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Technical Documentation

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Tall kan ikke forekomme	Category not applicable	.
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Abstract

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MEMLI – The Indonesian model for environmental analysis
Technical documentation

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The Indonesian model for environmental and macroeconomic analysis (MEMLI) is documented. MEMLI is a 29 sector nation-wide model designed to analyse effects of traditional economic policy measures as well as new policies such as tax-based environmental policies, within the government administration in Indonesia. According to the model changes in energy prices induce factor substitution. Energy in physical units and CO_2 emissions due to combustion of fuels are among the variables included. The model captures important elements from the traditions of input-output modelling, general equilibrium modelling and macroeconomic modelling. The report contains the equation structure and simulations of changes in a number of policy variables. According to the model, there is a significant potential for reducing pollution by using the market mechanism without harmful effects on traditional macroeconomic variables.

Keywords: Indonesia, macroeconomic model, environmental economics, CO_2-emissions.

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Contents

1. Introduction

The interdependence between the economy and the natural environment becomes increasingly apparent both in high-income and low-income countries. Very often environmental problems increase as population and average incomes rise. Environmental policy measures to alleviate these negative effects of economic activity are in many cases detailed and directly related to limited environmental problems. But some environmental issues are so comprehensive, that environmental policy to contain degradation of the environment will affect the overall economy. One example of this is national and international policies to curb emissions of greenhouse gases. Policies using the price mechanism to reduce combustion of fuels in a large scale, will have profound effects on economic activity in firms and households as well as significant macroeconomic effects. Change in the industrial structure in the course of such as policy may pose transitional problems in labour markets and imbalances in financial flows between domestic sectors or between countries. But a continued business as usual-policy is not problem-free either. It is thus very important to show the environmental consequences of a policy that does not take specific environmental policy actions.

A macroeconomic model extended with environmental variables can - in the hands of a skilled user - be a powerful tool in analysing problems in environmental and economic policy. Given good forecasts for varables not determined by the model (exogenous variables), the model calculates a trajectory for macroeconomic and environmental (endogenous) variables. Thus, by the aid of the model, one can produce or scenarios for the economic development and the corresponding development of environmental indicators. That may be interesting in its own right. A model can also be very useful in analysing choices in policy-making. It can provide policy-makers with a menu of policy actions and corresponding outcomes. It also may serve as a framework for discussions between government institutions and in the political debate.

Of course a model can not produce final answers. No one can. But a well constructed model including important definitional and accounting relationships will often impose a certain dicipline on a discussion, which otherwise might be difficult to obtain. Building into the model behavioural mechanisms also enables the user of the model to take into account a large number of effects which otherwise might be difficult to accomplish. This is the reason why the Indonesian environmental/macroeconomic model MEMLI has been constructed. MEMLI is an acronym for (in Indonesian) MakroEkonomik Model Linkungan Indonesia - a macroeconomic environmental model for Indonesia.

This report is a technical documentation of MEMLI. A user's guide in operating the data system and software surroundings is published in Bowitz et al. (1995). An analysis of future developments and policy options in Indonesia will be published soon (Bowitz (1996, forthcoming)). The model is a result of a co-project between the Ministry of Environment in Indonesia (LH) with the Central Bureau of Statistics (BPS) as a central participant, and Statistics Norway (SN). One basic aim of the project is to enable the central administration in Indonesia to carry out analyses based on a general economic model that takes account of repercussions between sectors and institutions in the economy and between the economic and environmental development.

MEMLI is a macroeconomic model for Indonesia distinguishing 29 production sectors, 5 institutional sectors (urban and rural households, general government, the corporate sector and the foreign sector), 12 consumption categories, and 3 types of intermediate inputs to each sector (oil inputs (fuels), electricity and other inputs). The model is closely linked to the Input-Output (IO) table and the Social accounting matrix (SAM), calculated in the Central Bureau of Statistics (BPS) in Indonesia. The IO and SAM data are taken from 1985. The model exhibits a consistent description of commodity and service flows between the production sectors, as well as the financial flows from the SAM. The variable classification is however adjusted compared to the IO and SAM, both because of analytical relevance and because reconciliation with other data sources has been necessary. The model calculates aggregate economic variables such as GDP and employment, as well as use of energy. Elements of resource accounting is also included in the model, in the form of emissions of CO_2 related to combustion of fossil fuels.

Modelling the interplay between the economy and the environment has taken various directions. Often such models are in the tradition of computable general equilibrium (CGE) models. Such models emphasize consistency with (often neoclassical economic) theory. Furthermore such models often have a consistent flow-of funds account, describing the financial flows between the sectors in a consistent way. As long term issues are (implicitly) assumed to be relevant, full resource utilization is the general assumption. Thus adjustment problems such as unemployment and underutilization of resources do not appear as problems in such models. Neither does the speed of adjustment play a role in such models. Examples of CGE models with links to the environment is the GREEN model of the OECD (Burniaux et al. (1992)) or for Indonesia, Lewis (1991). Centre for World Food Studies in the Netherlands have had a large project in constructing a disaggregated CGE-model for Indonesia, with emphasis on food production, see e.g. SOW (1990) or Thorbecke (1991). The Norwegian MSG- model is another example in an array of such models (Holmøy (1991).

More pure Input-Output (IO) based models have also been used in Indonesia and elsewhere to analyse effects of future economic development on environmental issues. One example of such a model is the IO model in Duchin and Lange (1992), where sectoral use of land was the environmental variable in focus. The model was a project of the Ministry of Planning in Indonesia (BAPPENAS). The Ministry of Environment (LH) has developed an IO-based model for generating scenarios where the effects of different economic growth paths are explored (Djajadiningrat et al. (1992)). That model contained a comprehensive list of environmental variables such as different emissions to air, waste and land conversion. Both these models seem to contain little or no economic behaviour except what is included in the IO part of the model. There seems to be no effects on demand and factor use of changes in incomes or prices, and no description of financial flows and prices seems to be present in these models.

MEMLI is an attempt to integrate the two traditions. It contains basic elements from both. The model contains an input-output core where the deliveries to and from each sector are described. But unlike basic IO models, (large parts of) final demand is endogenous. The model also describes the earning of revenues by the two household classes (an the other institutional sectors). Prices on different products are determined by wages, productivity and import prices, as well as commodity (excise) taxes. Demand for each consumption good depends on income for each household class, the size of each household class and relative consumer prices for each consumption good. This approach gives MEMLI a flavour of a traditional macroeconometric model, where fluctuations in demand plays the key role in determining output (and consequently emissions) and employment. The close integration with the IO and SAM as well as the behavioural equations where price and income effects are present, is in accordance with the CGE tradition. The basic difference from the CGE models is that there is no guarantee that the available resources (i.e. the labour force) will be fully utilized. Demand will be important. Use of the model is thus warranted in the short to medium run. But MEMLI will also be useful in long term analyses if the model user is careful when making exogenous assumptions.

This report is organised as follows. Chapter 2 contains an overall description of the model structure. Chapter 3 shows the simulated effects of a number of changes in exogenous variables. These are not intended to be realistic policy analyses, but to show the working of the model. Chapters 4 to 8 describe the equation structure of the model. In the process of developing MEMLI, we have constructed a slightly extended model version, where the firms' reactions to changes in relative prices have been modelled. This model version is described in chapter 9, which also includes a policy analysis of increasing the fuel tax. This version of the model marks MEMLI more similar to a CGE model, although the assumption of full employment is still not invoked. The report contains 7 appendices where selected parts of the model, the data work and lists of variables are presented.

2. The main structure of MEMLI

MEMLI is a model based on the 1985 input-output (IO) table and Social Accounting Matrix (SAM) of Indonesia. It represents a synthesis of traditional IO modelling, macroeconomic modelling and also applied general equilibrium modelling traditions. The model consists of 29 production sectors and 5 institutional sectors (urban/rural households, government, the corporate sector and the foreign sector).

This chapter gives a short outline of its main mechanisms. Chart 1 gives a graphical picture of the main structure of the model. In ch. 3 and 9 a number of policy experiments are shown, giving a closer description of the model's main mechanisms.

The input-output table constitutes the core of the model. It describes from which sectors each sector's inputs come from, and to which final demand components outputs are delivered to. The model distinguishes between 3 types of intermediate inputs; electricity, fuels and non-energy intermediate inputs. Each sector consumes the 3 inputs in exogenous proportions, but the model user can assume different developments of these variables over time. Gross investment by sector is exogenous. Imports of each commodity is determined by sector-specific input-output coefficients for imports. Given import shares and final demand, intermediate inputs, gross production and imports are simultaneously determined.

For all final demand components, there are IO price equations, where the sectoral domestic and import prices are weighted together. Each sector's output price is assumed to depend fully on unit variable costs, which includes the effects of factor prices and factor productivities. In this part of the model, there is also a detailed representation of net indirect taxes, that affect the aggregate price level, but also government revenues. The development in the financial markets is not modelled explicitly, although a number of financial flow variables are present in the model. The exchange rate (Rupiah/US dollar) is exogenous.

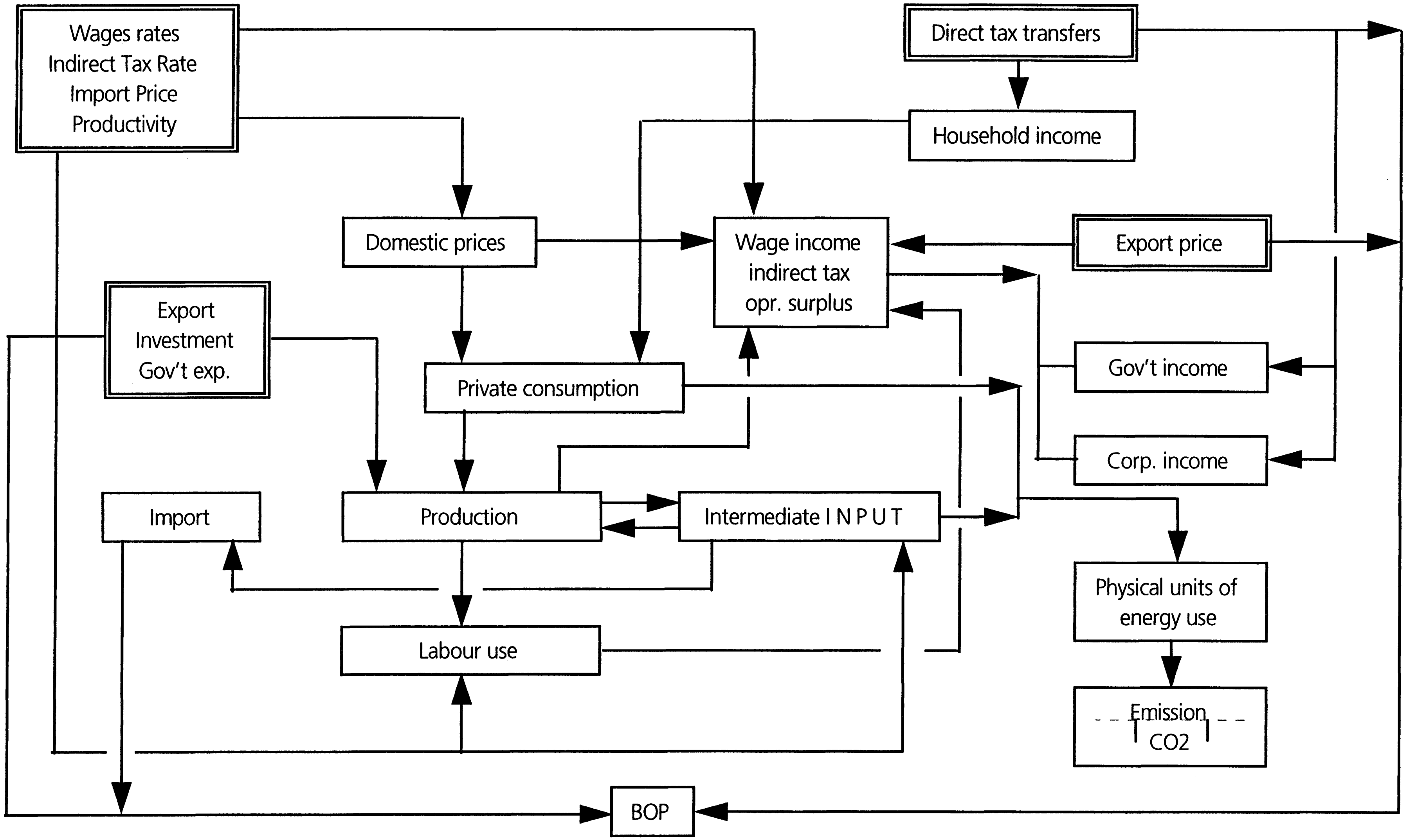
Unlike many traditional input-output models, final demand is endogenous (in this case - private consumption). This represents the integration of the IO tradition and the tradition of macroeconomic modelling. Private consumption is distinguished by social class (rural and urban households). Each class consumes 12 consumer categories. Exogenous population variables determine the absolute size of each class.

Household demand is represented by a two-level linear consumption system. There private per capita consumption of the consumer categories in each class are determined by per capita income and relative prices. Electricity and fuels are specified as separate consumption categories. An increase in e.g. the relative price on fuels will induce households to consume less fuels and products that indirectly contain fuels (via the production process), and more of other goods and services.

Incomes and expenditures for the other institutional sectors are modelled consistently. The social accounting Matrix (SAM) constitutes the basis for this part of the model, but a lot of adjustments to this data source have been made (see appendix 5).

Household incomes (for each class) are determined by an income block. Household incomes consist of wages, interest, operating surplus etc. Each class' wage income is derived from employment and exogenous wage rates. A fraction of operating surplus in the non-oil economy accrues to each household class. Household taxes are determined by class-specific average tax rates. Real disposable income is nominal after-tax income deflated by the consumer price index. Household consumption is then determined by exogenous saving rates (urban and rural).

Chart 1: Flow-chart of the Memli model version 1



Note: - Full boxes are indicating model blocks which determine the endogenous variables.

- Double-line boxes are indicating exogenous variables.

In the first version of the model, a number of variables in the Indonesian economy that are obviously endogenous, are still exogenous. These are inter alia gross real investment in the production sectors, export volumes and prices for each sector and import shares. Also factor intensities are exogenous in the first model version[1].

Energy uses in physical units are calculated by using the intermediate inputs and private consumption of electricity and fuels as indicators. Finally CO_2 emissions are calculated from the energy figures in physical units.

The model also calculates a number of financial flows. These are the current account, government saving and net lending, and household saving. The model for calculating various government revenue flows, such as custom duties, excise taxes and VAT is incorporated into the IO framework of the model.

Important exogenous variables are traditional fiscal policy instruments such as taxes and government consumption and investment. Various indirect taxes are represented in some detail. The model is suitable as a tool for analysing the overall impacts (economic and environmental) of policies aimed at changing the relative prices on e.g. fuels. Other environmentally interesting variables can in principle be included in the same way as we have done for energy use and CO_2 emissions.

The model as it stands must be labelled as a 'demand-driven' macroeconomic input-output model. The supply of production factors (e.g. the available labour force) does not constitute any formal limit on the level of aggregate production. This means that in practical use, the model user must assure himself that the model-calculated employment, production and energy use can be realized within the limits of available resources.

Production in the petroleum sector is exogenously given; the production here can not be expected to be demand-determined. It will be the outcome of a complicated process where expectations of future petroleum prices, national policies and resource discoveries will be important. The domestic oil price is also exogenous, while all other domestic prices are determined by mark-up pricing.

The IO matrix from the BPS is published in purchaser's value, but in the construction of the IO core of MEMLI, we have tried to identify various indirect taxes. Thus the commodity balancing in the IO equations in principle takes place in basic value. Commodity tax rates such as excise taxes, import duties and VAT for each commodity are present in the IO equations. Imports are in CIF value and exports in FOB value. The other variables in the model are measured at market value, which means purchaser's value for the demand variables (intermediate inputs, private and government consumption, real investment and changes in stocks). Gross output is in producer's value. All constant price figures are measured in mill. 1985-Rupiah.

[1] In the 2. version, cf. ch. 9, factor substitution in the production sectors is modelled.

3. Model properties

MEMLI is not a complete model of the Indonesian economy. Important parts of the economy are not endogenized. The most important areas in the model that are not modelled are export volumes and prices, wages and factor intensities in the production sectors. In addition to this, the monetary sector is not modelled in MEMLI. This leaves the model incomplete as a description of the behaviour of the economy, and the model user must be aware of which effects that are described in the model, and which effects that are not. Version 1 of the model can be seen to a large extent as a disaggregated input-output version of a Keynesian macro-model, where the supply side behaviour of the labour market and the product market are not modelled. The model user must himself by the help of exogenous coefficients for factor intensities and for important exogenous variables such as the ones mentioned above, take account of such effects. Later, such mechanisms can be built into the model. A first step in that direction is described in chapter 9.

In order to describe the functioning of the version 1 of the model, we have made a number of policy experiments. First, a reference simulation has been run. Then an exogenous variable (or a group of exogenous variables) was changed and another simulation was run (impact simulation). Then the effects on important endogenous variables were calculated. The effects are measured by elasticities or multipliers. As version 1 is purely static, the effects from changes in exogenous variables will appear instantly (within one year) on the endogenous variables. We thus show the effects in the base year. The simulation experiments, are:

Increase in government consumption by 2 %
Increase in gross investment in all sectors by 4 %
Decrease in household tax rates by 2 %-points
Increase in exports of all commodities by 4 %
Increase in fuel taxes from 0 to 20 %

Table 3.1 Simulated effects of an increase in government consumption by 2 % in 1985. Bill. 1985-Rupiahs and %

	Abs change	% change
Government consumption	228	2.0
Private consumption	319	0.6
Exports	-16	-0.1
Imports	62	0.4
Gross investment	0	0.0
GDP	469	0.5
Consumer prices		0.0
Employment (1000 persons)	338	0.5
Current account	-78	
Government saving	-157	
CO_2 emissions (1000 tonnes)	325	0.5

In the first simulation, government consumption is increased by 2 %. Increased demand for the different commodities requires more factor inputs (labour, energy, other intermediate inputs). Increased private sector incomes due to increased employment and production, results in higher private disposable incomes. Consequently private consumption rises. A part of the increased domestic demand feeds into imports, which also rises, but to a little extent. This is due to small import shares. The reason why total exports are reduced, is solely due to declining exports of crude oil as a residual, as exports of all other goods are exogenous. For crude oil, production is exogenous, while exports is determined in the input-output balancing equation. While oil production is constant and domestic demand for fuels and consequently crude oil, increases, less is available for exports. Employment in all sectors are proportional to gross production. Still, differences in the percentage effects on GDP and total employment might occur, if sectors with different level of employment per unit of output do not change proportionally. In this simulation, however, employment and GDP have an equal increase. Government saving is reduced, but less than the initial increase in government consumption. While government consumption was increased by 228 bill. Rupiahs, government saving was only reduced by 157 bill. rupiahs. This is due to the partly offsetting effects from direct and indirect taxes. As the level of activity in the economy rises due to the increased government consumption, both direct taxes and indirect taxes rise as well.

Table 3.2 Simulated effects of an increase in the fuel tax rate from 0 to 20 % in 1985. Bill. 1985-Rupiahs and %

	Abs change	% change
Government consumption	0	0.0
Private consumption	-157	-2.8
Fuel consumption		-11.1
Fuel use in production sectors		-1.7
Exports	122	0.5
Imports	-218	-1.4
Gross investment	0	0.0
GDP	-1231	-1.3
Employment (1000 persons)	-1059	-1.6
Current account	-96	
Government saving	935	
Consumer prices		2.4
CO_2 emissions (1000 tonnes)	-2667	-3.8

An increase in the fuel tax from 0 to 20 %, increases the consumer price of fuels by 17-18 %. The pass-through was not 100 %, because parts of the consumer price of fuels consist of labour costs and non-fuel intermediate inputs, which are not affected directly by the fuel tax. Increased fuel prices give a direct contribution to the increase in the aggregate private consumption deflator. But also production costs in all sectors will increase, and this adds further price increase impulses to the prices on all consumer categories. The prices of the consumer categories with the highest (direct and indirect) fuel content will experience the highest price rises. As nominal wages and transfers are exogenous and assumed constant in this simulation experiment, increased consumer prices implies a reduction of the household sector's real disposable income. Consequently, real aggregate private consumption goes down. We have included the figure for fuel consumption in the table. Fuel consumption goes down much more than aggregate consumption. This is due to the price elasticities embedded in the consumer demand system. Also fuel use in the production sectors go down. Remember that as factor intensities are exogenous and unchanged in this experiment, fuel use per unit of output in each sector is unchanged. But both the level and composition of aggregate demand will infuence the production sectors differently. Aggregate consumer demand will decline, and imply a lower level of production. But as prices will rise most for the most fuel-intensive demand, this will have as a result that the sectors producing consumer goods with the highest direct and indirect fuel content, will experience the largest contraction. The increased tax revenues result in a great increase in government saving, despite lower direct and indirect tax revenues due to lower demand and production. If increased fuel taxes are combined with e.g. increased government consumption (i.e. making a linear combination of the simulation in table 3.1 and in 3.2), a reduction in fuel use may be accomplished without loss in output.

Table 3.3 Simulated effects of an increase in gross investment in all sectors by 4 % in 1985. Bill. 1985-Rupiahs and %

	Abs change	% change
Government consumption	0	0.0
Private consumption	757	1.3
Exports	-66	-0.3
Imports	335	2.2
Gross investment	871	4.0
GDP	1227	1.3
Employment (1000 persons)	858	1.3
Current account	-401	
Government saving	241	
Consumer prices		0.0
CO_2 emissions (1000 tonnes)	1343	1.9

An increase in gross investment in all sectors, will result in a multiplier effect similar to increased government consumption. The qualitative effects are the same as for increased government consumption, but the quantitative effects differ due to the fact that the composition of government consumtion and total investment differ with respect to the content of the different commodities and the fraction of each commodity that is imported.

Table 3.4 Simulated effects of a reduction in the household tax rate by 2 %-points in 1985. Bill. 1985-Rupiahs and %

	Abs change	% change
Government consumption	0	0.0
Private consumption	2515	4.4
Household taxes	-1353	
Exports	-89	-0.4
Imports	336	2.2
Gross investment	0	0.0
GDP	2091	2.1
Employment (1000 persons)	1960	3.0
Current account	-425	
Government saving	-984	
Consumer prices		0.0
CO_2 emissions (1000 tonnes)	1964	2.8

The reducton of household taxes initiates a multiplier effect, which increases GDP. Imports increase as a fraction of the increased domestic demand is directed towards imports.

Table 3.5 Simulated effects of an increase in all exogenous exports by 4 % and an increase in oil production by 4 % in 1985. Bill. 1985-Rupiahs and %

	Abs change	% change
Government consumption	0	0.0
Private consumption	467	0.8
Exports	1018	4.5
Imports	126	0.8
Gross investment	0	0.0
GDP	1358	1.4
Employment (1000 persons)	612	0.9
Current account	892	
Government saving	515	
Consumer prices		0.0
CO_2 emissions (1000 tonnes)	614	0.9

In this simulation,all exports and the production of crude oil are increased by 4 %. Exports of crude oil, which is determined as production plus imports minus domestic demand, increases by more than 4 %, since the absolute increase in production is a quantity that is greater than 4 % of initial exports of crude oil (cf. above). The increased export demand results in larger production in all sectors. This effect is reinforced by the increased demand for intermediate inputs. As labour income increases due to increased employment, household disposable income and thus private consumption also go up.

In order to assess the relative strengths of the effects from changing different exogenous variables, we have calculated GDP multipliers, which is the absolute change in GDP relative to the absolute change in the variable that is changed in that particular simulation. GDP-multipliers from 4 of the 5 simulation experiments above are shown in table 3.6 (as there is no corresponding quantity concept in the simulation with increase fuel taxes, this simulation is omitted). In the same table changes in CO_2/GDP ratios are also shown.

Table 3.6 GDP multipliers and per cent changes in CO_2/GDP ratios by changes in exogenous variables in 1985

	GDP mult.	CO_2/GDP
Government consumption	2.06	0.0
Total investment	1.41	0.7
Household taxes	1.55	0.7
Total exports	1.33	-0.5
Increased fuel tax	.	-2.5

The GDP multiplier for government consumption is the largest one, as expected from textbook analysis. One reason for this is that government consumption to a greater extent is directed towards domestic demand than private consumption and investment. Increases in exports has the lowest GDP multiplier. The CO_2/GDP-ratio increases 0.7 per cent when investment and private consumption increases, and is somewhat lowered with a proportional increase in all exports. This means that the sectors mainly producing for exports are somewhat less CO_2-intensive than sectors delivering to the domestic economy. Finally, increased fuel taxes induces a significant reduction in the CO_2/GDP ratio.

4. The quantity sub-model

This chapter describes the quantity part of MEMLI, the input-output quantity equations and the determination of factor inputs.

The value-added tax (VAT) is given a simplified gross treatment in the original IO table. Firms pay VAT on the goods they sell, but they can deduct the part of the purchases of intermediate inputs that is VAT. This is deductible VAT. Gross treatment of VAT means that intermediate inputs are measured including deductible VAT. But as VAT paid on purchases of intermediate inputs can be deducted, firms will not consider deductible VAT as production costs. Consequently we apply a net treatment of VAT in the internal part of the model. But in calculating value added, the simplified gross treatment is used, so that accordance with the IO is maintained for value added. The price indices for intermediate inputs are all constructed so that only non-deductible VAT is included. As a simplification, trade and transport margins are not part of the tax base in the model, even if this is the case according to the tax regulations (which is the case for the VAT). This is discussed in more detail in appendix 2.

4.1 The input output equations

As MEMLI is an input-output based model, commodity transactions are represented by means of industry by industry input-output matrices. The equation balancing supply and use for each commodity is given by:

$$(4.1) \qquad \lambda_{xi} \cdot X_i = -(1+BTRCD_i) \cdot M_i + \Sigma_j\Sigma_s \alpha_{sij} \cdot HN_{sj} + \Sigma_k \beta_{ik} \cdot C_k + \gamma_i \cdot I + \delta_i \cdot G + \varepsilon_{ij} \cdot E_j + \theta_{ij} \cdot \Delta S_j + ZZX_i$$

$$i \in \{LISPSEC\}, \qquad j \in \{LISPSEC\}, \qquad s \in \{E, O, R\}, \qquad k \in \{LISCON\}$$

LISPEC and LISCON are the lists of the production sectors and private consumption categories, respectively (cf. appendix 7).

E, O, R refer to intermediate input types (electricity, fuels (oil products) and non-energy intermediate inputs (rest)).

λ_{xi}	Output in industry *i* in basic value as a share of total output in industry *i* in producers' value in the base year.
ε_{ij}	The ratio between the content of commodity *i* measured in basic value and the total export of "export activity" j valued FOB in the base year.
$BTRCD_i$	The base year custom duty tax rate on import of commodity *i*. (B(ase year) T(ax) R(ate) C(ustom) D(uty))
X_i	Output sector *i*, producers' value
M_i	Import commodity *i*, CIF.
HN_{sj}	Total intermediate input of intermediate input category *s* in sector *j*, purchasers' value net of deductible VAT
	HN_E Intermediate input of electricity
	HN_O Intermediate input of fuel and gas
	HN_R Intermediate input of other commodities
C_k	Aggregate consumption of consumption category *k*, purchasers' value
I	Aggregate gross investment or gross fixed capital formation, purchasers' value
G	Aggregate government consumption, purchasers' value

E_j Export, product j, FOB.
ΔS_j Change in stocks commodity j, basic value
ZZX_i Residual introduced to calibrate the model through the years between the base year and the last year for which there exist official National Account figures.
α_{sij} Intermediate deliveries of commodity i to intermediate input category s in sector j in *basic value* divided by total intermediate input of category s in sector j in purchaser's prices net of deductible VAT (H_{sij}/HN_{sj} where H_{sij} indicates the intermediate deliveries of commodity i to input type s in sector j in *basic value*). Base year figures
β_{ik} Deliveries of commodity i in basic value to consumption category k divided by total private consumption of consumption category k in purchasers' prices. Base year figures
γ_i Deliveries of commodity i in basic value to investment divided by aggregate investment in purchasers' value. Base year figures
δ_i Deliveries of commodity i to government consumption in basic value divided by aggregate government consumption in purchasers' value. Base year figures
θ_{ij} Deliveries of commodity i measured in basic value divided by change in stocks of commodity j. Base year figures.

4.2 Import determination

Imports of commodity i are determined as an exogenous share of domestic demand for each commodity. The IO equations for imported products in basic value are given as:

(4.2) $$(1+BTRCD_i) \cdot M_i = DIMPS_i \cdot [\Sigma_j \Sigma_s \alpha^M_{sij} \cdot HN_{sj} + \Sigma_k \beta^M_{ik} \cdot C_k + \gamma^M_i \cdot I + \delta^M_i \cdot G + \theta^M_{ij} \cdot \Delta S_j]$$

$i \in \{LISPSEC\}$, $j \in \{LISPSEC\}$, $s \in \{E, O, R\}$, $k \in \{LISCON\}$

Where:
$DIMPS_i$ Index for changes in the average import share of commodity i, compared to the base year's import share. The base year (1985) = 1
α^M_{sij} Imports of commodity i delivered as intermediate inputs to intermediate input category s in sector j in basic value (H^M_{sij}) divided by total intermediate input of category s in sector j in purchasers' value net of deductible VAT. H^M_{sij}/HN_{sj}. Base year figures.
β^M_{ik} Import of commodity i in basic value delivered to private consumption category k divided by total private consumption of consumption category k in purchaser's prices. Base year figures.
γ^M_i Import of commodity i in basic value delivered to investment divided by total investment in purchasers' prices. Base year figures.
δ^M_i Import of commodity i in basic value delivered to final government consumption divided by total government consumption in purchasers' prices. Base year figures
θ^M_{ij} The import share for changes in stocks of commodity i (=Change in stocks of imported commodity i divided by total change in stocks of commodity i in the base year).

The superscript M in the coefficients is introduced to differentiate the coefficients of imported commodities from those of total transactions in the I-O equations.

$\alpha^M_{sij}/\alpha_{sij}$ defines the import share in the base year for each use of commodity i for different purposes. Thus, while $\alpha_{sij} \cdot HN_{sj}$ measures total demand for commodity i by sector j as intermediate input of category s, a certain share (in the base year of the model) given by $\alpha^M_{sij}/\alpha_{sij}$ is imported. If the import share changes in a model simulation, all users of commodity i are assumed to change their import share proportionally relatively to the baseyear share.

It is useful to see gross production in each sector, X_j and imports, M_j, as simultaneously determined in the input-output equation (4.1) and the import input-output equations (4.2), given exogenous investment and government consumption, while changes in stocks and exports, intermediate inputs and private consumption are being determined elsewhere in the model. The changes in import shares compared to the base year level, $DIMPS_i$, is exogenous. For commodity 004, Crude Oil and Natural Gas Mining, production is exogenous. For this sector we have chosen to let exports be endogenized in the input-output equation (4.1).

4.3 Factor demand

Assume that the general production function is given by:

(I) $X_j = f_j(K_j, L_j, HN_{Rj}, HN_{Ej}, HN_{Oj})$

where K_j is the capital stock in sector j. Assume further that producers minimize short run variable cost defined as: $W_j \cdot L_j + PH_{Rj} \cdot HN_{Rj} + PH_{Ej} \cdot HN_{Ej} + PH_{Oj} \cdot HN_{Oj}$ where W_j is total wage cost per unit of labour and PH_{sj} is a purchaser's price index of intermediate input of intermediate input category $s(= R, E, O)$. We may now derive input demand functions of the form:

(II)
$$L_j = g_{Lj}(W_j, PH_{Rj}, PH_{Ej}, PH_{Oj}, X_j, K_j)$$
$$HN_{Rj} = g_{Rj}(W_j, PH_{Rj}, PH_{Ej}, PH_{Oj}, X_j, K_j)$$
$$HN_{Ej} = g_{Ej}(W_j, PH_{Rj}, PH_{Ej}, PH_{Oj}, X_j, K_j)$$
$$HN_{Oj} = g_{Oj}(W_j, PH_{Rj}, PH_{Ej}, PH_{Oj}, X_j, K_j)$$

If we in addition cannot reject the hypothesis that there are increasing returns to scale in *K,L,H* in the production function but constant returns wrt. to *L* and *HNs* only, then we may simplify (II) as:

(II*)
$$L_j = g^*_{Lj}(W_j, PH_{Rj}, PH_{Ej}, PH_{Oj}, K_j) \cdot X_j$$
$$HN_{Rj} = g^*_{Rj}(W_j, PH_{Rj}, PH_{Ej}, PH_{Oj}, K_j) \cdot X_j$$
$$HN_{Ej} = g^*_{Ej}(W_j, PH_{Rj}, PH_{Ej}, PH_{Oj}, K_j) \cdot X_j$$
$$HN_{Oj} = g^*_{Oj}(W_j, PH_{Rj}, PH_{Ej}, PH_{Oj}, K_j) \cdot X_j$$

The firms are assumed to minimize variable costs, given production and the (predetermined) capital stock.
In the first version of the model, factor intensities are all exogenous. Input per unit of output are determined by exogenous coefficients.

Intermediate input of non-energy in constant prices is given as:

(4.3) $HN_{Rj} = \mu_j^R \cdot X_j$

Where:
HN_{Rj} Intermediate inputs of goods and services other than energy, sector *j*, Met of deductible VAT.
μ_j^R Intermediate consumption of goods and services other than energy products in sector *j* per unit of output.

Total intermediate input of non-energy products are given as:

(4.4) $HN_R = \Sigma_j HN_{Rj}$

Intermediate input of electricity, in constant prices is given as:

(4.5) $HN_{Ej} = \mu_j^E \cdot X_j$

Where:
HN_{Ej} Intermediate inputs of electricity, sector *j*, net of deductible VAT
μ_j^E Intermediate inputs of electricity, sector *j* per unit of output.

Intermediate input of fuel products, in constant prices is given as:

(4.6) $HN_{Oj} = \mu_j^O \cdot X_j$

Where:
HN_{Oj} Intermediate inputs of fuel products, sector *j*, net of deductible VAT.
μ_j^O Intermediate inputs of fuel products, sector *j* per unit of output.

Total intermediate inputs in constant purchasers' prices, net of deductible VAT, in each sector is given as:

(4.7) $HN_j = HN_{Ej} + HN_{Oj} + HN_{Rj}$

Labour input in persons is given as:

(4.8) $L_j = \mu_j^L \cdot X_j$

Where:

L_j Persons employed in sector j (1000).

μ_j^L Inverse of labour productivity, sector j. Employment in 1000 persons per unit of output.

Eq. (4.3), (4.5), (4.6) and (4.8) characterize the production structure of the model. In this model version μ_j^E, μ_j^O, μ_j^R and μ^L_j are all exogenous variables. In version 2. of MEMLI (cf.ch. 9), these variables are made endogenous in accordance with a production theoretic framework in I and II.

The correspondence between (II*) and (4.3, 4.5, 4.6, 4.8) is that $g_{Lj}^* = \mu^L_j$, $g^*_{Rj} = \mu^R_j$, $g^*_{Ej} = \mu^E_j$, and $g^*_{Oj} = \mu_j^O$. Whether II* is a valid simplification of II or not is an empirical question to be analysed in later econometric work. In the 2nd version of MEMLI (cf. ch. 9), factor demand functions are based on Cobb-Douglas production functions.

4.4 Depreciation, capital stock and capital formation

Gross fixed capital formation (real investment) by sector is exogenous in MEMLI.
Depreciation is determined by a fixed depreciation rate.

(4.9) $FD_j = DEPR_j \cdot K_j$

Where:

K_j Capital stock at the end of the year in constant prices, sector j.

$DEPR_j$ Depreciation rate, sector j.

FD_j Depreciation in constant prices, sector j.

Depreciation in current prices by industry is given as:

(4.10) $FD_j^C = FD_j \cdot PI$

Net fixed capital formation in constant prices:

(4.11) $NI_j = I_j - FD_j$

Where:

NI_j Net fixed capital formation in constant prices, sector j

I_j Gross fixed capital formation in constant prices, sector j

The capital stock is determined by the accounting identity:

(4.12) $K_j = K_{j,-1} + NI_j$

The capital/output ratio is thus endogenous, determined by:

(4.13) $\mu_j^K = K_j/X_j$

Finally we have the adding up to aggregate investment:

(4.14) $I = \Sigma_j I_j$

5. The price sub-model

In modelling the commodity markets we assume that commodities are imperfect substitutes. More precisely, the model has been constructed on the assumption that it is possible to identify separate demand curves for competing Indonesian products both on foreign and domestic markets. Thus, for each commodity there are three market prices, an export price, an import price and a price on goods delivered to the domestic market by Indonesian producers.

5.1 The output price indices

The price formation mechanism in MEMLI is based on monopolistic competition. Prices are set as a mark up over unit variable costs, reflecting a firm equalizing marginal revenue with marginal costs. The capital stock is treated as given. This is in line with e.g. Blanchard and Kiyotaki (1987) who shows that in a symmetric equilibrium there exists an "aggregate price rule" with price set as a (constant) mark-up on marginal cost. In what follows we describe how we have specified marginal cost and the mark-up in MEMLI.

Letting for the time being C denote costs, marginal cost by sector is given by

(I) $$dC_j/dX_j = W_j \cdot dL_j/dX_j + PH_{Rj} \cdot dHN_{Rj}/dX_j + PH_{Ej} \cdot dHN_{Ej}/dX_j + PH_{Oj} \cdot dHN_{Oj}/dX_j$$

Remember that we assume L_j, HN_{Rj}, HN_{Ej} and HN_{Oj} to be proportional to X according to section 4.3. An assumption of constant returns to scale in L_j, HN_{Rj}, HN_{Ej} and HN_{Oj} is consistent with the factor demand equations in MEMLI, see section 4.3 above.

In this case the (short-run) factor demand equations can be written as

(II*) $$L_j/X_j = g^{*L}_j\,(W_j, PH_{Rj}, PH_{Ej}, PH_{Oj}, K_j)$$
$$H_{Rj}/X_j = g^{*R}_j\,(W_j, PH_{Rj}, PH_{Ej}, PH_{Oj}, K_j)$$
$$H_{Ej}/X_j = g^{*E}_j\,(W_j, PH_{Rj}, PH_{Ej}, PH_{Oj}, K_j)$$
$$H_{Oj}/X_j = g^{*O}_j\,(W_j, PH_{Rj}, PH_{Ej}, PH_{Oj}, K_j)$$

The g^*-function differ from the g-functions in section (4.3), due to the constant returns to scale property in (II*) above.

Variable unit cost (UC_j) is now equal to marginal cost as given by (I)

(III) $$UC_j = W_j \cdot L_j/X_j + PH_{Rj} \cdot HN_{Rj}/X_j + PH_{Ej} \cdot HN_{Ej}/X_j + PH_{Oj} \cdot HN_{Oj}/X_j$$

The mark-up is in principle related to properties of the demand function for the product which again depends on parameters of utility and production functions. Demand for a product is assumed to be a CES-aggregate of Indonesian and foreign goods classified as similar goods in the IO-table at our level of aggregation. In MEMLI, Indonesian and foreign goods are treated as heterogenoeus. Assuming that the buyers minimize the costs of buying Indonesian and foreign goods and that the CES-aggregate is homothetic (this is similar to assumptions in Blanchard and Kiyotaki (1987)) the mark-up will generally depend on relative prices between Indonesian and foreign goods. For simplicity, the mark up is exogenous in the first version of MEMLI.

We have also assumed that domestic costs are fully passed through to domestic product prices, with no influence from import prices. The pricing behaviour of domestic cost-plus pricing is embedded in equation (5.1). In equation (5.1) the variable UC for unit variable costs in equation II, is replaced by the formula for unit variable costs itself.

$$(5.1) \qquad PXD_j = ((W_j \cdot L_j + \Sigma_s PH_{sj} \cdot HN_{sj} + OTP_j)/X_j) \cdot (1 + MARKUP_j)$$

Where:

OTP_j	Other taxes on production, sector *j*
PXD_j	Price index for output to the domestic market from sector *j*, producer's value
PH_{sj}	Purchaser's price index for total intermediate inputs of intermediate input category *s*, sector *j*
W_j	Total wage cost per unit of labour, sector *j*
L_j	Total input of labour, sector *j*
$MARKUP_j$	Markup over unit variable costs, sector *j*

There is one exception from this formulation. The domestic prices for commodity 004 Crude Oil and Natural Gas Mining is exogenous, as this price is subject to government control and the development of oil prices at the world market.

5.2 The input - output price index equations

Discriminating custom duties are assumed to be levied as a specified percentage of the value of the good or service transacted. Thus the (Rupiah) import price index on commodity *i* in basic value (PM_i) is given as:

$$(5.2) \qquad PM_i = PMCIF_i \cdot EXR^C/EXR^B \cdot (1+BTRCD_i \cdot TRCCD_i) \cdot (1/(1+BTRCD_i))$$

Where:

$TRCCD_i$	Index for changes from the base year in the rate of custom duty of commodity *i* (1985 = 1) (B(ase year) T(ax) R(ate) C(hange) C(ustom) D(uty))
$BTRCD_i$	The base year custom duty tax rate on import of commodity *i*.
$PMCIF_i$	Import CIF price index, commodity *i*. "World market price index" in dollar (i.e. before taking account of changes in the exchange rate.)
EXR^C	Exchange rate (Rupiah per US dollar) in the current year.
EXR^B	Exchange rate in the base year.

The purchasers' price index (net of deductible VAT) for the total intermediate consumption of category *s* in sector *j* is given as:

$$(5.3) \qquad PH_{sj} = \Sigma_i(1+BTRNDVH_{sij} \cdot TRCV_i) \cdot (1+BTREH_{sij} \cdot TRCE_i) \cdot \{(1-DIMPS_i \cdot (\alpha^M_{sij}/\alpha_{sij})) \cdot PXD_i + DIMPS_i \cdot \alpha^M_{sij}/\alpha_{sij} \cdot PM_i\} \cdot \alpha_{sij}$$

$TRCV_i$	Index for changes from the base year in the VAT rate on commodity *i* (1985 = 1)
$BTRNDVH_{sij}$	The base year non-deductible VAT rate on commodity *i* delivered to intermediate consumption category *s* in sector *j*.
$TRCE_i$	Changes from the base year in the excise tax rate on commodity *i* (1985 = 1)
$BTREH_{sij}$	The base year excise tax rate on commodity *i* delivered to intermediate consumption category *s* in sector *j*. (B(ase year= T(ax) R(ate) E(xcise taxes))

Deductible VAT is not a part of the production costs from the company point of view. Thus intermediate consumption including deductible VAT is not the relevant concept when describing the behaviour of these industries. Therefore the price indices for intermediate consumption only include non-deductible VAT.

As a simplification trade and transport margins do not constitute any part of the tax base in the model even if they are included in the tax base according to the tax regulation (which is the case for VAT). This simplification in the IO price index equation and tax revenue part of the model introduce small errors in the calculations. For a more detailed discussion of the modelling of trade and transport margins and taxes on products see appendix 2.

The equations are formulated as if all excise taxes are treated as ad valorem taxes (as if all taxes are levied as a percentage of the value excl. taxes), regardless if the tax rules specify taxes both as ad valorem and quantity taxes (taxes per unit).

The purchasers' price index for total private consumption of each consumption category is given as:

(5.4) $$PC_k = \Sigma_i(1+BTRVC_{ik} \cdot TRCV_i) \cdot (1+BTREC_{ik} \cdot TRCE_i) \cdot \{(1-DIMPS_i \cdot (\beta^M_{ik}/\beta_{ik})) \cdot PXD_i + DIMPS_i \cdot \beta^M_{ik}/\beta_{ik} \cdot PM_i\} \cdot \beta_{ik}$$

Where:

$BTRVC_{ik}$ The base year non-deductible VAT rate on commodity i delivered to private consumption of category k.

$BTREC_{ik}$ The base year excise tax rate on commodity i delivered to private consumption of category k.

The purchasers' price index for the total government consumption is given as:

(5.5) $$PG = \Sigma_i(1+BTRVG_i \cdot TRCV_i) \cdot (1+BTREG_i \cdot TRCE_i) \cdot \{(1-DIMPS_i \cdot (\delta^M_i/\delta_i)) \cdot PXD_i + DIMPS_i \cdot \delta^M_i/\delta_i \cdot PM_i\} \cdot \delta_i$$

$BTRVG_i$ The base year invoiced or gross VAT rate on commodity i delivered to government consumption.

$BTREG_i$ The base year excise tax rate on commodity i delivered to government consumption.

The purchasers' price index for total gross fixed capital formation (investment) is given as:

(5.6) $$PI = \Sigma_i(1+BTREI_i \cdot TRCE_i) \cdot \{(1-DIMPS_i \cdot (\gamma^M_i/\gamma_i)) \cdot PXD_i + DIMPS_i \cdot \gamma^M_i/\gamma_i \cdot PM_i\} \cdot \gamma_i$$

Where:

$BTREI_i$ The base year excise tax on commodity i delivered to fixed investment.

There are no value added taxes on deliveries to gross fixed capital formation.

The purchasers' price index for changes in stocks by product is given as:

(5.7) $$PDS_j = \Sigma_i(\{(1-DIMPS_i \cdot (\Theta^M_{ij}/\Theta_{ij})) \cdot PXD_i + DIMPS_i \cdot \Theta^M_{ij}/\Theta_{ij} \cdot PM_i\} \cdot \Theta_{ij}$$

There is assumed no value added taxes and excise taxes on deliveries to changes in stocks. According to the Indonesian IO tables, however, there are trade and transport margins included in the purchasers' value of changes in stocks.

The relationship between the FOB and the basic price index for export by product is given as:

(5.8) $$PFOB_j = (\Sigma_i \varepsilon_{ij} \cdot Pe_j) \qquad e = E \text{ for } i = j \qquad e = XD \text{ for } i \neq j$$

PE_j and $PFOB_j$ are export prices measured in Rupiahs.

PE is the price of the commodity from the producer, while the FOB price includes transport and trade costs in bringing the product to the border. Typically, the prices influencing the *PFOB*'s are the domestic prices of sectors 024 Trade, 025 Air Transport and 026 Land and Water Transport. In MEMLI, $PFOB_j$ is the exogenous export price, while the basic price on exports, PE_j, is determined by equation (5.8) (the domestic prices on trade and transport being determined by (5.1)).

6. The income and outlay accounts

In MEMLI, calculation of tax revenues and tax effects on prices are integrated into the IO framework, although the IO-tables from the BPS originally did not allow for such treatment. MEMLI specifies sectoral custom duties, excise taxes (indirect tax rates on domestic purchases of each commodity) and VAT. This chapter also describes the determination of gross output and factor income in the production sectors. Equations for incomes and outlays for the institutional sectors are also described here.

6.1 Indirect tax revenues and value added by components

6.1.1 Custom duties and other import taxes

As custom duties are treated as ad valorem taxes, total custom duty revenue is given as:

(6.1) $TCD^C = \Sigma_i BTRCD_i \cdot TRCCD_i \cdot PMCIF_i \cdot EXR^C/EXR^B \cdot M_i$

For total supply to equal total demand in constant prices, when imports are valuated CIF, we need to define total custom duties in constant or fixed prices as:

(6.2) $TCD^F = \Sigma_i BTRCD_i \cdot M_i$

Total excise taxes by commodity (as part of import in producers' value) on imported products in current prices are given as:

(6.3) $TETM^C_i = BTREM_i \cdot TRCE_i \cdot (1+BTRCD_i \cdot TRCCD_i) \cdot PMCIF_i \cdot EXR^C/EXR^B \cdot M_i$

Total excise taxes by commodity (as part of import in producers' value) on imported products in constant prices are given as:

(6.4) $TETM^F_i = BTREM_i \cdot (1+BTRCD_i) \cdot M_i$

Total invoiced VAT by product on imported products in current prices are given as:

(6.5) $TIVM^C_i = BTRVM_i \cdot TRCV_i \cdot (1+BTREM_i \cdot TRCE_i) \cdot (1+BTRCD_i \cdot TRCCD_i) \cdot PMCIF_i \cdot EXR^C/EXR^B \cdot M_i$

Total invoiced VAT by product on imported products in constant prices are given as:

(6.6) $TIVM^F_i = BTRVM_i \cdot (1+BTREM_i)(1+BTRCD_i) \cdot M_i$

6.1.2 Excise taxes

Total excise taxes by commodity ("industry deliveries") are given as:

$$
\begin{aligned}
(6.7)\quad TET_i = \; & \{\Sigma_j\Sigma_s\, [BTREH_{sij} \cdot \{(1\text{-}DIMPS_i \cdot \alpha^M_{sij}/\alpha_{sij}) \cdot PXD_i + DIMPS_i \cdot \alpha^M_{sij}/\alpha_{sij} \cdot PM_i\} \cdot \alpha_{sij} \cdot HN_{sj} \\
& + \Sigma_k\, BTREC_{ik} \cdot \{(1\text{-}DIMPS_i \cdot \beta^M_i/\beta_i) \cdot PXD_i + DIMPS_i \cdot \beta^M_{ik}/\beta_{ik} \cdot PM_i\} \cdot \beta_{ik} \cdot C_k \\
& + BTREI_i \cdot \{(1\text{-}DIMPS_i \cdot \gamma^M_i/\gamma_i) \cdot PXD_i + DIMPS_i \cdot \gamma^M_i/\gamma_i \cdot PM_i\} \cdot \gamma_i \cdot I \\
& + BTREG_i \cdot \{(1\text{-}DIMPS_i \cdot \delta^M_i/\delta_i) \cdot PXD_i + DIMPS_i \cdot \delta^M_i/\delta_i \cdot PM_i\} \cdot \delta_i \cdot G \\
& + BTREDS_{ii} \cdot \{(1\text{-}DIMPS_i \cdot \Theta^M_i/\Theta_i) \cdot PXD_i + DIMPS_i \cdot \Theta^M_i/\Theta_i \cdot PM_i\} \cdot \Theta_{ij} \cdot \Delta S_{ij} \\
& + BTREE_i \cdot PE_i \cdot \varepsilon_i \cdot E_i] \;\} \cdot TRCE_i
\end{aligned}
$$

6.1.3 VAT

Total invoiced or gross VAT by commodity (or "industry deliveries") is given as:

$$
\begin{aligned}
(6.8)\quad TIV_i = \; & \{\Sigma_j\Sigma_s\, [BTRVH_{sij} \cdot (1+BTREH_{sij} \cdot TRCE_i) \cdot \{(1\text{-}DIMPS_i \cdot \alpha^M_{sij}/\alpha_{sij}) \cdot PXD_i \\
& + (DIMPS_i \cdot \alpha^M_{sij}/\alpha_{sij}) \cdot PM_i\} \cdot \alpha_{sij} \cdot HN_{sj} + \Sigma_k BTRVC_{ik} \cdot (1+BTREC_{ik} \cdot TRCE_i) \\
& \cdot \{(1\text{-}DIMPS_i \cdot \beta^M_i/\beta_i) \cdot PXD_i + DIMPS_i \cdot \beta^M_{ik}/\beta_{ik} \cdot PM_i\} \cdot \beta_{ik} \cdot C_k + BTRVI_i \\
& \cdot (1+BTREI_i \cdot TRCE_i) \cdot \{(1\text{-}DIMPS_i \cdot \gamma^M_i/\gamma_i) \cdot PXD_i + DIMPS_i \cdot \gamma^M_i/\gamma_i \cdot PM_i\} \cdot \gamma_i \cdot I \\
& + BTRVG_i \cdot (1+BTREG_i \cdot TRCE_i) \cdot \{(1\text{-}DIMPS_i \cdot \delta^M_i/\delta_i) \cdot PXD_i + DIMPS_i \cdot \delta^M_i/\delta_i \\
& \cdot PM_i\} \cdot \delta_i \cdot G + BTRVDS_i \cdot (1+BTREDS_i) \cdot \{(1\text{-}DIMPS_i \cdot \Theta^M_i/\Theta_i) \cdot PXD_i \\
& + DIMPS_i \cdot \Theta^M_i/\Theta_i \cdot PM_i\} \cdot \Theta_{ij} \cdot \Delta S_j]\} \cdot TRCV_i
\end{aligned}
$$

$(i \neq 24)$

As for excise taxes, there is no VAT on trade and transport margins (sector 24) as such in the model. As a simplification trade and transport margins do not constitute any part of the tax base in the model even if they are included in the tax base according to the tax regulation.

Total deductible VAT in current prices by industry is given as:

$$
\begin{aligned}
(6.9)\quad TDV^C_j = \; & \Sigma_s\Sigma_i\, BTRDVH_{sij} \cdot TRCV_i \cdot (1+BTREH_{sij} \cdot TRCE_i) \cdot \{(1\text{-}DIMPS_i \cdot \alpha^M_{sij}/\alpha_{sij}) \cdot PXD_i \\
& + DIMPS_i \cdot \alpha^M_{sij}/\alpha_{sij} \cdot PM_i\} \cdot \alpha_{sij} \cdot HN_{sj}
\end{aligned}
$$

Total deductible VAT "in constant prices" by industry is given as:

$$(6.10)\quad TDV^F_j = \Sigma_s\Sigma_i\, \{BTRDVH_{sij} \cdot (1+BTREH_{sij}) \cdot \alpha_{sij}\} \cdot HN_{kj} = \Sigma_s\, BTRDVH_{sj} \cdot HN_{sj}$$

$$(6.11)\quad NVAT = \Sigma_j TIV - \Sigma_j TDV^C$$

NVAT is VAT net of deductible VAT, and is the net government revenues from the VAT system.

6.2 Gross output in current prices, value added and the components in value added

The taxes on products by industry that is a part of value added *($TIPI_j$)* are given as:

$$(6.12)\quad TIPI_j = \Sigma_i ATIVTB_{ij} \cdot (TIV_i - TIVM^C_i) - TDV^C_j + \Sigma_i ATETPR_{ij} \cdot (\, TET_i - TETM^C_i\,)$$

Where:

$ATIVTB_{ij}$ Industry *j*'s share of total invoiced or gross VAT on product *i*

$ATETPR_{ij}$ Industry *j*'s share of total excise tax on product *i*

Gross output in current producers' value, for the non-margin producing industries, are given as:

$$(6.13)\quad X^C_j = PXD_j \cdot (\lambda_{xj} \cdot X_j - \varepsilon_{jj} \cdot E_j) + PE_j \cdot \varepsilon_{jj} \cdot E_j + (TIPI_j + TDV^C_j) \qquad j \neq 24, 25, 26$$

Gross output in current producers' value for the margin producing industries is given as:

$$(6.14)\quad X^C_i = PXD_i \cdot (\lambda_{xi} \cdot X_i - \Sigma_i\, \varepsilon_{ij} \cdot E_j) + \Sigma_i\, PXD_i \cdot \varepsilon_{ij} \cdot E_j + (TIPI_j + TDV^C_j) \qquad i = 24, 25, 26$$

Intermediate consumption by industry in current purchasers' prices, including deductible VAT, is given as:

(6.15) $H_j^C = \Sigma_s PH_{sj} \cdot HN_{sj} + TDV^C_j,$ $s=E, O, R$

Value added by industry in current prices is given as:

(6.16) $VA^C_j = X_j^C - H_j^C$

Intermediate consumption by industry in constant purchasers' prices, including deductible VAT, is given as:

(6.17) $H^F_j = \Sigma_s HN_{sj} + TDV_j^F$

Value added by industry in constant prices is given as:

(6.18) $VA^F_j = X_j - H^F_j$

Total indirect taxes, net, by industry as a part of value added in current prices, $TITN_j$, is given as:

(6.19) $TITN_j = TIPI_j + OTP_j$

Wages and salaries in sector j is given as:

(6.20) $WS_j = W_j \cdot L_i$

Where:
WS_j Wage costs, sector j

Factor income (net), sector j:

(6.21) $FI_j = VA^C_j - FD^C_j - TITN_j$

Total wage costs are defined as:

(6.22) $WS = \Sigma_j WS_j$

Operating surplus, sector j, current prices, is given as:

(6.23) $OS_j = FI_j - WS_j$

Total Operating Surplus is given as:

(6.24) $OS = \Sigma_j OS_j$

Operating surplus in the petroleum producing and refining sectors, OS_{OIL}, is given as:

(6.25) $OS_{OIL} = OS004+OS007+OS008$

6.3 Income and outlays for the institutional sectors

In the modelling of income flows, we have benefited from Lewis (1991).

The revenues for the two household classes are from a number of sources: Wage income, operating surplus, capital income and transfers.

Wage income and income from operating surplus in the non-oil sectors are:

(6.26) $WS_U = wshu^B \cdot (W \cdot L)$

(6.27) $WS_R = wshr^B \cdot (W \cdot L)$

(6.28) $OPS_U = opshu^B \cdot (OS-OS_{OIL})$

(6.29) $OPS_R = opshr^B \cdot (OS\text{-}OS_{OIL})$

Pre tax income for the two household classes (Y_U and Y_R) are:

(6.30) $Y_U = WS_U+OPS_U+TRG_U+TRM_U \cdot EXR^C+CPNT_U\text{-}TRH_R$

(6.31) $Y_R = WS_R+OPS_R+TRG_R+TRM_R \cdot EXR^C+CPNT_R+TRH_R$

Where:
OPS_h Operating surplus that accrues to household class h (h=R(rural), U(urban))
Y_h Pre tax income, socioeconomic class h
TRG_h Transfers from government to household class h
TRM_h Transfers from abroad to household class h. Mill. dollar.
TRH_R Transfers from urban to rural households (net)
$CPNT_h$ Net domestic capital income (interest and dividends) to household class h
wsh_h^B Base year value of share of total wages and salaries, accruing to household class h
$opsh_h^B$ Base year value of share of operating surplus excl. oil sector, accruing to household class h

TRH_R is net transfers from urban to rural households. Accordingly this variable is subtracted in the equation for YU and added in the equation for YR.

The variables TRM_U and TRM_R are transfers from abroad to the two household classes. They are measured in mill. dollars, and must thus be multiplied by the exchange rate, EXR^C. These variables also appear on the current account.

The definition of private consumption for both household classes must be consistent with the IO definitions. Thus the transfers in the SAM from the government to the two household classes has been adjusted to correct for the imputed transfer and consumption flows in the SAM due to the different definitions of private and government consumption, respectively. This of course also applies to the definitions of private consumption (cf. appendix 5).

Household taxes are calculated by exogenous average tax rates:

(6.32) $TAX_R = Y_R \cdot TAXR_R$

(6.33) $TAX_U = Y_U \cdot TAXR_U$

Where TAX_U and TAX_R are income taxes paid by urban and rural households, respectively. TXR_R and TXR_U are tax rates for the two household classes. The sum is household taxes:

(6.34) $TAXH = TAX_R+TAX_U$

Disposable income for household class h is pre-tax income minus taxes.

(6.35) $YDISP_h=Y_h\text{-}TAX_h$

Saving for the two household classes are modelled by exogenous saving rates, ($SAVR_h$).

(6.36) $SAV_h=YDISP_h \cdot SAVR_h$

Total private consumption expenditure in current prices for each household class is defined as:

(6.37) $HPC_h=YDISP_h\text{-}SAV_h$

Pre tax income in the corporate sector is Y_{COR}. The corporate sector includes the oil sector, see below.

(6.38) $Y_{COR}=(1\text{-}opshu^B\text{-}opshr^B) \cdot OS + EXR^C \cdot (FACTIN\text{-}REPAT\text{-}INTRF_{COR})\text{-}CPNT_R\text{-}CPNT_U\text{-}CPNT_{GOV} + INTRDGOV$

Corporate pre tax income consists of operating surplus that does not accrue to the two household classes, plus net factor income from abroad (*FACTIN*) minus repatriated profits from Indonesia to abroad (REPAT) and interest payments on foreign loans ($INTR_{COR}$) and minus net interest and dividend payments to the household sector and from government. The expression implies that repatriated profits (*REPAT*) are taken out of the country without being taxed. It also implies that corporate taxable income excludes dividends paid and that dividends are taxed by the receivers. *FACTIN, REPAT* and $INTRF_{COR}$ are measured in US dollars.

Corporate taxes levied on non-oil corporate profits are:

(6.39) $TAX_{COR}=TXR_{COR} \cdot (Y_{COR}-OS_{OIL})$

where TXR_{COR} is the corporate tax rate.

The equation is a simple way to take out the oil taxes paid by government owned companies from the tax function (6.39) for the company sector, without specifying these companies as an independent sector. It is important with a separate treatment of oil taxes since the tax rules for oil taxes are very different from the tax rules for ordinary companies.

Oil taxes are modelled as an exogenous (but variable) share of the operating surplus in the oil and gas sectors, using the tax rate variable TXR_{OIL}.

(6.40) $TAX_{OIL}=TXR_{OIL} \cdot OS_{OIL}$

OSOIL is the sum operating surplus in the petroleum producing sectors and the refinery sector (Sectors 004, 007, 008).

Corporate sector saving is:

(6.41) $SAV_{COR}=Y_{COR}-TAX_{OIL}-TAX_{COR}$

We need to model the surplus of the general government accounts properly, as this variable is important in policy-making. The surplus determines the path of government net assets, which are important in evaluating the sustainability of fiscal policy. There are important feedbacks of government surpluses via interest payments on government net assets. Interest payments should therefore ideally be modelled as a function of the stock of assets and interest rates. At the present stage of the project, however, we will limit ourselves to collect figures for the income flows, leaving interest payments exogenous.

Total government (general government) current revenue is defined by:

(6.42) $GCRV=TCD+TET+NVAT+OTP+TAX_H+TAX_{OIL}+TAX_{COR}+CPNT_{GOV}+TRM_{GOV} \cdot EXR^C$

TRM_{GOV}, transfers from abroad to government, are in the model measured in mill. dollars, as this variable also apperars on the current account. In the government balance, we must thus multiply by the current exchange rate to obtain mill. Rupiahs.

Total government current expenditure (*GCE*) is defined by:

(6.43) $GCE=PG \cdot G+EXR^C \cdot INTRF_{GOV}+TRNS_U+TRNS_R$

Where:
GCE is all expenditure except purchases of goods and services for real investment purposes.
$INTRF_{GOV}$ is net interest payments on the government's external debt (in dollars).

Total government expenditure (including expenditure for real investment purposes) is defined by:

(6.44) $GEXP=GCE+I_{GOV} \cdot PI$

I_{GOV} is government net capital formation (real net investment) in constant prices. PI is the price index for investment.
Government saving is:

(6.45) $SAV_{GOV}=GREV\text{-}GCE$

Government saving is net saving, as capital stock services (depreciation of government real capital) is not included in the definition of government income.

Government can allocate its savings for real investment or financial investment. Net financial investment (net lending) or the government surplus ($SURP_{GOV}$) is defined as net saving minus net real investment.

(6.46) $SURP_{GOV}=SAV_{GOV}\text{-}PI \cdot I_{GOV}$

Now we turn to the equations for the current account. All magnitudes on the current account are measured in US dollars. Aggregate exports (fob) and imports (cif) in current prices are given by:

(6.47) $EXPORT^C=(1/EXR^C)\cdot(\Sigma_j PFOB_j \cdot E_j)$

(6.48) $IMPORT^C=(1/EXR^B)\cdot(\Sigma_j PMCIF_j \cdot M_j)$

We divide with the current exchange rate in calculating the dollar value of exports, as the export price $PFOB_j$ is a Rupiah price index. For imports, we divide by the base year exhange rate as the variable $PMCIF_j$ already is a dollar price index.

The trade balance is just the difference between exports and imports :

(6.49) $TRBAL= EXPORT^C\text{-}IMPORT^C$

The current account is the trade balance minus repatriated profits, interest payments to abroad from the government sector, private corporations and public corporations, respectively:

(6.50) $CURACT= TRBAL\text{-}REPAT\text{-}INTRF_{GOV}\text{-}INTRF_{COR}+TRM_R+TRM_U+TRM_{GOV}$

6.4 Some accounting aggregates

Total exports (E), total change in stocks (DS), investment (I) and imports (M) in constant prices as a sum of the sectoral variables:

(6.50) $E = \Sigma_i E_i$

(6.51) $DS = \Sigma_i \Delta S_i$

(6.52) $I = \Sigma_i I_i$

(6.53) $M = \Sigma_i M_i$

The aggregated export and import price indices in domestic currency are given by:

(6.54) $PE = (\Sigma_i PE_i \cdot E_i)/E$

(6.55) $PM = (\Sigma_i PM_i \cdot M_i)/M$

GDP is calculated from the demand side. In order to reconcile GDP calculated from the demand side to GDP from the supply side, the residuals $GDPRES^C$ and $GDPRES^F$ are included (they are zero in the base year).

(6.56) $GDP^C = PC \cdot C + PI \cdot I + PG \cdot G + PE \cdot E - PM \cdot M + PS \cdot DS$

(6.57) $GDP^F = C + I + G + E - M + DS$

(6.58) $VA^C = \Sigma_j VA^C_j + TIVMC + TETMC + TCDC + GDPRES^C$

(6.59) $VA^F = \Sigma_j VA^F_j + TIVMF + TETMF + TCDF + GDPRES^F$

Where:

GDP^C *GDP* in Current Prices, calculated from the demand side as sum of volume figures for private consumption, gross investment, government consumption, exports less imports plus change in stocks.

GDP^F GDP in fixed prices, calculated from the demand side as sum of figures for private consumption, gross investment, exports less imports plus change in stocks.

(6.60) $GDPRES^F = GDP^F - \Sigma_j VA_j^F + TIVMF - TETMF - TCDF$

(6.61) $GDPRES^C = GDP^C - \Sigma_j VA_j^C - TIVMC - TETMC - TCDC$

7. The expenditure system for private consumption

Total consumption expenditure for the two household classes are given by (6.37). Consumption of each category is determined by a two-level linear expenditure (LES) system for each household class. The expenditure system is described in some more detail in appendix 1.

At the upper level, per capita consumption of upper level category l, household class h $(h=R,U)$, is determined by:

(7.1) $CC^h_l = \alpha^h_l + (\beta^h_l/P_l) \cdot (HPCC^h\text{-}HPCCMIN^h)$

(7.2) $HPCCMIN^h = \Sigma_l \alpha^h_l \cdot P_l$

Where

CC^h_l	Private consumption per capita, socioeconomic class h, upper level consumption category l, constant prices.
α^h_l	"Minimum consumption" per capita, upper level consumption category l, household class h
$HPCC^h$	Per capita consumption expenditure, socioeconomic class h, current prices.
$HPCCMIN^h$	Aggregate minimum per capita consumption, class h, current prices.
P_l	Price index, upper level consumption category l.
β^h_l	The expenditure derivative of upper level category l and is often denoted the marginal budget share of consumption category l, for household class h.

The α^h_l's in linear expenditure systems are often denoted minimum consumption quantities. There is no technical reason why the minimum consumption quantities could not be negative, which would make subsitution possibilities larger (cf. appendix 1). However, in that case, the interpretation of α's as minimum consumption quantites, does not make sense. This is utilized in the calibration/estimation stage. In all sub-systems, both upper and lower level, HPCCMIN is positive, but in some cases some of the α's are negative.

At the lower level the equations are:

(7.3) $CC^h_k = \alpha^h_k + (\beta^h_k/P_k) \cdot (P_l \cdot CC^h_l\text{-}HPCCMIN^h_l)$

(7.4) $HPCCMIN^h_l = \Sigma_k \alpha^h_k \cdot P_k, \qquad k \in \{I_k\}$

where subscript k refers to consumption of lower level consumption category k being part of upper level category l. I_k is the list of consumption categories at the lower level, contained in upper level consumption category l. $HPCCMIN_l$ is minimum per capita consumption of consumption category l.

Equation (7.3) and (7.4) split consumption of upper level category l out on the sub-categories of which it consists. For each upper level consumption category CC^h_l there is a system of equations (7.3) and (7.4).

On both levels, adding up in current prices is secured by deleting one of the equations, and including the adding up condition in stead, i.e.

(7.5) $HPCCMIN^h = \Sigma_l P_l \cdot CC^h_l$

Having determined CC^h_k for all k and h, national aggregates are calculated by multiplying with the population variables:

(7.6) $$C_k = POP^U \cdot CC^U_k + POP^R \cdot CC^R_k$$

C_k Private consumption of category k
POP^h Number of persons, class h
CC_k^h Per capita consumption of commodity k, class h

Aggregate private consumption is calculated by:

(7.7) $$C = \Sigma_k C_k$$

8. The emission sub-model

The basic idea in this sub-model is to transform modelled energy use in constant prices in the production sectors and in private consumption into energy use measured in physical units and further into emission of CO_2.

Energy use in constant prices are: Electricity HN_{Ej} and fuels HN_{Oj}. The variable code HN means that the variable is measured net of deductible VAT. This is a better quantity concept than use of intermediate inputs with deductible VAT included, cf. ch. 4. Energy use measured in physical units are obtained by using exogenous conversion factors.

The following equations link inputs of energy in fixed prices to inputs of energy measured in physical units. The PF_{sj} variables are exogenous coefficients that convert energy in fixed prices to energy in physical units.

(8.1) $FE_j = PFE_j \cdot HN_{Ej}$

(8.2) $FO_j = PFO_j \cdot HN_{Oj}$

Where:

FE_j	Use of electicity, sector j. *MWh*
FO_j	Use of fuels, sector j.1000 tons (kilotons =kt)
HN_{sj}	Use of energy type s (E, O), sector j, fixed prices, net of deductible VAT.

Data for electriciy use are calculated by BPS. Basis for the fuel calculations are energy balances published by UN (UN-Energy various issues). See appendix 4 for further details.

Use of electricity in physical units in private consumption is defined as a conversion of electricity consumption measured in fixed prices:

(8.3) $FCE = PCE \cdot C009$

The household sector's use of fuel is defined by the following equation:

(8.4) $FCO = PCO \cdot C003$

where *FCO* is household consumption of fuel measured in *kt*. PCO_s is conversion factor. C003 is consumption of fuels in constant prices.

Emission from production sector j:

(8.5) $CO2_j = C.CO2 \cdot FO_j$

CO2j	Emission of CO_2, sector j. kt.
C.CO2	Emission coefficient transforming energy in *kt* to CO_2 emissions in kt. The coefficient is 3.16 for all sectors.

Emission from private consumers due to use of fuel products:

(8.6) $CO2C = C.CO2 \cdot FCO$

Emission from government sector due to the use of fuel products:

Emissions from government sector due to combustion of fuels are treated in a specific way. In the I/O table there is no intermediate inputs in the government sector. Deliveries to government consumption are calculated in each I/O equation. Combustion of fuels in government sector thus does not appear as in the ordinary sectors. We have thus auxillary equations:

(8.7) $G007 = \delta_{007} \cdot G$

(8.8) $FO_{GOV} = PO_{GOV} \cdot G007$

(8.9) $CO2_{GOV} = C.CO2 \cdot FO_{GOV}$

Where:

$G007$ Government consumption of fuels, constant prices.

δ_{007} Base year coefficient for calculating government fuel consumption as a share of total government consumption.

FO_{GOV} Use of fuels in government sector, *kt*.

$CO2_{GOV}$ Emissions from government sector, *kt*.

Total energy use measured in physical units:

(8.10) $FE = \Sigma_j FE_j + FCE$

(8.11) $FO = \Sigma_j FO_j + FCO + FO_{GOV}$

Total emissions of CO_2:

(8.12) $CO2 = \Sigma_j CO2_j + CO2C + CO2_{GOV}$

9. A model version with factor substitution in the production sectors

In ch. 4 the simplified model for factor demand was set up, implying fixed (or rather: exogenous) factor intensities. We will here describe a simplified factor demand model with a specific production-theoretical point of departure. The approach is based on a the Cobb-Douglas production function. This function implies that the elasticity of substitution between all factors equal one.

In Norwegian models (cf. e.g. Cappelen (1992)) one have utilized a two-level factor demand system, where aggregate energy (a CES-aggregate of electricity and fuels), labour and non-energy intermediate inputs were determined at the upper level using a Cobb-Douglas production function. Electricity and fuels constitute a CES-aggregate, Energy. At the lower level, the elasticity of substitution between electricity and fuels determines the distribution of energy between electricity and fuels. This is more flexible than a pure Cobb-Douglas approach, but requires that one has econometric estimates to insert into the model. As we have few econometric analyses to support us at this stage, a transparent way of modelling factor demand within this context is to assume a Cobb-Douglas technology at the lower level as well. Pitt (1985) provides an econometric analysis of energy substitution in Indonesian manufacturing, that indicates significant price effects on energy demand. Eskeland et al. (1994) utilize these results in a partial equilibrium model of the Indonesian manufacturing sector. They utilize the translog functions, which is less restrictive then the Cobb Douglas function, which we use here. Our reason for doing that, is mainly due to simplicity.

The two-level approach implies certain separability conditions on the production function. Inter alia it implies that the optimal factor intensities between e.g. labour and non-energy inputs are not changed by changes in the optimal ratio of electricity and fuels, for a given quantity of of the energy aggregate. At the upper, level we have a Cobb Douglas production function in the 3 factors labour (L), energy (HNU), and non-energy intermediate inputs (HNR) is gross production and α_L, α_R, α_U, α_K are coefficients. K is determined by exogenous investment. The production function is:

(9.1) $X = L^{\alpha_L} HNR^{\alpha_R} HNU^{\alpha_U} K^{\alpha_K}$

At the lower level, electricity (HNE) and fuels (HNO) constitute the Cobb-Douglas aggregate energy:

(9.2) $HNU = (HNE)^{\beta_E} (HNO)^{\beta_O}, \beta_E + \beta_O = 1$

This represents the long run substitution possibilities. In the short run, possibilities for factor substitution are probably much smaller. In reality, energy use is closely linked to the capital stock. And as the capital stock is only gradually replaced, it takes a considerable time from relative factor prices change until actual factor intensities in the production sectors change. Another reason why it takes time from relative prices change until factor intensities change, is due to expectations formation. It is the future relative prices that are important for the firms when choosing future factor intensities when investing in new real capital. And it takes time for them to feel certain that an observed relative price change will be present also in the future.

This property of adjustment lags when factor prices change may be important in medium term and even long term analyses of price-based policies for curbing energy use or CO_2 emissions. The model for factor demand is divided in two parts, one determining the long run (equilibrium) factor intensities, and one part that determines the actual factor intensities. The actual factor intensities will gradually move towards the long run intensities. More details are given in appendix 3. There, short run and long run price elasticities of the factor demand sub-model, are also shown. The adjustment lags have been imposed somewhat arbitrary. It has been done by imposing a value of the time adjustment coefficients of 0.2 (cf. the equations below). This means that 95 per cent of the long run effect will have taken place within 15 years after a permanent relative price change. Within 5 years, 2/3 of the long run effect has taken place.

The firms are assumed to minimize variable costs given production and the predetermined capital stock. For practical reasons the capital stock has been eliminated from the long run factor demand equations, so long run factor demand depends upon gross production with an elasticity of 1, and relative factor prices with elasticities determined by the Cobb-Douglas production function and the cost shares in the base year. It is important to notice that e.g. an energy price rise besides reducing demand for energy, also increases demand for the other production factors. This property applies for all factors.

The Cobb-Douglas production function implies certain symmetry properties in the demand equations. But there is no guarantee that these will be present in the short run equations. We do not consider this to be so serious, as theory first and foremost says something about the long run production function.

Below the actual factor demand equations are shown. There are included correction variables (residuals) in each equation serving both as constant adjustments to calibrate the equations in the base year, as well as correction factors making it possible to implement assessments of factor neutral technological change in model simulations.

First, long run values at the upper level ("STAR" indicating long run level of the variable in question) are shown.

(9.3) $$\log(LSTAR_j) = ZZLSTAR_j + \log(X_j) - \alpha_R \log(\frac{PH_U}{PH_R}) + (\alpha_R + \alpha_U)\log(\frac{PH_U}{W})$$

(9.4) $$\log(HNUSTAR_j) = ZZHNUSTAR_j + \log(X) - \alpha_R \log(\frac{PH_U}{PH_R}) + (\alpha_R + \alpha_U - 1)\log(\frac{PH_U}{W})$$

(9.5) $$\log(HNRSTAR_j) = ZZHNRSTAR_j + \log(X) + (1-\alpha_R)\log(\frac{PH_U}{PH_R}) + (\alpha_R + \alpha_U - 1)\log(\frac{PH_U}{W})$$

Long run values at the lower level (electricity and fuels):

(9.6) $$\log(HNESTAR_j) = ZZHNESTAR_j + \log(HNUSTAR_j) - (1-\beta_E)\log(\frac{PH_E}{PH_O})$$

(9.7) $$\log(HNOSTAR_j) = ZZHNOSTAR_j + \log(HNUSTAR_j) + \beta_E \log(\frac{PH_O}{PH_E})$$

The actual factor demands will be (Δ is the difference operator ($\Delta x = x - x_{-1}$)):

(9.8) $$\log(L_j) = ZZL_j + \Delta\log(X_j) + C.LAML \cdot \log(LSTAR_{j,-1} / (L_{j,-1})$$

(9.9) $$\log(HNR_j) = ZZHNR_j + \Delta\log(X_j) + C.LAMR \cdot \log(HNRSTAR_{j,-1} / HNR_{j,-1})$$

At the lower level, energy demand will be:

(9.10) $$\log(HNE_j) = ZZHNE_j + \Delta\log(X_j) + C.LAME \cdot \log(HNESTAR_{j,-1} / HNE_{j,-1})$$

(9.11) $$\log(HNO_j) = ZZHNO_j + \Delta\log(X_j) + C.LAMO \cdot \log(HNOSTAR_{j,-1} / HNO_{j,-1})$$

Where:

$LSTAR_j$	Long run employment, sector *j*
HN_sSTAR_j	Long run factor demand of type *s* (*HNR, HNO, HNE, HNU*), sector *j*

ZZa Residual in the equation determining variable "a".
C.LAM$_s$ The speed of adjustment coefficient, production factor s (L: employment, R: non-energy inputs, E: electricity, O: fuels). All have been attributed a value of 0.2.

The factor substitution model has also been included in a full MEMLI model, which makes it a 2. version of MEMLI, called MEMLI2. The multipliers when increasing domestic and foreign demand are very similar, but since the second model version contains much more factor substitution, the model-calculated effects of changing factor prices are very different. Table 9.1 below shows the calculated effects of increasing the fuel tax from zero to 20 %. Since the factor demand equations have different elasticities over time, the overall effects of changing exogenous variables will also be time-dependent. We thus report effects on main macroeconomic variables for a number of years. The reference simulation goes from 1985 to 2010. The exogenous variable is changed with a constant amount in the same period.

Table 9.1 Simulated effects of increasing the fuel tax from 0 to 20 %. MEMLI model with factor substitution in the production sectors (MEMLI 2). Per cent difference from reference simulation

	Year after change					
Variable	1	2	3	5	10	25
Private consumption	-2.0	-1.9	-1.9	-1.7	-1.6	-1.7
Fuel consumption	-10.2	-10.0	-9.8	-9.7	-9.5	-9.6
Fuel use in production sectors	-4.0	-5.7	-7.0	-8.8	-10.8	-12.5
Exports	0.9	1.0	1.1	1.3	1.4	1.5
Imports	-1.4	-1.3	-1.2	-1.2	-1.1	-1.2
GDP	-0.8	-0.7	-0.6	-0.5	-0.4	-0.4
Employment	-1.3	-0.9	-0.6	-0.2	0.3	0.5
Consumer prices	1.5	1.7	1.8	1.9	2.1	2.2
Consumer price on fuels	16.5	16.5	16.5	16.6	17.0	17.4
Government saving [1]	0.9	0.9	0.9	0.8	0.8	0.8
Current account [1]	0.3	0.4	0.4	0.4	0.4	0.4
CO_2 emissions	-5.3	-6.5	-7.4	-8.7	-10.6	-11.5

1) Percentage points of GDP in current prices.

The simulation is the same as the one in table 3.2. The difference is that another model is used. All differences are due to the factor substitution model in MEMLI 2, while in MEMLI 1 there are exogenous factor intensities.

The immediate effect of increased fuel taxes is to raise prices on fuels and consequently the aggregate price level. As nominal wages are unchanged, household real disposable income is reduced, lowering private consumption. A traditional multiplier effect takes place. The short run contractionary effects e.g. on GDP and total employment are somewhat smaller than in the model with fixed factor intensities. The reason why they are smaller is that some factor substitution takes place already in the first year, and the production sectors substitute away from the production factor that has increased in price. Consequently the total cost increase will be a little smaller than if factor intensities were unchanged. Also non-energy intermediate input prices go up, due to increased production costs in producing them (indirect price effects). There will thus be substitution from non-energy inputs into labour as well, as wages is the only factor price that has not increased in price (by assumption; wages are exogenous).

Fuel use in the production sectors is reduced both because output is reduced, but as time passes, more because of increased prices of fuels. The first year after the change, fuel use in the production sectors is reduced by 4 per cent. After 10 years most of the adjustment in fuel use in the production sectors has taken place. The long run reduction in fuel use in the production sectors is 12.5 per cent.

The negative impacts on GDP in the long run are only one half of the short run effects. The reason is that the firms take time to substitute away from the production factor that has become more expensive. Thereby, the cost increase in the production sectors compared to the baseline simulation gradually becomes smaller. Even though GDP is reduced, total employment is larger than in the baseline simulation. This is again due to the effects of relative prices. Lower real wages motivates firms to employ more people and less energy and other intermediate inputs. Consumers are motivated to consume less energy-intensive products. The consequence is that the economy becomes more labour intensive.

The simulation in table 9.1 shows that with the imposed production structure, relative price changes can accomplish large reductions in fuel use and emissions accompanied with only small losses in aggregate output. Significant adjustments within sectors and between sectors have taken place to obtain that. In addition, we notice that both government saving and the current account has improved. As non-oil exports are exogenous, the improvement in the current account is due to lower imports because domestic demand has been reduced and because oil exports increase. The improvement in the government account is due to the direct effect from the imposed fuel tax. Since aggregate employment and production has gone down, tax revenues from other sources have been reduced.

The simulation draws attention to the possibility of increasing fuel taxes and using the revenues to lower e.g. personal taxes. In that way the level of domestic demand and production can be maintained, while factor substitution allows a decline in fuel use and CO_2 emissions.

However, it is important to have the still partial should nature of the model in mind when evaluating the results. Especially it is important to notice that if wages should react to prices, the increase in consumer and producer prices due to increased fuel taxes would have triggered wage rises. Then the relative price of labour would not have been so much reduced, and the overall picture would have been different from the one shown in table 9.1. In practical use of the model one must be careful to adjust model-exogenous but economy-endogenous variables to obtain as much realism in the analysis as possible.

Appendix 1

The linear expenditure system in MEMLI

1. Introduction

We here describe the consumer demand system for private consumption in MEMLI. The consumption system describes income and price elasticities for the various consumption categories. The properties of this system is crucial in how the model describes the possibilities for e.g. substitution of energy by other consumption goods. If there are large price elasticities for energy, the possibilities for reducing energy use and emissions by reducing fuel subsidies are good, while the opposite would be the case if the substitution possibilities are small.

We have implemented a two-level Linear Expenditure System (LES). The parameters describing substitution and income effects have been calibrated on the basis on a priori views. The imposed elasticities should thus be viewed as preliminary.

Section 2 describes the aggregation and classification. Section 3 specifies the equations in the LES system as they appear in the model. Section 4 describes the key elasticities.

2. Classification

We have a two level classification of consumption categories, given in table A1.1. The elasticities (price and expenditure) at the lower level (which we denote the composite elasticities) will be a mixture of lower level parameters and upper level parameters. The model contains separate consumption models for urban and rural households.

Table A1.1 Aggregation in the 2-level consumption system

Upper level classification Consumption categories $l \in L$	Lower level consumption good, Consumption categories $k \in K$	
1 Food, beverages and tobacco	001	Food beverages and tobacco
2 Energy	002	Non fuel energy
	003	Fuels
	009	Electricity and gas
3 Manufactured goods	004	Textile products
	005	Wood products
	006	Chemical products
	007	Electrical appliances and motor vehicles
	008	Other goods
4 Transport	010	Air transport
	011	Land and water transport
5 Other services	012	Other services

At the upper level consumption categories are C_l $l \in L$ {1, 2, 3, 4, 5,}. At the lower level (MEMLI aggregation) consumption categories are C_k, $k \in K$ {001, 002, 003, 004, 005, 006, 007, 008, 009, 010, 011, 012}. The correspondence between the two levels are given in table A1.1.

According to this aggregation, at the lower level there are 3 sets of equations.

It can be argued that the substitution possibilities should be approximately the same between the relatively aggregated categories at the top level. Intuition says us that the substitution possibilities between air transport and land/water transport are much larger than between food and air transport. Thus we aggregate the two transport categories together and model relatively limited substitution possibilities between transport and food at the upper level, and large substitution possibilities at the lower level.

3. Model specification

At the upper level, per capita consumption of upper level category *l*, household class *h*, is determined by:

(A1.1) $CC^h_l = \alpha^h_l + (\beta^h_l/P_l) \cdot (HPCC^h\text{-}HPCCMIN^h)$

(A1.2) $HPCCMIN^h = \Sigma_l \alpha^h_l \cdot P_k$

Where

CC^h_l	Private consumption per capita, socioeconomic class *h*, consumption category *l*, constant prices.
α^h_l	"Minimum consumption" per capita, consumption category *l*, household class *h*
$HPCC^h$	Per capita consumption expenditure, socioeconomic class *h*, current prices.
$HPCCMIN^h$	Aggregate minimum per capita consumption, class *h*, current prices.
P_l	Price index, consumption category *l* (base year (1985)=1).

β_l^h is the expenditure derivative of category *l* and is often denoted the marginal budget share of consumption category *l*, for household class *h*.

The α_l^h's in linear expenditure systems are often denoted minimum consumption quantities. There is no technical reason why the minimum consumption quantities could not be negative, which would make subsitution possibilities larger (cf. section 4). This is utilized in the calibration/estimation stage. In all systems both upper and lower level, *HPCCMIN* is positive, but in some cases some of the α's are negative.

At the lower level the equations are:

(A1.3) $CC^h_k = \alpha^h_k + (\beta^h_k/P_k) \cdot (P_l \cdot CC^h_l\text{-}HPCCMIN^h_l)$

(A1.4) $HPCCMIN^h_l = \Sigma_k \alpha^h_k \cdot P_k, \quad k \in K_l$

where subscript k refers to consumption of lower level consumption category *k* being part of upper level category *l*. K_l is the list of consumption categories at the lower level, contained in upper level consumption category *l*. $HPCCMIN^h_l$ is minimum per capita consumption of upper level consumption category *l*.

Equation ((A1.3), (A1.4)) split consumption of composite category *l* on the sub-categories of which it consists.

On both levels, adding up in current prices is secured by deleting one of the equations, and including the adding up condition in stead, i.e.

(A1.5) $HPCCMIN^h = \Sigma_l P_l \cdot CC^h_l,$ *(upper level)*

(A1.6) $HPCCMIN^h_l = \Sigma_k P_k \cdot CC^h_k,\ k \in K_l,$ *(lower level)*

Having determined CC^h_k for all *k* and *h*, national aggregates are calculated by:

(A1.7) $C^h_k = POP^U \cdot CC^U_k + POP^R \cdot CC^R_k$

C_k Private consumption of category k
POP^h Number of persons, class h
CC_k^h Per capita consumption of commodity k, class h

Aggregate private consumption is calculated by:

(A1.8) $C = \Sigma_k C_k$

Elasticities in the LES system are (here using k as a general subscript for consumption category):

(A1.9) Expenditure $\beta_k \cdot \left(\frac{hpcc^h}{P_k \cdot c_k^h}\right)$

(A1.10) Direct price, e_{kk}: $-1 + (1 - \beta_k) \cdot \left(\frac{\alpha_k^h}{c_k^h}\right)$

(A1.11) Cross price, $e_{k1,k2}$: $-\beta_{k_1} \cdot \left(\frac{P_{k_2} \cdot \alpha_{k_2}}{P_{k_1} \cdot c_{k_1}}\right)$ k_1, k_2

The expenditure elasticity is thus determined by the β_k's and the value shares.

With $\alpha_k^h > 0$ (positive minimum quantities of consumption commodity k, the direct price elasticities are always negative, but less than 1 in absolute value. Larger price elasticities can occur if α_k's are < 0, but then one cannot interpret them as minimum quantities. In the long run, c_k will probably increase for most k. Then the direct price elasticities in the LES system will approach -1. This can easily be seen from (A1.10) by letting c_k increase indefinitely.

4. Elasticities in the consumer demand system

The LES is based on utility-maximization of a representative consumer, maximizing the Stone-Geary utility function (omitting the household class index h here):

(A1.12) $U = \prod_{k=1}^{K}\left(\frac{c_k - \alpha_k}{\beta_k}\right), \quad \sum_{k=1}^{K}\beta_k = 1$

where U is utility, and the other variables are as defined above. A basic property of the utility function is the separability property. This enables us also to utilize so called utility trees, the utility counterpart of the 2 level Linear Expenditure System. Separability implies that demand for a commodity within a sub-group as a function of expenditure and prices within the group, is independent of prices of other goods outside the group. The latter factors enter only through the group expenditure functions.

Maximizing U given aggregate expenditure gives the linear expenditure system shown in (A1.1) and (A1.2).

The expression for the elasticity of the marginal utility of income is in the LES:

$$\varpi = -\frac{hpcc}{hpcc - \sum_k P_k \cdot \alpha_k}$$

By using assumptions (based on earlier research) on the elasticity of the marginal utility of money and the formula above, one can calculate hpccmin ($= \Sigma P_k \cdot \alpha_k$). If one has a dataset with price variation one could estimate this parameter, and this has been done in a number of studies, see e.g Selvanathan (1993) and Theil and Clements (1987). We must impose a value of ϖ based on other researcher's estimates and intuition. Remembering the definition of hpccmin from (A1.2), we have:

$$hpccmin = \frac{hpcc}{\left(\frac{\varpi}{\varpi + 1}\right)}$$

where hpcc is average per capita consumption expenditure in the base year.

Letting ϖ be -2, then hpccmin will be 0.5 ·hpcc. This is a typical result reported in Selvanathan (1993) for a sample of OECD countries and for relatively aggregated consumption categories. It has however been argued that this parameter should be lower in countries with lower average incomes. Imposing lower values makes hpccmin larger as a fraction of hpcc, cet. par., making the direct price elasticities smaller in absolute value (thus lowering the substitution possibilities in the consumer demand system). We have taken a relatively free attitude to this question, and imposed values for hpccmin in the different consumption systems, in order to obtain what we consider 'reasonable' elasticities. These are shown in tables A1.2 to A1.6.

Table A1.2 Elasticities in the consumption system in MEMLI, upper level. Per cent change in consumption when prices and aggregate consumption expenditure increase by 1%

	Rural					Urban				
Price of	1	2	3	4	5	1	2	3	4	5
1 Food, etc.	-0.72	-0.37	-0.37	-0.40	-0.47	-0.59	-0.32	-0.30	-0.28	-0.28
2 Energy	-0.02	-0,47	-0.02	-0.02	-0.03	-0.00	-0.95	-0.00	-0.00	-0.00
3 Man. goods	-0.05	-0.06	-0.49	-0.06	-0.07	-0.01	-0.02	-0.90	-0.01	-0.01
4 Transport	-0.02	-0.02	-0.02	-0.50	-0.02	-0.01	-0.03	-0.02	-0.85	-0.02
5 Other serv.	-0.08	-0.09	-0.09	-0.10	-0.68	-0.04	-0.08	-0.07	-0.07	-0.89
Expenditure:	0.89	1.00	1.00	1.09	1.28	0.65	1.40	1.31	1.21	1.22

Table A1.3 Elasticities in the sub-system for energy. Per cent change in consumption when prices and aggregate energy consumption expenditure increase by 1%

	Rural			Urban		
Price of	002	003	009	002	003	009
002 Non fuel energy	-0.55	-0.15	-0.15	-0.15	-0.02	-0.02
003 Fuels	-0.30	-0.84	-0.35	-0.03	-0.92	-0.14
009 Electr. and gas	-0.03	-0.04	-0.52	-0.01	-0.07	-0.85
Expenditure:	0.88	1.04	1.03	0.19	1.02	1.02

Table A1.4 Elasticities in the sub-system for manufactured goods. Per cent change in consumption when prices and aggregate consumption of manufactured goods increase by 1%

	Rural					Urban				
Price of	004	005	006	007	008	004	005	006	007	008
004 Textile products	-0.71	-0.10	-0.11	-0.10	-0.10	-0.82	-0.05	-0.06	-0.06	-0.05
005 Wood products	-0.03	-0,68	-0.03	-0.03	-0.03	-0.02	-0.69	-0.02	-0.02	-0.02
006 Chem. products	-0.05	-0.06	-0.75	-0.06	-0.06	-0.06	-0.05	-0.78	-0.06	-0.06
007 Electr. and vehicles	-0.08	-0.08	-0.09	-0.72	-0.08	-0.04	-0.04	-0.04	-0.83	-0.04
008 Other goods	-0.07	-0.08	-0.08	-0.07	-0.73	-0.10	-0.08	-0.09	-0.10	-0.75
Expenditure:	0.95	1.01	1.06	0.98	1.02	1.05	1.92	1.00	1.08	0.92

Table A1.5 Elasticities in the sub-system for transport. Per cent change in consumption when prices and aggregate transport consumption increase by 1%

	Rural		Urban	
Price of	010	011	010	011
010 Air transport	-1.06	0.01	-1.08	0.02
011 Land and water transport	-0.36	-0.91	-0.27	-0.94
Expenditure:	1.42	0.91	1.36	0.93

Table A1.6 Elasticities in the consumption system in MEMLI, total consumption model. Per cent change in consumption when prices and aggregate consumption expenditure increase by 1%

	Change in consumption, %											
Price of	001	002	003	004	005	006	007	008	009	010	011	012
1. Food	-0.68	-0.31	-0.36	-0.34	-0.34	-0.35	-0.35	-0.33	-0.34	-0.45	-0.30	-0.38
2. Non. fuel energy	-0.00	-0.48	-0.07	-0.00	-0.00	0.00	0.00	-0.00	-0.04	-0.00	-0.00	-0.00
3. Fuel	-0.00	-0.00	-0.65	-0.01	-0.01	-0.01	-0.01	-0.01	-0.08	-0.01	-0.01	-0.01
4. Textile	-0.00	-0.00	-0.00	-0.67	-0.01	-0.00	-0.00	-0.00	-0.01	-0.01	-0.01	-0.01
5. Wood	-0.00	-0.00	-0.00	-0.00	-0.66	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
6. Chem.	-0.01	-0.01	-0.01	+0.01	+0.02	-0.69	+0.01	+0.01	-0.01	-0.01	-0.01	-0.01
7. El. motor	-0.01	-0.01	-0.01	+0.00	+0.01	+0.01	-0.69	+0.01	-0.01	-0.01	-0.01	-0.01
8. Other goods	-0.01	-0.01	-0.01	+0.01	+0.02	+0.01	+0.01	-0.66	-0.01	-0.01	-0.01	-0.01
9. El./gas	-0.00	+0.08	+0.03	-0.00	-0.00	-0.00	-0.01	-0.01	-0.75	-0.01	-0.01	-0.01
10. Air transport	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	0.00	0.00	0.00	-1.01	+0.06	-0.00
11. Land, water transp.	0	0	-0.01	-0.01	-0.01	-0.01	-0.01	-0.02	-0.01	-0.12	-0.72	-0.00
12. Other services	-0.07	-0.07	-0.08	-0.08	-0.08	-0.09	-0.09	-0.08	-0.08	-0.11	-0.07	-0.78
Expenditure:	0.82	0.84	1.20	1.11	1.07	1.17	1.13	1.10	1.35	1.61	1.08	1.25

Energy (upper level category 2) and transport (upper level category 4) are considered expenditure elastic especially for urban households.

The upper level implies that substitution possibilities between the 5 aggregate consumption categories are limited. But we have implemented more substition between different energy types and kinds of transport.

Generally, we have imposed smaller substitution possibilities for rural than for urban households, as average income is lower. The expenditure elasticities also differ somewhat between groups. For rural households we have imposed a higher expenditure elasticity for food than for urban households.

Appendix 2

Nils Ø. Mæhle: The modelling of trade and transport margins and taxes on products in the price part of input-output based models

1. Introduction

In the first part of this appendix the modelling of trade and transport margins is discussed in a case where there are no taxes on products. It is shown that since we are assuming fixed input-output coefficients, nothing is gained in the *volume part* of the model by having separate (and fixed) trade and transport margin rates for each product flow. This, as long as the rates are the same for both imported and domestically produced products. It is also shown that this is *not* necessarily the case in the *price part* of the model.

In the second part, the modelling of taxes and subsidies on products in the input-output equations determining the model's price indices in purchasers' value is discussed through a detailed outline of the IO purchasers' price index equations. It is shown that *an ideal treatment* of the different types of taxes and subsidies on products in the *price part* of the model (and in the tax revenue calculations) requires separate trade and transport margin rates for each product flow, when trade or/and transport margins constitute a part of the tax base.

The discussion also suggests that trade margins should be modelled differently from in transport margins the IO price and tax revenue part of the model.

The input output equations determining the models' price indices in purchasers' value are the definitional link between 1) the prices paid by the purchasers', 2) the prices charged/received by the producers' and 3) taxes on products. Through a detailed outline of these equations we try to explain the structure of the equations and thus showing these links.

The price indices (and the tax revenue equations) implemented in MEMLI version 1 are simplified compared to the detailed outline in this appendix. In cases where trade and transport margins in basic values are a part of the tax base (as for VAT) the simplifications in the model introduce small errors.

2. Trade and transport margins in input-output models

In the National Accounts output of wholesale and retail trade activities are measured by the value of the trade margins, i.e. the trade margins realised on the goods wholesalers and retailers sell.

Trade and transport margins are defined wider, as the cumulative wholesale and retail trade margins (trade margins) plus any transport charges paid *separately* by the purchaser in taking delivery at the required time and place.

In the input-output context, the trade and transport margins can also be defined in terms of value components or differences in price concepts. Gross trade and transport margins can be defined as the purchasers' value of a good minus the producers' value (or ex factory value). Gross trade and transport margins include any taxes and subsidies on the product paid/received by the traders (and transporters).

The Indonesian input-output tables are published both in producers' and in purchasers' value. Thus there (implicitly) exists a gross trade and transport margin matrix. In the IO table in producers' value the trade and transport margins on the deliveries of products to each demand category are (1) aggregated together and (2) divided into deliveries from each of the margin producing industries (in the model 3). In the IO tables in producers' value, and the equations implemented in MEMLI version 1, these deliveries are lumped together with other deliveries from these industries forming "ordinary" products or industry deliveries.

In the model we use only one trade and transport margin rate matrix for total transactions (imported +domestically produced products). That means that the same rates are applied on both imported and domestically produced products.

Trade and transport margins could be modelled either 1) additively (as a specific amount per unit of quantity) or 2) multiplicatively (as a specific percentage of the price per unit or value of the good or service transacted). As it will be shown, the traditional treatment in IO tables and IO models (including MEMLI version 1 and the present Norwegian models) as "ordinary" products or industry deliveries implies a) an additively modelling of the margins and b) an assumption of uniform change in trade and transport margin rates on all products. These are quite strong assumptions. The multiplicative treatment of *trade* margins seems to be the most correct way of representing the behaviour of the trade industry in the model, and the one that probably should be preferred.

To ease the exposition, in the following discussion we assume that there are no taxes on products, which means that producers' value and basic value become equal.

In the *first case*, the margins accrued on a product *i* delivered to a specific demand category *j*, e.g. private consumption, in current prices is given as:

(A2.1) $TM^C_{ij} = TMRB_{ij} \cdot TMRC_i \cdot DCp_{ij}$

Where:

TM^C_i = Trade and transport margins accrued on a product *i* delivered to a specific demand category *j* in current prices

$TMRB_i$ = Base year trade and transport margin rate on product *i* delivered to demand category *j*

$TMRC_i$ = Changes from the base year in the trade and transport margin rate on product *i* (1985 = 1)

DCp_{ij} = Product *i* delivered to Demand Category *j* i constant Producers' value ($DCp= C_k, H_s, E, I, G$)

In *the second case*, trade and transport margins accrued on a product *i* delivered to a spesific demand category *j* in current prices is given as:

(A2.2) $TM^C_{ij} = TMRB_{ij} \cdot TMRC_i \cdot PDCp_{ij} \cdot DCp_{ij}$

Where:

$PDCp_{ij}$ = The average Price index on product *i* delivered to Demand Category *j* in Producers' value. The average of the domestic and import price indices for product *i*.

For the different domestic demand categories, e.g. private consumption category *k*, the average Price index on product *i* delivered to the Demand Category ,$PDCp_{ij}$ is given as:

(A2.3) $PDCp_{ij} = PDCb_{ij} = PCb_{ik} = [(1\text{-}DIMPS_i \cdot (\alpha^M_{ij}/\alpha_{ij})) \cdot PXD_i + (DIMPS_i \cdot \alpha^M_{kij}/\alpha_{kij}) \cdot PM_i]$

Where:

$PDCb_{ij}$ = The average Price index on product *i* delivered to Demand Category *j* in basic value.

In *constant prices, trade and transport margins* accrued on a product *i* delivered to a specific demand category *j* in both cases is given as:

(A2.4) $TM^F_{ij} = TMRB_{ij} \cdot Dcp_{ij}$

The total purchasers' value in constant prices of demand category *j* is by definition given as:

(A2.5) $DC_j = \Sigma_i(1+TMRB_{ij}) \cdot DCp_{ij} = \Sigma_i DCp_{ij} + \Sigma_i TMRB_{ij} \cdot DCp_{ij}$

To ease the exposition, let us for the discussion in this appendix regard both trade and transport margins as delivered from only one industry. Let the deliveries from this industry be denoted product number 81 (randomly selected). Then $DCp_{81j}=\Sigma_i TMRB_{ij} \cdot DCp_{ij}, \; i \neq 81$

The input coefficients for eg. intermediate consumption category *s*, are defined as:

$\alpha_{isj} = DCb_{ij}/DC_j = DCp_{ij}/DC_j$ (since we are assuming no taxes on products).

For i = 81 we specially have that:

$\alpha_{s81j} = DCp_{81j}/DC_j = \Sigma_i TMRB_{ij} \cdot DCp_{ij}/DC_j, \; i \neq 81$

And $\Sigma_i \, \alpha_{sij} = 1$

Total value in current prices of demand category j is in *the first case* given as:

$$\text{(A2.6)} \quad DC^C_j = \Sigma_i PDCp_{ij} \cdot DCp_{ij} + \Sigma_i TMRB_{ij} \cdot TMRC_i \cdot DCp_{ij}$$
$$= (\Sigma_i \, \alpha_{ij} \cdot PDCp_{ij} + \Sigma_i \, \alpha_{ij} \cdot TMRB_{ij} \cdot TMRC_i) \cdot DC_j \quad i \neq 81$$

And the purchaser's value price index for demand category *j* has to be defined as:

$$\text{(A2.7)} \quad PDC_j = (\Sigma_i \, \alpha_{ij} \cdot PD_{ij} + \Sigma_i \, \alpha_{ij} \cdot TMRB_{ij} \cdot TMRC_i) \quad i \neq 81$$

Given a uniform change in trade and transport margins, $TMRC_i = PDCp_{81}$ *for all i*, eq. 8 could be written as:

$$\text{(A2.8)} \quad DC^C_j = (\Sigma_i \, \alpha_{ij} \cdot PDCp_{ij} + \Sigma_i \, \alpha_{81j} \cdot PDCp_{81}) \cdot DC_j \quad i \neq 81$$

And the corresponding price index as:

$$\text{(A.2.9)} \quad PDC_j = (\Sigma_i \, \alpha_{ij} \cdot PDCp_{ij} + \Sigma_i \, \alpha_{81j} \cdot PDCp_{81}) \quad i \neq 81$$
$$=> PDC_j = \Sigma_i \, \alpha_{ij} \cdot PDCp_{ij}$$

By definition there could be no import of trade margins, and non of the imported transport services are treated as transport margins in the IO table so:

$PDCp_{81} = PXD_{81}$.

Equation A2.9 is equivalent to the price equations implemented in MEMLI version 1 in the case where there are no product taxes involved.

Total value in current price of demand category j is in *the second case* given as:

$$\text{(A2.10)} \quad DC^C_j = \Sigma_i PDCp_{ij} \cdot DCp_{ij} + \Sigma_i TMRB_{ij} \cdot TMRC_i \cdot PDCp_{ij} \cdot DCp_{ij} \quad i \neq 81$$
$$= \Sigma_i \, (1+TMRB_{ij} \cdot TMRC_i) \cdot PDCp_{ij} \cdot \alpha_{ij} \cdot DC_j \quad i \neq 81$$

And the purchasers' price index for demand category *j* has to be defined as:

$$\text{(A2.11)} \quad PDC_j = \Sigma_i \, (1+TMRB_{ij} \cdot TMRC_i) \cdot PDCp_{ij} \cdot \alpha_{ij} \cdot DC_j \quad i \neq 81$$

Which could not be reduced or rearranged to the price equations implemented in MEMLI version 1 or found in traditional IO models.

The multiplicative treatment of *trade* margins seems to be the most correct way of representing the behaviour of the trade industry in the model.

However, regarding the *transport margins*, it is more likely that the transporter charges by unit transported (and distance) and not as a percentage of the value of the goods transported. This means that the additive version of the margin modelling discussed above should be chosen, and transport margins could be handled as an "ordinary" product in the model.

To be able to model trade margins differently from transport margins, we need to have two separate matrices one for trade margins and one for transport margins, which we do not have in the Indonesian Input Output tables (and most IO tables for other countries). Thus we have to treat both trade margins and transport margins in the same way. We have chosen the simplest solution, which is an additive treatment of all the margins.

3. The modelling of taxes on products in the price part of input-output based models

The treatment of the different types of taxes on products, in MEMLI version 1, is discussed and explained by showing how the purchasers' value of a transaction could be constructed as the sum of its value components. Starting by defining the basic value of the transaction, this is done by adding net excise taxes and VAT paid by the producers, net trade and transport margins, excise taxes paid by the traders and/or transporters and finally VAT on trade and transport margins. VAT is given a simplified gross treatment.

The components in the producers' value

The deliveries of product *i* to demand category *j* in *current basic values* is given as:

(A2.13) $DCb^c_{ij} = PDCb_{ij} \cdot \alpha_{ij} \cdot DC_j$

Assume that there is levied some excise tax on product *i*, and that this tax is paid by the producers, ie. is part of the producers' value of the product.

If the excise tax is levied as a specific percentage of the value of the good or service transacted, *the producers' value*, net of VAT, is given as:

(A2.14) $(1 + BTREp_{ij} \cdot TRCEp_i) \cdot PDCb_{ij} \cdot \alpha_{ij} \cdot DC_j$

If the excise taxes are levied as a specific amount per unit of quantity transacted, the producers' value, net of VAT, is given as:

(A2.15) $PDCb_{ij} \cdot \alpha_{ij} \cdot DC_j + BTREp_{ij} \cdot TRCEp_i \cdot \alpha_{ij} \cdot DC_j = (PDCb_{ij} + BTREp_{ij} \cdot TRCEp_i) \cdot \alpha_{ij} \cdot DC_j$

where:

$TRCEp_i$ = Changes from the base year in the Tax Rate of net Excise taxes on product *i* (1985 = 1) paid by the producers.

$BTREp_{ij}$ = The Base year Tax Rate of net Excise taxes on product *i* paid by the Producers.

The producers' value including invoiced VAT of this product flow is in the two cases given as:

With ad valorem excise tax:

(A2.16) $DCp^C_{ij} = (1 + BTRV_{ij} \cdot TRCV_i) \cdot (1 + BTREp_{ij} \cdot TRCEp_i) \cdot PDCb_{ij} \cdot \alpha_{ij} \cdot DC_j$

And with quantity excise tax:

(A2.17) $DCp^C_{ij} = (1 + BTRV_{ij} \cdot TRCV_i) \cdot (PDCb_{ij} + BTREp_{ij} \cdot TRCEp_i) \cdot \alpha_{ij} \cdot DC_j$

where:

DCp^C_{ij} = Product *i* delivered to Demand Category *j* i current Producers' value (*DC= C, H, E, I, G*)

There is specified one base year tax rate for each demand category that purchase product *i*. Normally the tax rates are the same for all users of a specific product in micro. At the model's level of aggregation this might not be the case.

The distinction between ad valorem and quantity excise taxes is important. As it follows from the expressions above, the way the price equations should be written and thus the way price changes feed trough the system, differs. The equations implemented in version 1are based on an assumption that all excise taxes are ad valorem taxes.

The components in the gross trade and transport margins
The next stage in building up the purchasers' value of the transaction is to add the different elements in the gross trade and transport margins.That is; the basic value of trade and transport margins, excise taxes paid by the traders and/or transporters and VAT included in the gross trade and transport margin.

Above we discussed the modelling of trade and transport margins, and concluded with an additive treatment in MEMLI version 1. That means that we assume that both the traders and the transporters act as if they charge a specific amount per unit transacted. In that case we can model the basic value of trade and transport margins on the transactions either as a constant mark up at the producers' value or the basic value of the transaction in constant prices. The result will be the same. With product flows measured in basic values it is natural to model the trade and transport margins as a mark up on the basic value of the transaction in constant prices. This means that the basic value of trade and transport margins in current prices is given as:

(A2.18) $TM^{C}_{ij} = TMRB_{ij} \cdot TMRC_{i} \cdot \alpha_{ij} \cdot DC_{j}$

The tax base for excise taxes (and subsidies) paid/collected by the traders and/or transporters could in principle be both the basic value (value type 10) of the transaction or the basic value (value type 10) plus the trade and transport margin in basic value (value type 14). Normally there are no excise taxes on the transport margins as so.We have chosen the basic value (value type 10) of the transaction as tax base.

Total excise tax paid by the traders and transporters on the transaction (i.e. that is a part of the gross trade and transport margin) is then given as:

With ad valorem excise tax:

(A2.19) $TETttm_{ij} = BTREttm_{ij} \cdot TRCEttm_{i} \cdot PDCb_{ij} \cdot \alpha_{ij} \cdot DC_{j}$

With quantity excise tax:

(A2.20) $TETttm_{ij} = BTREttm_{ij} \cdot TRCEttm_{i} \cdot \alpha_{ij} \cdot DC_{j}$

where:
$TETttm_{ij}$ = Total excise tax paid by the traders/and or transporters on this transaction of product *i*. Current value.
$TRCEttm_{i}$ = Changes from the base year in the rate of excise tax paid by the traders' on product *i* (1985 = 1)
$BTREttm_{i}$ = The base year excise tax rate on product *i* paid by the traders'.

A value added tax (VAT) is a tax on goods and services collected in stages by enterprises but which is ultimately borne by the final purchasers. Producers are required to charge certain percentage rates of VAT on the goods or services they sell. However, producers are not required to pay to the government the full amounts of the VAT invoiced to their customers only the difference between the VAT on their sales (outgoing VAT) and the VAT on their purchases for intermediate consumption or gross fixed capital formation (incoming VAT)- Hence the expression value added tax.

The part of the total VAT levied on a product collected by the producer of the product is included in the producers' value. The rest is a part of the gross trade and transport margin. This amount is equal to total VATon the product (total outgoing VAT in the trade industry) minus the incoming VAT on the traders' purchase of merchandises (but not on there intermediate consumption and fixed capital formations). With a simplified gross treatment of value added taxes, VAT included in the gross trade and transport margins is treated as a tax on the gross trade and transport margin it self. Note that any excis taxes paid by the traders' constitutes a part of the tax base. VAT as a part of the gross trade and transport margins of the transaction could the be writen as:

$TVTttm_{ij} = (BTRV_{ij} \cdot TVRC_{i} \cdot (TMC_{ij} + TEttm_{ij})$

Note that we use the same base year VAT rate, $BTRV_{ij}$, when calculating the VAT that are a part of the gross trade and transport margin that used when calculating VAT as part of the producers' value of the transaction. With no transport margins or VAT also on the transport margin (with same rate), this has to be correct on the micro level but need not to be correct at a more aggregated level.

The purchasers' value

The current purchasers' value of the transaction is then given as:

$$(A2.21)\ DC^{C}_{ij} = VTTM_{ij} + TETT_{ij} + TMC_{ij} + DCp^{C}_{ij}$$

By putting together the expressions outlined above for the different elements that the purchasers' value consist of, the complete expression for the current purchasers' value of the transaction, when excise taxes are ad valorem taxes, could be written as:

$$\begin{aligned}(A2.22)\ DC^{C}_{ij} &= BTRV_{ij} \cdot TRCV_{i} \cdot (BTMR_{ij} \cdot TMRC_{i} \cdot \alpha_{ij} \cdot DC_{j} + BTREttm_{ij} \cdot TRCEttm_{i} \cdot PDCb_{ij} \cdot \alpha_{ij} \cdot DC_{j}) \\ &+ BTMR_{ij} \cdot TMRC_{i} \cdot \alpha_{ij} \cdot DC_{j} + (1+BTRV_{ij} \cdot TRCV_{i}) \cdot (1+BTREP_{ij} \cdot TRCEP_{i}) \cdot PDCb_{ij} \cdot \alpha_{ij} \cdot DC_{j} \\ &= [(BTRV_{ij} \cdot TRCV_{i} \cdot (BTMR_{ij} \cdot TMRC_{i} + BTREttm_{ij} \cdot BTREttmC_{i} \cdot PDCb_{ij}) \\ &+ BTMR_{ij} \cdot TMRC_{i} + (1+BTRV_{ij} \cdot TRCV_{i}) \cdot (1+BTREp_{ij} \cdot TRCEp_{i}) \cdot PDCb_{ij}] \cdot \alpha_{ij} \cdot DC_{j} \\ &= [(1+BTRV_{ij} \cdot TRCV_{i}) \cdot BTMR_{ij} \cdot TMRC_{i} \cdot \alpha_{ij} + (1+BTRV_{ij} \cdot TRCV_{i}) \\ &\cdot (1+BTREttm_{ij} \cdot TRCEttm_{i} + BTREp_{ij} \cdot TRCEp_{i}) \cdot PDCb_{ij} \cdot \alpha_{ij}] \cdot DC_{j}\end{aligned}$$

Since:

$$(A2.23)\ DC^{C}_{j} = \Sigma_{i} DC^{C}_{ij} = PDC_{j} \cdot DC_{j}$$

The aggregated purchasers' price index for total deliveries to each demand category could be written as:

$$\begin{aligned}(A2.24)\ PDC_{j} = &\Sigma_{i}[(1+BTRV_{j} \cdot TRCV_{i}) \cdot BTMR_{ij} \cdot TMRC_{i} \cdot \alpha_{ij} + (1+BTRV_{ij} \cdot TRCV_{i}) \\ &\cdot (1+BTRVttm_{ij} \cdot BTRVttmC_{i} + BTREp_{ij} \cdot TRCEp_{i}) \cdot PDCb_{ij} \cdot \alpha_{ij}]\end{aligned}$$

Above we have worked with the trade and transport margins distributed on each product flow, i.e. we have worked explicitly with a separate trade and transport margin rate on each transaction. This results in quite complicated IO price index equations. In MEMLI we have aggregated together all trade and transport margins on the different product delivered to each demand category. The trade and transport margins are thus treated as ordinary services delivered directly to each user category. This implies much simpler expressions. The discussion in chapter 2 of this appendix, with no taxes on products, showed that since we assume fixed input coefficients in constant prices and if we assume a) that both the traders' and the transporters' pricing behaviour are characterized by charging a certain amount per unit transacted and not a specific percentage of the value of the good or service transacted and b) uniform changes in trade and transport margin rates on all product, nothing is lost by this simplification. With taxes on products this conclusion holds as long as the trade and transport margins are not a part of the tax base for any of the different product taxes. For value added types of taxes the trade and transport margins *do constitute a part of the tax base* and us either have to stick to the complicated expressions outlined above or introduce some new assumptions or simplifications. The IO price index equations could be simplified in two ways.

Assume that the gross VAT rates are (approximately) equal for all products with non zero trade and transport margins purchased by demand category *j*, ie. that $BTRV_{ij} \approx BTRV_{j}$ for all i with $BTMR_{ij} \neq 0$. Then we could continue as above and treat all value added taxes included in the gross trade and transport margins on the different products delivered to each demand category as a tax on the aggregated trade and transport margin product.

As in chapter 2 let product code 81 represent the trade and transport margin product and define:

$$\alpha_{k81j} = DCb_{81j}/DC_{j} = \Sigma_{i} BTMR_{ij} \cdot Dk_{ij}/DC_{j} = \Sigma_{i} BTMR_{ij} \cdot \alpha_{ij},\ i \neq 81$$

Given a uniform change in trade and transport margins, $TMRC_{i} = PDCb_{81}$ *for all i*, then:

$$(A2.25)\ \Sigma_{i}\ [(1+BTRV_{ij} \cdot TRCV_{i}) \cdot BTMR_{ij} \cdot TMRC_{i} \cdot \alpha_{ij} = [(1+BTRV_{81j} \cdot TRCV_{81j}) \cdot PDCb_{81j} \cdot \alpha_{81j}$$

Which means that, as long as all excise taxes are treated as ad valorem taxes, the aggregated purchasers' price price index for the total purchases by demand category j could be written as:

(A2.26) $PDC_j = \Sigma_i[(1+BTRV_{ij} \cdot TRCV_i) \cdot (1+BTREttm_{ij} \cdot TRCEttm_i+BTREp_{ij} \cdot TRCEp_i) \cdot PDCb_{ij} \cdot \alpha_{ij}]$

Where all value added taxes included in the gross trade and transport margins are treated as a tax on the aggregated trade and transport margin product (product 81).

Compared with the price indices outlined above the price indices (and the related revenue calculations) implemented in MEMLI version 1 are simplified by letting the tax base for all value added taxes in the model be the purchasers' value of the transaction excluding trade and transport margins in basic value. By this we introduce some small errors. In addition we have not separated between excise taxes collected and paid by the producers and the traders. All excise taxes are assumed to be ad valorem taxes.

The price indices implemented have the following form:

(A2.27) $PDC_j = [PDCb_{81j} \cdot \alpha_{81j}+\Sigma_i(1+BTRV_{ij} \cdot TRCV_i) \cdot (1+BTRE_{ij} \cdot TREC_i) \cdot PDCb_{ij} \cdot \alpha_{ij}] \qquad i \neq 81$

or in more general terms as:

(A2.28) $PDC_j = [\Sigma_i(1+BTRV_{ij} \cdot TRCV_i) \cdot (1+BTRE_{ij} \cdot TREC_i) \cdot PDCb_{ij} \cdot \{(1-\Delta IMPS_i \cdot (\alpha^M_{ij}/\alpha_{kij})) \cdot PXD_i + \Delta IMPS_i \cdot \alpha^M_{kij}/\alpha_{kij} \cdot PM_i\} \cdot \alpha_{kij}]$

Appendix 3

Einar Bowitz: Description of factor demand in the extended version of MEMLI
In chapter 4 the simplified model for factor demand was set up, implying fixed (or rather: exogenous) factor intensities. In chapter 9 a model for factor substitution in the production sectors was decribed. We will here describe this part of the model in some more detail.

In some Norwegian models (cf. e.g. Cappelen (1992)) one have utilized a two-level factor demand system, where aggregate energy (a CES-aggregate of electricity and fuels), labour and non-energy intermediate inputs were determined at the upper level using a Cobb-Douglas production function. Electricity and fuels constitute a CES-aggregate - Energy. At the lower level, the elasticity of substitution between electricity and fuels determine the distribution of energy between electricity and fuels. This is more flexible than a pure Cobb-Douglas approach, but requires that one has econometric estimates to insert into the model.

As we have few econometric analyses to support us at this stage, a transparent way of modelling factor demand within this context is to assume a Cobb-Douglas technology at the lower level as well. The coefficients are calibrated by using base year data. The model distinguishes between short run and long run effects.

The long run equations
The two-level approach implies certain separability conditions on the production function. Inter alia it implies that the optimal factor intensities between e.g. labour and non-energy inputs are not changed by changes in the optimal ratio of electricity and fuels, for a given quantity of of the energy aggregate, PH_U. At the upper level we have a Cobb-Douglas production function for gross output (X) in the 3 factors labour (L), energy (HNU), non-energy intermediate inputs (HNR) and real capital K. Using a Cobb-Douglas production function together with assumptions on the scale elasticity, enables us to estimate the parameters from one observation. We have used the base year to calibrate the factor substitution model. The production function at the upper level is:

$$X = L^{\alpha_L} HNR^{\alpha_R} HNU^{\alpha_U} K^{\alpha_K} \qquad \text{(A3.1)}$$

At the lower level, electricity (HNE) and fuels (HNO) constitute the Cobb-Douglas aggregate energy:

$$HNU = (HNE)^{\alpha_E}(HNO)^{\alpha_O}, \alpha_E + \alpha_O = 1 \qquad \text{(A3.2)}$$

The α's are fixed parameters in the production function.

In principle, the adjustment of all factors should be modelled. In order to have a manageable sub-model and to focus on the most important topic for our energy-related model, gross investment is exogenous in MEMLI. In the factor substitution model described here, we have not departed from that.

We assume that the capital stock is predetermined, and that the firm will minimize variable costs for a given level of production, X.

Variable costs (upper level) are

$$C = WL + PH_R HNR + PH_U HNU \qquad \text{(A3.3)}$$

Where:

W	Wage rate
PM_R	Price index for non-energy intermediate inputs
PM_U	Price index for the energy input aggregate

Assuming constant returns to scale in the variable factors L, HNU, HNR ($\alpha_L+\alpha_U+\alpha_R=1$) together with the first order conditions, gives the following demand functions for each factor at the upper level:

(A3.4) $$L = const_L \cdot X \cdot (\frac{PH_U}{PH_R})^{-\alpha_R} \cdot (\frac{PH_U}{W})^{\alpha_R+\alpha_U} \cdot K^{-\alpha_K}$$

(A3.5) $$HNU = const_U \cdot X \cdot (\frac{PH_U}{PH_R})^{-\alpha_R} \cdot (\frac{PH_U}{W})^{\alpha_R+\alpha_U-1} \cdot K^{-\alpha_K}$$

(A3.6) $$HNR = const_R \cdot X(\frac{PH_U}{PH_R})^{1-\alpha_R} \cdot (\frac{PH_U}{W})^{\alpha_R+\alpha_U-1} \cdot K^{-\alpha_K}$$

We use the base year cost shares to estimate the marginal elasticities of the factors. The formulas are given below.

(A3.7) $$a_L = \frac{W \cdot L}{W \cdot L + PH_R \cdot HNR + PH_U \cdot HNU}$$

(A3.8) $$\alpha_U = \frac{PM_U \cdot HNU}{W \cdot L + PH_R \cdot HNR + PH_U \cdot HNU}$$

(A3.9) $$\alpha_R = \frac{PM_R \cdot HNR}{W \cdot L + PH_R \cdot HNR + PH_U \cdot HNU}$$

The parameters in the Cobb-Douglas aggregate for energy are determined in the same way:

(A3.10) $$\alpha_O = \frac{PH_O \cdot HNO}{PH_O \cdot HNO + PH_E \cdot HNE}, \alpha_E = \frac{PH_E \cdot HNE}{PHN_O \cdot HNO + PH_E \cdot HNE}$$

For the lower level, the demand equations become:

(A3.11) $$HNE = const_E \cdot HNU \cdot (\frac{PH_O}{PH_F})^{-(1-\alpha_E)}$$

(A3.12) $$HNO = const_O \cdot HNU \cdot (\frac{PH_E}{PH_O})^{(1-\alpha_O)}$$

Table A3.1 below shows the cost shares for all variable factors in the production sectors.

Table A3.1 Base year cost shares. Per cent of total intermediate input

Sector no.:	Electricity	Fuels	Non-energy inputs
1	0.3	1.6	98.1
2	1.5	21.0	77.5
3	0.2	10.5	91.2
4	0.1	4.7	95.2
5	4.2	21.1	74.7
6	0.5	31.3	68.2
7	0.7	0.3	88.9
8	0.2	1.0	98.7
9	0.2	0.9	98.9
10	0.9	2.4	96.6
11	1.5	1.4	97.0
12	0.7	5.0	94.3
13	2.1	4.1	93.9
14	1.2	7.4	91.4
15	1.2	1.9	96.9
16	6.6	26.1	67.3
17	7.3	7.8	84.9
18	0.6	0.6	98.7
19	0.9	0.9	98.1
20	1.1	3.3	95.5
21	21.1	58.1	20.7
22	5.1	18.7	76.2
23	0.1	16.4	83.4
24	5.5	10.1	84.2
25	0.0	39.6	60.3
26	0.8	34.6	64.6
27	3.4	1.3	95.2
28	..	..	..
29	4.5	3.9	91.5

We see that energy constitutes a relatively small share of total inputs in most sectors. For most sectors energy constitutes less than 5 % of total inputs, according to the model's databank. For some sectors, energy costs are large. These are sector 21, electricity and gas, that has a fuel cost share of 58 %. Also 25 Air transport and 26 Water transport have large energy costs. The latter two sectors practically only use fuels. In the input-output tables which are the basis for the model's databank, there are no use of intermediate inputs in sector 28 Public administration and Defence.

A question that arises is whether to impose the Cobb Douglas production structure for all sectors. Is it reasonable to impose a substitution elasticity of 1 for all sectors ? This is not easy to answer on apriori grounds. We have chosen to impose this restriction in MEMLI 2. The one exception from the rule is sector 28 Public administration and defence. The sector does not use energy, according to the input-output table. Thus demand for all factors is determined by exogenous parameters, in the way described in ch. 4.

Furthermore we have chosen not to include the capital stock in the factor demand equations. This is done largely to make practical use of the model easier. As gross investment is exogenous, it may be difficult to find out the exogenous values for real investment that will have the desired effects on the capital stock. And the inofficial nature of the capital stock data (they are inofficial data constructed by the Central Bureau of Statistics in Indonesia) is also a reason why we do not want to include the capital stock into the demand functions. Consequently the factor intensities will only depend on the relative prices of labour, electricity, fuels and non-energy intermediate inputs.

The dynamic adjustment to the long run substitution possibilities

The production function describes the long term substitution possibilities, and the equations above should be interpreted as long run equations, and the variables as long run variables. In practice, factor substitution will take time. The lags in the adjustment will occur due to a number of factors. One factor is expectations formation. A firm will not change technology just because current factor prices change. The important issue is what will the prices be when the equipment is used, i.e. in the future. In order for current relative price changes to influence the factor inputs, the price changes must be expected to last. An adaptive expectation formation mechanism, where the expectation only reacts slowly when current prices rise, is one explanation of adjustments from observed changes in factor prices until actual changes in production technology takes place. Time to install new equipment is also a factor behind adjustment lags. In practice factor use, especially energy use, is very dependent upon the technology used in the firms. It is embodied in the capital stock (in reality, not in the model).

A more realistic description of the production process is to impose an adjustment process until the long run solution is reached. We have assumed that it is only effects of changes in relative factor prices that take time to fulfill, and that changes in production immediately gives a similar change in factor demand. A 1 per cent increase in production is thus assumed to imply a 1 per cent increase in all variable production factors the same year (for unchanged relative factor prices). The following set of equations accomplish that. LSTAR, HNRSTAR, HNESTAR and HNOSTAR are determined in the long run equations (A3.4, A3.6, A3.11, A3.12). The factor demand equations are ($\Delta$is the difference operator: $\Delta x = x - x_{-1}$):

$$(A3.13)\quad \Delta\log(HNR_j) = \Delta\log(X_j) + \lambda_R \log(\frac{HNRSTAR_{j,-1}}{HNR_{j,-1}})$$

$$(A3.14)\quad \Delta\log(HNE_j) = \Delta\log(X_j) + \lambda_E \log(\frac{HNESTAR_{j,-1}}{HNE_{j,-1}})$$

$$(A3.15)\quad \Delta\log(HNO_j) = \Delta\log(X_j) + \lambda_O \log(\frac{HNOSTAR_{j,-1}}{HNO_{j,-1}})$$

$$(A3.16)\quad \Delta\log(L_j) = \Delta\log(X_j) + \lambda_L \log(\frac{LSTAR_{j,-1}}{L_{j,-1}})$$

This is a modification of a partial adjustment mechanism. The λ-coefficients indicate how large fraction of the deviation from the long run value of the factor (given from (A3.4, A3.6, A3.11 and A3.12) that is eliminated each period. The inclusion of the $\Delta\log(X)$ terms has the effect that the factors change in proportion with production for given relative factor prices. Somewhat arbitrarily we have chosen the value 0.2 for all λ-coefficients. That means that it takes 15 years until 95 per cent of the long run effect of price changes is completed.

Imposing the adjustment equations will imply that the symmetry properties of the theoretical equations will only be present in the long run equations. We consider this not to be so serious, as the theory first and foremost says something about the long term substitution properties.

In addition to the variables included above there will also be residuals with prefix ZZ before the name of the variable that is determined in the particular equation. This is shown in ch. 9. In addition to calibration to the base year values, these variables can be utilized by the model user to take account of autonomous technical progress. A Cobb-Douglas technology assumes factor neutral technical progress, so the annual change in the residuals due to technical progress, should be equal for all factors at each level.

In order to describe the properties of the factor substitution model, tables A3.2-A3.5 below show the effects of changing the factor prices. The tables are generated by model simulations from 1985 to 2010 on the factor demand sub-model only. Due to the dynamic nature, the effects on factor use of changes in factor prices, are time-dependent. Production in all sectors are unchanged in the simulations. The total own-price elasticity of eletricity is -0.12 in the long run, while the fuel elasticity is -0.79. About 2/3 of the long run effects are apparent after 5 years.

Table A3.2 Per cent change in total use of variable factor inputs when prices on electricity increase by 1%

	Year after change				
	1	2	5	10	25
Use of:					
Electricity	-0.18	-0.33	-0.62	-0.84	-0.92
Fuels	0.01	0.01	0.02	0.03	0.03
Labour	0.00	0.00	0.00	0.01	0.01
Non-energy inputs	0.00	0.00	0.00	0.01	0.01

Table A3.3 Per cent change in total use of variable factor inputs when fuel prices increase by 1%

	Year after change				
	1	2	5	10	25
Use of:					
Electricity	0.03	0.06	0.11	0.15	0.17
Fuels	-0.16	-0.29	-0.53	-0.73	-0.79
Labour	0.01	0.01	0.02	0.03	0.03
Non-energy inputs	0.01	0.01	0.03	0.05	0.05

Table A3.4 Per cent change in total use of variable factor inputs when wage rates increase by 1%

	Year after change				
	1	2	5	10	25
Use of:					
Electricity	0.05	0.09	0.17	0.22	0.24
Fuels	0.05	0.08	0.15	0.21	0.23
Labour	-0.12	-0.21	-0.39	-0.53	-0.58
Non-energy inputs	0.04	0.07	0.13	0.18	0.20

Table A3.5 Per cent change in total use of variable factor inputs when the price of non-energy inputs increase by 1%

	Year after change				
	1	2	5	10	25
Use of:					
Electricity	0.10	0.18	0.34	0.47	0.51
Fuels	0.11	0.19	0.36	0.48	0.54
Labour	0.11	0.19	0.36	0.50	0.54
Non-energy inputs	-0.05	-0.09	-0.17	-0.23	-0.26

Appendix 4

Construction of data for energy and emissions of CO_2
In order to obtain data for emissions of CO_2 from the various production sectors and from consumption, data for combustion of fossil fuels are needed. The input-output table only contains information on fuel use in money terms. Thus more information is needed. To our knowledge no data at our level of aggregation for fuel combustion is available. We have had to construct a dataset for combustion of fuels and CO_2 emissions.

The basic data source for energy use in physical units is the annual energy balances published by UN (see. e.g. UN-Energy (1992)). It contains supply, conversion (refineries, production of electricity and the like) and final consumption of energy of different types, measured in Tera-Joule (TJ). These figures form the basis for the calculations. The aggregation level is however not detailed enough for our purpose, so we have relied on the input-output data to distribute aggregate figures on the sub-sectors in the model.

In the input-output table, the production sector 28 - Public administration and defence - contains no intermediate input. All deliveries go directly to government consumption. Thus emissions due to combustion in that sector has been treated differently and the data has been constructed differently.

The procedure is as follows.

1. The data in the energy balance are converted into kilotons (kt) of fuel use. Kilotons is the chosen measure of fuel use in MEMLI, partly because the CO_2 emission factor then becomes identical for all uses of fuels for combustion (3.16 ton CO_2 per ton fossil fuel).

2. Final use of fuels for the iron and steel industry (sector 17) is taken directly from the energy balance.

3. The energy balance gives fuel use for "chemical industry" as well. This number is distributed to the 2 MEMLI-sectors for chemical industry. These are 14- Manufacture of fertilizers and pesticides and 15 - Manufacture of other chemicals. The input-output data for fuel use are used as weights.

4. Fuel use for MEMLI-sector 25 - Air Transport - is taken directly from the energy balance.

5. Fuel use for MEMLI-sector 26 - Land and water transport - is taken to be the rest of the aggregate in the energy balance.

6. Fuel use in households is taken directly from the energy balance.

7. The rest of the fuel use is distributed to all sectors. Intermediate inputs of fuels from the base year in the sectors are used as weights. There are some exceptions:

7.1 Refineries. Fuel use in refineries is mostly for conversion to petrol and heating oil, and is not combusted. The input of oil products from the input-output-table contains all input of oil products. As we are only interested in fuel input that is combusted, the input-output number for fuel input in refineries is adjusted downwards. We have assumed that 95 % of total oil input in this sector is converted to gasoline and heating oil, adjusting the oil input from the input-output table down by 95 %.

7.2 Public administration and defence. According to the input-output table, no (energy and other) inputs were required in that sector. This is probably due to accounting principles, not the reality. This sector combusts fuels and emits CO_2. In order not to interfere with the input-output structure in the original data, we have chosen to connect fuel use in physical units and emission from this sector directly to the variable for government consumption. The data has been constructed by assuming the same amount of fuel per unit of value added as in the MEMLI sector 29 - Other services.

Following conversion factors are assumed in the calculations:

Coal:	28.1 TJ/kt
Other petroleum products:	42.3 TJ/kt
Natural gas:	40.6 TJ/Sm3, 0.8 tons/MSm3 (mill Sm3)
LPG	46.0 TJ/kt

Our calculations says that Indonesia's CO_2 emissions from combustion of fossil fuels were 70 mill. tons in 1985, rising to 98.4 mill. tons in 1992. On average this amounts to an annual growth rate of 5 per cent. According to these data, fuel use in the households have only increased by 11 per cent, while fuel use in heavy processing industry have increased sharply. From 1985 to 1992, energy use in the steel industry more than doubled.

Appendix 5

The accounting structure in the income part of MEMLI
Documentation of data calculations

1. Introduction

The basic objective in deciding on the formulation of the income part of the model is to obtain a suitable definition of variables in order to model adequately the main income and outlay flows of 1) the two household sectors, 2) the current account and 3) the general government and the corporate sector. This should be done in a consistent way, but the different data sources are not always compatible, thus reconciliation of data must be done. The classification of income and outlay variables should be relevant for analytical purposes, be accessible from the primary data sources and be easy to determine in the model. The income and outlay variable classification is inspired by Lewis (1991), but valuable information has also been taken from SOW-VU (1990a,b) and van Ween (1991). The formulation of variable definitions does not coincide fully with any of the primary data sources, which are the IO table and the Social Accounting matrix.

The Balance Of Payments (BOP) statistics and statistics for General Government accounts (GGA) (BPS (1993): General Government Accounts of Indonesia 1984-1989)) contain variables of interest, which are not explicitly contained in the SAM. Thus the data for the model's databank have to stem from different sources, of which the SAM will only be one. The accounting structure in MEMLI 1 is to some extent different from the structure in SAM. Especially, we do not trace primary incomes (wages, operating surplus etc.) from the production accounts through the accounts for production factor to the income and outlay accounts for the institutional sectors (agents). Instead primary income is directly transferred from the production accounts, where it is generated, to the income and outlay accounts. Thus we had to build our own version of the SAM. The model requires that all base year data are consistent and harmonised.

Different figures in different primary data sources for the same variables, generates problems with presentation and interpretation of the figures. Our ambition has been that the model shall be able to describe the main variables on the balance of payments and government accounts, especially the current account surplus and government saving. There are large discrepances between the SAM figures for the current account and government saving and the same figures in the BOP and GGA statistics, respectively.

2. Documentation of data construction for each account

The IO table is the core of the model. Thus all income and outlay figures in the IO table (and determined in the IO part of the model) is taken as given. The overall balance of the income and outlay accounts (especially savings/surpluses) follow the same accounts in SAM. Entries in the SAM accounts have been renamed to match the terminology used in BOP and GGA. In addition we have tried to split some of the net transactions in SAM into its gross counterparts with the help of BOP and GGA.

2.1 Balance of payments

Below is shown the conversion from BOP statistics to model classification for selected variables.

- The figures for total export (fob) and total import (c.i.f.) in SAM are the same as in IO so there is no need for adjustment there.

- The figures for transfers to government and households (urban and rural) are kept (TRMj, j=u,r,gov).
- "Transfers to company" + "transfers to non-labour factor of production" are labelled factor income (gross) from abroad (FACINT).
- "Transfers from company" is renamed to (gross) Interest and dividends paid to the rest of the world INTRFcor.
- "Return from corporate" is renamed to repatriated profits REPAT.
- "Transfers from government" is renamed to government interest payment INTRgov. The figure seems small compared with the figure for total government interest payment in GGA and the figures for government domestic and foreign debt in IMF financial statistics.

The "rest of the world" account in the SAM shows a current account surplus of 2859 mill. dollars while BOP showing a deficits of 1923 mill. dollars in 1985. There are small differences between SAM and BOP for "Net factor income and transfers". Most of the large difference in the current account stems from the difference in the trade balance (total export - total import) of 4707 mill. dollars, which again seems to stem from the fact that total imports of goods and services is much higher in the BOP than in the SAM. Since imports is reported fob in BOP one would expect that both the figures for imports and exports to be lower than in SAM, but the balance should be the same. Imports of services should be larger in BOP than in SAM (in BOP it includes transport costs that are included in the c.i.f. value of imports of goods in SAM).

2.2 The households accounts

The IO itself does not allow splitting private consumption on different household classes. Data for private consumption for the two household classes are obtained by using SAM data for consumption of different commodities in rural and urban households as weights.

The border between private and public consumption is different in the SAM and the IO table. In the SAM, a lot of publicly provided services such as schooling and health services, are attributed to the households and classified as private consumption. This is not the case in the IO, which is our benchmark variable. The SAM data for urban/rural consumption of different goods thus had to be corrected for this discrepancy.

The figures for transfers between households, income taxes, transfers from the rest of the world and gross saving are taken directly from the SAM. Saving is measured gross because operating surplus/capital income is treated gross (includes depreciation) in the SAM.

The households' net interest and dividend receipts are equal to "transfer from company" in the SAM.

Government transfers to each of the household sectors are determined as a residual in the income and outlay accounts. For the household sector as a whole this is equal to:

  government transfers to households in the SAM
- (private consumption in IO- private consumption in the SAM)
= 1144,7 billion Rupiahs

The main problems seemed to be related to the household sectors' wage and unincorporated capital (operating surplus) income. The SAM's incomes are primary income; wages and salaries, imputed wages and salaries and unincorporated capital income. The first problem is that while total gross factor income are equal in the IO and the SAM, total wage costs in IO are larger than total wages and salaries, excluding imputed wages, in the SAM, and smaller than total wages and salaries including imputed wages. We have solved the problem by setting the rural sectors' wage income equal to the wages and salaries, excluding imputed wages, in the SAM. The rural sectors' income from operating surplus is consequently equal to total unincorporated capital income + imputed wages and salaries in the SAM. The urban household sectors' wage income is set to total wage costs in the IO - the rural sectors' wage income. This is equal to a little bit more than ordinary + imputed wages and salaries in SAM. The urban households' income from operating surplus is equal to the sectors' total primary income (wage + capital) according to the SAM - the estimated wage income.

2.3 The general government sectors accounts

Government net fixed capital formation is taken from GGA. Capital transfers from the rest of the world are set equal to transfers from abroad in the SAM, which is almost equal to the capital transfers in the GGA. Gross saving is equal to gross saving in SAM minus capital transfers, and much lower than in the GGA. Thus financial surplus (=net lending) is much smaller than in the GGA.

Total government consumption is taken from the IO. This figure is different from both the figure for government consumption in the SAM and the GGA. Government consumption in the GGA is equal to government consumption in the national accounts.

Transfers from government to household is calculated as described for the household sectors accounts.

Government domestic interest payments are set equal to total interest payment according to the GGA - foreign interest payments. As noticed, these figures seem unreasonable compared with the figures for government domestic and foreign debt.

Dividends, land rent & royalty income, CPNTgov, is taken from GGA.
The figures for indirect taxes, net, are taken from the IO. They are quite close to the same figures in GGA.

Oil taxes, TAXoil, are taken from GGA. Non-oil company taxes are calculated as transfers from company in the SAM + domestic interest payments (INTRDgov) - oil taxes(TAXoil) - dividends etc. (CPNTgov).

Household income taxes for the two classes are taken directly from the SAM.

2.4 The company sector account

Gross saving is equal to the figure in the SAM. The rest of the entries in this account follow from the description of the other accounts.

Appendix 6

A list of variables and fixed coefficients

The IO-data are measured in mill. Rupiah. Population is an measured in 1000 persons. Current account is measured in mill. US dollars. Electricity is measured in Mega Watt-hours (MWh). Fuels and CO_2 emissions are measured in kilotons (kt = 1000 tons).

Variables:

C	Aggregate private consumption, constant prices
C_k	Private consumption, category k, constant prices
CC_{kh}	Per capita private consumption, cateory k, household class h, constant prices
$CO2$	Total emissions of CO_2. 1000 tonnes
$CO2_j$	Emissions of CO_2, sector j. 1000 tonnes
$CO2C$	Emissions of CO_2 from private consumption. 1000 tonnes
$CO2GOV$	Emissions of CO_2 from government consumption. 1000 tonnes
$CO2RATIO$	CO_2/GDPF
$CPNTGOV$	Net domestic interest and dividend receipts for the government sector, current prices
$CPNT^h$	Net domestic interest and dividend receipts, household class h, current prices
$CURACT$	Current account. Mill. US dollar
$CACTGDP$	Current account as a fraction of GDP
$DEPR_j$	Depreciation rate, sector j
$DIMPS_j$	Index for change in average import share, sector j, compared to base year
DS	Total change in stocks, constant prices
DS_j	Change in stocks, sector j, constant prices
DSC	Total change in stocks, current prices
E	Total exports, constant prices
E_j	Exports,sector j, constant prices
EC	Total exports, current prices
$EXPORTC$	Total exports, current prices. Mill. US dollar
$FACTIN$	Net factor income from abroad. Mill. US dollar
FCE	Private consumption of electricity. MWh
FCO	Private consumption of fuels. kt.
FD	Total depreciation, constant prices.
FD_j	Depreciation, sector j, constant prices.
FDC_j	Depreciation, sector j, current prices.
$FDGOV$	Depreciation, government sector, constant prices.
$FDOIL$	Depreciation, oil sector, constant prices
FE	Total use of electricity. MWh.
FE_j	Use of electricty, sector j. MWh
FI_j	Factor income, sector j, current prices
FO	Total use of fuels. *kt*.
FO_j	Use of fuels, sector j. *kt*.
GCE	Government current expenditure, current prices
GCR	Government current revenue, current prices
$GDPC/F$	*GDP* in current/constant prices

GDPRESC/F	Residual in calculating *GDP*, current/constant prices
GDPFXOIL	GDP constant prices excl. oil sectors
GDPCXOIL	GDP current prices, ecsl. oil sectors
HC_j	Total intermediate inputs, sector *j*, current prices
HF_j	Total intermediate inputs, sector *j*, constant prices
HN_{Ej}	Intermediate inputs of electricity, net of deductible VAT, constant prices
HN_{Oj}	Intermediate inputs of oil products, net of deductible VAT, constant prices
HN_{Rj}	Intermediate inputs of non-energy products, net of deductible VAT, constant prices
$HPCCMIN_{lh}$	"Minimum consumption" upper level cateogry *l*, household class *h*, current prices
I	Total fixed investment, constant prices
I_{GOV}	Government fixed investment, constant prices
I_j	Gross investment, sector *j*, constant prices
IMPORTC	Total imports, current prices. US dollar
INTRDGOV	Government interest payments to domestic recipients, current prices.
INTRFCOR	Net interest payments on the corporate sector's external debt. Mill. US dollar
INTRFGOV	Net interest payments on the government's external debt. Mill. US dollar
K_j	Capital stock, sector *j*, constant prices
L	Total employment. Persons
L_j	Employment, sector *j*. Persons
M	Total imports, constant prices
M_j	Imports, commodity *j*, constant prices
$MARKUP_j$	Mark-up for the domestic price/unit variable cost ratio, sector *j*.
MC	Total imports, current prices
μ^H_j	Intermediate consumption of goods and services other than energy products per unit of output, sector *j*.
μ^E_j	Intermediate consumption of electricity in sector *j* per unit of output, sector *j*
μ^O_j	Intermediate consumption of fuel products in sector *j* per unit of output, sector *j*.
μ^K_j	Real capital per unit of output, sector *j*
NI	Total net fixed investment, constant prices.
NI_j	Net fixed investment, constant prices, sector *j*
NIGOV	Net fixed investment, government sector, constant prices
NVAT	Net government revenues from the VAT system (gross VAT-deductible VAT), current prices
OS	Total operating surplus, current prices
OS_j	Operating surplus, sector *j*, current prices
OSG_j	Gross (operating surplus plus depreciation) operating surplus, sector *j* (*j*= *GOV, OIL*), current prices
OSOIL	Operating surplus, oil sector, current prices
OTP	Total other taxes on production, current prices
OTPj	Other taxes on production, sector *j*, current prices
PC	Aggregate private consumption deflator
PC_k	Private consumption deflator category *k*
PCE	Conversion factor from electricity consumption in constant prices to physical units
PCO	Conversion factor from fuel consumption in constant prices to consumption of fuel in physical units
PDS	Deflator total change in stocks
PDS_j	Deflator, change in stocks, sector *j*
PE	Deflator total exports
PE_j	Deflator export, commodity *j*
$PFOB_j$	FOB deflator export, commodity *j*.
PFO_j	Coefficient for transforming energy uses for intermediate inputs in sector *j* from constant prices to physical units.
PG	Deflator government consumption
PH_{sj}	Deflator intermediate inputs of type *s* (electricity (*E*), fuels (*O*), non-oil inputs (*R*)) net of deductible VAT, sector
PI	Deflator total fixed investment
PM	Deflator total imports
PM_j	Deflator imports, sector *j*.
$PMCIF_j$	Deflator imports, sector *j*, CIF. Price in US dollar ("world market price")

POP^h	Population, household class *h*. 1000 persons
PXD_j	Deflator deliveries to the domestic market, sector *j*
REPAT	Repatriated profits to foreign owners, current prices. Mill. US dollar
SAVGOV	Government saving, current prices
SAV^h	Saving, household class *h*, current prices
$SAVR^h$	Saving rate, household class *h*, current prices.
SGOVGDP	Government surplus as a fraction of GDP (SURPGOV/GDPC)
SAGOVGDP	Government saving as a fraction of GDP (SAVGOV/GDPC)
SURPGOV	Financial surplus, general government sector ("net lending")
TAXCOR	Corporate sector taxes, current prices
TAXH	Total household taxes, current prices
TAX^h	Taxes, household class *h*, current prices
$TAXR^h$	Tax rate, household class *h*
TCDC/F	Total customs duties, current/constant prices
$TDVC_j$	Custom duties, sector *j*, current prices
$TDVF_j$	Custom duties, sector *j*, constant prices
TET	Total excise taxes, current prices
TET_i	Total excise taxes on commodity *i*
TETMC	Total excise taxes on imports, current prices
$TETMC_j$	Excise taxes on imports, commodity *j*, current prices
TETMF	Total excise taxes on imports, constant prices
$TETMF_j$	Excise taxes on imports, commodity *j*, constant prices
$TIPI_j$	Total taxes on production as part of value added, sector *j*, current prices
$TIVM^F_i$	Total invoiced VAT on import of product *i* in constant prices (as part of import in producers' value)
$TIVM^C_i$	Total invoiced VAT on import of product *i* in current prices (as part of import in producers' value)
$TITN_j$	Total net indirect taxes by industry as a part of value added in industry *j*
TIV_i	Total invoiced (gross) VAT on commodity *i*
$TIPI_j$	Total taxes on products as a part of value added in industry *j*
$TIVMC_j$	Invoiced VAT on imports, sector *j*, current prices
$TIVMF_j$	Invoiced VAT on imports, sector *j*, constant prices
$TRCCD_i$	Changes from the base year in the rate of custom duty of commodity *i* (1985 = 1)
$TRCE_i$	Changes from the base year in the excise tax rate on commodity *i* (1985 = 1)
$TRCV_i$	Changes from the base year in the VAT rate on commodity *i* (1985 = 1)
TRDBAL	Trade balance, current prices. Mill. US dollar
TRG^h	Transfers from government to household class *h*, current prices
TRHR	Transfers (net) from urban to rural households, current prices
TRMGOV	Current transfers from abroad to the government sector, current prices
TRM^h	Current transfers from abroad to household class *h*, current prices
TXRCOR	Tax rate corporate sector
TXROIL	Tax rate oil sector
VAC_j	Value added, current prices, sector *j*
VAF_j	Value added, constant prices, sector *j*
VAFMAN	Value added, constant prices, manufacturing
VAFOIL	Value added, constant prices, oil sectors
VAFMINI	Value added, constant prices, mining
VAFPRIM	Value added, constant prices, primary sectors
VC	Aggregate private consumption, current prices
W_j	Wage rate, sector j, current prices.
WS	Total wages and salaries
Xj	Gross output, sector *j*, constant prices
XCj	Gross output, sector *j*, current prices
YCOR	Corporate sector pre tax income, current prices
YDISPCOR	Corporate sector disposable income, current prices
YDISPGOV	Government sector disposable income, current prices
$YDISP^h$	Disposable income, household class *h*, current prices
Y^h	Pre tax income, household class *h*, current prices
Wj	Wage rate, sector *j*, current prices
ZZCChk	Residual in private consumption expenditure system, household class *h*, consumption category *k*

$ZZXj$	Residual in quantity input output equation, sector *j*
ZZY^h	Residual in calculating income for household class *h*

Coefficients

$\alpha^M_{sij}/\alpha_{sij}$	Defines the base year's import share for commodity *i* delivered to the demand category in question (here H_{sj}). Gives the relative weights of import prices to be used in the I-O Price equations
α_{ij}	Intermediate deliveries of commodity *i* to sector *j* in producers' prices divided by total intermediate consumption in sector *j* in purchasers prices (H_{ij}/H_j where H_{ij} indicates the intermediate deliveries of commodity *i* to sector *j* in producers' prices). Base year figures
α^M_{sij}	Imports of commodity *i* delivered as intermediate inputs to intermediate input category *s* in sector *j* in producers' prices divided by total intermediate consumption of category *s* in sector *j* in purchaser's value. H^M_{sij}/H_{sj}. Base year figures
β_{ik}	Deliveries of commodity *i* in producer prices to consumption category *k* divided by total private consumption of consumption category *k* in purchasers' prices). Base year figures
β^M_{ik}	Import of commodity *i* in producer's prices delivered to private consumption category *k* divided by total private consumption of consumption category *k*. Base year figures
ε_{ij}	The ratio between the content of commodity *i* measured in basic value and the total export of "export activity" *j*, valued FOB, in the base year.
γ_i	Deliveries of commodity *i* producer's prices to investment divided by total investment in purchaser's prices. Base year figures
γ^M_i	Import of commodity *i* in producers prices delivered to Investment divided by total investment in purchasers's prices. Base year figures
δ_i	Deliveries of commodity *i* to government consumption in producer's prices divided by government consumption in purchaser's prices. Base year figures
δ^M_i	Import of commodity *i* in producer' prices delivered to government consumption divided by government consumption in purchaser's prices. Base year figures
θ_{ij}	Deliveries of commodity *i* measured in basic value divided by change in stocks of commodity *j*. Base year figures.
θ^M_{ij}	Import share for changes in stocks of commodity *i* (=Change in stocks of imported commodity *i* divided by total stock of commodity *j* in the base year)
λ	The share of operating surplus accruing to the households
ops_h^B	Base year coefficient for share of operating surplus that accrues to household class
wsh_h^B	Base year coefficient for share of wages and salaries that accrues to household class *h*
$ATIVB_{ij}$	Industry *j*'s share of total invoiced or gross VAT on product *i*
$ATETPR_{ij}$	Industry *j*'s share of total excise tax on product *i*
$BTRCD_i$	The base year custom duty tax rate on import of commodity *i*
$BTREH_{sij}$	The base year excise tax rate on commodity *i* delivered to intermediate consumption category *s* in industry *j*
$BTREC_{ik}$	The base year excise tax rate on commodity *i* delivered to private consumption category *k*
$BTREG_i$	The base year excise tax rate on commodity *i* delivered to government consumption
$BTREI_i$	The base year excise tax rate on commodity *i* delivered to fixed investment
$BTREE_i$	The base year excise tax rate on commodity *i* delivered to export
$BTREM_i$	The base year excise tax rate on import of commodity *i* (as part of import in producers' value)
EXR^B	The base year exchange rate.
$BTRDVH_{sij}$	The base year deductible VAT rate on commodity *i* delivered to intermediate consumption category *s* in industry *j*
$BTRNDVH_{sij}$	The base year non-deductible VAT rate on commodity *i* delivered to intermediate consumption category *s* in industry *j*
$BTRNDVC_{ik}$	The base year non-deductible VAT rate on commodity *i* delivered to private consumption category *k*. ($BTRNDVC_{ik}=BTRVC_{ik}$)
$BTRNDVG_i$	The base year non-deductible VAT rate on commodity *i* delivered to government consumption ($BTRNDVG_i=BTRVG_i$)
$BTRVH_{sij}$	The base year invoiced or gross VAT rate on commodity *i* delivered to intermediate consumption category *s* in industry *j*

$BTRVC_{ik}$	The base year invoiced or gross VAT rate on commodity i delivered to private consumption category k
$BTRVG_i$	The base year invoiced or gross VAT rate on commodity i delivered to government consumption
$BTRVM_i$	The base year value added tax rate (invoiced VAT) on import of commodity i (as part of import in producers' value)

Appendix 7

Sectoral Classification

Production sectors

Code	Name	Input/Output 169x169 Code
001	Crops and Animal Husbandry	001-032
002	Forestry	033-035
003	Fishery	036-038
004	Crude Oil and Natural Gas Mining	040
005	Coal Mining	039
006	Other Mining and Quarrying	041-051
007	Petroleum Refinery	101
008	Manufacture of Liquified Natural Gas	102
009	Manufacture of Food, Beverages & Tobacco	052-074
010	Manufacture of Spinning and cleaning fibre, Textile and garments	075-079, 081
011	Manufacture of Leather and Footwear	082-083
012	Manufacture of Sawmill, Plywood & alike, other woods, Bamboo, Rattan and the like	084-089
013	Manufacture of Paper, Paper product and Cardboard	090-091
014	Manufacture of Fertilizer and Pesticide	094
015	Manufacture of Chemical products other than fertilizer and pesticides	093, 095-100, 103
016	Manufacture of Cement and Limestone	111
017	Manufacture of Basic Iron and Steel	113
018	Manufacture of Electrical Appliances, Communication equipment and apparatus; Photographic and Optical equipment; Watch, Clock and the like	122-124, 133-134
019	Manufacture of Vehicles and its repair	126-129, 131
020	Other Manufacturing Industries	080, 104-110, 112, 114-121 092, 125, 130, 132, 135-138
021	Electricity and Gas	139
022	Water Supply	140
023	Construction	141-145
024	Trade	146
025	Air Transport	153
026	Land and Water Transport	149-152, 154, 155
027	Financial Intermediaries	157-158
028	Public Administration and Defence	161
029	Other Services	147-148, 156, 159-169

Consumer categories

Code	**Name**	**Input/Output 29x29 Code**
001	Food, Beverages and Tobacco	001, 003, 009
002	Non fuel energy	002, 005
003	Fuel products	007
004	Textile	010-011
005	Wood and wood products	012
006	Fertilizer and pesticides	014-015
007	Electrical appliances and Motor vehicles	018-019
008	Other goods	004, 006, 008, 013, 016, 017, 020, 023
009	Electricity and Gas	021
010	Air transport	025
011	Land and water transport	026
012	Other Services	022, 024, 027-029

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