.54	3.11	3.45	2.71	3.02
8	es	0.71	0.26	0.39	0.34	0.28	0.19	0.22	0.37	0.50	0.65	0.66
10	fr	0.51	0.56	0.75	0.72	0.82	0.82	1.01	1.78	2.17	2.47	3.12
11	gb	0.17	0.18	0.20	0.20	0.30	0.39	0.59	0.76	0.98	1.17	1.13
15	it	0.33	0.29	0.34	0.34	0.45	0.49	0.47	0.55	0.75	0.51	0.75

6. Conclusions

This paper gives a short description on how the Austrian INFORUM model AEIOU in its early stage of development was linked to the BTM system as a satellite. It also raises the question whether the assumption of a one-way dependency which is the central idea behind the satellite approach can be justified.

The answer to the latter question will depend on whether we have the results of the entire BTM system in mind or the results of the satellite model. Seen from the perspective of the BTM system, the omission of feedback effects from countries of the size and the export structure of Austria seem to be quite acceptable. The distortions will be very small in size and limited to few commodity groups.

Seen from the perspective of the national model, the satellite approach can also be fully justified if the model is used for what might be called a 'standard forecasting exercise'. In such a situation the BTM results provide a perfect background scenario. Exports can be modelled as a direct function of the imports of other countries, import prices also can be taken from the system. Since these estimates are coming from the BTM, they are mutually consistent.

Limitations may occur in the case of policy simulations on the national level. On the one hand, the satellite status provides a lot of flexibility. «As soon as the results of the BTM are available, the satellite can stand alone» (Richter 1991: 71). A whole range of very useful scenarios can be calculated without the necessity to run the entire system.

The following policy analysis can be seen as a good example of such a simulation. In 2007 AEIOU was used to asses the impact of a moderate shift in public expenditure from general government (technical speaking from public consumption – collective consumption) to more health related public expenditures (technical speaking to public consumption – individual consumption). The fact that the model is still a stand-alone model does probably do no harm to a policy analysis of this kind.

On the other hand, a policy simulation assuming effects on the prices of domestic production and thus changes in the competitive position of the various tradable commodities in the domestic and international markets cannot be carried out without considerable loss of consistency. In such a simulation important feedback effects are ignored. Analyses of this type require a fully integrated system.

The evaluation of the EU enlargement effects on Italy with a stand-alone model and with the full system has clearly shown the shortcomings of a satellite approach for this kind of policy simulations. In two studies by Bardazzi and Grassini (2003; 2004) the effect of the direct Italy-CEEC relationship with regard to trade with Italy and the influence on Italy obtained from the more significant impact of the EU15-CEEC trade were compared.

In the first case, two countries, Italy and the CEEC were considered; in the second one, there were two countries – EU15 and CEEC –, with Italy constituting a single region of the EU. This second alternative permitted to measure the indirect effect of the Eastern European enlargement on Italy. Furthermore, there was a third option where the trend in the composition of the CEEC imports was taken into account. This experiment provided evidence that in the case of Italy – which whilst it is not on the Eastern EU border is nevertheless not far from it – the indirect impact on the GDP growth rate resulted to be even more important than the direct one. The transmission of the increase generated by enlargement appeared to be as important as the direct trade with the new entrants. Since the effect of the rising exports induced by a growing demand for goods by the CEEC was preserved along the simulation period, it was shown that the increase was doubled by the indirect effect and that the specialization in CEEC imports generated a further increase in the GDP rate of growth; so that, the total increase amounted to a factor of circa 2.6 with respect to that found in the case of Italy-CEEC.

Generally speaking, the satellite approach is acceptable only if a clear asymmetry in the degree of dependency is given: that is to say when the country under consideration is heavily dependent on demand and prices from the rest of the world (as represented by the BTM) whereas the rest of the world is not dependent on the demand and the prices of the country under consideration. This asymmetry or one-way-dependency has to exist on the level of all industries/commodity groups distinguished.

In any case the satellite status of a model always will not be more than a second best solution: it can be suggested if feedback effects can be ignored like in the case of Austria and if the state of development of the model does not allow a full integration, i.e. if the price side of the model is missing and if the model does not produce investment and capital stock by industries.

Linking a model as a satellite thus seems to be a recommendable general strategy for models for small countries in an early stage of development.

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Annex
AEIOU commodity groups covered by BTM forecast

01AgricF;	1	Products of agriculture and fishing
02Forest;	2	Products of forestry
10CoalLP;	3	Coal and lignite; peat
11CruOre;	4	Crude petroleum, natural gas, metal ores (1)
14MinQua;	5	Other mining and quarrying products
15FoodBe;	6	Food products and beverages
16Tobacc;	7	Tobacco products
17Textil;	8	Textiles
18Appar;	9	Wearing apparel; furs
19Leather;	10	Leather and leather products
20Wood;	11	Wood and products of wood
21Paper;	12	Pulp, paper and paper products
22PrintM;	13	Printed matter and recorded media
23RefPet;	14	Coke, refined petroleum products
24Chem;	15	Chemicals, chemical products
25RubbPl;	16	Rubber and plastic products
26GlassC;	17	Other non-metallic mineral products
27BasMet;	18	Basic metals
28MetPrd;	19	Fabricated metal products
29MachEq;	20	Machinery and equipment n.e.c.
30OfMach;	21	Office machinery and computers

31ElecMA;	22	Electrical machinery and apparatus
32RadCEq;	23	Radio, TV and communication equipment
33MedIns;	24	Med., precision, opt. instruments; watches, clocks
34MotVeh;	25	Motor vehicles, trailers and semi-trailers
35OthTra;	26	Other transport equipment
36FurOth;	27	Furniture; other manufactured goods n.e.c.
37Recov;	28	Recovered secondary raw materials
40Elec;	29	Electrical energy

CLOSING CHINA'S TRADE SURPLUS

Douglas Nyhus

The Chinese economy has been exploding in recent years. The output of the economy is nearly four and half times larger than it was in 1992, or, for a more recent comparison it is more than twice the size that it was in 2000. In recent years that growth has been led by exports. They are now about four times as large as they were seven years ago. The mounting trade surpluses in recent years have led to reserves topping one trillion US dollars. US policy makers have made trips to Beijing to discuss this issue and the mounting trade imbalance between the US and China.

In all the analyses of trade surpluses/deficits one must keep in mind that the problems and the solutions are primarily domestic in nature. In the case of a surplus there is a surplus of savings over investment and in the case of a deficit there is a deficit of savings less investment. Thus, the problem from this perspective looks mainly at domestic policies rather than export controls and/or managed trade for a solution.

This paper will examine several scenarios to examine the effects of possible policies that China could do that would narrow and/or close its merchandise trade gap over the next ten years. How would such policies change the structure of the Chinese economy? The trade balances with its major trading partners? The incomes of its citizens? Which sectors of the economy would suffer? Employment repercussions?

1. MUDAN the model

MUDAN (Multisector Dynamic Analysis tool) is a 59-sector dynamic macroeconometic input-output model of China. It is part of Inforum's system of some 13 such national models and is connected to them by a model of bilateral trade at the level of 120 commodities.

MUDAN is macroeconometric. Macro means that it has the main economic aggregates that are inherent in most macroeconomic models: GDP, aggregate consumption, investment, exports, imports, government, wages, taxes, depreciation, profits, employment, the price level, etc. In addition it is econometric meaning it uses econometrically estimated structural equations to explain economic behavior. In fact there are over a thousand such equations. To do this a unique historical data base of the Chinese economy has been developed. The database now covers the years 1992-2005. These data are fully consistent with the recently revised national accounts. It entailed several years of effort to create. The database is under constant revision as new data become available and older data is revised or new sources become available.

MUDAN is dynamic. Past levels of economic activity impact current levels of investment, production, profits, prices, income and employment. Thus when the model is used to study the impacts of a particular economic policy (such as WTO entry) it is able to show the impact path and timing of the effects of that policy shift. Policy makers are often as interested in the path of the results as in the ultimate results. China's entry into the WTO is a prime example. The initial effects were negative as imports were allowed to gain a significant foothold (such as the automotive industry) while certain positive impacts (greater efficiency in the use of labor and capital) took more time to become apparent. One has only to recall the controversies regarding Chinese growth during 2003 (could it be contracting despite the official statistics?) or was it growing approximately as stated by the government statisticians. The main direct gain for China's entry into the WTO has been to free it from MFA restraints which we are now seeing the huge increases of Chinese exports to the US of apparel this year.

MUDAN is a 59 sector input-output model**.** A list of the sectors is attached. The input-output characteristics ensure that the sector forecasts are mutually consistent. That is, the forecast of coal mining (5) is consistent the domestic production of steel (29) which is, in turn, consistent with the production of the automotive sector (34). The input-output relationships themselves are changing over time as industries become more energy efficient for example or as the use more electronic equipment in the production process.

MUDAN has significant industrial feedbacks to the behavior of the entire economy. Aggregate exports and imports, for example, are the sum of exports and imports at the level of 59 sectors. The same is true for employment, profits, investment and depreciation. This means that a change in the labor productivity in the steel industry will affect not just steel employment and prices but employment and the price level for the entire economy. This makes the MUDAN model ideal for studying effects of industry specific policies such as WTO entry, trade policy and the like. The inherent consistency of the forecast ensures that the various connections in the economy have been considered.

MUDAN has been used to study such economically important subjects as the following: (1) the impact of its entry into the WTO on the USA; (2) how China is affecting current raw material prices on the world market; (3) the accuracy and consistency of Chinese economic data; (4) the economic causes of the social upheavals in the late 1980's; and (5) the economic effects of a free trade area consisting of Japan, Korea and China.

2. Business as usual

Table 1, on the following page, shows the general outlines of the base line scenario. The main features of this forecast are first of all rapid growth. GDP is set to grow an average rate of some 9% over the ten year forecast period. Exports are slated to lead the way with approximately a 12% rate. The growth is projected to be relatively balanced. Investment and household consumption are both projected to grow at about the rate of overall GDP. Only government spending is projected to be lower at around 6%. Import grow is expected to slightly outpace exports as energy demands increase (China's output of crude oil is slated to remain stagnant) and China's increasingly prosperous population's diet changes adds more meat to its diet implying more grain imports. Secondly, inflation is projected to remain low - around 1% per year with the prices of imports rising ever so slightly faster than those for exports or domestically produced goods. Thirdly, net exports in current prices are set increase still further from present levels until 2010 and then fluctuate about that value until 2017. Net exports, expressed as a percent of GDP are also expected to crest in 2010 after rising another percent or two from current levels. After that a significant lowering of the rate is expected. Finally we have the Riminbi (yuan) set appreciate about 15% (or 1.4% on average) during the period.

Several factors make closing the trade surplus difficult in the Chinese case. The first is that much of China's trade is in the form of "process" trade. That is, goods and services are imported solely to reprocessed and sold for export. The domestic content of goods and services is relatively low. The major domestic inputs are labor and capital. China's export producing factories are almost all new and many use the current state-of-the-art technologies. Thus, a change in the exchange rate lowers costs a significant amount so that export prices can fall so as to keep the foreign prices of their exports competitive. Secondly, the import content of investment is quite high. Any policy which reduces investment slows imports more than in proportion to the overall slowdown. Finally, the import content of household consumption is still relatively low, so increasing household incomes will not necessarily increase imports more that proportionally.

Tab. 1. China Base – Business as Usual

	2002	2005	2006	2007	2010	2015	2017	07-17
Values in 2002 prices, 100M yuan								
Gross Domestic Product	121859	166886	184691	205482	276418	424305	487811	9.1
Private Consumption	52571	62062	66323	74339	99779	153327	178559	9.1
Rural private consumption	16272	16316	16841	18663	23158	35380	41291	8.2
Urban private consumption	36300	45746	49482	55676	76621	117947	137268	9.4
Public Consumption	19120	21486	22929	24408	29004	38184	42624	5.7
Total Fixed Investment	43632	72752	83028	91542	118910	188259	217020	9.0
Net exports	3999	11901	13473	15302	23959	26761	31283	7.6
Exports	30943	63722	77995	90631	141149	235067	280292	12.0
Imports	-26944	-51820	-64521	-75329	-117190	-208306	-249009	12.7
Deflators, 2002=100:								
GDP	100	110	112	114	117	121	124	0.9
Rural private consumption	100	112	116	116	117	122	127	0.9
Urban private consumption	100	104	108	108	110	115	119	1.0
Fixed asset investment	100	106	107	107	109	113	116	0.8
Exports	100	108	108	107	110	117	120	1.1
Imports	100	113	111	107	111	122	126	1.6
Values in current prices, 100M yuan								
Gross Domestic Product	121859	183231	207683	233597	322396	511336	607285	10.0

Private Consumption	52571	70882	78700	88152	120703	194983	235732	10.3
Rural private consumption	16272	19010	20434	22588	28553	45825	55593	9.4
Urban private consumption	36300	51871	58267	65564	92151	149158	180140	10.6
Investment	43632	77451	89103	98191	130151	212960	251874	10.0
Government	19120	26012	28704	31689	41426	61643	73211	8.7
Net exports	3999	10408	12634	15936	24959	20413	23715	2.9
Exports	30943	68744	83948	96583	155004	274263	337658	13.3
Imports	-26944	-58337	-71314	-80646	-130045	-253850	-313943	14.6
Net Trade as Percent of GDP	3.3	5.7	6.1	6.8	7.7	4.0	3.9	
Exchange rate, yuan per 100US$	828	819	798	758	713	680	661	-1.4
Household savings rate	29	26	28	28	30	31	31	

3. Exchange Rate Changes

It is just about impossible to see how China can close its trade gap without a significant appreciation of its currency. Let us begin with an appreciation of twenty percent and examine its effects. The appreciation takes place over three years, 2008-2010 and is in addition to underlying appreciation of the business as usual scenario.

Tab. 2. Exchange Rate Assumptions – First Appreciation

	2008	2009	2010	2012	2015	2017
Base Assumption	735	713	713	705	680	661
First Appreciation	667	600	576	573	554	539
Percent of Base	91	84	81	81	81	81

Let us look now at the effect of this on trade balance. The pluses represent net trade as a percent of GDP (all in nominal terms) for the base and the boxes for the twenty percent appreciation case.

A couple of things become apparent from an examination of the graph. First, twenty percent is NOT enough on its own. Second, it does have a substantial effect that grows slightly over time leaving about half the original margin in ten years.

What about the effect on GDP?

Figure 2 shows these results. What is clear that is that an appreciation reduces the surplus via two mechanisms? First, it reduces real GDP and second it depresses exports. This leads us to the next steps in our explorations.

Fig. 1. Net Trade

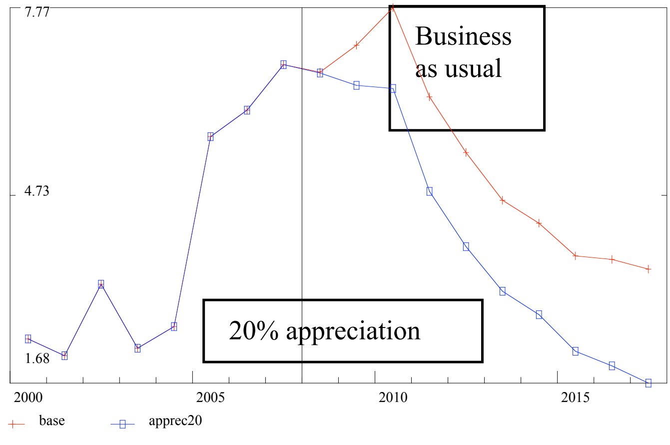
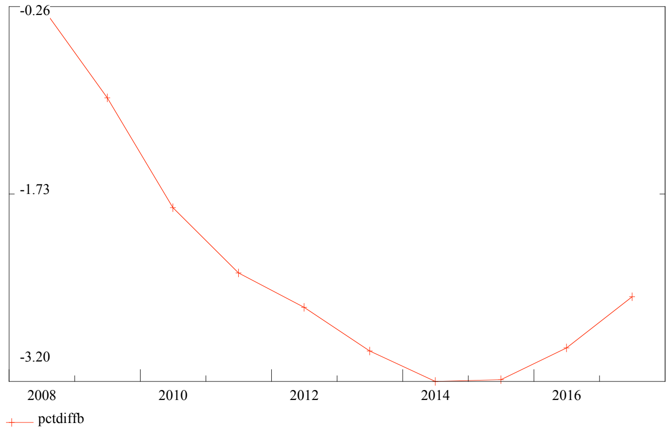


Fig. 2. GDP



4. Domestic Demand Side Measures

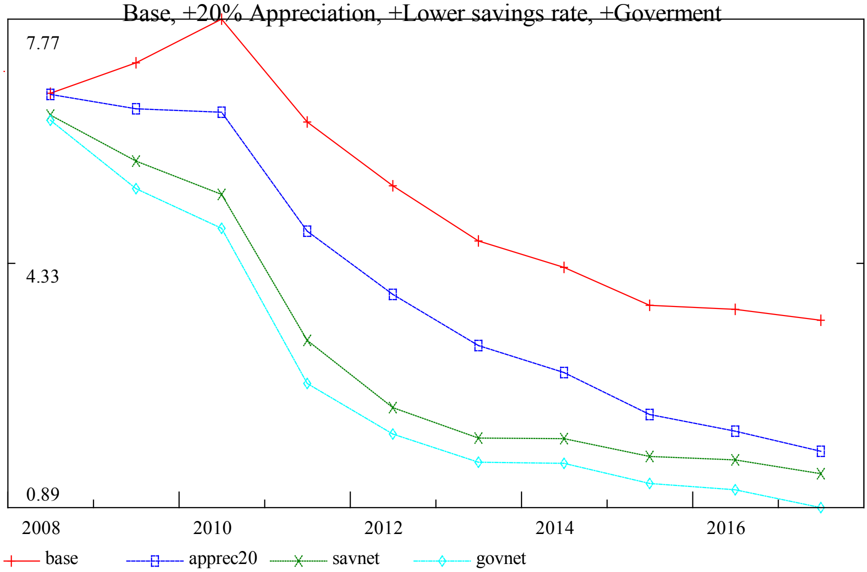
Let us now move on to possible measures to expand domestic demand to create more demand for imports. If we look closely at table 1 we note two areas where such policies might be help.

The first is the high personal savings rate found on the last row of the table. What measures could China initiate to reduce the high savings rate? At least two come to mind: a better social security system and more state aid to education. The current old age assistance program has evolved out of a system of employers providing it all. Now the plans are dependent upon the different provinces. This means that richer provinces provide more generous benefits than do the poorer ones. In fact the poorest ones have plans that do not even meet poverty standards. Reforming taxes and using the monies for these poorest of the poor would mean that all of the money would be spent—the net result would be lower overall household savings rates. The reform would have the side effect of reducing the need of relatively poor relatives saving out meager incomes to meet the pressing needs of their parents. There could be other measures to reduce savings as well. For purposes of this paper we will just assume that such measure reduce the household savings rate from what it would otherwise be by first 2% in 2008, 4% in 2009, 6% in 2010 and 8% thereafter. For education we approximately doubled government spending on public education.

Now how did these affect the trade surplus and overall economic growth?

The upper two lines repeat the results shown in figure 1. The lower two lines represent the results on the trade balance with first the house-

Fig. 3. Net Trade: Percent of GDP



hold savings rate reduced and then with the addition of government spending added as well. The differences are relatively small by adding the additional government spending but clearly in the right direction. The additional government spending was purely government expenditure and was not financed by higher taxes.

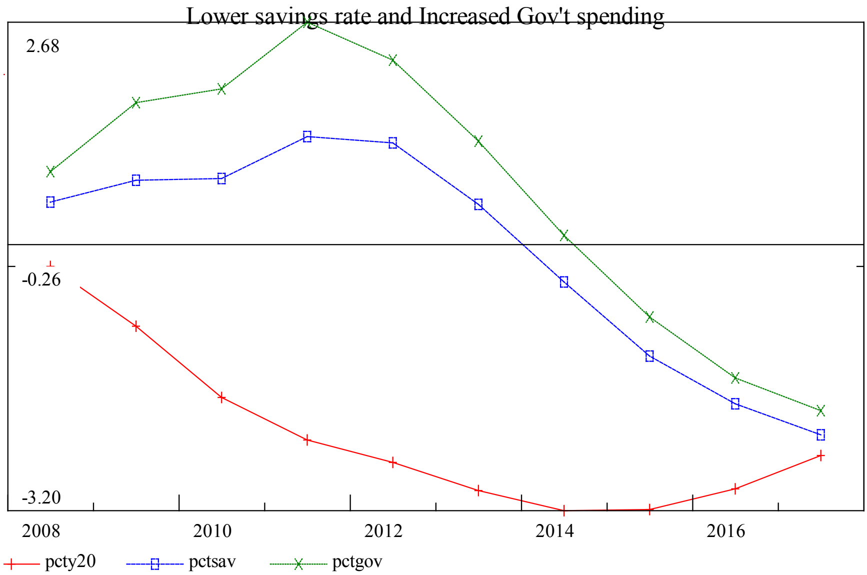
The additional stimulus from lowering the savings rate by eight percentage points is substantial. The losses in GDP are erased entirely for the first five years and the losses in the outer years are moderated as well. Table 3 shows how the changes in the household savings rate affected various components of GDP for the year 2012, the first full year of all the effects.

Tab. 3. Direct and Indirect Effects of Lower Savings Rate

	2002 prices 2012	Percent of base GDP in 2012
Total Gains	12697	3.8
Household Direct	10286	3.1
Household Indirect	1505	0.5
Investment	6070	1.8
Net Trade	-6679	-2.0
Inventory	1515	0.5

Figure 4 shows how the combination of lowering the savings rate and increasing government spending affects GDP. The intermediate effect is to lessen the appreciating exchange rate's negative effects on output while, at the same time, reducing the trade surplus (see Figure 3).

Fig. 4. GDP: Percent Deviaton from Base



From these results we conclude that a twenty percent appreciation is not enough. Let us try thirty-five. The results are shown in figure 5 below. Note that figure 5 is only different from figure 3 by the addition of the 35% appreciation line. From this picture it is apparent that an appreciation of about 35% does yield the desired closure in about 8 years.

Figure 6 shows the net trade in terms of US dollars. Keep in mind in the previous the values were all calculated in Chinese currency and here they are shown in US$. Thus, both exports and imports grow faster but since exports are larger to begin with the resulting net grows even faster when expressed in dollars rather than in yuan.

Table 4 shows the changes in the trade balance for 2017. It is crucial to note that both exports and imports fall but that exports fall by more. Both series fall in nominal terms because the prices change. Imports prices because of the exchange rate appreciation and export prices fall as exporters struggle to maintain markets both foreign and domestic.

Figure 7 shows the development of exports and imports in nominal yuan over time in the two cases.

Fig. 5. Net Trade

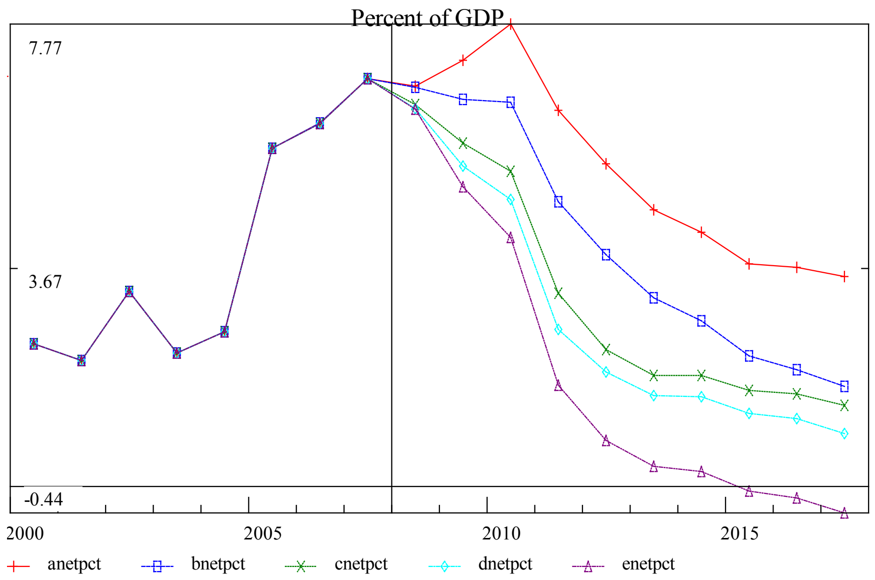


Fig. 6. Net Trade in Billion of US Dollars

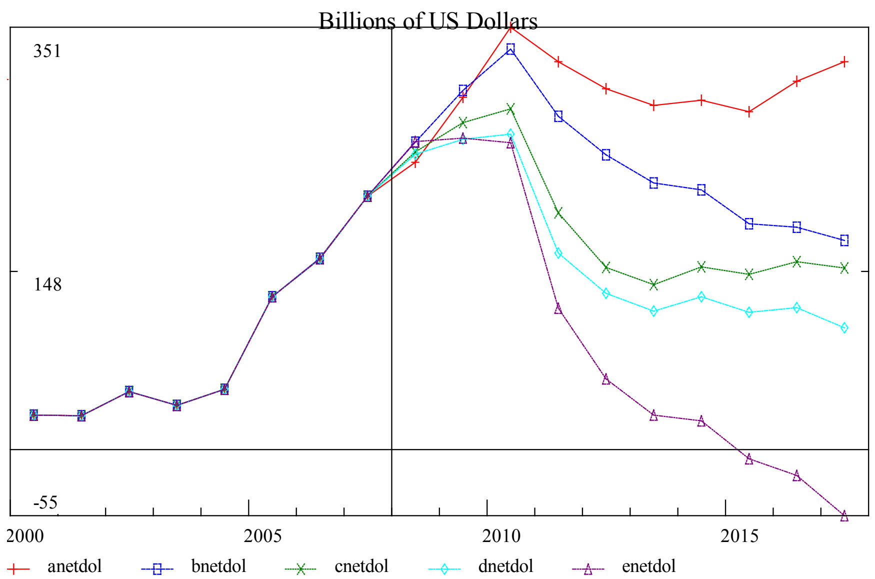
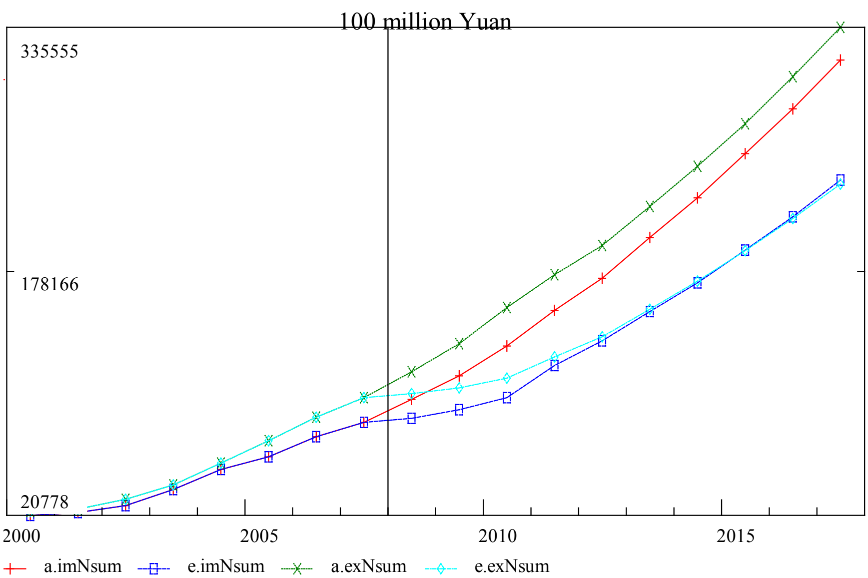


Figure 8 looks broadly at changes in the structure of the domestic economy. One of the truly amazing features of the Chinese economy from 2000 to 2007 has been the very sharp decline in the share of the econ-

Tab. 4. Trade Balance in 2017 (100 Million Yuan)

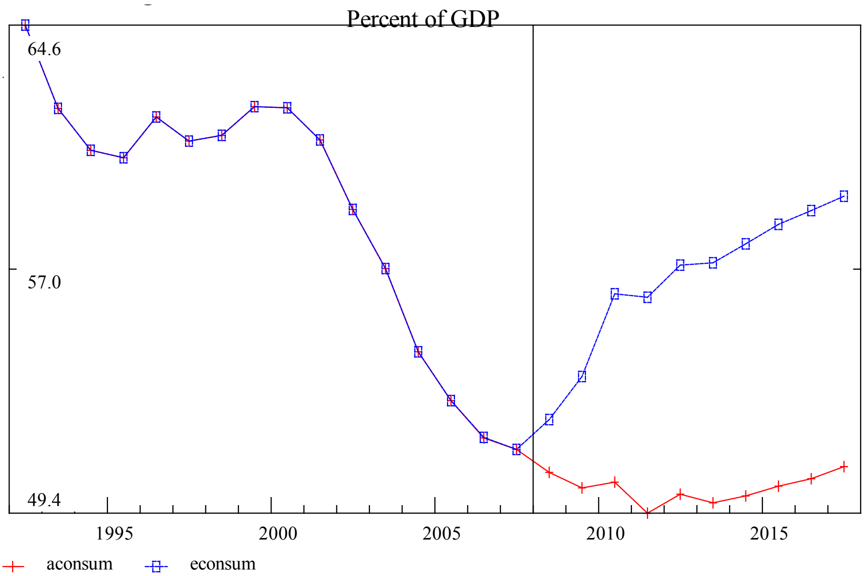
	2017 Base	2017 Closing	Percent Change
Exports			
Nominal	335555	234199	-30.2
Real	280609	241725	-13.9
Price	120	97	-19.2
Imports			
Nominal	314218	236698	-24.7
Real	249345	264597	6.1
Price	126	89	-29.4
Net			
Nominal	21337	-2499	
Real	31264	-22872	

Fig. 7. Exports and Imports



omy devoted to consumption—both household and government. The rapid rise of trade and investment during that period has reduced quite dramatically the importance of domestic household consumption. Each

Fig. 8. Consumption as a Percent of GDP



of the policies implemented has a direct effect increasing the portion of consumption in GDP. Lowering the savings rate and raising government spending on education quite obviously add directly to the share. Changing the exchange rate lowers the price of imported household goods. If these are price elastic then their share of GDP will increase.

Figure 9 shows the effects of appreciation on inflation. We start with one very important fact: the price of imports does *not* enter into the price of GDP. It is the gross *domestic* product that we are measuring. So, then, why does it change the GDP deflator? Harking back to our discussion on nominal exports we recall that the price of exports fell as exporters lowered their prices to maintain markets abroad and domestic manufacturers lower prices in order to maintain domestic markets. The lower prices mean lower profits.

Figure 10 shows the US trade deficit with China under the two scenarios. The reduction in the US trade deficit with China is substantial but it the gap still grows

Figure 11 shows net trade with Japan. The gap here is negative and changes only slightly. This is because of the concentration of heavy machinery in Japanese exports to China. China's imports of these goods increases only modestly in the closure scenario. Figure 12 shows the net trade of China with the UK, France, Germany, Spain, Italy, Belgium and Austria. In several respects this picture is similar to that of the one with the US except that the values are somewhat smaller.

Fig. 9. GDP deflator

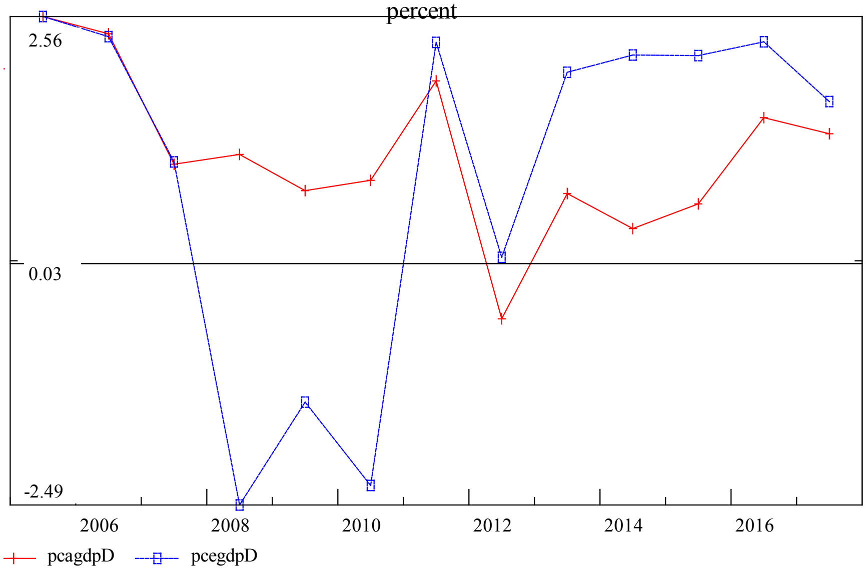


Fig. 10. US Net Deficit with China

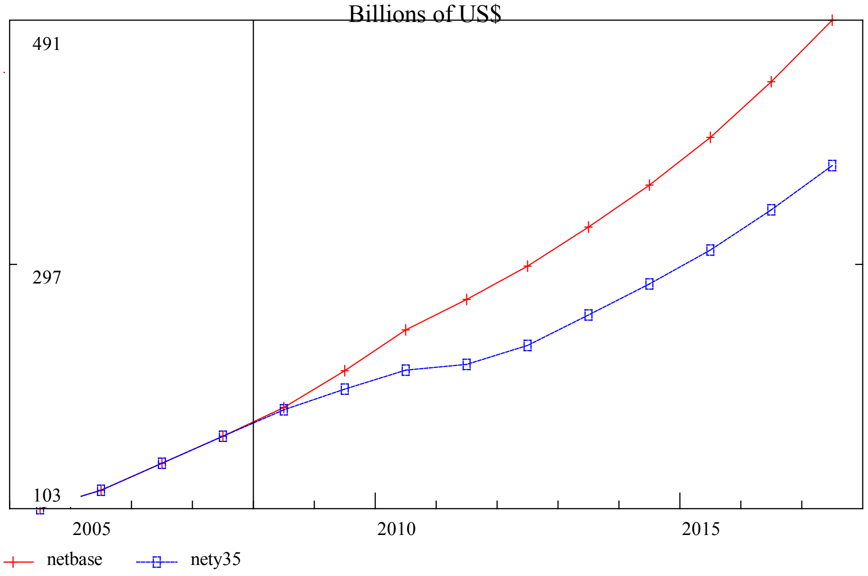


Fig. 11. China-Japan Net Trade

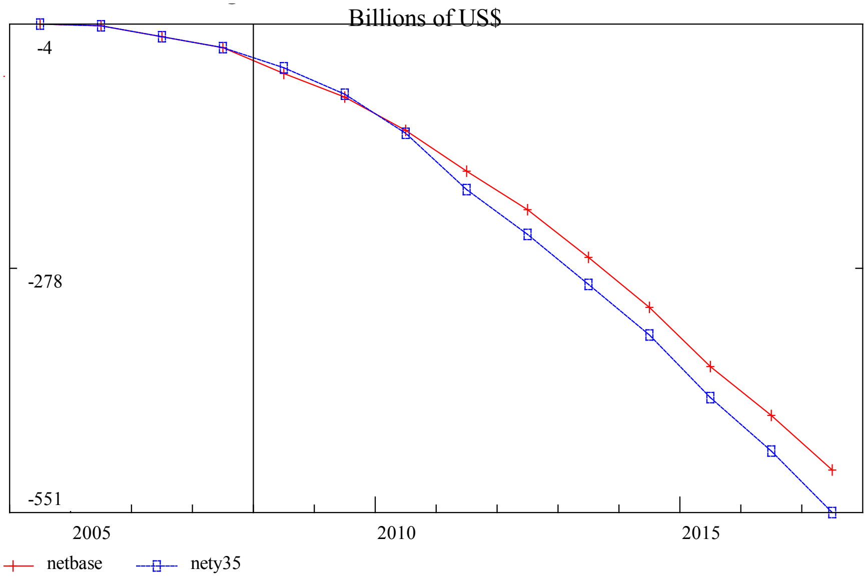
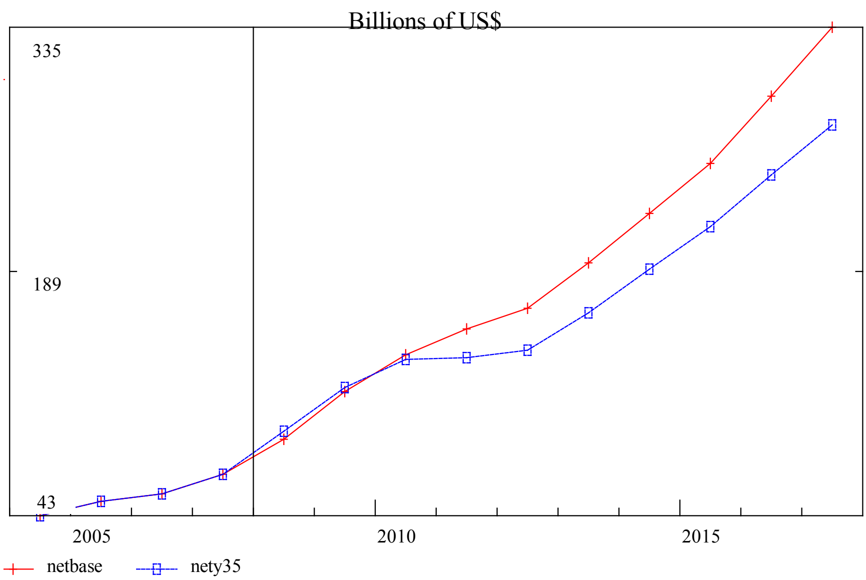


Fig. 12. China-Europe Net Trade



5. Industrial Effects

The following sets of tables will show where changes have been proportionally the greatest and how the largest sectors were affected. We begin with gross output.

Tab. 5. Gross output percentage changes in 2017

Sector	Output	Volumes 2017 Percent Difference
Total Gross Ouput		-4
Gainers		
57 Education		21
56 Health Care & sports		20
24 Medicines		18
12 Beverages		18
53 Restaurants		10
Losers		
8 Non-ferrous Mining		-66
7 Ferrous Mining		-20
26 Rubber Products		-18
30 Metal Products		-18
30 Non-ferrous Metals		-18
Largest in 2007		
39 Electronic & Comm Mach.		-8
45 Construction		1
55 Real Estate		1
52 Trade		-5
42 Electricity		-5

Total gross output is down four percent since there is considerable double counting in such a sum. (For example the value coal mining is counted at the mine and again when used to make steel and again when used to make a machine tool.) The largest gainers in output are those directly impacted by the increased government spending on education and health. Medicines are indirectly impacted by government health expenditures and by the high real incomes of households. The household income effect shows up in the restaurant and beverage sectors. The losing industries are those that are affected both directly (through export losses and import competition) and indirectly as their sales to those sectors negatively impacted are reduced. Thus, mining shows up very high on the list. In addition we see that metals and rubber (tires) are also sharply curtailed. What about the sectors with largest gross outputs in 2007? Once again we see the realigning of the economy visible in figure 8 where consumption regains its prominence. Thus, the largest sector, Electronic and Communications Machinery, is down while Construction and Real Estate are up slightly. Trade is down as the wholesale component drops and its retail side gains. Electricity consumption drops as industrial production is lower under the closing scenario.

Next we turn our attention to imports.

Tab. 6. Import Volume Percentage Changes in 2017

Sector	Import	Volumes 2017 Percent Difference
Total Import Volume		6
Up		
28 Building Materials		161
1 Farming		45
24 Medicines		36
56 Health Care		33
8 Non-Ferrous Mining		31
Down		
7 Ferrous Mining		-3
22 Petroleum Refining		-5
27 Plastics		-5
9 Non-Metallic Mining		-4
29 Iron and Steel		-3
Largest		
39 Electronic Machinery		3
32 Machinery		5
23 Chemicals		-5
38 Electric Machinery		4
40 Instruments		-3

Imports are up somewhat. The largest proportional gain is in building materials. While substantial the increase expressed as a proportion of domestic demand is relatively modest—from 2.2% in the base case to 6.0% in the closing case. The change in Farming is similarly modest. The other areas where imports increased were where there was a strong increase in domestic demand—namely Medicines and Health Care. Imports were down in some of the mining sectors, Iron and Steel and for Petroleum Refining. In these later sectors the domestic demand factor also dominated. Looking at the sectors where imports are largest we see increases for Electronic Machinery and Non-electrical Machinery. In both these sectors the price effect dominated the demand effect for imports. For example the import share (in 2017) for Electronic Machinery rose from 40.1% to 43.3% in the two scenarios. For Non-electric Machinery the changes were from 36.7% to 41.7%.

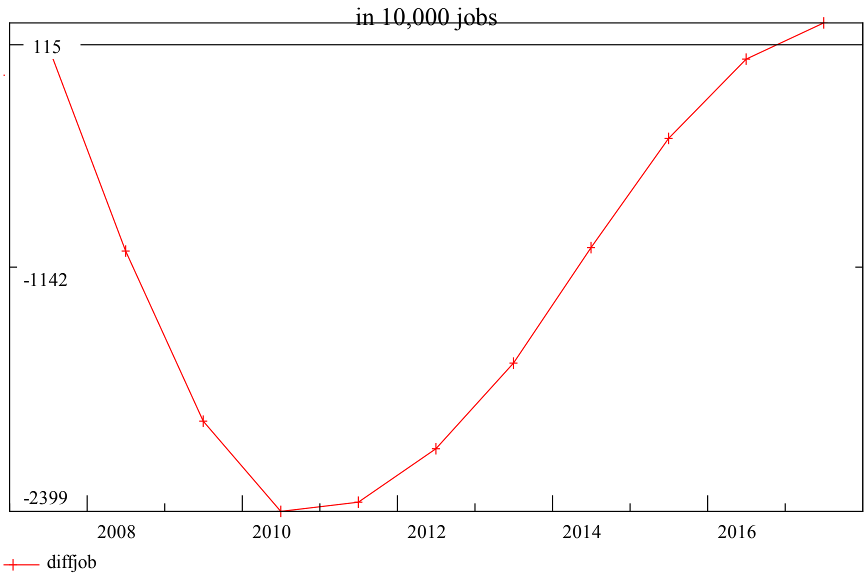
Now, our next table, we look at export volumes.

Tab. 7. Export Volume Percentage Changes in 2017

Sector	Export	Volumes 2017 Percent Difference
Total Export Volume		-14
Down Least		
6 Crude Petroleum		-1
24 Medicines		-2
21 Cultural items		-4
5 Coal Mining		-6
Down Most		
34 Motor Vehicles		-48
4 Fishing		-42
25 Chemical Fibers		-40
17 Sawmills		-38
23 Chemicals		-34
Largest		
39 Electronic Machinery		-7
14 Textiles		-16
52 Commerce		-14
38 Electric Machinery		-11
40 Instruments		-18

The changes are uni-directional—downward. The total change of 14% appears at first to be somewhat modest given the 35% appreciation. But one must recall that exporters absorbed much of the appreciation themselves as overall export prices of manufactures fell some 23%. The sectors with least negative impacts were all small sectors (as exporters) or where there were distinctly other factors as work (Cultural items). The greatest impact was felt in Motor Vehicles where the price increases cut deeply into a fledgling export market. Apparently the exports of the basic manufacturing sectors were most deeply impacted. This is evident from the appearance of Fishing, Chemicals and Sawmills on the list. The largest exporting sector is once again Electronic Machinery where the impact was a relatively modest 7%, less than one year's growth of exports. The fall in Commerce reflects the overall drop in exports as it consists of the trading margins necessary to get the products to the port for transport abroad.

Fig. 13. Employment Difference



Next we look at employment. The total change in employment in 2017 was an increase of some 1.15 million jobs. This is less than half a percent of the labor force. The result, while driven by the overall properties of the model, is *not* a result by assumption. Indeed, as shown in figure 13, if we look at the total employment over then entire time period of the experiment we see that total employment falls by about 24 million jobs in 2010 and then only then begins a long slow climb back up.

In this table we look at proportional changes and, for the largest sectors at the actual level of the change.

The sectors with largest gains and loses in employment closely, but not precisely, follow those given in table 5 on gross output. The differences arise because the employment coefficients, or level of labor productivity, vary because they are dependent in varying degrees on the level

Tab. 8. Employment Differences in 2017

Sector	Employment	2017 Percent Difference
Total Employment		0
Lose		
6 Non-metal Mining		-65
29 Machinery		-22
4 Ferrous Ore Mining		-20
28 Metal Products		-17
27 Primary Non-ferrous Metals		-14
Gain		
21 Medicines		21
49 Health Care		18
9 Beverages		17
50 Education		16
46 Restaurants		12
Largest	Difference	10,000 Persons
Total		115
1 Agriculture		834
38 Construction		14
52 Public Administration		-2
48 Real Estate		10
50 Education		255

of the capital stock in that sector. In showing the results for the largest employment sectors we see, at once, the dominance of Agriculture in the overall employment picture of China. In the closing scenario we see more than 8 million more jobs in Agriculture. This is a result of higher consumer incomes and more consumption of food in restaurants for example and more consumption of higher protein foods. With the exception of Education the changes in employment in the other sectors is trivial. The large increase in Education is due entirely to assumption of greater government spending on education.

ON THE APPLICABILITY OF THE GRAVITY APPROACH WHEN MODELING SECTORAL TRADE FLOWS

Reelika Parve

1. Introduction

The primary purpose in the field of international trade analysis is to understand why countries trade. During the last century, a number of theories of international economics were developed, especially from the Sixties onwards when time series of trade statistics became available for quantitative studies. Among them, the gravity model introduced by Tinberger in 1962 is perhaps the most successful empirical trade flow equation even now. Commonly used to estimate aggregate trade flows, this study aims to investigate whether the gravity model can be considered a useful tool able to explain and quantify sectoral trade patterns.

This paper intentionally overlooks a screening of which traditional trade theories are consistent with the gravity formulation as several authors have already provided this kind of investigation. For a detailed review of their contributions see, for example, Oguledo, MacPhee (1994) or Deardorff (1995)[1].

A constantly growing number of applied works reveals that the gravity equation is still a very fashionable approach for analyzing foreign trade patterns between single countries or groups of them (EU, Mercosur, Nafta etc). It should be remembered that already in 1979, Anderson - the first contributor to its theoretical foundations - labeled it «probably the most successful empirical device of the last 25 years». Its success has been so astounding that, in 1996, Eichengreen and Irwin pointed out that «the gravity model of international trade has been the workhorse for empirical studies [...] to the virtual exclusion of other approaches». In 2000, Rose noted that the gravity model of international trade has a remarkably consistent (and for economics, unusual) history

[1] Deardorff (1995) underlined the weakness of the theoretical content of the gravity equation by arguing that it was «derivable from any plausible model of trade». And Bussière *et al.* (2005) pointed out that the gravity models are «consistent with standard models of international trade».

of success as an empirical tool, while Leamer and Levinsohn (1995) defined it as having «some of the clearest and most robust empirical findings in economics»[2].

However, despite its widespread empirical success, over the years, the 'original' gravity model has repeatedly been criticized because of its lack of theoretical foundation. As a matter of fact, over the years, a number of theoretical backgrounds have been provided, but its performance in terms of fit and significance of estimated parameters has often led to this not insignificant shortcoming being overlooked.

The gravity equation has frequently been indicated as well-suited for policy analysis (Bussière *et al.* 2005)[3]. Most of these cases focus on the impact of a number of policy measures such as, for example, the abolishment of trade barriers or participation in a currency union (Rose, 2000). Harris and Mátyás (1998) also noted its excellent performance in forecasting. Papazoglou et al (2006) used the gravity model to generate a forecast of trade patterns for 10 'new' EU Member states[4]. One of the aims of this paper is, indeed, to check whether this approach can be used to predict trade flows, and in particular to find out whether this method can be successfully adopted for sectoral forecasts.

The gravity model has also been extensively used for regional studies and, in particular, to evaluate effects of regional trade agreements. Greenaway and Milner (2002) include a detailed survey of previous works on regional trade agreements using the gravity equation (see their Table 1 with the list of countries covered , the time period and the specific type of regional trade effects under investigation).

The gravity equation has also been applied to many other contexts with focus on trade barriers, such as trade or monetary unions (Rose

[2] According to Leamer and Levinsohn (1995), «the estimates of gravity models have been both singularly successful and singularly unsuccessful. [...] But, paradoxically, they have had virtually no affect on the subject of international economics».

[3] Bussière *et al.* (2005) announced in their study that «the intended role of the model is to give some structure to the policy discussion». Nevertheless, their explicitly declared initial aim was then circumscribed to indicate benchmark trade links which did not reveal anything unknown: firstly, industrialized countries were found, on average, to be more integrated in world markets than emerging ones; and secondly, trade integration between most of the largest Central and Eastern European countries and the euro area appeared already well-advanced, while Baltic countries and the South Eastern European countries still had significant scope to strengthen their trade links with the euro area. These results which «seem to suggest that trade of these countries was low at the beginning of the transition process and converged to more normal levels over time» can hardly be viewed as a new and fundamental contribution in addressing and supporting concrete policy discussion.

[4] The panel data for 1992-2003 was used to predict trade effects in 2006 in both the accession and non-accession scenarios. The estimated coefficients describing the main determinants of the EU Member states' trade, were applied to new Member countries' trade patterns in order to predict their potential trade flows after their adhesion.

2000 and following contributions), different cultural and linguistic heritages, geographical proximity and so on.

The paper is structured as follows: after the introduction, the next section describes the still often debated question of the theoretical foundations of the gravity equation; section 3 reports previous empirical contributions, and the fourth section illustrates data and results of sectoral analysis. The final section presents the concluding remarks.

2. *Theoretically founded?*

The theoretical underpinnings of the gravity model have probably been one of the most questioned issues over the last 25 years. It may seem strange but many authors, after having drawn attention to the lack of theoretical background, continued to use it in their empirical works in spite of that deficiency[5].

Anderson (1979) is commonly regarded as the very first who aimed to provide a theoretical explanation for the gravity equation. Anderson listed the potential areas for its future improvements and observed that «the major remaining unidentified part of the equation is the function stipulating that trade's share of budgets is dependent on income and population. While this is a well-established empirical relation, it would be nice to have an explanation. None is offered here». As a result, the bulk of the standard gravity equation itself remained unexplained[6].

Many subsequent authors appeared to ignore that early contribution and tried to fill that gap by proposing new and/or additional justifications. For example, in 1985, Bergstrand, aiming to offer some microeconomic foundations, stated that «despite the model's high statistical power, its use for predictive purposes has been inhibited owing to an absence of strong theoretical foundations».

Over the years, different theories have been invoked to support the gravity equation, and as highlighted by Oguledo and MacPhee (1994), «the differences in these theories help explain the many different forms of gravity equations and differences in their results». This statement is rather surprising: in gravity analysis, a log-linear model should be considered a standard and the main explanatory variables are generally the same over time, too[7]. Differences in results are axiomatic as the equa-

[5] Quoting Cheng and Wall (1999): «The widespread use of gravity equations is despite the fact that they have tended to lack strong theoretical bases».

[6] Leamer and Levinsohn reputed Anderson's attempt formally fruitful but «too complex to be part of our everyday toolkit».

[7] The basic specification of the gravity equation contains supply factors of the exporting country (such as its GDP and population), demand conditions in the importing

tion is estimated for different country-pairs, using different data and estimation methods.

Yet in 1994, Oguledo and MacPhee called it «a model in search of a theory». A year later Deardorff answered this persistent claim for a theoretical justification by asserting that «it's certainly no longer true that the gravity equation is without a theoretical basis, since several of the same authors who noted its absence went on to provide one». And he did the same. However, he reminded us that «just about any plausible model of trade would yield something very like the gravity equation, whose empirical success is therefore not evidence of anything, but just a fact of life».

In 1995, Leamer and Levinsohn stressed once more the «very weak link between theory and the empirical work». Quoting these authors: «the gravity models are strictly descriptive. They lack a theoretical underpinning, so once the facts are out, it is not clear what to make of them. In addition, they do not link clearly with any issues».

Five years later Davis (2000), in a survey of major developments in international trade patterns analysis, pointed out that «in the space of little more than a decade, the gravity model went from theoretical orphan to having several competing claims to maternity». Greenaway and Milner (2002) affirmed that «it has in fact been shown to be derivable from a number of models of trade in homogeneous and differentiated goods and Evenett and Keller is an elegant demonstration of how data can be used to discriminate between alternative theories». But in 2003 Anderson and van Wincoop argued once again that «contrary to what is often stated, the empirical gravity equations do not have a theoretical foundation»[8], and developed a gravity model which was still based on the constant elasticity of substitution (CES) expenditure system (like the

country (GDP and population), as well as a set of dummies incorporating other characteristics common to both trading partners acting as trade encouraging or hampering factors (mainly geographical distance, tariffs, common border and/or language).

The GDP of the exporting country and that of its trading partner with its possible variants (difference between two GDPs, GDPs pro capita) are conventional explanatory variables, while the exports (or sometimes sum of imports and exports) represent the standard dependent variable. However, it might be worth bearing in mind that as exports contribute to the formation of the GDP, the production data would be more appropriate to explain a country's capacity or ability to export. Up untill now, to my knowledge, this variable has never been used in an empirical work.

So, what really makes the difference between applied gravity works are dummy variables.

[8] According to Anderson and van Wincoop, trade between two regions depends on the bilateral barrier between them relative to the average trade barriers that both regions face with all their trading partners. So, the correct gravity equation based on theory is the one where bilateral trade flows between two regions depend on their output, their bilateral distance and whether they are separated by a border.

original version presented by Anderson in 1979), but modified to derive an operational gravity model with «an elegantly simply form», later labelled "micro-founded» by De Nardis *et al.* (2007).

Even those who recognized the attempts made to provide a theoretical foundation for the gravity equation – such as Soloaga and Winters (2001) – pointed out that none of these models generated exactly the equation used in empirical work.

In Rose's view (2000), the gravity model «stands proudly on both theoretical and empirical legs». However, he still observed that «which theoretical model best underpins the empirical findings of the gravity model is a matter of dispute».

Recently, Baldwin (2006) argued that the gravity model «has more theoretical foundations than any other». So, the long-term search for a theory in support of this successful tool might finally have reached a happy end.

2.1 The lasting question of (lacking) prices

The conventional gravity model does not care about prices. This omission derives from the assumption that prices merely adjust to equate supply and demand as reported by Bergstrand (1985). Quoting Hamilton and Winters (1992): «the gravity model does not relate trade directly to prices which are endogenous and adjust to equate supply and demand. The model should be viewed as a reduced form in which GDP, population and distance are the ultimate determinants both of trade and of prices». In existing literature, all the references are to the reduced form while the structural form of the gravity equation never appeared in any research and nobody ever cared about it.

Bergstrand tried to preserve a structural point of view with a model that explicitly includes price variables (1985, 1989)[9]. Oguledo and MacPhee (1994) followed the same line and included in their model for 10 countries and the EC area the following additional variables: export and import unit value indexes, as well as wholesale price indexes. In some other cases, the real exchange rate was supposed to act as a proxy for prices (see Harris and Mátyás 1998). However, the usual and still most frequent version of the model excludes any price variable assuming implicitly that prices or any other measure of international competitiveness do not play any significant role in explaining variations in trade between countries. This is, clearly, a very strong hypothesis, since it is

[9] In his paper of 1989, aggregate wholesale price indices are used instead of sectoral product price indexes because of lack of availability.

well-known that a country's capacity to export and gain market shares is deeply affected by variations in relative prices.

2.2 The question of distance

Traditionally, the economic distance between country-pairs is measured as the geographical flight distance between two capital cities. Martínez-Zarzoso and Nowak-Lehmann (2002) distinguished between economic distance (measured as the absolute difference in per capita incomes) and geographical distance (miles/km and infrastructure endowment of trading locations). In order to measure it, they constructed an additional geographical distance variable using an infrastructure index[10].

As mentioned in Leamer and Levinsohn (1995), the effect of distance on trade patterns does not diminish over time. As the gravity models account for economic size as well as for distance, the increased trade across the Pacific and the Atlantic oceans must be explained as due to the dispersion of economic mass and not as a 'shrinking globe'.

Analogously, the radical reorientation of trade flows that took place between the former USSR republics (such as for example, the Baltic countries) and Russia during the Nineties cannot be explained by a gravity equation: the geographical distance between the capital cities – the most frequent distance measure in gravity analysis – did not increase from year to year. The geographical distance is obviously a misleading indicator, especially in the case of big countries. Firstly, when one of the partners is extensive, like the U.S. or Russia, it is clear that goods enter the country from several ports and/or airports. Secondly, the capital city of a country does not necessarily represents its financial and economic core.[11]

Finally, as the gravity model belongs to the family of spatial interaction models, one possible way to take into account spatial structure effects is to include some additional variables in the standard gravity specification. Hu and Pooler (2002) used an augmented gravity model where the spatial structure effect is captured by the inclusion of an additional variable that measures accessibility of the destination country[12].

[10] Transport costs tend to increase with distance but they also tend to be reduced by a better infrastructure, Martínez-Zarzoso and Nowak-Lehmann calculated an infrastructure index which accounts for information on roads, paved roads, railroads and telephones. Then, the geographical distance was scaled using this index on infrastructure.

[11] This might be the case of choice of Rome and Milan in Italy, or Berlin and Hamburg or Frankfurt in Germany. Probably for the Baltic countries, the distortion is almost irrelevant because of their smallness.

[12] Given by the weighted sum of distances between the origins and the destination, in which each origin's mass is the relevant ponderer.

3. Previous empirical contributions

In recent years, many econometricians have paid increasing attention to the gravity approach. Egger said that «first and independently of the researcher's interest, consistent estimates is a must, and I think that we should not base our conclusions on simple OLS estimates».

Cheng and Wall (1999) were disappointed that «the perceived empirical success of the gravity model has come without a great deal of analysis regarding its econometric properties, as its empirical power has usually been stated simply on the basis of goodness of fit, i.e. a relatively high R^2». That's why, in recent years, econometricians have made several efforts to discover a «proper econometric specification» of the model (Mátyás 1997; Egger 2000, 2002, 2005; Egger, Pfaffermayr 2003, Baltagi et al 2003) both for cross-section and panel data. However, it should be clear that the question concerns as accurate as possible a specification of a single equation, removed from the rest of the economy and without any feedback effect on it, regardless of the reduced or structural approach.

Oguledo and MacPhee (1994) prepared one of the most meticulous literature reviews on the past applications of the gravity model. These two authors listed all the different variables that had been used in 50 years of history of gravity modeling from the very first applications by Tinbergen and Linnemann[13].

The previous empirical works can be divided into three groups: early cross-section applications, then panel framework and, recently, dynamic specification. In addition, relatively few sectoral studies have been carried out until now.

3.1 Cross-section applications

For a long time, the gravity model was estimated using cross-section data. Almost all the early gravity equations were estimated using data for only one year or, as an alternative, statistics averaged over a period. This approach was chosen to evaluate the trade potential between the former Comecon countries and Western Europe after the breakup of the Soviet system (Hamilton and Winters 1992, Nilsson 2000)[14] , but also

[13] 54 variables are listed in table 2 (p. 112).

[14] Hamilton and Winters (1992), in their analysis of the trade potential of the Soviet Union and Eastern European countries (SUEE), affirmed that the gravity equation they were going to apply, provided a long-run equilibrium view of trade patterns, but had to admit that «hence for now, we ignore the issue of how the SUEE makes the transition to that pattern». For this study, data averaged over 1984-1986 were used. In Nilsson (2000) data were averaged for 1995 and 1996.

by Bayoumi and Eichengreen (1995) to measure the impact on trade of preferential agreements in Europe after the Fifties, and recently by Sargento (2006).

3.2 Panel applications

Only from the Nineties onwards did software developments allow the use of panel or longitudinal data (i.e. repeated cross-section). The term «panel data» refers to the pooling of observations on a cross-section of statistics over several time periods.[15] In fact, one of the most debated questions for researchers working with panel data is «to pool or not to pool» because the pooling of cross-section data implies making no distinction between observations over time and space. It implies that it does not matter anymore which country-pair is analyzed – the intercepts are all the same –, which is obviously an excessively gross oversimplification of the real world. Only in the case of fixed-effects panel models does each exporting country have its own intercept accounting for unobserved country heterogeneity.

The gravity model is usually estimated by a fixed effects model (FEM) or a random effects model (REM)[16]. As pointed out by Egger (2000), «it seems not clear whether one should apply a random or fixed effects model. [...] Some of the main forces behind the fixed export effects should be tariff policy measures and export driving or impeding «environmental» variables (as size of country, geographical and historical determinants) as most of these effects are not random but deterministically associated with certain historical, political, geographical and other facts».

Mátyás (1997) argued that the proper econometric specification of a gravity panel with time variation would consider three factors with main time, exporter and importer effects. In 2002, Egger remarked that from an econometric point of view, in the analysis of bilateral trade flows fixed effects methodology has to be preferred to random effects models. In 2005, Cheng and Wall recommended, once more, the FE-formulation. Bussière *et al.* (2005) used the fixed effects model as well to evaluate the trade integration of the Central and Eastern European countries and the Euro-area.

The first ever empirical application of the random effects model was by Harris and Mátyás (1998) and recently it was also used by Papazoglou *et al.* (2006).

[15] The same individual, firm etc. is followed over time.

[16] The detailed description of these two estimation methods can be found in any textbook of econometrics where panel data are treated.

3.3 Dynamic specification: history matters

The question of whether it would be opportune or not to introduce a lagged trade variable among regressors probably stems from the very simple form of the gravity equation. As already mentioned, in addition to a wide set of dummies, in the standard gravity model formulation, current trade depends only on current incomes and population without any variable accounting for effects from past economic performance. Given that the gravity model is usually a single-equation model, it must have seemed quite natural to introduce a lagged trade variable to the standard gravity specification justifying in a comprehensive and quite charming way what is hard not to share: sunk costs due to the entrance into a market encourage a sort of trade persistence. History matters, is the rationale for that[17]. So, in the context of gravity models, the dynamic specification stands for the inclusion of a lagged dependent variable (export flows) among the regressors to the model.

Eichengreen and Irwin wrote in 1996 «current trade flows should be a positive function of past trade flows even after controlling for the determinants of bilateral trade included in the gravity model». Their paper concluded with an astonishing announcement that should alarm every researcher with any real econometric experience: «we will never run another gravity equation that excludes lagged trade flows. If our paper is successful, neither will other investigators». These two authors did not care about their estimation outcome where almost all current trade was explained by the lagged variable while the other explanatory variables were only able to influence it marginally[18].

Two years later, Harris and Mátyás 'discovered' that «lagged exports exert a positive and highly significant effect on current export flows, but this appears to be at the expense of several previously significant variables».

In 2002, Bun and Klaassen, using a panel data framework with 221 annual bilateral trade flows over 48 years, included lagged trade and lagged income (both of order 2) in their model. The static gravity model with time-invariant country-pair effects and time specific effects was chosen as a benchmark, and then compared to the dynamic specification. The latter was found strongly significant, so the conclusion was that a static gravity model should be misspecified and, from an econometric point of view, including dynamics is important to obtain a proper gravity model specification[19].

[17] Eichengreen, Irwin (1996) is, probably, one of the first applications of the dynamic gravity equation.

[18] See table 4 in Eichengreen, Irwin (1996).

[19] According to their estimates, current trade is determined mainly by trade[1] and current GDP.

A dynamic specification was also used by De Benedictis and Vicarelli (2004), but unfortunately their paper does not report results for the 11 European countries they had estimated[20]. They too found that the dynamic estimator produced better results in terms of standard errors and regression fit.

Martínez-Zarzoso *et al.* (2006) estimated trade creation, export and import diversion effects[21] in a dynamic panel data framework and noticed that the inclusion of the lagged dependent variable determined a lowering in magnitude of most estimated coefficients compared to the static formulation[22]. However, they disregarded this and seeing that the coefficient on the lagged exports was statistically significant at 1% level, asserted that the gravity model should be estimated in a dynamic form. The latter effect had already been pointed out by Eichengreen and Irwin: «current income and distance still help to predict current trade but the magnitude of their coefficients is reduced». The authors' comment was: «The large coefficients on lagged trade suggest a high degree of persistence in trading patterns and imply that small changes in current trade patterns can end up having quite large long-run effects»[23].

The problems which arose when working a dynamic specification were briefly summarized in Almon (2002). He warned us that «just because you get a close fit when using a lagged value of the dependent variable, do not suppose that you have arrived at any kind of structural relation between the dependent and independent variables. Possibly you have found such a relation, but much more probably you have simply found that the determinants of the dependent variable change slowly from period to period». As a result, the excellent fits obtained using a lagged dependent variable do not provide evidence of any causal relation between dependent and independent variables.

In 2007, De Nardis et al. pointed out that the induction of dynamics would raise econometric problems. Quoting their study on the Euro's effects on trade in a dynamic setting: «the transformation needed to eliminate the country-pair fixed effects produces a correlation between the lagged dependent variable and the transformed error term that renders the least square estimator biased and not consistent». As a result, they

[20] De Benedictis and Vicarelli (2004) focus on the behavior of the «standardized potential trade indicator» with the change in estimator (OLS, FE Within estimator and GMM).

[21] Hamilton and Winters (1992) stated that the gravity model cannot distinguish between trade creation and trade diversion, but many subsequent studies focus on these two Viner's concepts (for example, Bayoumi and Eichengreen 1995, Soloaga and Winters 2001, Morais and Bender 2006).

[22] The coefficient of the lagged exports was about 0.91 for the first sub-sample and 0.95 for the second one.

[23] The coefficient of lagged trade was equal to 0.7 in 1954 and 0.94 in 1964 (Eichengreen, Irwin 1996).

preferred to use the GMM estimator instead of OLS but not to abandon the lagged dependent variable[24].

3.4 Sectoral studies

While the gravity equation is extensively used in international trade analysis[25], on the other hand there are very few empirical studies at a sectoral level. It seems reasonable that the basic idea lying behind the gravity equation – mass and distance influence a country's trade – should be detectable and even more significant in the case of disaggregated data, especially for some product categories (such as, for example, heavy and not easily shipped goods).

Probably the very first empirical sectoral study was carried out by Bergstrand (1989) who estimated a «generalized gravity equation» for single digit SITC industry (?!) groups for four years[26]. The main explanatory variables – exporter's and importer's income and distance – proved significant for most product groups while both per capita incomes as well as price indices were not. The best performing product groups were SITC1 «Beverages and Tobacco» and SITC6 «Manufactures classified chiefly by material».

In 1995, Bayoumi and Eichengreen prospected a future development of their study on the impact of the formation of the EEC and EFTA free trade areas in the direction of disaggregated data and trade in different types of products (food or manufactures).

In 2002, Martínez-Zarzoso and Nowak-Lehmann analyzed Mercosur exports to the EU15 at 2-digit SITC level and found that different products have a different sensitivity to distance and underlined the importance of using disaggregate data instead of aggregated trade flows statistics.

In the paper by Hacker and Einarsson (2003), the gravity model was estimated for 2-digit level and 4-digit level of Combined Nomenclature (CN) in order to find any systematic pattern in the coefficient estimates related to industry (?!) type. The estimation results summarized in tables 6 and 7 brought to light that one traditional gravity variable – distance – was performing quite poorly with disaggregated data[27]. The authors'

[24] The lagged dependent variable was statistically significant at level of 0.001 and the authors define the magnitude of the «persistence effect» in line with the literature.

[25] Quoting Eichengreen and Irwin (1996): «Few aggregate economic relationships are as robust».

[26] The equations are estimated using cross section data for nine single-digit SITC commodity groups: food and live animals, beverages and tobacco, raw materials, fuels, animal and vegetable oils and fats, chemicals, manufactures classified chiefly by material, machinery and transport equipment, miscellaneous manufactures.

[27] Only in 7 per cent of cases, the coefficient for distance met the researchers' prior expectations.

comment under the table is noteworthy: «a large portion of individual regressions lack significance for most coefficient estimates».

Marques and Metcalf (2005) estimated four different sectoral gravity models for eight separate commodity groups between EU country groups[28]. They found out that the determinants of trade could differ greatly across sectors with different characteristics. The benchmark specification, which contained skilled/unskilled labor ratios in addition to the usual gravity variables performed quite well, but that might have been because of the aggregation of data into sufficiently large commodity categories.

In 2005, Baldwin et al. evaluated, for the first time, the impact of Europe's monetary union on sectoral trade using an augmented gravity specification and to estimate exchange rate uncertainty and volatility at sectoral level using a fixed-effect panel estimator for a number of ISIC 2- and 3-digit manufacturing sectors. Their study highlighted that the impact of EMU differed substantially across sectors.

The traditional specification of the gravity model was used by Sargento (2007) to estimate equations for 10 manufactured product groups. Table 1 summarizes her results: out of six estimated coefficients, most of them were not found statistically significant. Different equations were estimated[29] and the author concluded that « the gravity model generates quite good results when trade flows are known a priori, i.e., when the model is used with an explanatory purpose». Coefficients for each traded product category were quite variable. The distance coefficient tended to be higher for products with a high weight for the monetary unit. She concluded her paper saying that: «most of the time, the gravity model is used in the construction of larger models, like input-output models, which require product specific estimated values. […] This empirical test suggests that the gravity model is not the most adequate to generate undisclosed trade data».

4. Models, data and empirical results

The simplest gravity model assumes that the behavior of all individuals is identical over time and that all observations are homogeneous. Then k+1 coefficients are estimated on the pooled sample. The simplest

[28] The eight commodity groups are the following: chemicals, leather products, machinery, metals, minerals, textiles and clothing, transport equipment, wood products. The 27 EU countries are grouped into high- (i.e. Northern), middle- (Southern) and low-income (Eastern) countries with different skilled/unskilled labor ratios and different spatial and non-spatial trade costs. The 4 different types of gravity model were estimated both for exports as well as for imports.

[29] A spatial autoregressive model was tested, considering 3 different types of spatial dependence. In addition, 2 alternative non-spatial equations were estimated.

way to account for individual and/or time differences in behavior, in the context of a panel framework, is to assume that some of the regression coefficients are allowed to vary between individuals and/or over time. The dynamic specification includes the lagged dependent variable. Here four models (pooled, dynamic, FE, RE) were estimated for six countries at sectoral level in order to test the ability of this tool to produce forecasts at a sectoral level for single country models.

4.1 Data

This study uses bilateral trade data between six European Union countries – Italy, Germany, Austria, Estonia, Latvia and Lithuania – and a group of selected partner countries[30]. The data for Italy, Germany and Austria are available from 1995 to 2006, while the three Baltic countries have shorter time series (1999-2006). The disaggregated data are classified by CN, considering therefore 97 different product categories. A country's exports are evaluated in current €, the national GDP data is also expressed in current €[31]. All this data originates from Eurostat. The distance is calculated, as usual, between the capital cities of each country-pair.

4.2 Estimation results

To check the validity of the gravity model as a tool able to produce sectoral forecasts for country models, approximately 2300 regressions were run (388 for each exporting country). It is not feasible to show all the results here, even for a single country[32].

Trying to sum them up, it should be noted that if one looks solely at the model's fit and believes that its performance can be evaluated merely by looking at the significance of coefficients, the "best performing" specification was, undoubtedly, the dynamic one. In that case, parameters were usually highly significant, and it was really a pity that almost all the variability of current exports was explained by a country's past export performance (see figure 1).

[30] 29 trading partners are: 24 EU countries (statistics for Belgium and Luxembourg were summed), as well as U.S., Japan, Norway, Switzerland, and Turkey.

[31] Nominal or real values? Baldwin (2006) called the practice to deflate nominal values for GDP and exports in order to get real values the most frequent mistake in gravity equation estimation. As a matter of fact, the overwhelming majority of empirical works are done using values in real terms.

[32] The estimation results will be available on request.

Fig. 1. Comparison of the static and dynamic specification for Italy

```
. reg lex litgdppc lgdppc ldist

      Source |       SS       df       MS              Number of obs =     372
-------------+------------------------------           F(  3,   368) =   58.38
       Model |  254.379966     3  84.793322            Prob > F      =  0.0000
    Residual |  534.494281   368  1.45243011           R-squared     =  0.3225
-------------+------------------------------           Adj R-squared =  0.3169
       Total |  788.874247   371  2.12634568           Root MSE      =  1.2052

------------------------------------------------------------------------------
         lex |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
    litgdppc |   .4871855   .4371656     1.11   0.266    -.3724706    1.346842
      lgdppc |   .8649748   .0688605    12.56   0.000     .7295654    1.000384
       ldist |  -.3292437    .103555    -3.18   0.002    -.5328774   -.1256099
       _cons |   11.08351   4.328864     2.56   0.011     2.571097    19.59592
------------------------------------------------------------------------------

.
end of do-file

. reg lex L.lex litgdppc lgdppc ldist

      Source |       SS       df       MS              Number of obs =     341
-------------+------------------------------           F(  4,   336) = 13393.68
       Model |   695.03202     4  173.758005           Prob > F      =  0.0000
    Residual |  4.35897165   336   .01297313           R-squared     =  0.9938
-------------+------------------------------           Adj R-squared =  0.9937
       Total |  699.390991   340  2.05703233           Root MSE      =   .1139

------------------------------------------------------------------------------
         lex |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         lex |
         L1. |   .9848843   .0050919   193.42   0.000     .9748682    .9949003
    litgdppc |  -.0648603   .0543567    -1.19   0.234    -.1717826    .0420619
      lgdppc |  -.0285853    .008249    -3.47   0.001    -.0448115   -.0123591
       ldist |   .0095824   .0103733     0.92   0.356    -.0108225    .0299872
       _cons |   1.253876   .5408132     2.32   0.021     .1900695    2.317682
------------------------------------------------------------------------------

. capture log  close
```

Source: Stata 10 output, Author's calculations

Looking at sectoral regressions, it seems impossible to find any common characteristics for product groups. Looking at the results of three Western European countries (with the same length of time series and more similar economic structures) did not highlight any category of products by CN for which the gravity equation produced somewhat similar results. For example, the case of CN68 «Articles of Stone, Plaster, Cement, Asbestos or similar materials» is reported here for Italy and Germany.

It would seem reasonable that a heavy good which is difficult to transport such as cement should be a good example of the gravity model working well. However, these results did not support such theory . In the Italian case, almost all the variables were statistically significant, with the right signs and the RE model explained Italian cement exports well but in the second case, the gravity model was hardly able to explain anything. Unfortunately this was the case for many of the product groups. In the case of the Baltic countries, where the time series was shorter and some CN chapters present unexplainable buckets, the estimation results were even poorer making this tool completely unfeasible for providing any reasonable forecast.

Fig. 2. Results for CN68. Italy and Germany

Variable	random
litgdp	.0839
lgdp	1.13***
litpop	-5.4***
lpop	-.358***
ldist	-1.09***
_cons	112***
rho	.892

legend: * p<0.05; ** p<0.01; *** p<0.001

Variable	fix
leegdp	1.77
lgdp	-3.51*
leepop	-62.1
lpop	-11.9
ldist	0
_cons	1107
rho	.996

legend: * p<0.05; ** p<0.01; *** p<0.001

5. Concluding remarks

This paper takes a wide overview of previous gravitational studies and tries to find out if this tool can be used to produce sectoral forecasts for a single country model fed with this kind of information. In this case four different gravity models were used (pooled, dynamic, FE and RE model) but it appeared impossible to find a satisfactory common specification for a single country or for a specific product category. The dynamic specification almost always performed very well but left very little space for all the other explanatory variables, so that in practice it was just the same as applying a simple trend to current exports and there was no need to run a regression. The panel specification (FE and RE) models produced quite different results, sometimes good and sensible, sometimes completely misleading or unable to explain anything. The gravity equation was, therefore, found almost useless for my main aim: as a tool which worked well in making sectoral forecasts.

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ENERGY

PRICES OF ENERGY AND FOREIGN TRADE IN THE FRAMEWORK OF THE POLISH MODEL IMPEC

Michal Przybylinski[1]

1. Introduction

Energy carriers have become a crucial issue for policy makers in the XXth century. The new impulse for economic analyses and simulations concerning energy has been the increasing focus on the concept of sustainable development. Energy is now among the major focal points of economic studies and projections. Inforum models have a great potential for studies of the different aspects of interconnections between energy, the economy and the environment, especially for simulating alternative government policies (Henry and Stokes 2006; Hoerner *et al.* 2002; Meade, Werling 2007; Meyer, Ewerhart 1998).

This paper describes a new block of foreign trade equations for IMPEC – the multisectoral model of the Polish economy, based on the Inforum concept (Balcerak *et al.* 1997). The model was modified to enable analysis of how changes in world prices of basic energy carriers can influence the domestic economy, especially households. This research was supported by the Polish Ministry of Science and Higher Education as part of the project «Analyses of the economic and social impact of changes in energy prices in the Polish Economy»[2]. The general concept of the model developed for the purpose of this project is described in Boratynski *et al.* (2007).

The horizon for scenario analyses is 2020, which in the case of the energy market should be considered as short, given the very long investment cycle. Thus, the model should be prepared to investigate, above all, price effects and their influence on the economy. Despite the short term character of the scenarios planned for the project, the new foreign

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[2] The project started in March 2007 and is scheduled to run for 20 months. It is run in cooperation with Technical University of Lodz. Partners from TU are responsible for the preparation of scenarios of possible changes in energy prices and energy consumption.

trade equations would also explicitly include some long term relations. This would make it possible to use the model for projections of changes in the technology of energy production and consumption.

Below, the general concept of import and export equations and their connections with other parts of the model is given, together with the preliminary results of estimation.

2. Primary and secondary energy carriers

There are two types of energy carriers – primary (e.g. coal, oil and natural gas, but also renewable sources) – and secondary (e.g. electricity, thermal energy, fuel oils and gasoline). To be delivered to the market, energy is usually transformed from primary to secondary carriers, but some consumers, as well as some producers, use primary carriers directly (like coal or natural gas for heating). Thus, the prices of primary carriers are the base for calculating the prices of all products, even if producers only use secondary carriers.

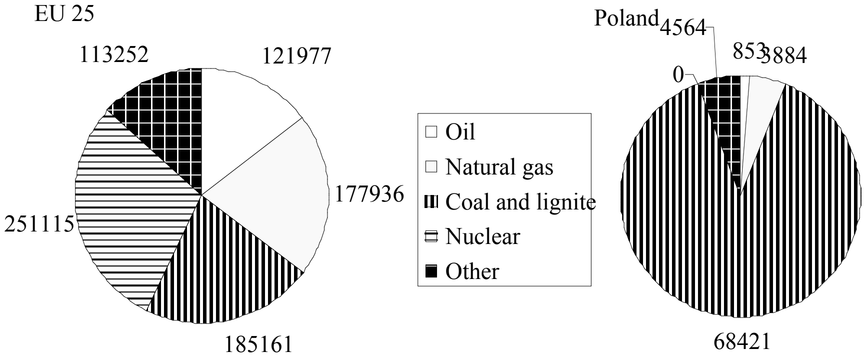
Scenarios will consider changes in prices both of primary and secondary energy carriers. The foreign trade part of the model will, however, concentrate on primary carriers, because the transformation from primary to secondary carriers is mostly done domestically and its cost depends on government regulations. Secondary energy carriers will be treated in the foreign trade block as 'normal' goods, and investigated in-depth in the domestic part of the model.

In Figure 1, the Polish 'pie' seems dramatically dominated by coal and lignite compared to the balanced structure of production in EU25. The obvious reason for this is the endowment of natural resources, but the small amount of 'other' (mostly considered 'clean') energy is another story.

The structure of production is reflected in the structure of consumption. Most electricity and heat in Poland comes from coal combustion. Of course, the structure of consumption is not so dominated by coal because of the need for oil refining. Poland seems to be more sensitive to changes in prices of coal than other European countries, and less sensitive to changes in prices of oil. As there are no nuclear power plants in Poland, prices of nuclear fuels don't affect the economy directly.

Table 1 shows that all energy carriers constitute less than 10 per cent of Polish imports. The most important energy carriers in the structure of imports are petroleum and natural gas. The share of this group (about 5–6 per cent) remains more or less stable over the whole period. This observation may lead to a conclusion, that the import of oil and natural gas rises according to the development of the whole economy Another important observation is that the import of electrical energy is not high enough to play a serious role in model simulations. However, this may change in the future.

Fig. 1. Production of primary energy in 2005 (in 1000 toe)



Source: Eurostat

Tab. 1. Energy carriers in the structure of Polish imports, current prices

Type of products	1996	1998	2000	2002	2004	2006
Coal and lignite; peat	0.22%	0.33%	0.10%	0.18%	0.14%	0.24%
Crude petroleum and natural gas; uranium and thorium	5.69%	3.75%	7.24%	5.86%	5.52%	5.92%
Coke, refined petroleum products and nuclear fuel	1.84%	1.37%	1.67%	1.58%	2.25%	2.77%
Electrical energy, gas; steam and water	0.04%	0.07%	0.03%	0.13%	0.08%	0.12%
Other foods	77.63%	82.04%	75.43%	77.96%	79.81%	78.34%
Services	14.58%	12.43%	15.53%	14.29%	12.21%	12.62%
	100%	100%	100%	100%	100%	100%

Source: Yearbooks of Foreign Trade Statistics, Balance of Payments NBP

Energy carriers play a much less significant role in the structure of exports than in the structure of imports. Their share in total exports is decreasing, mainly because of stagnation in the coal mining sector.

Under the communist regime, exports of this fuel was the main position in the Polish trade balance. The introduction of market mechanisms in Poland after 1989 led to the reduction of coal mining, accompanied by dynamic growth in the exports of processed goods. In 2006 coal and lignite did not even account for 1% of total Polish exports (see table 2).

To recapitulate, the Polish economy is based on domestically produced coal (and lignite), and imported petroleum and natural gas (about 1/3 of the demand for natural gas is met by domestic extraction).

Tab. 2. Energy carriers in the structure of Polish exports, current prices

Type of products	1996	1998	2000	2002	2004	2006
Coal and lignite; peat	3.36%	2.46%	1.76%	1.61%	1.59%	0.99%
Crude petroleum and natural gas; uranium and thorium	0.01%	0.01%	0.05%	0.18%	0.04%	0.09%
Coke, refined petroleum products and nuclear fuel	1.14%	1.17%	1.63%	1.69%	2.44%	2.12%
Electrical energy, gas; steam and water	0.35%	0.29%	0.34%	0.48%	0.49%	0.55%
Other foods	66.60%	68.33%	71.47%	76.41%	80.24%	80.62%
Services	28.54%	27.74%	24.74%	19.63%	15.19%	15.63%
	100%	100%	100%	100%	100%	100%

Source: Yearbooks of Foreign Trade Statistics, Balance of Payments NBP

3. General concept of the foreign trade block

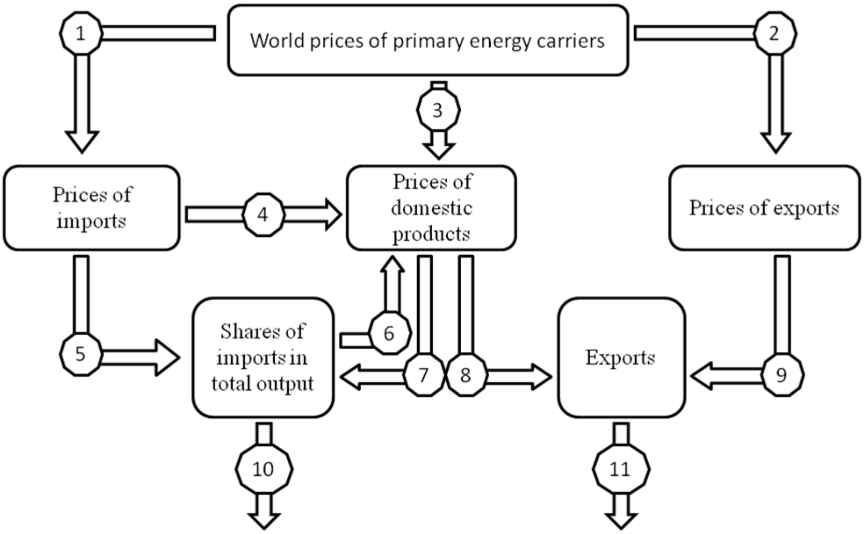
The foreign trade block of IMPEC consists of equations explaining the value of exports in constant prices and the shares of imports in total output. World prices, which are used as explanatory variables are usually treated as exogenous variables. For the purpose of this study, however, world prices should be investigated deeper and endogenized, to enable simulation of changes in energy prices and consumption per unit of output.

The most important feature of this part of the model is that it should ensure the consistency of scenarios regarding prices. Domestic prices are calculated in the framework of the model according to assumptions made about the rise in prices of different types of energy. Most energy resources are offered on the global market. If domestic producers suffer from the rise in prices of energy, so do their foreign competitors.

Both domestic and foreign producers experience the same price impulses, and the reaction of imports and exports rises in energy prices depends on the difference in technology of production between domestic and foreign goods, especially on the quantity and type of energy used per unit of output. As can be seen from Figure 1, this difference seems to be quite significant. Thus, the crucial point when calculating imports and exports is to assume a change in prices of imports in line with the changes in the prices of energy assumed for the domestic price equations.

The general idea of this part of IMPEC is shown in figure 2. The main exogenous impulses determining imports and exports are the world prices of primary energy carriers. They influence the prices of goods and services produced by Polish partners proportionally to their share in the cost structure of production. World prices of products are not to be considered, import and export deflators will be used instead.

Fig. 2. General concept of foreign trade part of IMPEC



Relations numbered in octagons are described below. The block is connected to the model most of all via the prices of domestic products, shown in figure 2. Prices of domestic products are determined by unit of value added, calculated inside the main part of the model. This link was omitted in figure 2.

The connection also exists on the 'real side'. Shares of imports are used to split the total output into imports and domestic production (octagon 10), exports as a component of final demand determine the total output (octagon 11).

4. Equations

The price of imports of product *i* is determined by the cost of primary energy used to produce a unit of output of this product. If there are K primary carriers, the general form of the equation explaining the import price of *i*-th product may be denoted as:

$$P_i^M = f(\sum_{k=1}^{K} P_k^C E_k W_k , F_i) , \tag{1}$$

where:
P_k^C – price of *k*-th primary energy carrier

E_k – technological index showing changes in energy production per unit of k-th primary carrier,
W_k – weight, share of k-th primary carrier in energy production,
F_k – technological index showing changes in energy consumption per unit of output of i-th product.

Distinguishing four factors determining the import price allows for short term as well as long term simulations. In the short term changes in prices (P_k^C) are not accompanied by changes in variables E, W, and F.

The place of the above equation in the framework of the model is marked in Figure 2 by the octagon numbered 1. Prices of exports may be calculated in the same manner (octagon 2 in figure 2).

Prices of primary energy sources are transferred into prices of domestic products by an I-O price equation (in the notation below capital letters are used for variables and small letters are used for coefficients, superscript D stands for domestic, and M - imported):

$$P_j^D = \sum_{i=1}^{n} a_{ij}^D P_i^D + \sum_{i=1}^{n} a_{ij}^M P_i^M + V_j \,, \tag{2}$$

where:
P^D- prices of domestic products (product described by the equation is denoted as j, i denotes products which are inputs for product j),
$\tilde{a}_{ij}^D$ - input-output coefficient, volume of domestic product i used per unit of output j,
$\tilde{a}_{ij}^M$ - input-output coefficient, volume of imported product i used per unit of output j,
$\tilde{V}_j$ - value added per unit of output.

Equation (2) should be modified to reflect the fact that the prices of imported intermediate goods affect the prices of domestic products according to the share of imports in total output:

$$P_j^D = \sum_{i=1}^{n} (a_{ij}^D + a_{ij}^M)(1 - s_{ij}) \frac{(1 - S_i)}{(1 - s_i)} P_i^D + \sum_{i=1}^{n} (a_{ij}^D + a_{ij}^M) s_{ij} \frac{S_i}{s_i} P_i^M + V_j \,, \tag{3}$$

where:

$$s_{ij} = \frac{a_{ij}^M}{a_{ij}^D + a_{ij}^M} \tag{4}$$

s_i- share of imports in total output for product i,
S_i - simulated share of imports in total output.

Relations described by equation (3) are marked in Figure 2 as octagons 4 and 6.

To simulate the shares of imports in total output (S_i) we use nonlinear function, which guarantees that these shares will never exceed 1. This form of equation was successfully exploited in previous versions of IMPEC (see Przybylinski, 2006):

$$\ln(S_i / (1 - S_i)) = \alpha_0 + \alpha_1 \frac{P_i^M T_i R}{P_i^D} + ... \tag{5}$$

where:
P_i^M – price of imports (world price),
T_i – import taxes etc.,
R – exchange rate,
P_i^D – domestic price.

Ellipsis means that in some cases additional explanatory variables should be added to catch the influence of factors specific to particular products. They may be classified as long term variables (time trend, total output, growth rate of total output) and short term dummies (0-1). Equation (5) is shown in octagons 5 and 7. Import taxes and exchange rates are omitted in Figure 2, as well as those additional variables.

Exports are described by typical demand-driven equations with price relations as the main instruments designed to be used in simulations:

$$Ex_i = f\left(\frac{P_i^W R}{P_i^D}, D_i, T\right), \tag{6}$$

where:
Ex_i – volume of exports,
P_i^W – world price,
R – exchange rate,
P_i^D – domestic price,
D_i – world demand (volume of world trade),
R– time trend.

Relations between the volume of exports and the relative price may be found in figure 2 as octagons 8 and 9. World demand is not shown there, this variable is purely exogenous.

5. The data and first results

The core of IMPEC is the input-output table, used for calculating output and prices. All other sections of the model should be consistent with it. For this version of IMPEC the input-output table was prepared in a product by product layout at the level of disaggregation considering 40 types of products and services (see Table 3).

The available foreign trade statistics are not very well fitted to the purposes of the model. The most popular SITC or CN differ from NACE, which is the basic classification used in national accounts and I-O tables. It is quite easy to find data on international trade, and it is quite easy to find data on domestic activities, but it is really hard to put them together.

The problem which plays an extremely important role in the case of foreign trade is the level of aggregation. Modeling of shares (or just the volume) of imports is very imprecise when a group of products consists of both tradables and non-tradables. For example, electrical energy, which is one of the products the project is focused on, is put with non-tradables (group 28 in table 3).

The starting point for creating the database was a set of make and use I-O tables for the period 1995-2002, prepared by the Polish Central Statistical Office (two of them were published). The layout of the tables changed each year, so it took a lot of work to make them consistent. They were represented in constant prices as well.

The data on imports and exports were then extended until 2005. The main source for that operation was the Statistical Yearbook of Foreign Trade. In addition, despite the fact that the Yearbooks were published by the Central Statistical Office, the data differ from those published in the I-O tables. The next set of I-O tables will be prepared for 2005, but it is not expected soon.

On the basis of these data, import shares equations (5) were estimated. The results are shown in table 4. The time period used in these calculations was short (1995-2005). The numbers in the first column correspond to the numbers in table 3. Available data allows for estimation of 20 equations. The most important reason for such aggregation was the complete lack of detailed data on the imports of services. Even the total is questionable; data from national accounts are quite different from those supplied by the National Bank of Poland. Here, both versions of equation for services were presented. Some industry commodities also had to be aggregated. Crude petroleum and gas were excluded from group 4 and treated separately with more attention. Water and its distribution (29) were classified as non-tradables, so the share of imports in total output was fixed as 0.

In most cases the results appear quite reasonable. Equations for groups 15, 20-23 and 26-27 do not fit well (low coefficients of determination) but, what is important from the point of view of future simulations, all price coefficients are negative. It should be stressed that these coefficients cannot be interpreted as price elasticities, but might be treated as their

Tab. 3. Product classification used in IMPEC (energy carriers outlined)

1	Products of agriculture and forestry
2	Products of fishing
3	Coal and lignite
4	Other mining products (including crude petroleum and natural gas)
5	Food products and beverages
6	Tobacco products
7	Textiles
8	Wearing apparel and furs
9	Leather and leather products
10	Wood and wood products
11	Pulp, paper and paper products
12	Printed matter and recorded media
13	Coke, refined petroleum products
14	Chemicals and chemical products
15	Rubber and plastic products
16	Other non-metallic mineral products
17	Basic metals
18	Metal products
19	Machinery and equipment
20	Office machinery and computers
21	Electrical machinery and apparatus
22	RTV and communication equipment
23	Medical, precision, optical instruments etc.
24	Motor vehicles, trailers and semi-trailers
25	Other transportation equipment
26	Furniture and other manufactured goods
27	Recovered secondary raw materials
28	Electrical energy, gas, steam and hot water
29	Water and its distribution
30	Construction works
31	Trade and repair services…
32	Hotel and restaurant services
33	Transport and communication
34	Financial intermediation (including insurance)
35	Real estate and business services
36	Public administration services
37	Education services
38	Health and social services
39	Other services
40	Households services

Tab. 4. Results of estimation of import shares equations (5)

No.	Group of products	Mean share 1995-2005	Price coefficient	Dummy variables	Long term variables	R2
1	Products of agriculture, hunting, forestry	0.09	-0.778	-	-	0.661
2	Fish and other fishing products	0.28	-2.033	2004-05 (+)	-	0.865
3	Coal and lignite	0.03	-4.970	2005 (+)	-	0.750
4	Crude petroleum and natural gas	-	-	-	-	-
4	Metal ores, other mining, quarrying products except of energy materials	0.32	-1.007	-	Growth rate of total output (+)	0.861
5-6	Food products, beverages and tobacco	0.09	-0.658	2004-05 (+)	Growth rate of total output (+)	0.918
7-8	Textiles, textile products and wearing apparel	0.35	-1.025	-	Linear trend (+)	0.988
9	Leather and leather products	0.40	-2.277	-	Log trend (+)	0.964
10	Wood and wood products	0.10	-1.541		Volume of total output (+)	0.925
11-12	Pulp, paper and paper products; recorded media	0.23	-0.819	2004-05 (+)	-	0.636
13	Coke, refined petroleum products and nuclear fuel	0.23	-1.777	-	Linear trend (+)	0.784
14	Chemicals, chemical products and man-made fibres	0.48	-0.387	-	Log trend (+)	0.937
15	Rubber and plastic products	0.32	-0.285	-	-	0.295
16	Other non-metallic mineral products	0.17	-0.241	1997-98 (+) 2004-05 (-)	-	0.952
17-18	Basic metals and fabricated metal products	0.25	-2.302	-	Volume of total output (+)	0.934
19	Machinery and equipment n.e.c.	0.48	-0.680	2005 (-)	Log trend (+)	0.852

(continued)

No.	Group of products	Mean share 1995-2005	Price coefficient	Dummy variables	Long term variables	R2
20-23	Electrical and optical equipment	0.51	-0.901	–	–	0.345
24-25	Transport equipment	0.37	-2.186	2005 (-)	Linear trend (+)	0.900
26-27	Manufacturing n.e.c.	0.18	-0.582	–	–	0.360
28	Electrical energy, gas; steam and water	<0.01	-1.303	–	Linear trend (+)	0.808
29	Water and its distribution	0	–	–	–	–
30-40	Services (National accounts)	0.02	-0.493	–	Volume of total output (+)	0.841
30-40	Services (Central bank)	0.02	-0.407	–	–	0.955

approximation. For groups 14, 15 and 16 price coefficients are close to 0, which means, that import shares in the case of these products are not very sensitive to price impulses. Low price coefficients were also noticed for services and other manufacturing (26-27). The sensitivity of imports of coal and lignite seems to be overestimated.

Dummy variables reflect the effect of joining the EU. In most cases they appeared to be statistically insignificant, because trade with the EU has gradually become more intensive over the last 15 years. Integration should be considered as one of the elements in the long term process of opening up the Polish economy, so it is expressed by long term variables.

Results of estimation are in line with economic theory, and this fact leads to an optimistic conclusion, that the Polish economy will become stable and predictable. This is promising from the point of view of model forecasts and projections. The ultimate verification of the equations presented will be their integration into the model.

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ENVIRONMENTAL EXTENSION OF INFORUM-TYPE MODEL FOR POLAND WITH USE OF NAMEA

Mariusz Plich[1]

1. Motivation

Sustainable development is a challenge for modelers and for national accounts builders. For many years national accounts and models of national economies have only concerned the economy. Social problems connected to the economy as well as the environmental pressure of the economy on the environment were not usually considered in this framework. The situation has changed since the Brundtland Commission report in 1987. The report underlined economic, social and environmental problems with the same importance and introduced the term of «sustainable development». The definition states that sustainable development is «development that seeks to meet the needs and aspirations of the present without compromising the ability to meet those of the future» (World Commission on Environment and Development 1987). This definition is now commonly known and used.

Sustainable development means that capital needed by humans must be maintained or stable – this is a necessary condition of sustainability. Needs and aspirations are satisfied by different types of 'capital'. Three categories of capital can be recognized[2]: human-made (machines, buildings, infrastructures), natural (renewable and non-renewable natural resources) and social (education, health, nutrition, culture, governance, etc.). They are attributed to three areas of human activity, i.e. the economy, environment and society. Thus three aspects of sustainability can be recognized: economic, environmental and social. Like the three areas of human activity, the categories of capital and the three aspects of sustainability are interlinked. They are usually strong complements but weak (or nil) substitutes. The main problem is the increasing scarcity of natural capital which is used by economy and society.

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[2] Some authors distinguish between «human» and «social» capital (see Serageldin, Steer 1994). Here, we do not make such a distinction.

Social sustainability relies on the education, health and nutrition of individuals but also on 'moral capital'. It requires maintenance and replenishment of shared values and equal rights, and of community, religious and cultural interactions. Without such a care it depreciates as surely as does physical capital (Goodland 1999).

Economic sustainability means that economic capital should be stable, but much more often Hick's definition of income is quoted to express it. It says that «income is the amount one can consume during a period and still be as well off at the end of the period». This definition underlines that the purpose of economic development is current consumption but it should not diminish consumption in the future.

Environmental sustainability means that natural capital must be maintained. It is important because it is needed by humans and originated because of social concerns. It seeks to improve humans welfare by protecting the sources of raw materials used for human needs and holding waste emissions within the assimilative capacity of the environment, so as not to be injurious to humans (Goodman, Daly 1996).

The Inforum-type model of the Polish economy IMPEC (Orłowski, Tomaszewicz 1991, Plich 2000) is being developed to deal with some aspects of sustainability connected with energy use and air pollution. In the paper we describe the extension of IMPEC's database which takes the form of NAMEA, i.e. national accounting matrix including environmental accounts. There are several reasons behind this and we shall explain them below.

NAMEA was developed by Statistics Netherlands at the end of the 1980s (Haan *et al.* 1994, Keuning S.J., A.E. Steenge 1999). It is a framework in which economic and environmental data, which are normally separate parts of the statistical system, are consistently organized. The core of the framework is composed of tables containing economic data from national accounts, presented in a matrix form and expressed in money terms. The environmental accounts consist of tables with data which are usually expressed in physical units. The hybrid structure means that there are no limits on the kind of environmental data put into NAMEA. All kinds of data on emissions (into the air, water or soil), the supply and use of energy as well as environmental assets, like subsoil assets or forests, can also be included.

The consistency of economic and environmental data in NAMEA makes it possible to calculate various indicators. For example, the Netherlands has a system of Environmental Policy Performance Indicators within 7 themes and goals set for each of these. The themes are: climate change, stratospheric ozone depletion, acidification, eutrophication, dispersion of toxic substances, disposal of solid waste and the disturbance of local environments, but the most advanced area of compilation of the environmental part of NAMEA concerns air emission. The original Dutch NAMEA is based on matrices that cover production and distribution issues, but Eurostat recommends a simplified approach based on supply-use or input-output tables for this purpose (see Eurostat 2004). This approach requires, however, detailed data on the industrial structure of environmental issues.

NAMEA not only provides an integrated summary picture of economy-environment interface, but also permits analytical investigations based on statistical, econometric as well as I-O approaches. The time path of the indicators created with use of NAMEAs may help assess results of the environmental policy aimed to measure human pressure on the environment. However, this type of analysis assumes that NAMEA time series are available. A database including such accounts – with substances measured in physical units – makes it possible to investigate interactions between the economy and environment. Input – output techniques are widely used in economic-ecological models because of their simplicity and clear depiction of links between elements in complex systems. The possibility of dividing the economy as well as the environment into many sectors is, however, crucial.

Now, all EU Members States are involved in the compilation of air emissions for NAMEA and some of them already produce and publish these data on an annual basis. In the data reported to Eurostat using standard tables or ones that are compatible with them, time series covering from half to almost all the 1990s for 8 of the most common atmospheric pollutants (3 greenhouse gases, 3 acid rain precursors plus NMVOC and CO) are available for 10 countries. Unfortunately, there is no official NAMEA for Poland so far.

The next two sections of the paper describe the background of the compilation of NAMEA and the efforts made to compile NAMEA for Poland. In the last section we present the results of analyses based on the data which has been collected so far.

2. Air pollution surveys and NAMEA

There is still no single standard method for evaluating air pollution. Among EU countries, there are basically two main approaches for compiling air emission accounts for NAMEA (see Eurostat 2003: 21):

1. based on energy accounts;
2. based on air emission inventories.

2.1 Surveys based on energy accounts

Some of the EU countries have a tradition of compiling energy accounts, and therefore emission accounts, in the context of national accounts.

In 4 of the EU countries – Denmark, Germany, Sweden and the United Kingdom – plus Norway, air emission accounts for NAMEA are mostly based on energy accounts data. On the 8 main pollutants currently included in NAMEA, 5 emission types – CO_2, SO_2, NOx, CO and, to a lesser extent NMVOC – are almost totally related to the combustion of fuel (see table 1). In this context, the relevant air emission data are calculated combining energy use industry-by-industry with relevant emission factors (see Eurostat, 2003: p. 21).

Tab. 1. Proportions of emissions stemming from fuel combustion (%)

Country	CO_2	CH_4	N_2O	SO_2	NO_x	NH_3	NMVOC	CO
Denmark	99.0	5.0	16.0	99.0	99.0	2.0	80.0	94.0
Germany	97.0	2.0	17.0	91.0	98.0	3.0	31.0	90.0
UK	95.0	3.5	14.0	98.0	99.0	–	37.0	99.0

Source: Eurostat 2003: 21

Taking into account anthropogenic sources only it is easy to prove that the energy processes produce most of the air pollution regardless of the methodology used in a survey. In this case, however additional data is necessary for

- non-fuel related emissions and
- directly-measured emissions within large industrial installations such as electric power plants.

Also, transport statistics could be used in both cases, since NAMEA emissions of national residents operating abroad and emissions of foreigners on the national territory, which are respectively to be included and excluded, mostly concern transport activities.

2.2 Air emission inventories

In the other countries, air accounts are based on air emission inventories. Therefore, emission data are reclassified using, on the one hand, the correspondence between categories of process-oriented classifications generally used by inventories and economic categories based on NACE plus households consumption categories used for NAMEA. On the other hand, when a category in the inventory is to be connected to several industries, data are allocated using factors such as fuel consumption, but also economic or technical information, whether it is included or not in the basic data of the inventory concerned. Below we quote some important comments from the NAMEA compilation guide (Eurostat 2003) throwing light on the possibility of transformation from classification-specific to air emission inventories to NACE classification.

Air emission inventories are process-oriented data whereas emission accounts are economically-oriented – they are presented according to the national account industry classification, where they are attributed to the economic agents actually carrying out the activity from which emissions derive. Secondly, inventories more or less cover national, territory-oriented data, whereas NAMEA takes into account data related to domestic economic activity, no matter where the national residents operate. Some of the totals in NAMEA differ from air emission inventories 'totals', mostly because of international transport activity.

When air accounts for NAMEA are not based on energy accounts, basic air emission data come from inventories usually produced for national purposes as well as international reporting obligations. In this context, producing an air emission account for NAMEA consists of arranging functionally classified or process-oriented data in order to make them fit into the NACE-based classification (plus households) adopted for NAMEA.

In nine of the EU countries – Belgium, Greece, Spain, France, Ireland, Italy, Luxembourg, Austria and Portugal – air emission accounts prepared for NAMEA are mostly based on emissions data from CORINAIR (CORe INventory of AIR emissions), in which they are classified according to the Selected Nomenclature for sources of Air Pollution (SNAP). Therefore, emissions registered in SNAP categories need to be connected to NACE-based industry or groups of industries, plus households consumption categories. Most of the SNAP categories concern a unique economic activity registered in only one NACE industry, but for a certain number of them, emissions have to be split into several industries of the NAMEA.

Air emission inventories prepared using the CORINAIR methodology are process-oriented. In the SNAP, most of the 6-digit level emissions are classified either according to the power developed by the combustion processes (combustion plants under the headings 01 and 02, plus most of those under heading 03), their technical characteristics (under the headings 04 and 05) or their condition of use (e.g. transport equipment and most of the other mobile sources under the headings 07 and 08). However, at different levels of the SNAP, many of the criteria taken into consideration clearly identify the concerned industries or could help to do so.

Most of the 4-digit level categories under the headings 01 and 05 are in fact rather economically oriented. Moreover, some of the 6-digit level sub-categories in the above-mentioned headings, as well as under the headings 06 and 09 are defined by the output of the processes.

Thanks to these pre-economic-oriented categories in the SNAP, for the main air pollutants commonly included in NAMEA, significant proportions of total CORINAIR emissions are straightforwardly attributed to a unique industry or to households. Table 2 shows these proportions for 3 of the countries. Despite the totals in CORINAIR and NAMEA not strictly corresponding because of differences in their respective coverage, these figures highlight the importance of the economic information that is in fact included in the SNAP, and therefore its relevance for the compilation of air accounts for NAMEA.

Tab. 2. Proportions of total CORINAIR emissions attributed to unique economic sector

Country	CO_2	CO_2 bio-fuel	CH_4	N_2O	HFCs	PFCs	SF6	SO_2	NO_x	NH_3	NM VOC	CO
France	53	–	99	95	100	100	100	81	43	99	62	53
Italy	74	98	92	93	–	–	–	91	50	99	50	24
Austria	83	–	99	95	–	–	–	74	86	99	98	86

Source: Eurostat 2003: 27

There is no standard connection between SNAP and NACE categories. Attribution of SNAP-based emission data to NACE-based accounts depends on the economic structure of the countries and on whether their NAMEA is based on economic accounts with homogenous branches or (heterogeneous) industries. However, in the comparison made below between France, Italy and Austria, it is nonetheless possible to observe many useful similarities.

This method of collecting data on air pollution for NAMEA looks more attractive than surveys based on energy accounts. However, in the Polish case the energy accounts approach is more reliable, because air emission inventories data is often published only in a two digit SNAP classification which is not sufficient for preparing NAMEA.

3. Data on the economy and environment in Poland

3.1 Sources and classifications used

Since the early 1970s the Polish Central Statistical Office (CSO) has been collecting environmental data. However up to the end of 1980s it was not published regularly. The contents of available publications has been extended and refined for years and they have constituted a good record of both environmental conditions and hazards in Poland for over three decades. However, from the point of view of economic-ecological analysis the following types of shortcomings of the data can be distinguished.

First, the data does not reveal the reasons of the phenomena presented because it is rarely disaggregated into economic sectors. There are no integrated economic-ecological data sources for Poland like NAMEA or SEEA[3] (United Nations *at al.* 2003). So far, Polish data on the environment and economy has been published independently. Moreover, sectoral classifications used for environmental data are (if any) usually different from economic ones, so an attempt to combine the sources requires aggregation of the data to common classification level and this means loss of information. Consequently, the data-based analysis cannot be as detailed as it could be if classifications were standardized at the stage of data collection.

Second, the environmental data published for different periods is hard to compare. This shortcoming is caused by two main factors:

- Parallel to the transformation of the Polish economy in the 90's many changes in the statistical system appeared, especially regarding the accounting system. The old MPS (Material Product System) was replaced by SNA. This means that many concepts and definitions as well as classifications and valuation methods have changed;
- Very often environmental data is not the result of direct observation but of estimation. In the 90's in Poland the methods of estimation, for example in the case of air emissions, were frequently modified.

Thirdly, Eurostat recommends the use of SNAP. There is no official data on some gases, like CO_2 in a detailed disaggregation which would be sufficient to transform data from SNAP to the NACE classification.

Three sources of data were used for the construction of the NAMEAs for Poland: input-output tables, energy balances and air emission by sectors.

Starting from 1990's, input-output tables were published in NACE classification at the two digit level (divisions). Two tables were officially released for 1995 and 2000. They distinguish 57 and 55 products/industries adequately.

The other source of data for the NAMEA are energy balances published both in natural and energy units. In Poland they are prepared by the Agency of Energy Market (EMA) and CSO. They contain data not only on commercially distributed energy carriers but also on autonomously produced and consumed energy. The balances are prepared using NACE sectors at the level of sections. For sections C, D and E more details are available on: divisions (D – manufacturing) and groups, i.e. three-digit classification (for C – mining and quarrying, as well as E – electricity, gas and water supply).

[3] System of Integrated Environmental and Economic Account.

Information on air emissions in Poland used in the model comes from the Energy Market Agency and is published in series entitled *Air Emission in Poland by Sector.* Air emissions are estimated using energy balances which are consistent with OECD rules, which means a different sectoral detail. In the publication, as many as 7 air pollutants are distinguished, namely: carbon dioxide (CO_2), carbon oxide (CO), sulphur dioxide (SO_2), nitrogen oxide (NO), methane (CH_4), nitrous oxide (N_2O) and non-methane volatile compounds (NMVOC).

Despite different systems of classification and levels of aggregation used in the source data, it was possible to standardize sectoral classification of the 3 data sources (economic data, energy use and emissions) to the level of 19 sectors – see table 3. Data on fuels were standardized to the level of 21 energy carriers.

Tab. 3. Aggregation codes to convert from 57 sectors classification to NAMEA (19) and NAMEA (8)

No.	NACE division	Sectors	NAMEA (19)		NAMEA (8)	
			Codes	Sector name	Kody	Sector name
1	1	AgrHunt	17	Agriculture	1	Agriculture
2	2	Foresrty	19	OthSectors	8	OthSectors
3	5	Fishing	19	OthSectors	8	OthSectors
4	10	CoalPeat	1	Coal	2	Mining
5	11	OilGas	2	OilGas	2	Mining
6	13	MetalOres	7	NEnMining	2	Mining
7	14	OthMining	7	NEnMining	2	Mining
8	15	FoodBever	14	Food	5	OthIndust
9	16	Tabacco	14	Food	5	OthIndust
10	17	Textiles	13	Textile	5	OthIndust
11	18	WearAppFurs	13	Textile	5	OthIndust
12	19	Leather	13	Textile	5	OthIndust
13	20	Wood	11	Wood	5	OthIndust
14	21	Paper	12	Paper	5	OthIndust
15	22	Printed	12	Paper	5	OthIndust
16	23	CokeRefPetr	4	CokeRaf	3	RafChMin
17	24	Chemicals	9	Chemicals	3	RafChMin
18	25	RubberPlastic	15	OtherManuf	5	OthIndust
19	26	OtherMineral	10	Mineral	3	RafChMin
20	27	Metals	5	Matals	4	Metals
21	28	MetalProd	6	Machinery	5	OthIndust

(continued)

No.	NACE division	Sectors	NAMEA (19)		NAMEA (8)	
			Codes	Sector name	Kody	Sector name
22	29	MachEquip	6	Machinery	5	OthIndust
23	30	OffMachComp	6	Machinery	5	OthIndust
24	31	ElectricalMach	6	Machinery	5	OthIndust
25	32	RadioTVcomm	6	Machinery	5	OthIndust
26	33	MedicalOptical	15	OtherManuf	5	OthIndust
27	34	MotorVehicles	8	TransEquip	5	OthIndust
28	35	OthTrans	8	TransEquip	5	OthIndust
29	36	FurnitOthManuf	15	OtherManuf	5	OthIndust
30	37	RecovSecRaw	15	OtherManuf	5	OthIndust
31	40	ElHwatSteGas	3	ElWatGas	6	Energy
32	41	ColdWat	3	ElWatGas	6	Energy
33	45	Construction	16	BuildInd	8	OthSectors
34	50	VehSaleRepairs	19	OthSectors	8	OthSectors
35	51	Wholesale	19	OthSectors	8	OthSectors
36	52	Retail	19	OthSectors	8	OthSectors
37	55	HotelRest	19	OthSectors	8	OthSectors
38	60	TranspLand	18	Transport	7	Transport
39	61	TranspWater	18	Transport	7	Transport
40	62	TranspAir	18	Transport	7	Transport
41	63	Tourism	19	OthSectors	8	OthSectors
42	64	PostTelecom	19	OthSectors	8	OthSectors
43	65	FinanciaInterm	19	OthSectors	8	OthSectors
44	66	InsurPensFund	19	OthSectors	8	OthSectors
45	67	FinanAux	19	OthSectors	8	OthSectors
46	70	RealEstate	19	OthSectors	8	OthSectors
47	71	RentMach	19	OthSectors	8	OthSectors
48	72	CompServ	19	OthSectors	8	OthSectors
49	73	ResDev	19	OthSectors	8	OthSectors
50	74	OthBusServ	19	OthSectors	8	OthSectors
51	75	PublicAdm	19	OthSectors	8	OthSectors
52	80	Education	19	OthSectors	8	OthSectors
53	85	Health	19	OthSectors	8	OthSectors
54	90	SewageServ	19	OthSectors	8	OthSectors
55	91	Membership	19	OthSectors	8	OthSectors
56	92	RecrCultSport	19	OthSectors	8	OthSectors
57	93	OthServ	19	OthSectors	8	OthSectors

3.2 NAMEAs for Poland

The first NAMEA for Poland was presented during the Montreal IIOA conference (in 2002) and then published (Plich 2003). It concerns the year 1995. To extend the analytical framework of the IMPEC model, time series of NAMEAs from 1995 to 2002 were built[4]. Additionally, data on emissions as well as data on energy was updated to 2005. In this section we present the basic principles of construction of Polish NAMEA using the example of the 1995 matrix (NAMEA '95). NAMEAs for the period 1996-2002 are built in a similar way.

The Polish NAMEA is based on the Danish solution (Jensen, Pedresen 1998) which is close to Eurostat recommendations. This means, specifically, that it is centered around the input-output table. The matrix is extended by adding rows and columns to show non-renewable domestic energy resources, energy use and air emissions caused by it. As in the Danish NAMEA environmental themes are also included.

In addition the level of sectoral aggregation used for NAMEA'95 differs from the Danish one, where as many as 117 sectors are distinguished whereas the maximum number of sectors for Poland is 20 (including households). Polish NAMEA '95 recognizes 7 types of air emissions, 21 energy carriers and 4 types of non-renewable energy resources: hard and brown coal, crude oil and natural gas.

Within NAMEA '95 different types of emissions are transformed into two indicators called Global Warming Potential (GWP) and Potential Acid Equivalents (PAE), which represent two environmental themes, i.e. the greenhouse effect and acidification. For GWP and PAE calculations the same weighting factors as in Denmark are used – see table 4.

Tab. 4. GWP and PAE weighting factors

	Greenhouse gases			Acid gases		
	CO_2	N_2O	CH_4	SO_2	NOx	NH_3
GWP	1	310	21	%	%	%
PAE	%	%	%	1/32	1/46	1/17

Source: Jensen and Pedersen 1998

Data on non-renewable energy resources given in statistical yearbooks in natural units has been converted into energy units (PJ) using the power values used in energy balances (see table 5).

[4] They are based on input-output tables for 1996-1999 and 2001-2002, prepared in the Department of Theory and Analyses of Economic Systems University of Lodz (not published, yet) by Ph.D. student Jakub Boratynski.

Tab. 5. Heating values of prime energy carriers applied to NAMEA.pl

Type of carrier	Heating value	Unit
Hard coal	22	PJ / 10^6 t
Brown coal	9	PJ / 10^6 t
Natural gas	30	PJ / km^3
Crude oil	42	PJ / 10^6 t

Source: Energy statistics 1997

Table 7 shows NAMEA '95. In the table the economy is aggregated into 8 sectors shown in table 6. The use of most of the energy carriers has also been aggregated into the matrix – only the carriers corresponding to the non-renewable energy resources are retained in the original form – their shares in the energy balance for Poland are high. Wood and Waste make up the group called «Renewable». All secondary energy carriers create one group called «Secondary».

Tab. 6. Classification of sectors in NAMEA '95 applied for presentation

No.	Sectors of NAMEA (8)	
	Abbreviation	Contents (sectors of NAMEA (19))
1	Agriculture	Agriculture
2	Mining	Coal, OilGas, NEnMining
3	RafChMin	CokeRaf, Chemicals, Mineral
4	Metals	Metals
5	OthIndust	Machinery, TransEquip, Wood, Paper, Textile, Food, OtherManuf
6	Energy	ElWatGas
7	Transport	Transport
8	OthSectors	BuildInd, OthSectors

The structure of NAMEA '95 differs from the Danish NAMEA scheme. This is caused in particular by the:

- unavailability of data on domestic inter-industry flows in basic prices (the flows contain imports and margins);
- unavailability of data on transboundary air pollution (both exports and imports);
- unavailability of data on non-energy emissions like ship bunkering, use of solvents, distribution of fossil fuels, waste treatment, disposal of fertilizers used in agriculture etc.

Tab. 7. NAMEA 1995 for Poland (aggregated to 8 sectors and 6 energy carriers)

	Output (mln z_)								FinalUse			Imports	OthSupply	Total	Reserves				Emission (1000 tons)							EnvThemes		TotalEm	
	Agriculture	Mining	RafChMin	Metals	OthIndust	Energy	Transport	OthSectors	PCE	Eksports	Other				HardCoal	BrownCoal	CrudeOil	NaturalGas	CO2	SO2	NOx	CO	N2O	CH4	NMVOC	GreenhEf	Acidific		
OpenStock															**1.324.026**	**127.332**	**189**	**4.380**											**OpenStock**
Agriculture	12.789	10	70	0	17.900	2	1	3.795	15.935	1.652	1.263	-3.433	-5.784	**44.199**					14.743	49	115	384	0,43	24,8	36	15.398	4		Agriculture
Mining	732	2.595	5.136	1.672	1.237	6.217	536	2.979	1.734	3.668	62	-6.386	-1.936	**18.246**					7.472	41	24	17	0,12	0,6	3	7.520	2		Mining
RafChMin	3.650	561	11.339	2.654	10.837	2.442	2.711	15.157	12.610	10.265	2.183	-13.128	-21.949	**39.332**					24.886	130	66	57	0,33	5,6	8	25.107	6		RafChMin
Metals	63	154	412	7.805	8.257	442	238	1.773	6	6.919	202	-2.771	-1.794	**21.705**					25.937	64	56	217	0,21	0,9	2	26.020	3		Metals
OthIndust	5.755	3.148	3.943	2.945	66.640	1.964	2.986	31.854	81.488	35.895	27.746	-36.942	-58.018	**169.404**					19.630	115	58	179	0,36	1,7	29	19.778	5		OthIndust
Energy	792	989	1.148	1.012	3.564	2.810	748	7.507	7.015	249	1	-21	-472	**25.341**					178.065	1.450	443	103	2,49	4,2	19	178.924	55		Energy
Transport	257	394	1.511	416	2.593	660	3.270	5.740	5.134	5.556	3	-2.508	-121	**22.903**					24.290	20	281	1.071	0,92	8,7	249	24.759	7		Transport
OthSectors	1.696	1.438	6.778	1.272	13.959	2.315	3.270	52.638	60.856	13.968	82.847	-5.746	50.259	**285.550**					8.804	34	11	247	0,16	16,2	16	9.195	1		OthSectors
Households																			51.710	177	40	1.597	0,92	129,1	98	54.708	6		Households
ValueAdded	18.464	8.957	8.996	3.929	44.417	8.490	9.143	164.108																					ValueAdded
Total	**44.199**	**18.246**	**39.332**	**21.705**	**169.404**	**25.341**	**22.903**	**285.550**	**184.776**	**78.172**	**114.306**	**-70.935**	**-39.815**	**626.681**															**Total**
HardCoal	61	77	536	140	202	1.106	9	17	317	837		-44		**3.257**	-3.257														HardCoal
BrownCoal	1	2	1	0	1	528	0	0	4					**538**		-538													BrownCoal
CrudeOil			560									-540		**20**			-20												CrudeOil
NaturalGas	0	6	114	30	15	49	0	9	160			-244		**140**				-140											NaturalGas
Secondary	120	51	361	289	137	129	399	113	403					**2.001**															Secondary
Renewable	19		5	0	24	1	0	11	105					**165**															Renewable
OthChanges																													OthChanges
Corrections															-13	-2	8	7											Corrections
TotEnergy	200	136	1.577	459	378	1.814	408	151	988	837				**6.948**	**-3.271**	**-540**	**-12**	**-133**											**TotEnergy**
CO2																										355.538		**355.538**	CO2
SO2																											65	**2.080**	SO2
NOx																											24	**1.094**	NOx
CO																												**3.870**	CO
N2O																										1.844		**6**	N2O
CH4																										4.025		**192**	CH4
NMVOC																												**459**	NMVOC
TotalEm*																			**355.538**	**2.080**	**1.094**	*3.870*	**6**	**192**	*459*				**TotalEm***
CloseStock															**1.320.755**	**126.793**	**177**	**4.247**											**CloseStock**
ReservChang															3.271	540	12	133											ReservChang
EnvThemes																										**361.407**	**89**		**EnvThemes**

* Emissions marked by italics are not included in theme calculations.

4. Factors of changes of greenhouse and acid gases emissions in Poland

Here we present the results of some analyses based on data collected for Polish NAMEAs. The analyses concern GWP and PAE indicators and aim at breaking down their growth rates into three factors: changes in output, energy intensity and emission coefficients.

The level of emission depends on economic activity and intensity of emission per unit output. If emission is caused by fuel combustion, this can be broken down further because emission per unit of output is a product of energy intensity and emission per unit of energy used for the process. This is shown in the following formula

$$Em = \frac{Em}{En} \cdot \frac{En}{Out} \cdot Out = em \cdot en \cdot Out$$

where

Em – emissions
En – energy use
Out – output
em – emission coefficient
en – energy intensity

Dividing emission taken for the year *t* by the emission taken for the base year *0* we obtain the relative changes of emission (index). The above equation can be changed to indices:

$$\frac{Em_t}{Em_0} = \frac{em_t}{em_0} \cdot \frac{en_t}{en_0} \cdot \frac{Out_t}{Out_0}$$

which can be written in the following form:

$$\dot{Em}_t^0 + 1 = \left(\dot{em}_t^0 + 1 \right)\left(\dot{en}_t^0 + 1 \right)\left(\dot{Out}_t^0 + 1 \right)$$

where

t – time
X_t^0 – growth rate of the variable *X* in the period from the year *0* to to the year *t*

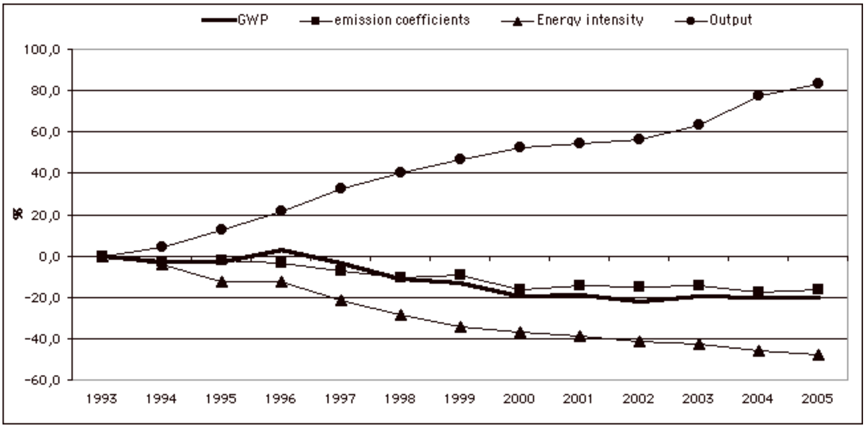
The last equation decomposes changes in emissions to changes in energy intensity emission coefficient and output. It was used to analyse changes in GWP and PAE in Poland in the period 1993-2005. Decomposition results are shown in table 8 as well as graphs 1 and 2.

In the period 1993-2005 in Poland, real output increased by over 80%, in other words 5.1% per year (see the line marked with circles at the graphs). Despite this significant increase in production, the analyzed indicators of environmental pressure, i.e. GWP and PAE decreased significantly. GWP decreased by 20.5% and PAE decreased by 45.4%, which gives a respective average of 1.6% and 3.2% per year. This was possible because of the substantial decrease in energy intensity as well as emission coefficients. Energy intensity decreased by 48% in the analyzed period, which means that the average yearly decrease was about 3.3%. Changes in emission coefficients were diversified in the period. In the case of GWP gases, emission coefficients decreased by16.5%, i.e. 1.3% on average per year. The decrease of coefficients of gases contributing to acidification was even more substantial – 42.7% over 12 years which gives a yearly average of 3%.

The permanent and significant decreases in energy intensity and emission coefficients in Poland lasting over a dozen years, were the results of the transition from a centrally planned economy to a market economy, which started in 1990. They are related on the one hand to changes in relative prices of energy carriers, especially at the beginning of transition, and on the other to changes in environmental policy.

Prices of energy carriers, like coal, crude oil or electricity increased over 15 times from 1990, while food only increased 6 times and investment products even less. The significant increase in the relative price of energy was a strong incentive for firms and households to save energy and is the explanation for the decrease in energy intensity.

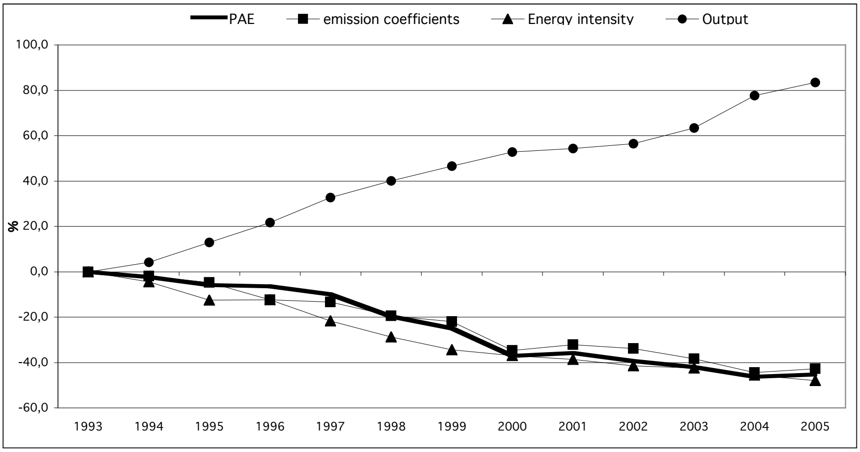
Graph. 1. Decomposition of GWP growth rates 1993-2005



Tab. 8. Changes in emissions, energy use and output in Poland 1993-2005

Specification			1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Greenhouse effect	GWP	10^6 t. of CO_2 equivalent	373	362	361	383	360	332	324	300	303	291	300	296	297
		growth rate compared to 1993 (%)	0.0	-3.0	-3.0	2.9	-3.5	-11.0	-13.0	-19.4	-18.8	-22.0	-19.6	-20.5	-20.4
	emission coefficients	10^3 t. of CO_2 / PJ	60.3	58.7	59.1	58.1	56.0	53.8	54.6	50.4	51.7	51.4	51.5	49.6	50.3
		growth rate compared to 1993 (%)	0.0	-2.6	-1.9	-3.6	-7.1	-10.8	-9.5	-16.3	-14.2	-14.8	-14.5	-17.7	-16.5
Acidification	PAE	10^3 t. of acid equivalent	94.4	92.2	88.8	88.3	84.9	75.8	70.8	59.3	60.6	57.2	54.7	50.7	51.6
		growth rate compared to 1993 (%)	0.0	-2.3	-5.9	-6.5	-10.0	-19.7	-25.0	-37.1	-35.8	-39.4	-42.0	-46.3	-45.4
	emission coefficients	10^3 t. of CO_2 / PJ	15.3	15.0	14.5	13.4	13.2	12.3	11.9	10.0	10.3	10.1	9.4	8.5	8.7
		growth rate compared to 1993 (%)	0.0	-2.0	-4.8	-12.3	-13.4	-19.5	-21.9	-34.7	-32.2	-33.8	-38.4	-44.4	-42.7
	Energy intensity	PJ / 10^3 zł	11.1	10.7	9.8	9.8	8.7	7.9	7.3	7.0	6.8	6.5	6.4	6.1	5.8
		growth rate compared to 1993 (%)	0.0	-4.4	-12.5	-12.3	-21.7	-28.8	-34.5	-36.9	-38.7	-41.5	-42.4	-45.7	-48.0
	Output	billion zł	555	578	627	675	736	777	814	848	857	869	907	986	1.018
		growth rate compared to 1993 (%)	0.0	4.2	12.9	21.7	32.7	40.0	46.6	52.7	54.4	56.5	63.5	77.7	83.4

Graph. 2. Decomposition of PAE growth rates 1993-2005



The decrease of emission coefficient was caused by an environmental charges policy. Environmental charges had already been introduced in Poland in the 1970's but in a centrally-planned economy the financial instruments failed due to the administered allocation of inputs and low price-responsiveness of economic agents. Given that in the 1970's and 1980's environmental policy was ineffective, the charges were always treated as 'too low' regardless of how high they really were (Zylicz 1994). It seems that the situation changed in the 1990's, when the transition from a centrally-planned to a market economy started. In 1990 and 1991 the high rate of inflation and the rule that the charges were collected after the end of the year in which they were assessed, meant that the situation did not change, despite very high fees introduced in 1990. Modified legislation, which became effective in 1992, caused emission coefficients to start to decline.

It is worth noticing, however, that the decline, both of energy intensity and of emission coefficients, was stronger in the 1990's than over the last several years. This means, that at present there are fewer and fewer possibilities of saving energy (by energy users) and decreasing emission coefficients (by those paying environmental charges), than at the beginning of the transition period. Taking into account a high growth rate of the Polish economy forecast for the future, one can expect that the pressure of the economy on the environment, which was quite stable at the beginning of this century (see table 8), will increase in the near future. The NAMEAs will be used to extend the IMPEC model to enable forecasts of such pressure to be made.

5. Conclusions

Usually, NAMEAs link input-output tables with energy use and data on air emissions. The big advantage of NAMEAs is the harmonization of classifications used to express flows between the economy and the environment. This facilitates environmental policy assessment. Air pollution is included in NAMEA with the use of emission inventories or energy accounts, but both methods are flawed to some extent, and must be supported by additional data sets.

The research presented in the paper concentrated on extending the analytical framework of the IMPEC by bringing together environmental accounts, energy accounts and economic accounts, in the form of NAMEA. The main problem of the construction of NAMEA for Poland is the limited availability of official data on input-output tables as well as data on pollution by sectors. Due to the scarcity of data, NAMEAs for Poland include only 19 industries, 7 air pollutants responsible for global warming and acidification, and concern the period 1995-2002.

The constructed NAMEAs were used for decomposition analyses of greenhouse gases and acid gases emissions. The decomposition proved that in the period 1993-2005, despite the high growth of production in Poland, the GWP indicator decreased by about 20% and PAE decreased by over 40%, which was possible because of the substantial decrease in emission coefficients and energy intensity, but these trends have weakened since 2000, which could increase pressure of the economy on the environment. This danger will be an area for research in the near future, in which the IMPEC model will be extended with the NAMEA database.

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ELECTRICITY CONSUMPTION DYNAMICS AND FORECASTS IN LATVIA

Velga Ozoliņa[1], *Remigijs Počs*[2]

Economic development is to a great extent connected with energy consumption. On the one hand, it is not possible to produce something or provide services without energy resources. On the other hand, a growing amount of production requires more energy.

Such relationship also holds between electricity consumption and GDP in Latvia, as seen in figure 1. One of the major electricity consumers in Latvia is industry: 42.5% of all the electricity in 1990 was consumed in this sector. After regaining its independence at the beginning of 1990's, Latvia's production potential decreased together with its power consumption not only in industry, but also in other sectors.

While different changes occurred in the economy, the share of industry in electricity consumption gradually fell to 31.8% in 2006 (see figure 2). Compared to other electricity consumer groups, industry is still the most important power consumer.

Electricity consumption in industry is largely connected with the amount of produced goods. Power consumption in industry (C+D+E)[3] fell together with the decline in output as seen in figure 3. The greatest drop in electricity consumption in industry, as in the dynamics of total electricity consumption, was observed in 1992 and 1993, when the amount of consumed power decreased by 20.8% and 23.9% respectively. In 1990-2005 there are similar trends in electricity consumption and output dynamics – output grows or declines together with consumption, with exceptions in 1998, 2000 and 2002.

In most branches of industry electricity consumption has decreased, most of all in the manufacture of chemicals and chemical products (D24) – by -491 GWh – and in the manufacture of fabricated metal products, machinery and equipment, electrical machinery and apparatus and radio,

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[3] Here and further in the brackets – industries and branches by NACE – Classification of Economic Activities in the European Community.

Fig. 1. Dynamics of electricity consumption and GDP in Latvia

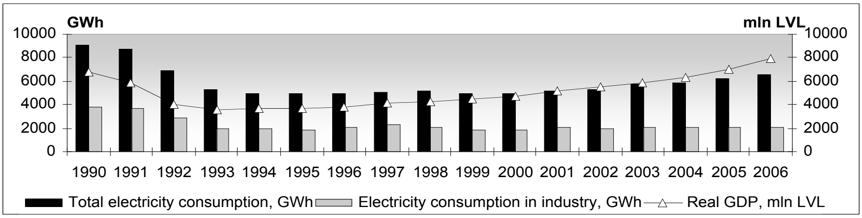


Fig. 2. Structure of electricity consumption in 2005, %

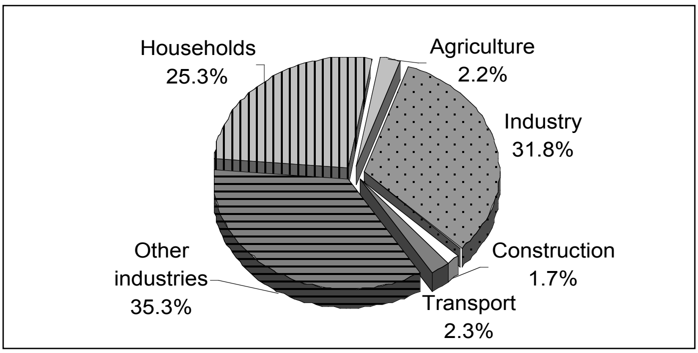
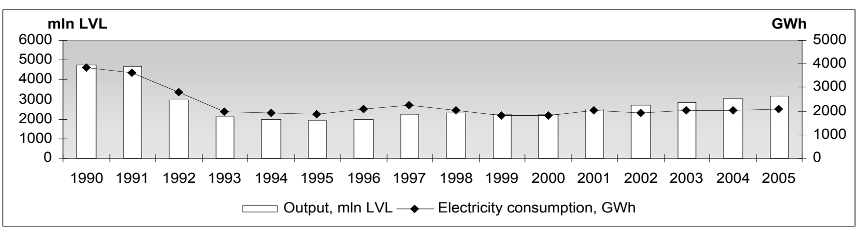
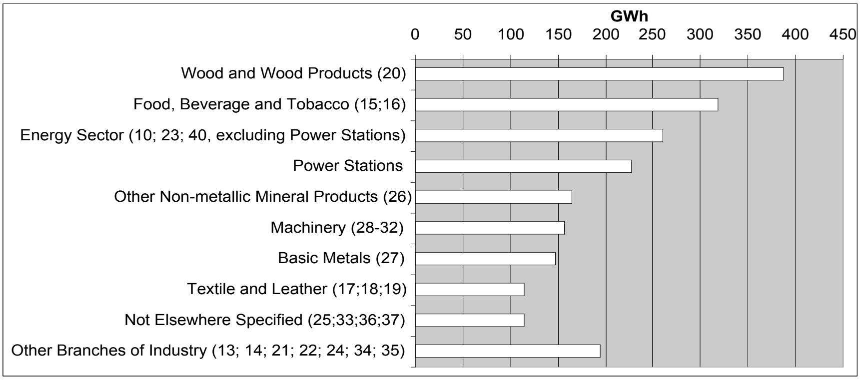


Fig. 3. Electricity consumption and output in industry



television and communication equipment and apparatus (D28-D32) – by -450 GWh – branches which in 1990 were the largest electrical power consumers. During this period electricity consumption grew only in the manufacture of basic metals (D27) and the manufacture of rubber and plastics products, medical and surgical equipment and orthopaedic appliances, furniture, manufacturing n.e.s. and recycling (D25; D33; D36; D37). A comparatively large increase can be observed in the manufacture of wood and wood products (D20), which in 2005 became the major electricity consumer at 388 GWh (see figure 4).

Fig. 4. Electricity consumption in the branches of industry in 2005



An analysis of the elasticity coefficients of electricity consumption to industrial output, given in table 1, shows that the values of these coefficients in most branches of industry are decreasing. This may indicate a tendency towards a more efficient use of electricity in the production process. A decline is particularly evident in the manufacture of other non-metallic mineral products (D26) and the manufacture of chemicals and chemical products (D24). A decrease in the value of the coefficient in the manufacture of chemicals and chemical products (D24) is stepwise – larger falls (in 2000 and 2005) interspersed with smaller ones. A similar situation can be observed in the manufacture of textiles, wearing apparel and dressing (D17 – D19), where in 1999 the value of the coefficient actually increased substantially.

The coefficients in the manufacture of wood and wood products (D20) and in the manufacture of motor vehicles, trailers and semi trailers and other transport equipment (D34; D35) do not follow a clearly decreasing trend – the values rather level out. However, a small increase in the values of these coefficients is evident in the manufacture of pulp, paper and paper products and publishing and printing (D21; D22).

An evaluation of relations between electricity consumption and output in separate branches of industry follows.

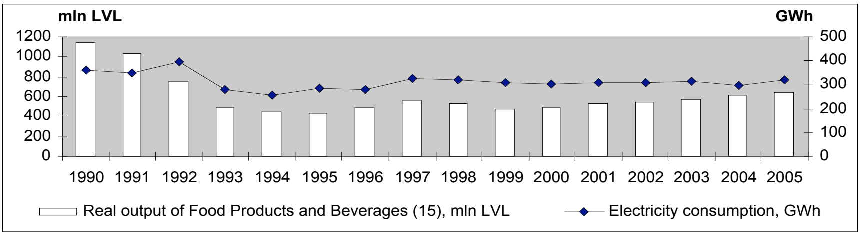
In the manufacture of food products, beverages and tobacco products (D15; D16), which is one of the major electricity consumers in industry, the relationship between electricity consumption and industrial output is pretty close, as seen in figure 5. However, the output of the manufacture of food products and beverages (D15) in 1992-1995 dropped significantly – by more than 60% while electricity consumption in this branch together with the manufacture of tobacco products fell by only 20%. This can be explained partly by the fact that output is given only for the

Tab. 1. Coefficients of Electricity Consumption to Industrial Output in the Branches of Industry, kWh/LVL (at prices of 2000)

Branches of Industry	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Food, Beverage and Tobacco[1] (15–16)	0.656	0.574	0.590	0.597	0.640	0.612	0.594	0.560	0.543	0.483	0.490
Textile and Leather (17-19)	1.723	1.477	1.483	1.379	1.609	1.504	1.435	1.457	1.358	1.196	0.650
Wood and Wood Products (20)	1.054	0.869	0.796	0.773	0.807	0.812	0.843	0.720	0.690	0.721	0.760
Pulp, Paper and Printing (21; 22)	0.594	0.507	0.241	0.178	0.222	0.303	0.226	0.297	0.299	0.316	0.288
Chemical, incl. Petrochemical (24)	2.259	2.032	1.857	1.799	1.854	1.413	1.352	1.259	1.276	0.962	0.922
Other Non-metallic Mineral Products (26)	2.785	2.459	2.877	2.128	1.854	1.874	1.568	1.357	1.217	0.990	1.245
Machinery[2] (28–32)	1.115	1.129	0.898	0.954	1.151	0.983	1.025	0.749	0.635	0.599	0.569
Transport Equipment (34; 35)	1.260	1.596	1.965	1.834	1.747	1.331	1.456	1.360	1.428	1.144	1.227

[1] To industrial output in manufacture of food products and beverages (15)
[2] Industrial output does not include manufacture of office machinery and equipment (30)

Fig. 5. Indicators of manufacture of food products, beverages and tobacco products



manufacture of food products and beverages (D15)[4], but electricity consumption is also given for the manufacture of tobacco products (D16). The coefficient of correlation between these indicators in 1990-2005 is 0.729, which indicates a comparatively close relationship.

The dynamics of electricity consumption and output in the manufacture of textiles, wearing apparel, furs, leather and leather products (D17-D19) is not fully consistent. For example, in 2003-2005 along with the increase in output, electricity consumption fell, as shown in figure 6. The value of the coefficient of correlation in 1995-2003 is quite high – 0.904. However, in 2004 and 2005 electricity consumption fell sharply together with the increase in output. Such a dramatic change can be explained by the fact that after accession to the EU in 2004, competition in some sectors increased to the extent that it was no longer profitable to produce goods which required a substantial use of energy.

In contrast to the majority of branches of industry, the output of which decreased dramatically in 1991-1993, in the manufacture of wood and wood products (D20) the decline was negligible, as shown in figure 7. Moreover, starting in 1993 output in this branch grew. Electricity consumption since 1993 has also increased and only declined in 2002. The coefficient of correlation between output and electricity consumption in 1990-2005 is 0.980, which indicates a close relation between these indicators.

Output in the manufacture of chemicals and chemical products (D24) in 1992-2000 declined (a small increase may be observed in 1997) and thereafter has mainly increased, as seen in figure 8. Similar trends are also present in electricity consumption dynamics in this branch, however, since 2002 tendencies in both time series differ. As the value of the coefficient of correlation for 1990-2005, which is 0.971, indicates a close relationship between these indicators, output can be used as a factor influencing electricity consumption.

[4] The database of the Central Statistical Bureau of Latvia does not provide information on gross industrial output indices of branches 16., 23., 27., 30., 33. and 37. by NACE classification.

Fig. 6. Indicators of manufacture of textiles and leather

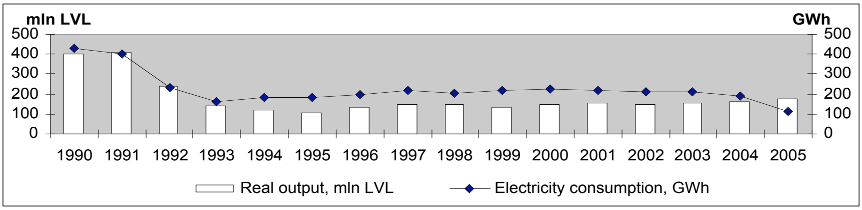


Fig. 7. Indicators of manufacture of wood and wood products

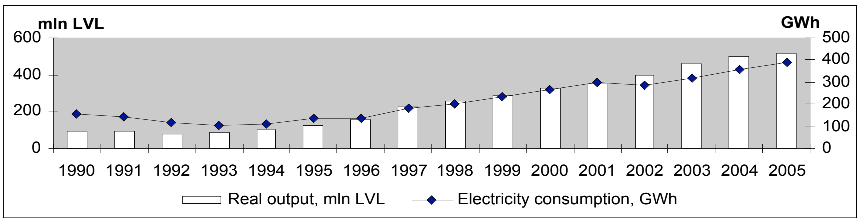
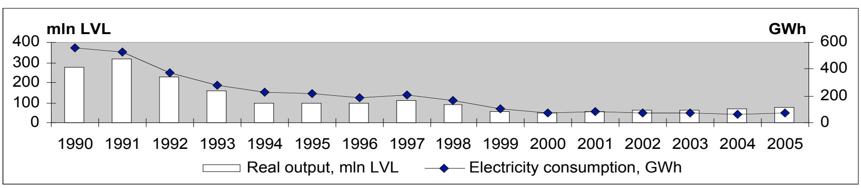


Fig. 8. Indicators of manufacture of chemicals and chemical products



In the manufacture of other non-metallic mineral products (D26) the dynamics of electricity consumption and output are similar (see figure 9). Since 2001 output has increased much faster than electricity consumption, which in 2004 did not change at all, compared to 2003. The coefficient of correlation for 1990-2005 is 0.978, therefore the relationship between these indicators exists.

An analysis of electricity consumption and output in the manufacture of fabricated metal products, machinery and equipment, electrical machinery and apparatus and radio, television and communication equipment and apparatus (D28-D32) reveals that the dynamics of these time series differ only in 1991, 1996 and 2002 (see figure 10). The value of the coefficient of correlation, which was 0.967 in 1990-2005, confirms that there is a possible relationship between these indicators.

Up until 1998 electricity consumption in the manufacture of rubber and plastics products, medical and surgical equipment and orthopaedic

Fig. 9. Indicators of manufacture of other non-metallic mineral products

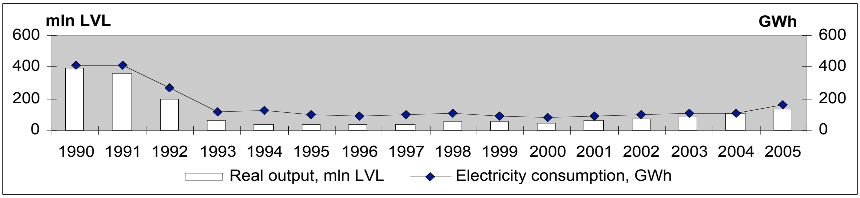


Fig. 10. Indicators of manufacture of machinery

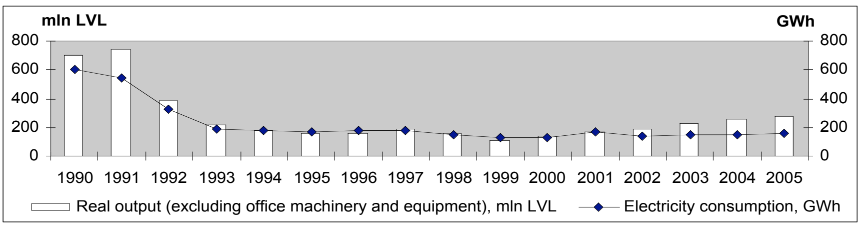
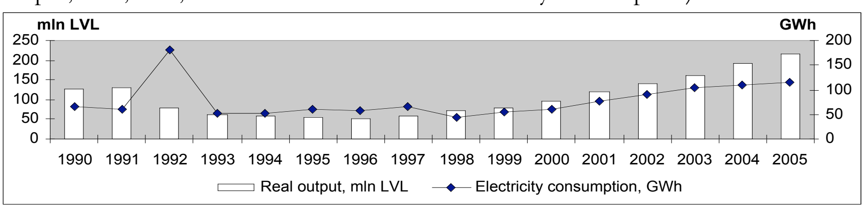


Fig. 11. Indicators of manufacturing not elsewhere specified (D25 and D36 branches in output, D25, D33, D36 and D37 branches in electricity consumption)



appliances, furniture, manufacturing not elsewhere specified and recycling (D25; D33; D36; D37) does not seem to relate to output in the manufacture of rubber and plastics products and furniture and manufacturing not elsewhere specified (D25; D36), but after 1998 these indicators show similar trends, as seen in figure 11. Moreover, it seems that there may be some kind of mistake in statistical data in 1992. However, the existing relationship between these variables is substantiated by the coefficient of correlation, which in 1993-2005 was 0.943.

During the analysis some other factors, which might influence electricity consumption, were considered. First of all, the possible influence of government policy was analysed. In different policy documents, the government states that its aim is to facilitate an improvement in energy efficiency. However, there are no particular measures taken in order to ensure that. There are no energy taxes (except for excise tax on oil products), which would make enterprises think about more effective energy consumption. There are also no incentives, which would motivate investments in energy saving projects.

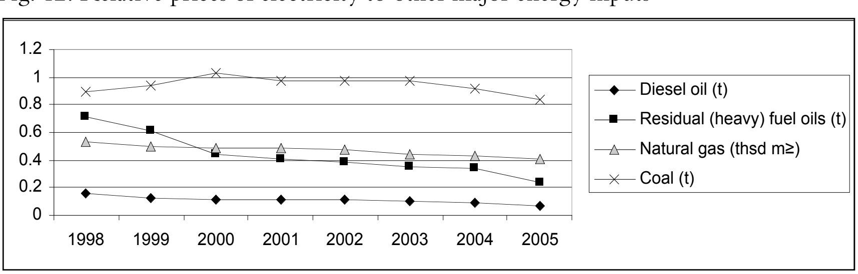
As electricity in Latvia is provided by the state-owned enterprise Latvenergo, which is a monopoly in this sphere, the government controls decisions regarding the price of electricity. Therefore the price of electricity is relatively stable, for example, in 1999-2003 it was 32 LVL per MWh. However, since 2004 the price of electricity has been rising.

If we compare the price of electricity with the prices of other major types of energy in the manufacturing sector (see figure 12), we can see that the relative price of electricity in 1998-2005 basically decreased. This factor has encouraged enterprises to use electricity rather than other energy sources. However, this factor was not included in equations for several reasons. Firstly, it does not improve the statistical description of equations. Secondly, it is hard to predict the future values of relative prices as energy price equations are not included in the model. And thirdly, official statistics on energy prices in manufacturing are only available from 1998, therefore they reduce the sample of equations.

As a result, the energy block of the Latvian INFORUM model (Auziņa, Počs (2007), Auziņa (2006)) was made, taking into account the close relations between electricity consumption and output in most branches of industry as well as some trends towards more efficient use of energy. At the moment, the energy block has to be considered as an external block of the Latvian INFORUM model as it provides no feedback to the relations described in the basic part of the model, but only uses the output generated by the model. A description of equations estimated for electricity consumption, are given in tables 2-14 (R^2 – coefficient of determination, DW – Durbin-Watson criterion, in square brackets – sample). Where necessary, trend factor (1990 = 1) was used in the equations.

In the equations for electricity consumption industrial output indicators are used, but in the INFORUM model there are indicators of output from National Accounts. In order to use output forecasts obtained with

Fig. 12. Relative prices of electricity to other major energy inputs



Tab. 2. Equation of electricity consumption in mining and quarrying

Variable	Coef.	t-stat.	Description
elect_013			Electricity consumption in mining and quarrying (excluding mining of coal and lignite; extraction of peat).
Intercept	5.86*	6.9	
out_c	0.0961*	3.4	Real industrial output of mining and quarrying.
R^2 = 0.51; DW = 1.87 [1994 – 2006]			

* significant at the 0.01 level. ** significant at the 0.05 level.

Tab. 3. Equation of electricity consumption in manufacture of food products, beverages and tobacco products

Variable	Coef.	t-stat.	Description
log(elect_015)			Electricity consumption in manufacture of food products, beverages and tobacco products.
Intercept	3.86*	9.5	
log(out_015)	0.2953*	4.6	Real industrial output in manufacture of food products and beverages.
R^2 = 0.61; DW = 2.08 [1990 – 2005]			

* significant at the 0.01 level. ** significant at the 0.05 level.

Tab. 4. Equation of electricity consumption in manufacture of textile and leather

Variable	Coef.	t-stat.	Description
log(elect_017)			Electricity consumption in manufacture of textile and leather.
Intercept	2.25*	4.5	
log(out_s017)	0.6181*	6.3	Real industrial output in manufacture of textile and leather.
d_04p	-0.4258*	-3.9	Dummy [1990-2003] = 0, otherwise = 1
R^2 = 0.81; DW = 1.98 [1990 – 2005]			

* significant at the 0.01 level. ** significant at the 0.05 level.

Tab. 5. Equation of electricity consumption in manufacture of wood and wood products

Variable	Coef.	t-stat.	Description
elect_020			Electricity consumption in manufacture of wood and wood products.
Intercept	43.61*	3.5	
out_020	0.6432*	15.1	Real industrial output of wood and wood products.
R^2 = 0.97; DW = 1.48 [1995 – 2005]			

* significant at the 0.01 level. ** significant at the 0.05 level.

Tab. 6. Equation of electricity consumption in pulp, paper and printing

Variable	Coef.	t-stat.	Description
log(elect_021)			Electricity consumption in pulp, paper and printing.
Intercept	1.30★	3.6	
log(t)	0.8716★	6.2	Time trend (t = 1, 2, 3,…n).
R^2 = 0.83; DW = 2.39 [1997 – 2006]			

★ significant at the 0.01 level. ★★ significant at the 0.05 level.

Tab. 7. Equation of electricity consumption in chemical, incl. petrochemical manufacturing

Variable	Coef.	t-stat.	Description
log(elect_024)			Electricity consumption in chemical, incl. petrochemical manufacturing.
Intercept	0.7793★	6.1	
log(out_024)	3.69★	5.1	Real industrial output of chemical, incl. petrochemical manufacturing.
log(t)	-1.00★	-9.4	Time trend (t = 1, 2, 3,…n).
R^2 = 0.98; DW = 1.83 [1995 – 2005]			

★ significant at the 0.01 level. ★★ significant at the 0.05 level.

Tab. 8. Equation of electricity consumption in manufacture of non-metallic mineral products

Variable	Coef.	t-stat.	Description
elect_026			Electricity consumption in manufacture of non-metallic mineral products.
Intercept	101.38★	6.8	
out_026	1.17★	4.2	Real industrial output of non-metallic mineral products.
t	-6.67★★	-2.5	Time trend (t = 1, 2, 3,…n).
R^2 = 0.79; DW = 2.11 [1995 – 2005],			

★ significant at the 0.01 level. ★★ significant at the 0.05 level.

Tab. 9. Equation of electricity consumption in manufacture of basic metals

Variable	Coef.	t-stat.	Description
log(elect_027)			Electricity consumption in manufacture of basic metals.
Intercept	3.45★	33.0	
log(t)	0.5676★	13.4	Time trend (t = 1, 2, 3,…n).
R^2 = 0.96; DW = 2.41 [1997 – 2005]			

★ significant at the 0.01 level. ★★ significant at the 0.05 level.

Tab. 10. Equation of electricity consumption in machinery

Variable	Coef.	t-stat.	Description
log(elect_028)			Electricity consumption in machinery.
Intercept	3.38*	8.9	
log(out_s028)	0.4619*	7.8	Real industrial output of machinery (excluding office machinery and equipment).
log(t)	-0.3183*	-7.8	Time trend (t = 1, 2, 3,…n).
R^2 = 0.97; DW = 1.61 [1990 – 2005]			

* significant at the 0.01 level. ** significant at the 0.05 level.

Tab. 11. Equation of electricity consumption in manufacture of transport equipment

Variable	Coef.	t-stat.	Description
log(elect_034)			Electricity consumption in manufacture of transport equipment.
Intercept	3.55*	10.7	
log(out_s034)	0.3608*	4.7	Real industrial output of manufacture of transport equipment.
log(t)	-0.3053*	-5.6	Time trend (t = 1, 2, 3,…n).
R^2 = 0.88; DW = 1.85 [1995 – 2005]			

* significant at the 0.01 level. ** significant at the 0.05 level.

Tab. 12. Equation of electricity consumption in other industry branches

Variable	Coef.	t-stat.	Description
elect_037			Electricity consumption in other industry branches.
Intercept	27.97*	4.0	
out_s037	0.4160*	7.7	Real industrial output in manufacture of rubber and plastics products and manufacture of furniture; manufacturing not elsewhere specified.
R^2 = 0.88; DW = 1.56 [1996 – 2005]			

* significant at the 0.01 level. ** significant at the 0.05 level.

Tab. 13. Equation of electricity consumption in energy sector

Variable	Coef.	t-stat.	Description
elect_010			Electricity consumption in energy sector (excluding power stations).
Intercept	184.77*	4.3	
(1/t2)	21228.31*	5.2	Time trend (t = 1, 2, 3,…n).
R^2 = 0.77; DW = 2.36 [1996 – 2004]			

* significant at the 0.01 level. ** significant at the 0.05 level.

Tab. 14. Equation of electricity consumption in power stations

Variable	Coef.	t-stat.	Description
d(elect_energo)			Electricity consumption in power stations.
Intercept	-3.80	-0.6	
d(elect_r_tot)	0.0088***	1.5	Total electricity production.
d_95	83.14*	-3.9	Dummy (1995 = 1, otherwise = 0)
d_03	83.80*	4.0	Dummy (2003 = 1, otherwise = 0)
R^2 = 0.79; DW = 1.86 [1992 – 2005]			

* significant at the 0.01 level. *** significant at the 0.2 level.

the INFORUM model to evaluate the future output of the branches of industry, conversion coefficients were used (see table 15).

In most branches the values of conversion coefficients for future years were set at the level of 2005. In branches where these values show a stable decrease – the manufacture of textiles (D17), manufacture of pulp, paper and paper products (D21), manufacture of machinery and equipment (D29), manufacture of other transport equipment (D35) and the manufacture of furniture, manufacturing not elsewhere specified (D36) – the values of conversion coefficients keep declining until 2020.

Forecasts of average growth rates of output in branches of industry for 2006-2020 obtained with the INFORUM model are presented in table 16. After adjustment of the output values, these indicators are incorporated into the electricity consumption block of the model as exogenous variables.

The main base-scenario assumptions of the Latvian INFORUM model are as follows: government expenditures average annual growth rate is 3%, non-profit organisations serving households average annual growth rate is close to the average total household expenditure growth rate, and changes in stocks are close to zero in the long-run. Household expenditures are modelled by estimated regression equations. Exports of goods are modelled by estimated exports development indexes (Grassini, Parve 2007), it is assumed that the annual average growth rate of exports of services is close to the annual average growth rate of total exports of goods. Sectoral imports are modelled by import shares questions on the basis of statistical data analysis and expert estimates regarding further development trends. Sectoral output is modelled via the input-output relationships.

According to such prognoses, electricity consumption in mining and quarrying (C13; C14) will grow from 11 GWh in 2005 to approximately 22 GWh in 2020, as shown in figure 13. The corresponding growth rate would therefore be about 4.5% a year.

Tab. 15. Conversion coefficients of industrial output indicators

Branches of Industry	2000	2001	2002	2003	2004	2005
Manufacture of food products and beverages (D15)	0.917	0.753	0.764	0.797	0.829	0.792
Manufacture of textiles (D17)	0.916	0.769	0.667	0.631	0.560	0.520
Manufacture of wearing apparel; dressing and dyeing of fur (D18)	0.434	0.321	0.266	0.235	0.238	0.188
Manufacture of leather and leather products (D19)	0.613	0.168	0.127	0.105	0.125	0.114
Manufacture of wood and wood products (D20)	0.873	0.862	0.889	0.928	0.895	0.725
Manufacture of pulp, paper and paper products (D21)	0.769	0.724	0.709	0.651	0.565	0.513
Publishing, printing and reproduction (D22)	0.881	0.913	0.808	0.819	0.814	0.781
Manufacture of chemicals and chemical products (D24)	0.835	0.537	0.544	0.511	0.559	0.571
Manufacture of rubber and plastic products (D25)	0.904	1.180	1.313	1.620	1.923	2.010
Manufacture of other non-metallic mineral products (D26)	0.704	0.753	0.839	0.888	0.921	0.961
Manufacture of fabricated metal products, except machinery and equipment (D28)	0.789	0.780	0.737	0.880	0.837	0.800
Manufacture of machinery and equipment not elsewhere specified (D29)	1.000	0.937	0.907	0.874	0.840	0.710
Manufacture of electrical machinery and apparatus (D31)	0.912	1.028	1.163	1.222	1.129	1.090
Manufacture of radio, television and communication equipment and apparatus (D32)	1.079	1.190	1.224	1.746	1.394	1.050
Manufacture of motor vehicles, trailers and semi-trailers (D34)	0.776	0.920	0.979	1.164	1.565	1.079
Manufacture of other transport equipment (D35)	0.946	0.576	0.494	0.397	0.331	0.295
Manufacture of furniture; manufacturing not elsewhere specified (D36)	0.948	0.889	0.885	0.773	0.724	0.596

Industrial output indicator in Lativan Industry statistics to output indicator in National Accounts statistics

The amount of electric energy consumed in the manufacture of food products, beverages and tobacco products (D15, D16) is forecast to increase (see figure 14) and in 2020 electricity consumption in these branches should reach 352 GWh.

Tab. 16. Output Forecasts of the Branches of Industry (%)

Branches of Industry	2006-2010	2011-2015	2016-2020	2006-2020
Mining of coal and lignite; extraction of peat (C10)	14.3	8.6	6.9	9.9
Other mining and quarrying (C14)	4.8	3.5	3.0	3.8
Manufacture of food products and beverages (D15)	2.4	2.0	1.9	2.1
Manufacture of tobacco products (D16)	4.1	4.5	2.8	3.8
Manufacture of textiles (D17)	10.8	8.1	6.9	8.6
Manufacture of wearing apparel; dressing and dyeing of fur (D18)	8.0	6.7	6.0	6.9
Manufacture of leather and leather products (D19)	4.0	3.6	2.7	3.5
Manufacture of wood and wood products (D20)	10.1	7.9	7.4	8.4
Manufacture of pulp, paper and paper products (D21)	8.9	7.0	6.0	7.3
Publishing, printing and reproduction of recorded media (D22)	9.9	7.5	6.2	7.9
Manufacture of coke, refined petroleum products and nuclear fuel (D23)	4.6	3.6	3.4	3.9
Manufacture of chemicals and chemical products (D24)	5.1	4.5	4.5	4.7
Manufacture of rubber and plastic products (D25)	8.2	6.3	5.8	6.8
Manufacture of other non-metallic mineral products (D26)	8.2	6.2	6.0	6.8
Manufacture of basic metals (27)	9.4	7.2	6.8	7.8
Manufacture of fabricated metal products, except machinery and equipment (D28)	8.1	6.2	5.9	6.7
Manufacture of machinery and equipment not elsewhere specified (D29)	8.6	6.2	5.8	6.8
Manufacture of office machinery and computers (D30)	8.0	5.5	5.1	6.2
Manufacture of electrical machinery and apparatus (D31)	9.3	6.6	5.8	7.3
Manufacture of radio, television and communication equipment and apparatus (D32)	8.7	5.4	4.5	6.2
Manufacture of medical, precision and optical instruments, watches and clocks (D33)	9.1	6.8	5.8	7.3

(continued)

Branches of Industry	2006-2010	2011-2015	2016-2020	2006-2020
Manufacture of motor vehicles, trailers and semi-trailers (D34)	6.2	3.2	2.0	3.8
Manufacture of other transport equipment (D35)	10.9	7.3	6.2	8.1
Manufacture of furniture; manufacturing not elsewhere specified (D36)	9.8	7.2	6.6	7.9
Recycling (D37)	10.6	7.9	7.3	8.6
Electricity, gas, steam and hot water supply (E40)	4.6	4.0	4.0	4.2
Collection, purification and distribution of water (E41)	3.6	2.2	1.1	2.3

In the manufacture of textiles, wearing apparel, furs, leather and leather products (D17-D19) electricity consumption is forecast to grow from 114 GWh in 2005 to 275 GWH in 2020, as seen in figure 15. A large decline in electricity consumption in 2005 is considered as non-indicative, growing electricity consumption has already been considered for forecasts of 2006.

The consumption of electric power in the manufacture of wood and wood products (D20) is forecast as continuously increasing. Growing at a rate of about 7% annually, in 2020 it would reach approximately 1150 GWh, as figure 16 shows.

In the manufacture of pulp, paper and paper products and publishing, printing and reproduction of recorded media (D21, D22) electricity consumption is forecast to grow 3.6% a year on average. Thereby in 2020 it would be about 73 GWh (see figure 17).

Electricity consumption in the manufacture of chemicals and chemical products (D24) could decrease to 66 GWh in 2020, as figure 18 illustrates.

According to forecasts, electricity consumption in the manufacture of other non-metallic mineral products (D26) could grow from 164 GWh in 2005 to 323 GWh in 2020, as seen in figure 19. The consumption of electric power would grow by 4.6% on average.

Prognoses of electricity consumption in the manufacture of basic metals (D27) correspond to previous trends in this time series (see figure 20). In 2020 the amount of electric power consumed in this branch would reach 222 GWh.

According to the forecasts, electricity consumption in the manufacture of fabricated metal products, machinery and equipment not elsewhere specified, electrical machinery and apparatus and radio, television and communication equipment and apparatus (D28-D32) will grow in the future, as seen in figure 21. With an average growth rate of about 1.8% per annum, in 2020 it would be 204 GWh.

Fig. 13. Forecasts of electricity consumption in mining and quarrying, GWh

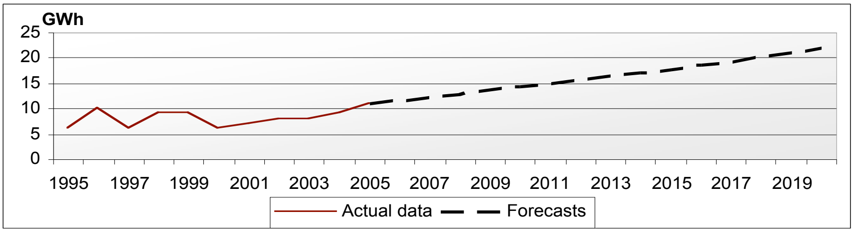


Fig. 14. Forecasts of electricity consumption in manufacture of food products, beverages and tobacco products, GWh

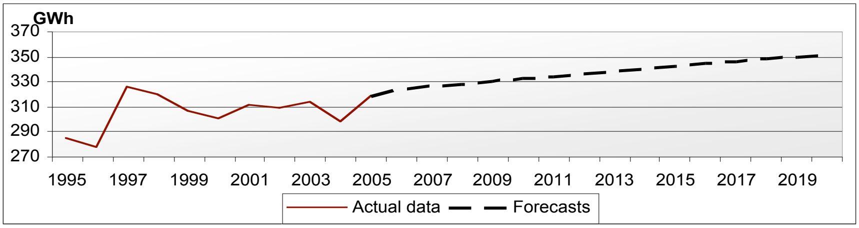


Fig. 15. Forecasts of electricity consumption in manufacture of textiles and leather, GWh

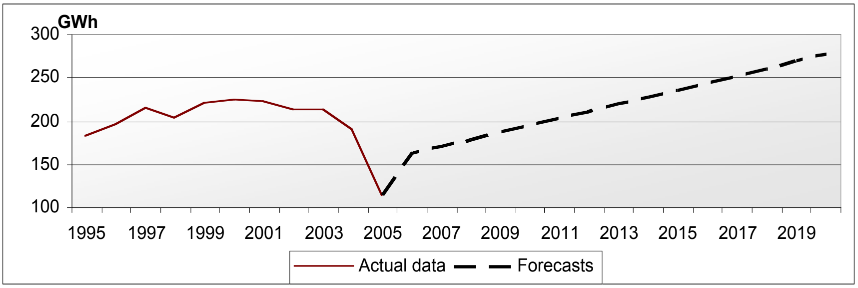


Fig. 16. Forecasts of electricity consumption in manufacture of wood and wood products, GWh

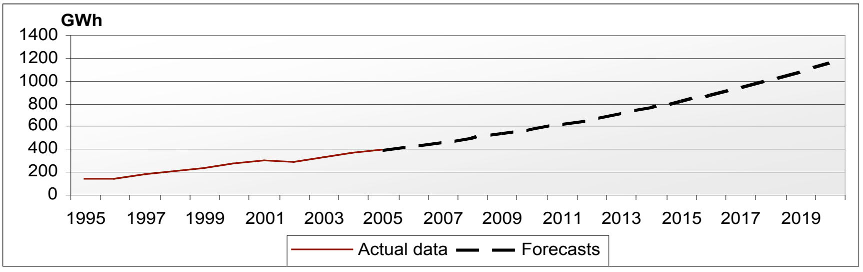


Fig. 17. Forecasts of electricity consumption in manufacture of pulp, paper and paper products and printing, GWh

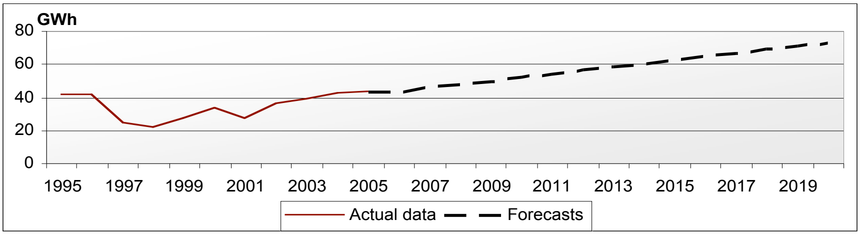


Fig. 18. Forecasts of electricity consumption in manufacture of chemicals and chemical products, GWh

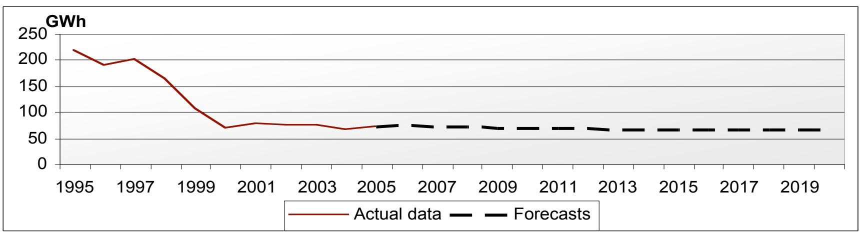


Fig. 19. Forecasts of electricity consumption in manufacture of other non-metallic mineral products, GWh

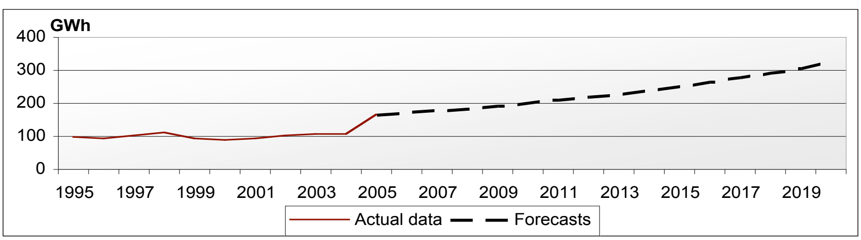
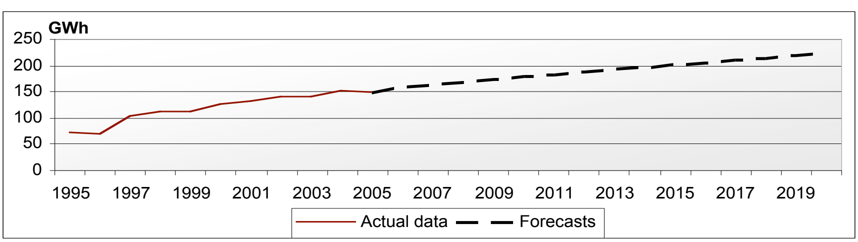


Fig. 20. Forecasts of electricity consumption in manufacture of basic metals, GWh



It is forecast that electricity consumption in the manufacture of motor vehicles, trailers and semi-trailers and other transport equipment (D34, D35) will remain approximately 68 GWh until 2020 (see figure 22).

Electricity consumption in manufacturing not elsewhere specified (D25, D33, D36, D37) is forecast to grow. With a growth rate of 5.8% a year, it would reach approximately 265 GWh in 2020, as illustrated in figure 23.

Using trends to forecast electricity consumption in the energy sector (C10, D23, E40 excluding power stations), the amount of electrical power consumed would decrease from 260 GWh in 2005 to 205 GWh in 2020 (see figure 24).

Forecasts obtained in modelling electricity consumption in power stations as a function of electric power produced, show that electricity consumption in this sector would decline with the exception of 2009, when TEC-2 is scheduled to be commissioned after its reconstruction (see figure 25). In order to evaluate the credibility of these forecasts, additional information is needed, including sources of electricity use in power stations and possibilities of improving the efficiency of electricity consumption.

Summing up the forecasts shown above, the prognoses for electricity consumption in industry are obtained. According to these forecasts, electricity consumption in industry would grow from 2085 GWh in 2005 to approximately 3420 GWh in 2020 (with a growth rate of about 3.3% a year), as shown in the figure 26.

By adding forecasts of electricity consumption for other industries and consumer groups as well as forecasts of electricity losses, to the prognoses of power consumption in industry, the forecasts of total electricity consumption in Latvia are obtained. As seen in figure 27, total electricity consumption could reach 11.4 TWh in 2020.

Comparing these forecasts with possible amounts of electricity produced in Latvia – on average 2.8 TWh in Daugava'HPP, 3.3 TWh in Riga's CHPs after 2009 and from 0.5 TWh to 1.1 TWh produced in other plants – it is possible to assess the problems of increasing the production capacity of electricity and imports.

Analysis of these forecasts show that initially the electricity deficit would fall – to 1.3 TWh in 2009, but would then increase again to 4.2 TWh in 2020 together with proportionally higher electricity consumption growth. Compared to the deficit in 2005 (30.5%) of total electricity consumption, it would fall to about 16% in 2009 and then increase again to approximately 37% in 2020.

This deficit should be covered with net imports or new production facilities. The choice of new production facilities, more precisely, new capacities should be considered taking into account electricity consumption forecasts as well as other factors like environmental issues, the investment required, the origin of resources needed to operate new power plants, the desired level of security of the electricity supply etc.

Fig. 21. Forecasts of electricity consumption in manufacture of machinery, GWh

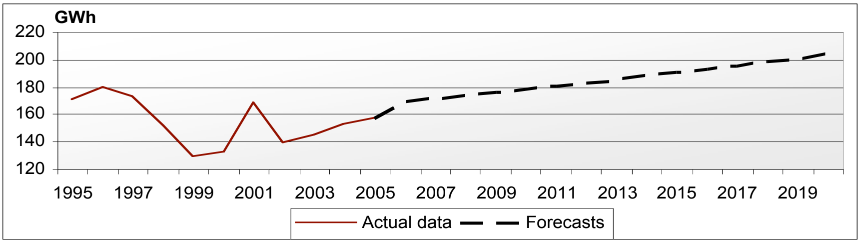


Fig. 22. Forecasts of electricity consumption in manufacture of transport equipment, GWh

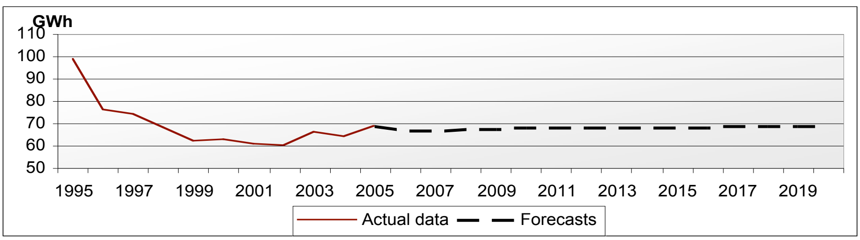


Fig. 23. Forecasts of electricity consumption in manufacturing not elsewhere specified, GWh

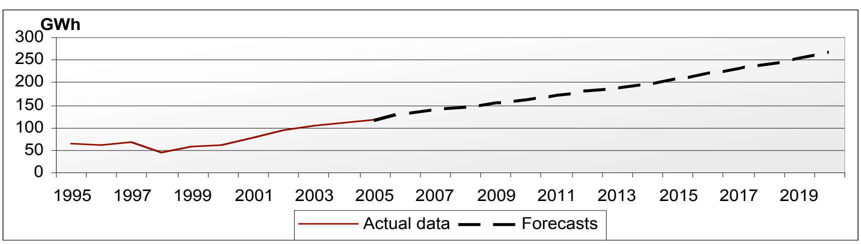


Fig. 24. Forecasts of electricity consumption in energy sector (excluding power stations), GWh

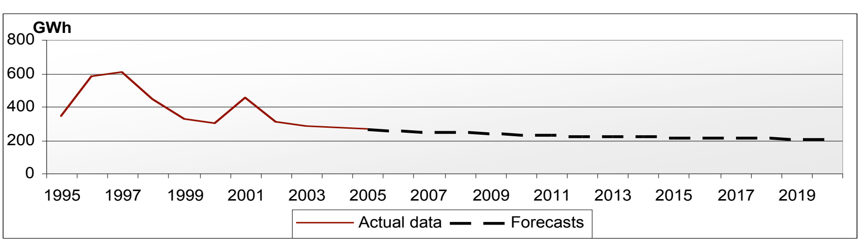


Fig. 25. Forecasts of electricity consumption in power stations, GWh

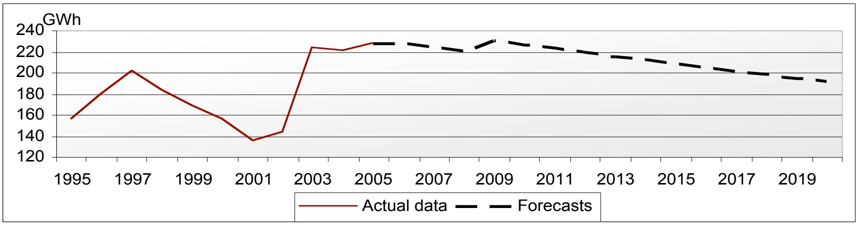


Fig. 26. Forecasts of electricity consumption in industry, GWh

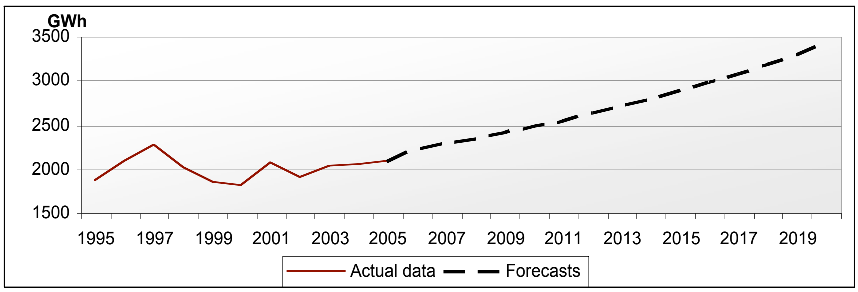
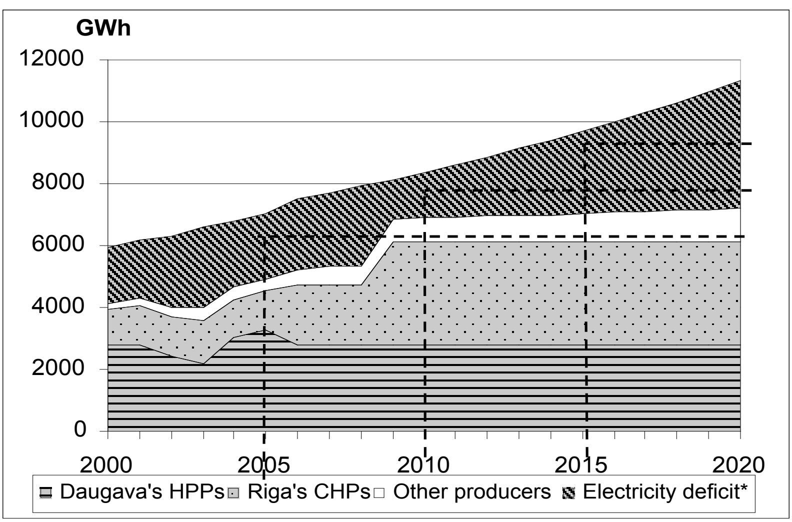


Fig. 27. Forecasts of total electricity consumption (including losses), Gwh (Import = Total electricity consumption + losses – electricity production)



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Structural Changes, International Trade and Multisectoral Modelling

In September 2007 the national team members of the International Inforum (Interindustry Forecasting Project at the University of Maryland) group held the XV annual World Conference in Trujillo, Spain. Such Conferences offer the participants to report their achievements in the different fields concerning the macroeconomic multisectoral modeling approach and data development. The national partners build their country model based on a common input-output accounting structure and a similar econometric modeling approach for sectoral and macroeconomic variables. In each Conference, the contributions refer to the wide spectrum of research activities carried on within the Inforum system of models.

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