2. The skeleton of the multisectoral Estonian model

2.1 The Input-output table and the basic data base

The basic purpose of the model is to make long-term projections for the Estonian economy. Most of the data used in the present version are from the input-output table made available by the Estonian Statistical Office for the year 1997[7]. The data on final demand and value added components are not yet available in time series with a sectoral detail similar to that of the IO table. Furthermore, the Estonian Statistical Office has not used the IO table as benchmark for the product accounts.
At present, we notice two significant discrepancies: a) differences between the column and row totals of the IO table and the flows in the national accounts and b) discrepancies in the product account between resources and intermediate and final consumption components.

With the available data, mostly from the IO table, a skeleton of the Estonian model has been built with a minimum of equations. The IO table distinguishes domestic and imported flows; contains 6 final demand components (personal consumption expenditure, investments, inventory changes, exports, government expenditure and collective consumption expenditure; no value added component is available at sectoral level.

Matrices and vectors supporting the Estonian model are collected in a file (a vam file described in Interdyme [8]) which constitute the basic data base. The matrices and vectors which come from the IO table and are used in the present version of the Estonian model are:
am : the input-output coefficients matrix
mm : the import shares matrix
gm : the value added shares matrix
out : the sectoral output vector
pceio : the private consumption expenditure vector
ccp : the private collective consumption vector
gov : the government consumption vector
pde : the investment by producers vector
ven : the inventory changes vector
ex : the exports vector
imp : the imports vector

taxprodv: the net taxes on products vector
wagv : the compensation of employees vector
indtaxv : the other net taxes on production vector
rgev : the operating surplus and other income
vad : the value added vector

Besides these vectors and matrices obtained directly or through very simple manipulation from

[7] The first description of the Estonian input-output table is in Dedekgkajeva (2000).

[8] The following acronyms are from the configuration file of the Estonian vamfile. This file, named vamest.cfg, is reproduced in the APPENDIX 7. This file drives the construction of the vam file by using G7.

the IO table, there are other vectors such as:
emp : the employment vector
and others which represents exogenous (for the standing alone model) variables such as:
pim : the import prices vector
as well as vectors generated during the solution of the model:
cim : the cost of imported materials vector
unitva : the value added per unit of output vector
pdm : the domestic prices vector
pmix : the domestic consumption prices vector (IO sectoral classification)

Bridge matrices for personal consumption and investment are not yet available. Consequently, investments by investors and personal consumption classified on the side of the consumer are not yet introduced in the Estonian vam file.

2.2 Equation formulation

The model contains equations for a) *import shares* and b) very simple *(labour) productivity functions*.

a) *import share equations*

Whatever the analytical structure of a sectoral import equation may be, total (sectoral) output appears among the explanatory variables. In fact, total real resources (imports plus output) vary to match the total (intermediate plus final) real demand. An increase (decrease) of total demand generates an increase (decrease) in total resources; then, an increase (decrease) in domestic output is expected to be associated to an increase (decrease) of imports. In other words, total demand is satisfied with domestic and foreign productions; however, the shares of these two 'resources' may vary. Imports substitution means that imports take the place of domestic production; imports elasticity (not equal to one) evokes that, as GDP increases, imports may increase (elasticity grater than one) or decrease (elasticity less than one) its weight over domestic resources.
As for any economic variable, there may be many analytical forms suggested by the pure economic theory, by the econometric assumptions about the 'probability generating function' and by the economic wisdom. The pure economic theory, which is a synonymous of neoclassical theory, leads to analytical forms deduced through an optimization process applied to rarely observed functions (such as utility functions and production functions) but widely available from economic textbooks. The econometric assumptions may ignore the economic theory in favour of a rich and sophisticated description of the random error attached to any analytical form. For a given economic phenomenon, the economic wisdom suggests a list of determinants supported by economic theories and by the model builder's experience.
Anyhow, sectoral output is expected to be always among the explanatory variables; this implies a simultaneous solution of sectoral import and sectoral total output[7]. However, the choice of the analytical form is up to the model builder.
In the present case, sectoral import share equations have been implemented. The import share is related to the total resource (imports plus total output). The analytical form is very naive; given the sectoral import share at the base year, $impsh_0$, it varies following a trend. Then for each

[7] The Interdyme code fulfils this property in the Seidel function.

sector, the import share equation has the following form

$$impsh_t = impsh_0 + a * t$$

a may be positive or negative interpreting respectively the case of import penetration or domestic output expansion.

b) *Labor productivity equations*

The labour productivity equations have been estimated for a subset of IO sectors. The Estonian Statistical Office publishes data on employment and data on industrial production indexes. Both data do not match the IO sectoral classification. However, some data may be easily related to the IO sectors; other data do not offer sufficient hints to be related to a well defined sectors. Time series of indexes of industrial production, applied to the sectoral output from the IO table, have made possible the production of time series of sectoral total output at constant prices. Both employment and total output time series have been used to estimate labour productivity equations in the framework of the Verdoorn's law. Not all the sectors have a labour productivity equations, neither cross-over effects on price formation have been implemented. Anyway, these equations enlighten the impact of the output growth on the sectoral labour requirements over time.

2.3 The 'past' and futures scenarios

The Estonian Statistical Office has not yet harmonized the IO table with the national account statistics. The Office is in the process to revise the construction of the Estonian IO tables and the production of time series strictly related to the IO final demand and value added components. Meanwhile, the macro variables of the national accounts are the only time series available. They have been used to design the 'past' scenarios.
The past scenario is the scenario which fills the time span up to the present time. Of course, it must include the IO table base year[8].
Table 3 shows the macro variables used to reconstruct the 'past' from year 1993 to 2003. Table 4 shows the rate of growth of the data of Table 3.
The macro variables from Table 1 have been used as indexes and applied to the corresponding vectors of the IO table. The rate of growth of each element of a vector as well as its total sum is equal to that of the macro variable.
This 'updating' has not been applied to the inventory changes vector. This vector contains negative and positive flows, which are expected to change sign over time. It does not make any sense to 'move' the vector preserving the sign of each flow, because this imply e constant decay or a constant accumulation of inventories at sectoral level. The sectoral inventory change deserves a modelling approach rather a simple indexation[9].
Furthermore, the 'statistical discrepancy' is not present in the IO table; hence, it has not been used to complete the re-construction of the past. This makes the GDP computed from the

[8] The IO table base year is the year which the table refers to. In the present case, the base year is 1997. Notice that the data base spans from 1990 to 2015 (the first active line of the vam configuration file); it contains the 'available' time series and provides room to project up to year 2015.

[9] See, for example, the modelling approach suggested in Almon *et al.* (1974).

national account not comparable with the GDP from the IO table. Table 4 shows the GDP rate of growth without the 'statistical discrepancy'. The difference between the GDP rates of growth is noticeable; it stresses the importance of the rates of growth of the variable in the product accounts in determining the GDP rate of growth.

The 'future' has been designed following the economic perspectives prepared by the Ministry of Finance of Estonia, the Statistical Office of Estonia and the Bank of Estonia and shown in the *Source of growth* section of APPENDIX 2 table. The following Table contains the data used for designing the 'future' scenario.

Table 5 The rates of growth driving the 2004-2010 scenario

	2004	2005	2006	2007	2008	2009	2010
Private Consumption	6.2	6.0	6.3	5.4	5.3	5.3	5.3
Government expenditure	6.5	3.9	3.6	3.3	3.1	2.9	2.7
Investments	6.7	9.1	7.8	7.7	7.7	7.7	7.7
Exports of goods and services	7.4	8.5	9.9	9.3	9.3	9.3	9.3
Imports of goods and services	7.2	7.9	8.9	8.7	8.5	8.5	8.5

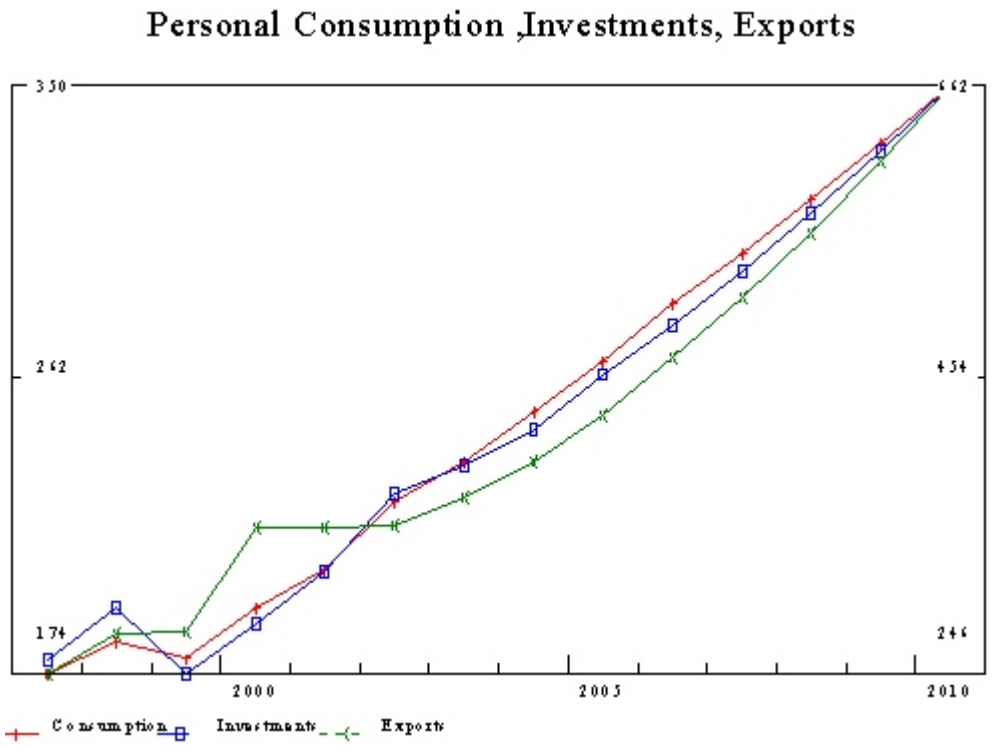
The rates of growth from 2004 to 2008 are taken from Appendix 2; the rates of growth in years 2009 and 2010 are a simple extension of those recorded in the year 2008 with the exception of the Government expenditure rate of growth. This has been reduced to the levels of 2.9 and 2.7 respectively for the years 2009 and 2010 following a trend which should interpret the tightening of the Government expenditure in the view to join the euro area or to behave according to the euro area fiscal monetary constraints.

The skeleton of the Estonian model allows us to start a preliminary evaluation of the model performance.

All the final demand components are assumed exogenous; each sector of any final demand components follows the corresponding total. Figure 3 shows in a multigraph box the scatter of Personal consumption expenditure, Investments, Government expenditure and Exports. The graphs of these final demand components are the same in all the sectors.
In the present version of the multisectoral model, both imports and output are endogenous variables. Since imports have processed as any other final demand component, their simulated values may now be compared with the 'past' and 'future' reconstructed values.

Figures 4-9 show the behaviour of the naive import equations described above. In general, they generate good simulations of the sectoral imports time series. The Figures show the values in the time interval 1993-2010; up to year 1997, the model does not compute any simulation value. In the years 1998 to 2010, assuming that the scenario variables (ImpSce) be really observed, the scatter of their simulated values (ImpSim) show the power of the model to mimic the 'observed' economy. Wearing apparel, Leather and leather products, Products of Agriculture and Machinery and equipment imports appears to be well predicted by the model; Wood and product of wood and Pulp, paper and paper products imports are respectively over and under predicted.

Figure 3



Looking at the import equations, the Wood and product of wood sector has a relative modest import share (15%) and the Pulp, paper and paper products sectors marks one of the highest import share (73%). The assumed rate of growth of (total) imports leads to an increase of sectoral import shares. Sectors with low import shares may speed up sectoral imports much more than those sectors which already show an high degree of import penetration (unless, in front of an increasing demand, the sector reacts expanding vigorously its output).

Figures 10-13 compare the imports and total output indexes (1997=1) at sectoral level. These Figures show the composition of the sectoral total resources requirements. All final demand components are assumed to grow (Table 3) and consequently total resources will grow at their average rate. Their composition is expected to change over time. Because of the assumed scenario and its implementation in the model framework, imports grow faster than output in all the sectors. Sectoral performance is influenced by the sectoral 'openness'. Pulp, paper and paper products and Chemicals, chemical products show a remarkable increase of imports and a declining output; as reported above, Pulp, paper and paper products sector has an import share very high and the Chemicals, chemical products sector belongs to the seriously unsheltered sectors with an import share of 69%. Other mining products sector with an import share of 47% maintains a constant output level over time while Product of agriculture with its 25% may lightly expand its output.

Figures 14-18 show the relationship between total output and employment at sectoral level. Only a limited number of sectors have a labour productivity equation as above described. At present, there is no employment feedback with the rest of the model. Hence, only a cursory analysis of the employment over the scenario horizon may be given. Leather and leather products and Wood and products of wood sectors show and increasing output and a declining level of employment.

Chemicals, chemical products sector has both output and employment declining; the first two sectors show the effect of a labour productivity equation interpreting a clear labour productivity improvement over time while the third sector show an unclear increase in labour productivity in presence of a declining level of output. The Motor vehicle sector shows a strong unsatisfactory labour productivity equation; if the total output remains constant over time, it is unrealistic to assume that no labour productivity gain is going to take place. Construction sector show the interesting case of a good trend in output which is strong enough to maintain a constant level of employment under a good improvement of labour productivity.

Table 3

GROSS DOMESTIC PRODUCT BY EXPENDITURE APPROACH AT 2000 CONSTANT PRICES

Unit: million kroons

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Private consumption expenditure	35708.7	35927.0	37715.9	41539.8	45946.3	48338.3	47023.3	51036.5	54057.5	59428.6	62614.9
General government final consumption expenditure	15412.3	16031.6	18195.7	17640.4	17411.2	17703.2	18213.5	18406.7	18744.3	19848.4	21002.4
Consumption expenditure of non-profit institutions serving households	649.7	635.1	673.8	742.6	787.5	818.0	928.0	1023.6	1225.2	1536.7	1796.0
Gross fixed capital formation	14265.2	15582.6	16452.8	18024.8	21612.4	24642.6	20796.7	23769.4	26856.2	31475.2	33176.7
Change in inventories	1088.5	303.1	428.4	657.4	2141.3	326.0	146.3	2059.8	2262.9	3473.9	3303.0
DOMESTIC DEMAND	67124.4	68479.4	73466.6	78605	87898.7	91828.1	87107.8	96296	103146.1	115762.8	121893.0
Exports of goods and services (f.o.b.)	39131.4	40498.8	42663.2	43874.7	56569.9	63336	63777.8	81831.7	81686.7	82185.6	87107.2
..exports of goods	22877.8	24228.9	25809.9	26170.5	35315.0	41079.5	40128.8	56345.9	53226.8	55070.3	58445.5
..exports of services	16253.6	16269.9	16853.3	17704.2	21254.9	22256.5	23649.0	25485.8	28459.9	27115.3	28661.7
Imports of of goods and services (f.o.b.)	38088.7	42321.0	45019.2	48378.3	62543.8	70245.4	66586.3	85400.7	87167	91847.3	100130.7
..imports of goods	29664.6	33619.9	35999.3	38438.8	51463.8	56690.8	52236.7	69489.5	69685.1	73302.0	83046.8
..imports of services	8424.1	8701.1	9019.9	9939.5	11080.0	13554.6	14349.6	15911.2	17481.9	18545.3	17083.9
Statistical discrepancy	685.8	1091.1	-286.2	-79.7	-113.5	1152.1	1705.4	-9.9	979.1	-309.9	2364.1
GDP	**68852.9**	**67748.3**	**70824.4**	**74021.7**	**81811.3**	**86070.8**	**86004.7**	**92717.1**	**98644.9**	**105791.2**	**111233.6**
GDP without Statistical discrepancy	68167.1	66657.2	71110.6	74101.4	81924.8	84918.7	84299.3	92727	97665.8	106101.1	108869.5

The data for 1993-2003 have been revised on 18.05.2004.

Due to the accession with the European Union. the methodology of macroeconomic statistics changed. The changes concerned the calculation methodology of imputed rent and consumption of fixed capital. and changed also the level of gross domestic product and gross national income in the period 1993-2003.

Table 4

CHANGE OF GROSS DOMESTIC PRODUCT COMPARED WITH PREVIOUS YEAR BY EXPENDITURE APPROACH AT 2000 CONSTANT PRICES

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Private consumption expenditure	0.6	5	10.1	10.6	5.2	-2.7	8.5	5.9	9.9	5.4
General government final consumption expenditure	4	13.5	-3.1	-1.3	1.7	2.9	1.1	1.8	5.9	5.8
Consumption expenditure of non-profit institutions serving households	-2.2	6.1	10.2	6	3.9	13.4	10.3	19.7	25.4	16.9
Gross fixed capital formation	9.2	5.6	9.6	19.9	14	-15.6	14.3	13	17.2	5.4
Change in inventories	-72.2	41.3	53.5	225.7	-84.8	-55.1	1307.9	9.9	53.5	-4.9
Exports of goods and services (f.o.b.)	3.5	5.3	2.8	28.9	12	0.7	28.3	-0.2	0.6	6
..exports of goods	5.9	6.5	1.4	34.9	16.3	-2.3	40.4	-5.5	3.5	6.1
..exports of services	0.1	3.6	5	20.1	4.7	6.3	7.8	11.7	-4.7	5.7
Imports of of goods and services (f.o.b.)	11.1	6.4	7.5	29.3	12.3	-5.2	28.3	2.1	5.4	9
..imports of goods	13.3	7.1	6.8	33.9	10.2	-7.9	33	0.3	5.2	13.3
..imports of services	3.3	3.7	10.2	11.5	22.3	5.9	10.9	9.9	6.1	-7.9
GDP	**-1.6**	**4.5**	**4.5**	**10.5**	**5.2**	**-0.1**	**7.8**	**6.4**	**7.2**	**5.1**
GDP without Statistical discrepancy	-2.2	6.7	4.2	10.6	3.7	-0.7	10.0	5.3	8.6	2.6
Difference	0.6	-2.1	0.3	0.0	1.6	0.7	-2.2	1.1	-1.4	2.5

Unit: percentages
by expenditure approach

The data for 1994-2003 have been revised on 18.05.2004.
Due to the accession with the European Union. the methodology of macroeconomic statistics changed. The changes concerned the calculation methodology of imputed rent and consumption of fixed capital. and changed also the level of gross domestic product and gross national income in the period 1993-2003.

Table 6 shows the rates of growth of the variables from Table 5 and the GDP rate of growth in a Product account which does not include Inventory Changes and Statistical discrepancies

Table 6

Product acccount	03-04	04-05	05-06	06-07	07-08	08-09	09-10
Personal Consumption	6.0	5.8	6.1	5.3	5.2	5.2	5.2
Government Expenditure	6.3	3.8	3.5	3.2	3.1	2.9	2.7
Investments	6.5	8.7	7.5	7.4	7.4	7.4	7.4
Imports	7.5	8.6	9.0	8.5	8.5	8.5	8.5
Esports	7.1	8.2	9.4	8.9	8.9	8.9	8.9
GDP	4.3	5.1	5.5	4.9	4.9	4.9	4.9