Final report

of project #13362 funded through the

"Oesterreichische Nationalbank" (*Jubiläumsfonds*)

A new Austrian Input/Output-Model: AEIOU II

Florian Schwendinger, Christian Sommeregger, Josef Richter,
Margit Reischer, Alexander Erdelyi, Dieter Gstach[1]

July 2011

[1] Corresponding author: Dieter Gstach, Vienna University of Economics, Augasse 2-6, 1090 Vienna/Austria. email: dieter.gstach@wu.ac.at

Contents

Acknowledgements

We gratefully acknowledge the help from many colleagues without whom this work would not have been possible.

This applies in particular to the support from Erwin Kolleritsch, Ursula Havel, Florian Gruber, Eveline Pfeiler, Thomas Schachl, Alexander Ninaus and Thomas Raich at Statistics Austria. They not only provided special data necessary for disaggregation, but also massive help at various stages of this work by clarifying intricate details of data compilation and the associated links between various relevant quantities in several rounds of personal talks.

The help of Clopper Almon, Douglas Nyhus, Douglas Meade, Ronald Horst, Jeffrey Werling and their colleagues at INFORUM was indispensable for the linkage of this project to the INFORUM world model. Clopper Almon made valuable comments to the model setup at a visit to Vienna, and provided further assistance with his colleagues when it came to tie together AEIOU II with the BTM model on location at the INFORUM home base, the University of Maryland. Further aid to orientation at the early modelling stage also came from Maurizio Grassini on occasion of a visit to Vienna. He particularly provided helpful details about the Italian counterpart of AEIOU II.

We also highly appreciate the contributions of Mikulas Luptacik and Bernhard Böhm, project members themselves, who gave guidance regarding model specification and the econometric implementation of AEIOU II. Special thanks also to Ulrike Oschischnig, who provided data from earlier relevant work at the Austrian Chamber of Commerce for the breakdown of commodity "Energy" and to Reinhold Russinger from the Austrian Chamber of Labour and member of Statistics Austria consulting board, who helped improve the project coordinators understanding of the official data.

Of course, any remaining errors in this text are our sole responsability.

Executive Summary

The presented research provides a detailed account of Austrian interindustrial flows of goods and services and the corresponding foreign trade flows. Based on this account a 60-sector model for forecasting purposes is developed. This model is member of the mutually linked worldwide family of input-output models known as INFORUM models.

Beyond the usual disaggregation of total output into outputs of 57 commodities the present analysis accounts separately for four major types of goods, “Electricity”, “Other Energy”, “Real estate services, market” and “Imputed rental services”. Furthermore, it distinguishes between the demand categories “Consumption of Austrians” and “Consumption of tourists in Austria”. This enables more specific analysis of relevant economic policies compared to earlier studies, which entail these items only in aggregate form.

Compared to the older Austrian INFORUM model, another major improvement are prices, which now are determined by the model itself rather than being stipulated arbitrarily. Driving force behind this price determination are productivity estimates. Together with output estimates they lead to employment and wage bills per sector. From sector-specific profit shares prices can then be derived.

This model is linked to the worldwide INFORUM model maintained at the University of Maryland: The forecasts based on the presented model regarding import quantities and export prices serve as input to the worldwide model. The reciprocal forecasts of the worldwide model serve as input to our model in the form of export quantities, exchange rates and import prices.

As output the AEIOU II model provides full sets of 60-commodity input-output tables both in constant as well as in current prices and corresponding sets of price indices for each single year up to 2030. Furthermore, the model predicts economic key variables for each of 60 sectors of the Austrian economy for output, productivity, employment etc. up to 2030. This outcome is refered to as “base case”.

The primary purpose of the “base case” forecast is to serve as reference scenario for comparison. To illustrate the models general capacity for policy analysis three relevant scenarios are investigated: 1) An increase of foreign tourist expenditures in Austria, 2) The introduction of an ecotax on electricity, 3) A shift of object-oriented towards subject-oriented housing subsidies.

In scenario 1) the consequences of an increased annual growth of tourist’s expenditures in Austria from 1% (base case) to 2.6% are studied as one of two alternatives. According to the estimates such higher growth would increase yearly GDP growth by 0.12 percentage points and employment growth by 0.08 percentage points (on average per year over the whole period 2009 – 2030). The effects at the commodity level are much more pronounced. E.g., in 2030 the level of output of “Hotel and restaurant services” would be 13% higher, the one of “Air transport” 8% and the output in “Recreational services” 7% higher relative to the base case.

Scenario 2) starts with an extra tax of 1.5 Euro cent per KWh on electricity. With redistribution of tax revenues we expect from this measure a lasting increase of GDP by 0.1%, a drop in the unemployment rate between 0.02 and 0.04 percentage points and a CPI-increase of 0.15% (all figures relative to base case).

In scenario 3) object-oriented housing subsidies are cut back by 260 Mio Euro and subject-oriented subsidies increased by the same amount to maintain budget neutrality compared to base case. Additionally, profits of sector "Real estate services, market" are estimated rather than working with historical profit shares. Compared to the base case, it is estimated that this measure would lead to a loss of housing investment of roughly 8%, as subject-oriented subsidies are primarily absorbed by higher rental prices (+1.5%). This confirms regular claims, that without tight rent ceiling regulations increased subject-oriented subsidies go largely into higher prices rather than into extended quantities of rental housing.

Chapter 1

Introduction

The present report details the research undertaken as project #13362 funded through the **"Jubiläumsfond der Oesterreichischen Nationalbank"**. Target of this research was to give a more detailed account of Austrian interindustrial flows of goods and services and the corresponding foreign trade flows and the development of a corresponding dynamic model for forecasting. This model is member of the mutually linked worldwide family of input-output models known as INFORUM models.

Beyond the usual disaggregation the present analysis accounts separately for five major types of goods, "Electricity", "Other Energy", "Real estate services, market" and "Imputed rental services", plus one good of less importance, "Other real estate services". In other words, the model developed below is based on a 60-goods-classification rather than the published 57-goods-classification. The reason for distinguishing between the two major types of energy is clear: Electricity generation in Austria constitutes not only an important part of total output with very specific production structures, but it is also a predominantly domestic issue. Gas, the other major energy source within the broad class of "Energy", is instead primarily imported. Studies of economic policy regarding these two items therefore should account for these obvious differences. The same logic applies to the broad sector "Real estate services", which comprise three very different segments. Sector "Real estate services, market" is highly capital intensive, is subject to a very specific legal basis and entails true cash flows primarily in the form of profits. Sector "Imputed rental services", instead, not only serves a different bracket of the income distribution but more importantly does not include any real cash flows, as all of these services are merely imputed. Sector "Other real estate services", is of minor importance compared to the other two just mentioned and relies almost completely on labour rather than capital input.

In this model, furthermore, the demand categories "Consumption of Austrians" and "Consumption of tourists in Austria" are distinguished unlike in officially available data. It is clear, that demand from tourists is determined by other variables (importantly: foreign income) than demand from Austrians. Consequently, this disaggregation enables more specific analysis of relevant economic policies compared to earlier studies, which entail these items only in aggregate form.

Compared to the older Austrian INFORUM model, another major improvement are prices, which now are determined by the model itself rather than being stipulated arbitrarily. Two basic types of endogenizing prices in input-output models exists: 1) Estimating prices with traditional regression equations and 2) Determining prices with the Leontief-price model implicit in any input-output-model. We decided for the latter type primarily because it makes more rigorous use of the intermediate use technology which is at the core of any input-output model. The choice of type 2) price determination requires value added estimates. These, as regards wages, the primary component of value added, are determined from productivity and derived employment estimates. Together with output estimates they lead to employment and wage bills per sector. From commodity-specific profit shares, depreciation rates and taxes prices can then be derived.

Major input to the present model comes from the worldwide INFORUM model: Our forecasts regarding import quantities and export prices will serve as input to the worldwide model. The reciprocal forecasts of the worldwide model serve as input to our model in the form of export quantities, exchange rates and import prices. All of this, it should be stressed, at the commodity level. The worldwide models focus is on the economic interaction between major economies including the US, China, Japan, Germany, the UK and many more. As such we regard the input from the INFORUM worldmodel as more informed type of forecast for key foreign trade variables than we could come up with ourselves. Clearly this does not rule out to modify certain elements of these forecasts whenever more accurate Austrian data are available. This is what we do.

With the model developed here we forecast economic key variables for all 60 commodities of the Austrian economy until 2030: The two endogenous final demand components consumption and investment (exports, as mentioned above, are exogenous), output, productivity, employment and the two major type of prices, producer prices and consumer prices. Albeit of interest in its own, the primary purpose of this forecast is to serve as reference scenario for later comparisons. These comparisons come in the form of three illustrative applications of relevant alternative scenarios of economic development: 1) An increase of foreign tourist expenditures in Austria, 2) The introduction of an ecotax on electricity, 3) A shift of object-oriented towards subject-oriented housing subsidies. All of these scenarios serve to illustrate the models general capacity for commodity-specific policy analysis.

Overview of the present report: Chapters 3-6 document the premliminary steps of estimating behavioural relationships for consumption, investment, imports and labour demand. In chapter 7 the calculation of prices is described. The linkage of AEIOU II to the INFORUM world-model is covered in chapter 8. Calculation of real disposable income of private households is the topic of chapter 9. We stick to the tradition of INFORUM model by labeling this section “Accountant”. A brief description of sources and basic statistics of the data used and eventual modifications are described in chapter 2. The setup and functioning of the model used for forcasting, the core part of this research project, is detailed in chapter 10. For mathematically inclined readers the whole work culminates in section 10.2, which gives a very brief, formal description of the iteration loop, by which, year after year, our forecasts are estimated. Results of corresponding calculations for various scenarios regarding the future development of exogeneous variables are described in chapters 11–14. First, in chapter 11 a reference scenario (base case) is developed for later comparison with three particular alternative scenarios. Next, in chapter 12, the first of these alternative scenarios, the dynamic impact of increased expenditures of tourists in Austria is estimated with the model. In chapter 13 the effect of an increased tax on electricity (ecotax) is studied. The dynamic consequences of a changing structure of housing subsidies are analysed in chapter 14. An outlook of future work is found in chapter 15. Appendix A defines the variables used in the model and states their `C++` code name and the dimensionality of vectors and matrices.

Finally in appendix B alternative types of modelling prices in various INFORUM models is analyzed and compared. This chapter was moved to the appendix, as it actually contains a separate, rather self-contained preparatory study on price modelling. Also by style of presentation and notation it differs from the rest of this report. The placement in the appendix will help avoiding potential confusion of readers.

1.1 IO-Tables versus time series information

A regular major challenge for research on the basis of input-output models are the different classifications, into which aggregate production is usually broken down. The starting point of the present analysis is the official input-output table (IOT) for 2005. Together with additional data from Statistics Austria, particularly in the form of specific commodity and sector accounts, we construct the core of the AEIOU II model: 60×60 matrices of direct input coefficients for total use, domestic production and imports. These constitute the technology which translates final demand into total output and, on the other side, value added coefficients into prices.

The major final demand components are endogenously determined via final demand equations. These, of course, have to be estimated before model simulations (forecasts) can start. For estimation purposes we can not work with IOT data, because they are provided only irregularly and exhibit some notable changes in definitions across time. Instead, we need consistent time series information on top of the IOT information. Unfortunately, time series are not always available at the same level of disaggregation and the same type of classification as the variables of the IOT's. Longer consumption time series, for example, are available only in the less detailed COICOP rather than CPA classification and generally are available at consumer prices rather than producer prices. Value added components as time series, to give an another example, are typically available in activities rather than in goods.

To overcome these quite common problems in multisectoral modeling we have to resort to various assumptions and auxiliary constructions to bridge between the two worlds. This enables to come up with a consistent framework, where the IOT-figures and a full fledged set of time series figures for all goods and all variables truly coincide in the base year 2005, the year from which we derive technology information. But this creates yet another problem: It often forces us to work with shorter time series than would otherwise be available, because, after all, we need time series which can be related consistently to IOT type of information. Therefore, not all available time series qualify here. To give an idea of the major transformations needed to bring time series information into line with IOT's see figure 1.1

1.2 Notation

The main variables to be used frequently in this report are listed below in standard IO-table form for clarification together with row and colum sums. The corresponding numbering scheme of the official Austrian I/O tables in 2005 is also given: *Tabelle* 43 refers to the standard A-version of flows of commodities including imported goods, *Tabelle* 44 is the B-version thereof, comprising only of domestically produced goods and *Tabelle*

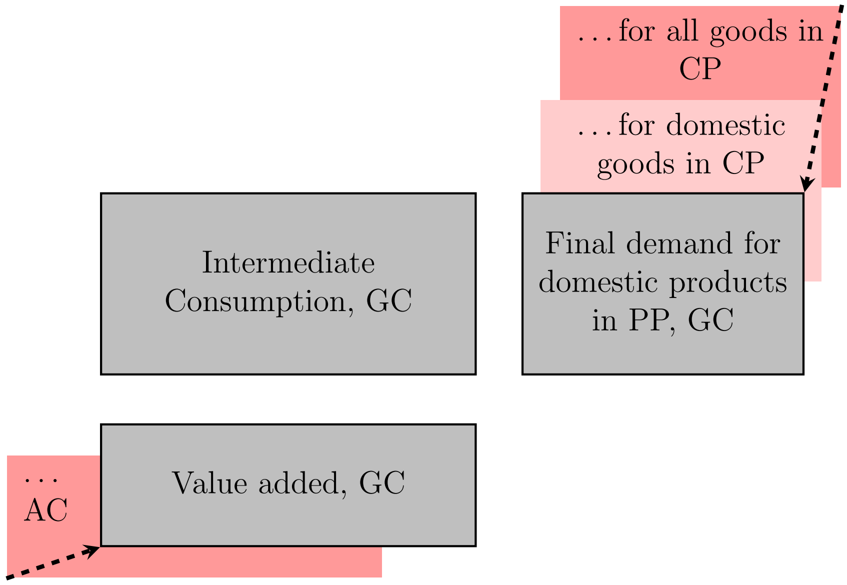

Figure 1.1: Input-Output tables vs. time series information
(GC= goods classification, AC=activities classification, CP=consumer prices, PP=producer prices)

45 completes the picture with the flows of imports only. By construction the summation of tables 44 and 45 yields the corresponding item in table 43.

A full list of variables, mainly specific vectors as parts of the tables in 1.1, is given in the Appendix in chapter A.

Tabelle 43

Z	Y	X_Σ
V'		
M'		
X'_Σ		

modified T 43

Z	$Y-M$	X
V'		
X'		

associated coefficients:

$A = Z/X$
$\nu' = V'/X$

Tabelle 44

Z_D	Y_D	X
$Z'_M\iota$	$Y'_M\iota$	$M'\iota$
V'		
X'		

associated coefficients:

$A_D = Z_D/X$

Tabelle 45

Z_M	Y_M	M

associated coefficients:

$A_M = Z_M/X$

Table 1.1: Notation for basic elements of IOT's and associated coefficients

1.2.1 Abbreviations

For easier reading some frequently used concepts will be abbreviated:

- IOT for input-output table. If no additional information is given, we refer to the official IOT from Statistics Austria for the year 2005
- SAW for "*Sonderauswertung*", a rich set of data specially compiled by Statistics Austria for the present project
- CPA for "Statistical classification of products by activity in the European Economic Community" (commodity classification) in the Austrian version thereof, ÖNACE 2002
- NACE for "Statistical classification of economic activities" (activity classification) in the Austrian version thereof, ÖNACE 2003
- COICOP for "Classification of Individual Consumption According to Purpose"

Chapter 2

Data

Input-Output models are heavily data dependent. Data collection and preparation, therefore, accounts for a large and laborious part of input-output projects. This is particularly true for the present project, because we aimed, successfully, at a model based on further disaggregated tables than are officially available. This chapter briefly describes the data sources used and preparatory compilations. Many more details about the necessary compilation of all relevant matrices can be found in the interims report of this project for the Austrian Federal Bank ("*Zwischenbericht*", 2010). Further details about time series and additional data used can be found in the chapters 3 – 6 covering estimation of behavioral equations and the chapters 12 – 14, where particular alternative scenarios are analyzed with the new AEIOU II model.

The main sources of data by type:

- Official input-output tables from Statistics Austria for 2005 (57 commodities and activities)
- Special compilations of the 2005 data from Statistics Austria for the present project ("*Sonderauswertung*")
- Time series from Statistics Austria and the Austrian Institut of Economic Research covering the periods 1976 – 2008 (2009)
- Forecasts from the INFORUM world model for Austrian exports, import prices and the Euro/Dollar exchangerate (2010-2030)
- Forecasts from Statistics Austria regarding labour force and population (2010-2030)
- Earlier work at the Austrian Chamber of Commerce for the breakdown of CPA 40 based on the input-output tables for 2003.

2.1 Data sources

2.1.1 Official input-output tables for 2005

The central reference point of the present project are the official input-output tables from Statistics Austria for 2005 in CPA 2002 classification with 57 goods and/or 57 activities.[1]

[1] The more recent CPA 2008 classification, applied to later tables, is quite different from the CPA 2002 variant. This has to be stressed, because missing this point could lead to serious misinterpretations.

When the work for the present project started, in summer 2010, these were the most recent tables available.[2] The interindustrial flows of commodities are covered in particular by 3 symmetrically organized tables (version A including imports, version B in domestic goods only, and a version with imported commodities only) plus make and use matrices in mixed classification.

Final demand in the official tables is broken down into 12 categories: 3 consumption categories, 8 investment categories and an aggregate, single export category. Value added is split into 6 categories: net operating surplus, wages and salaries, production taxes, production subsidies, social contributions and depreciation. No bridges between commodities and activities classifications are publicly available (only the tables for margins, taxes and subsidies), and neither are bridges between consumer and producer prices.

2.1.2 Special compilations from Statistics Austria (SAW)

Statistics Austria provided invaluable support for this project in the form of special compilations (*"Sonderauswertungen"*) which we will refer to as SAW. The SAW constitutes a rich set of data with far more detailed information than the official tables which allows not only further disaggregation of but also various time series regressions. The SAW data are underlying the construction of the official tables, but themselves are not being published. In particular, SAW contains production and commodity accounts of CPA/NACE commodity/activity 40 (Energy) and CPA/NACE commodity/activity 70 (Housing), the microcensus data from firms (*Leistungs- und Strukturerhebung*) related to these two sectors, time series for consumption, investment, value added and gross output, capital stocks and depreciaton at the commodity and/or activitiy level from 1976 – 2008.

Another important item of SAW are tables in mixed classifications, e.g. CPA vs. COICOP, which allowed transformation from one into the other classification. These mixed classifications come handy, not only because they enriche the set of potentially useful data, but also because they enable various crosschecks during estimation and simulations. Detailed accounts for the private household sector (sectors S.14 + S.15 by national accounting classification) were another element of SAW, which should be mentioned.

2.1.3 Time series

Most of our time series data required for the estimation of roughly 300 behavioral equations are also part of the SAW. A few additional times series were available from the Austrian Institute for Economic Research and other sources. Unlike for the other time series, which cover the 1976 – 2008 period, the consumption and import data in the desired classification are available only for 1995 – 2008. Consumption time series in a 37 commodity COICOP classification would be available starting in 1976. But these series could not be employed as COICOP is not merely an aggregated version of CPA but based on a different classification scheme altogether. For investment and all the other categories mentioned above the situation was better with time series covering the period 1976 – 2008

[2] Although by today tables for 2007 would be available, the task of updating the model based on these more recent tables is far beyond the scope of this project, because of the extremely time consuming work of disaggregation applied to the original tables.

2.1.4 Other sources

From the INFORUM world model (refered to below as BTW) we use forecasts of Austrian exports, import prices and the exchange rate between Euro and Dollar. Clearly, this is indispensable information for a dynamic equilibrium model like AEIOU II including foreign trade relationships. For details on these data and their transformation into CPA classification see chapter 8.

Two other important pieces of information from Statistics Austria are a labour force forecast (*Erwerbsprognose 2006 (2001 – 2050)*) and the population forecasts for Austria.[3]. Both of them will be required to either define or estimate unemployment rates. In chapter 6 more details can be found about their use.

For crosschecking purposes rather than as primary information source we also employed data from the Austrian Institute for Economic Research (*WIFO*): The total number of persons unemployed (=monthly series `GEN:AALOGM"M`, original source: *BMAS - Bundesministerium für Arbeit und Soziales*) and the standard Austrian definition of unemployment (=monthly series `GEN:AALRGM"M`,[4] original source: AMS/HSV). Both of these series cover 1976 – 2008.

2.2 Disaggregation CPA 40 and CPA 70

One major improvement of our input-output tables compared to publicly available ones is the disaggregation of the official CPA 40 commodity "Energy" and CPA 70 commodity "Real estate services". The disaggregation is into the new commodities "Electricity" (40.1) and "Other Energy" (40.2+3), "Real estate services, market" (or market rentals, 70AM), "Imputed rental services" (or imputed rentals, 70AI) and "Other real estate services" (70B). We will refer to these commodities repeatedly by using the code (related to CPA code) given in brackets. The disaggregation results in extended tables with 60 commodities (or activities) shown in table 2.1. The new commodities from disaggregation are marked red therein.

It should be stressed, however, that our commodity 70AM as such includes rentals of real estate for commercial or industrial use too. So we can not distinguish at the outset between residentially and commercially used real estate. For practical purposes this causes no problems, however, because in IOT's the rents for residential real estate are recorded as a final consumption item, whereas rents for commercial or industrial use are recorded as intermediate consumption. Therefore estimation of final consumption of commodity 70AM in fact contains only residential real estate services, as desired.

The official CPA 2002 classification (see Eurostat `http://ec.europa.eu/eurostat/`) would basically provide the above distinction also in the form of the two 6-digit items 70.20.11 ("Renting or leasing services involving own residential property") and 70.20.12 ("Renting or leasing services involving own non-residential property"). Unfortunately Statistics Austria does not compile data in this disaggregated form. The CPA classification, on the other hand, does not care about whether recorded real estate services are based on true market transactions (actual rentals) or come in imputed form of owner-

[3] Statistics Austria, *Bevölkerungsprognose 2010, Hauptvariante. Erstellt am 01.10.2010 mit Altersstrukturprognose*

[4] *Arbeitslosenquote insgesamt - Arbeitslose in Prozent der Unselbständigen*

occupied housing. This distinction only matters in national accounting, where owner-occupied housing services must be estimated separately, because of lacking underlying transactions.

Table 2.1

CPA	Commmodity group	Gütergruppe
1	Products of agriculture, hunting	Erzeugnisse d. Landwirtschaft und Jagd
2	Products of forestry, logging	Forstwirtschaftliche Erzeugnisse
5	Fish, other fishing products	Fische und Fischereierzeugnisse
10	Coal and lignite; peat	Kohle und Torf
11	Crude petroleum, natural gas, metal ores (1)	Erdöl und Erdgas, Erze
14	Other mining and quarrying products	Steine und Erden
15	Food products and beverages	Nahrungs- und Futtermittel sowie Getränke
16	Tobacco products	Tabakerzeugnisse
17	Textiles	Textilien
18	Wearing apparel; furs	Bekleidung
19	Leather and leather products	Leder und Lederwaren
20	Wood and products of wood	Holz sowie Holz-, Kork- und Flechtwaren
21	Pulp, paper and paper products	Papier, Pappe und Waren daraus
22	Printed matter and recorded media	Verlags- und Druckerzeugnisse
23	Coke, refined petroleum products	Mineralölerzeugnisse
24	Chemicals, chemical products	Chemische Erzeugnisse
25	Rubber and plastic products	Gummi- und Kunststoffwaren
26	Other non-metallic mineral products	Glas, Keramik, bearbeitete Steine und Erden
27	Basic metals	Metalle und Halbzeug daraus
28	Fabricated metal products	Metallerzeugnisse
29	Machinery and equipment n.e.c.	Maschinen
30	Office machinery and computers	Büromaschinen, EDV-Geräte und -Einrichtungen
31	Electrical machinery and apparatus	Geräte der Elektrizitätserzeugung und -verteilung
32	Radio, TV and communication equipment	Nachrtechn., Rundfunk- u. FS-Geräte, elektr. Bauteile
33	Med., precision, opt. instruments; watches, clocks	Medizinisch-, mess-, regeltechnische u. opt. Erz.; Uhren
34	Motor vehicles, trailers and semi-trailers	Kraftwagen und Kraftwagenteile
35	Other transport equipment	Sonstige Fahrzeuge
36	Furniture; other manufactured goods n.e.c.	Möbel, Schmuck, Musikinstrumente, Sportgeräte u.a.
37	Recovered secondary raw materials	Dienstleistungen der Rückgewinnung
40.1	Electrical energy	Elektrizität
40.2+3	Other energy	Sonstige Energie

Continued on next page

Table 2.1 – continued from previous page

CPA	Commmodity group	Gütergruppe
41	Water; distribution services of water	Wasser und DL der Wasserversorgung
45	Construction work	Bauarbeiten
50	Trade and repair services of motor vehicles etc.	Handelsleistungen m. Kfz, Rep. v. Kfz; Tankstellenleist.
51	Wholesale and comm. trade serv., ex. of motor vehicles	Handelsvermittlungs- u. Grohandelsleistungen
52	Retail trade serv., repair serv., exept of motor vehicles	Einzelhandelsleistungen; Reparaturarb. an Gebrauchsg.
55	Hotel and restaurant services	Beherbergungs- und Gaststättendienstleistungen
60	Land transport and transport via pipeline services	Landverkehrs- u. Transportleist. in Rohrfernleitungen
61	Water transport services	Schifffahrtsleistungen
62	Air transport services	Luftfahrtleistungen
63	Supporting transport services; travel agency services	DL bezüglich Hilfs- u. Nebentätigkeiten für den Verkehr
64	Post and telecommunication services	Nachrichtenübermittlungsdienstleistungen
65	Financial intermediation services	DL der Kreditinstitute
66	Insurance and pension funding services	DL der Versicherungen (ohne Sozialversicherung)
67	Services auxiliary to financial intermediation	DL des Kredit- u. Versicherungshilfswesens
70AM	Real estate services, market	DL der Vermietung von Realitäten Markt
70AI	Imputed rental services	DL der Vermietung von Realitäten Nicht-Markt
70B	Other real estate services	DL der Vermittlung und Verwaltung von Realitäten
71	Renting services of machinery and equipment	DL der Vermietung beweglicher Sachen ohne Personal
72	Computer and related services	DL der EDV und von Datenbanken
73	Research and development services	Forschungs- und Entwicklungsleistungen
74	Other business services	Unternehmensbezogene Dienstleistungen
75	Public administration services etc.	DL der öffentl. Verwaltung, Verteidigung u. Sozialversich.
80	Education services	Erziehungs- und Unterrichtsdienstleistungen
85	Health and social work services	DL des Gesundheits-, Veterinär- und Sozialwesens
90	Sewage and refuse disposal services etc.	Abwasser-, Abfallbeseitigungs- u. so. Entsorgungsleist.
91	Membership organisation services n.e.c.	DL v. Interessenvertretungen, Kirchen u.a.
92	Recreational, cultural and sporting services	Kultur-, Sport- und Unterhaltungs-DL

Continued on next page

Table 2.1 – continued from previous page

CPA	Commmodity group	Gütergruppe
93	Other services	Sonstige Dienstleistungen
95	Private households with employed persons	Dienstleistungen privater Haushalte

Table 2.1: Extended classification of goods used in AEIOU II (with CPA 2002 codes)

Details of the disaggregation can be found in the interims report mentioned above. The general approach is the following: From official tables with more structure (e.g. the 73 commodity/activities tables) and in particular from the SAW data we calculate the column and/or row sums of the relevant commodities/activities for the desired table (intermediate use, final demand, value added, imports, margin matrices,...). When the data allow direct disaggregation of specific commodities/activities the corresponding entries in the tables are fixed. For the remaining commodities/activities the information on column and/or row sums is used to distribute the aggregates along rows and columns by applying the usual RAS/CAS procedure. When this procedure does not yield economically plausible and/or consistent tables[5], certain missing entries in the table are manually fixed, relying on additional information from Statistics Austria. If no such additional information is available, proportionality assumptions are invoked to distribute aggregates into their components.

As indicated above, a few official tables already provide some guidance regarding the proper way to disaggregate certain commodity groups. This is the case for example for the make-matrix at producer prices (*Tabelle 04*), which is published also in a 73 CPA×73 NACE classification, or the extended matrix of final demand published also in a 73 CPA commodities version (*Tabelle 16*). This disaggregation level immediately allows to fix the total domestic output of 4 from our desired 5 new commodities. Information from the microcensus for firms (*Leistungs- und Strukturerhebung*), particularly contributes to the disaggregation of value added and employment items. But they are organized by activity and, therefore, have to be translated into commodities before final use.

2.3 Disaggregation of final demand

Final demand as modeled here is much more disaggregated (25 categories) than in the official tables (12 categories). Consumption was broken down into 5 categories (see table 2.2). In particular the distinction between “Consumption of Austrians in Austria” versus “Consumption of foreigners in Austria” deserves special mentioning. With this distinction we try to capture essential differences in consumption patterns of Austrians and foreigners and their respective behavioral determinants. The split of “Government consumption” into “Government consumption, collective” and “Government consumption, individual” was carried out but did not become operational in the forecasts, as we stipulated growth

[5]An example of potentially arising inconsistency is easily described: Suppose new intermediate use tables, one of type A (=inlcuding imported goods) and one of type B (only domestic products) would have been created. These together imply a matrix of intermediate use of imports, which may contain negative entries.

1	Consumption of private households, Austrians in Austria
2	Consumption of private households, tourists in Austria
3	Government consumption, collective
4	Government consumption, individual
5	Non-profit institutions serving households (NPISH's)

Table 2.2: Consumption expenditure categories

#	Category	%
1	Residential buildings	20.3
2	Other buildings	32.4
3	Machinery and equipment by activities NACE 01 to 37, NACE 45 (agriculture, manufacturing, construction)	9.4
4	Machinery and equipment by activities NACE 40 and 41 (utilities)	2.3
5	Machinery and equipment by activities NACE 50 to 55 (trade, hotel, restaurants)	2.6
6	Machinery and equipment by activities NACE 60 to 65 (transportation...)	4.6
7	Machinery and equipment by other activities	8.4
8	Transportation equipment by activities NACE 01 to 05 (agriculture, forestry)	0.8
9	Transportation equipment by activities NACE 10 to 55 (manufacturing, trade)	1.8
10	Transportation equipment by activities NACE 60 + 61 (transportation land, water)	2.7
11	Transportation equipment by activities NACE 62 (transportation air)	0.5
12	Transportation equipment by other activities	6.7
13	Productive livestock	0.3
14	Intangible fixed assets by NACE 92	0.5
15	Intangible fixed assets by all other activities	6.6

Table 2.3: Investment categories (percentage figures refer to total investment)

rates only for the total.

Investment was split into 15 categories compared to the offical 6 categories[6] (see table 2.3) based on earlier work of **?**. The motivation for this breakdown is the achieved greater homogeneity of the typical commodity in each of the 15 investment categories compared to the original 6 categories. This renders estimation of corresponding investment demand equations economically more sound. The originally intended split of "Residential buildungs" into "Buildings for rental use" and "Buildings for owner occupiers" unfortunately turned out impossible due to lack of data.

Exports were split into "Exports of goods" and "Exports of services", because information from INFORUM forecasts cover only goods and no services.

Overall, the compilations for final demand led to 8 new tables in 60 commodities:

[6]The original tables contain two additional items beyond the 6 mentioned, namely "Net addition to stocks and valuables" and "Inventory changes" as part of total investment. In the simulations these two items were stipulated to be zero and therefore did not require any prior disaggregation treatment. Consequently they are not listed in the final breakdown shown in table 2.3.

24	Exports, fob, goods
25	Exports, fob, services

Table 2.4: Export categories

- Final demand at consumer prices (Tabelle15modmod.xls)
- Final demand at producer prices (Tabelle17modmod.xls)
- Imported final demand (Tabelle20modmod.xls)
- Wholesale margins (Tabelle27modmod.xls)
- Retail margins (Tabelle28modmod.xls)
- transport margins (Tabelle29modmod.xls)
- Product taxes on final demand (Tabelle30modmod.xls)
- Product subsidies for final demand (Tabelle31modmod.xls)

Chapter 3

Consumption

3.1 Introduction

A core part of every INFORUM model is the determination of private consumption expenditures. For a rough, graphical assessment of the quantitative importance of consumption within final demand see figure 3.1. Hence, consumption equations perhaps are second in importance only to the fundamental input/output identities. Consequently they should receive particular attention in terms of data preparation and estimation. This implies also, to pay respect to quite distinct consumption patterns of residents and non-residents, despite the latters small share of only 8% in total private consumer expenditures in Austria. The share of "Services of hotels and restaurants" provided to non-residents is more than a third of the total consumption of such services in Austria.

In principal, literature suggests two major approaches to estimate consumption behavior: the single equation and the demand system approach. It is well known that all the popular demand systems (PADS, AIDS, Rotterdam Model, LES, ELES etc.) can be shown be to derived from utility maximization problems (see **?** for a comparison). Hence, they are consistent with standard-theory and imply restrictions which can be used to improve parameter estimates (symmetry of the Slutsky matrix, homogeneity, summing-up condition). However, we prefer the flexibility entertained by using single equations. This allows for good-specific modelling. See **?** and **?** for related applications and further discussion.

The major practical difficulty with consumption function estimation for Austria is the lack of corresponding long time series in the desired CPA classification. Such series at the commodity level are available only since 1995. Given the last available observations in 2008, this leaves little headroom in terms of degrees of freedom to model corresponding consumption equations elaborately. Superfluous to add, that specification and unit root testing suffer as severely from this restricted time horizon. Consequently we payed more attention to economic plausibility than econometric elaboration in the case of these equations. It should be noted, however, that this impediment trough limited data availability does not apply to aggregate consumption, which will be estimated on time series covering the much longer period 1976 – 2008.

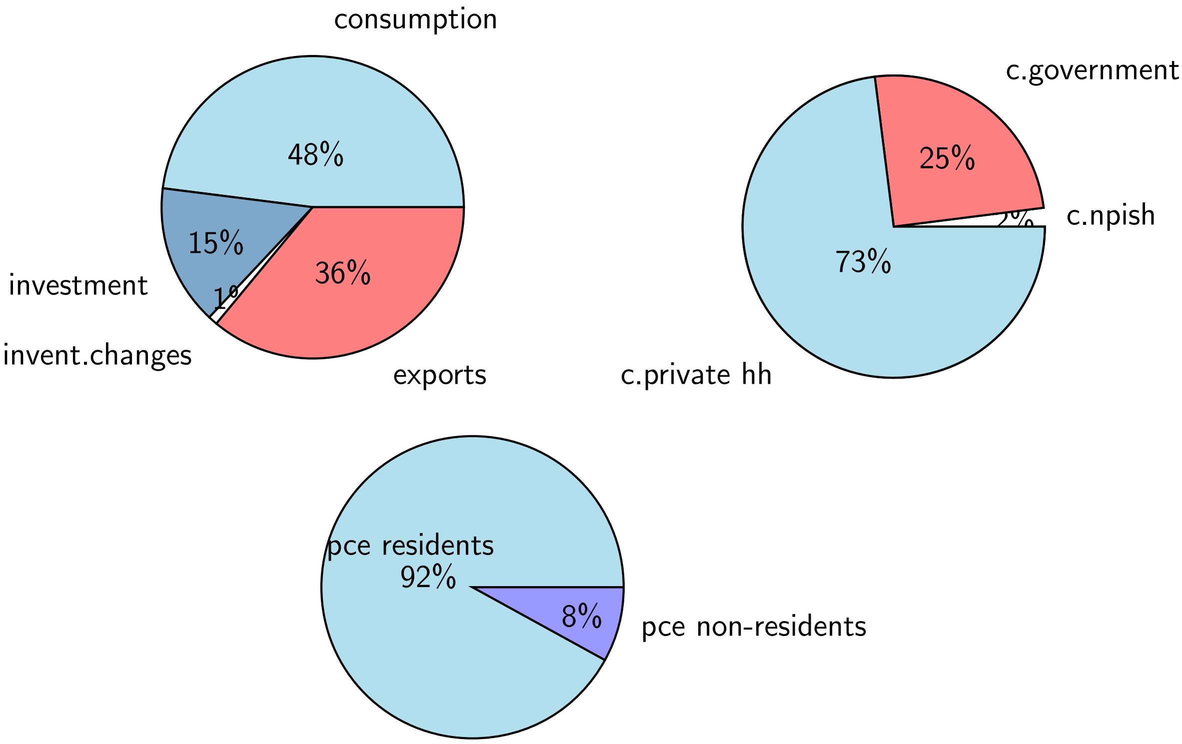

Figure 3.1: Consumption within final demand in Austria 2005. Topleft: Final demand. Topright: Total consumption. Bottom: Private household consumption.

3.2 Consumption of private households per good

It should be stated clearly at the outset, that sections 3.2 – 3.4 deal only with the consumption of residents and do not include tourists expenditures in Austria. The motivation for the separation of these two consumer groups is not just the very distinct consumption patterns of residents and non-residents ($\simeq$ tourists), but more importantly the different determinants of tourists expenditures. The latter comprises foreign income, whereas the former clearly depends on Austrian incomes. Likewise, the USD/EURO exchange rate matters directly only for non-European tourists, whereas it is of secondary importance for consumption of residents. Consumption of non-residents is coverd in section 3.5.

Early testing with different parametrizations of consumption functions confirmed the concerns that using the same regression specification for all goods resulted in many insignificant or implausibly signed parameter estimates for various goods. Keep in mind, that the time series available at goods level for estimation cover only the period 1995 – 2008. Consequently, after deciding for a common baseline specification for all goods, we proceeded by modifying regression specifications for each single commodity when necessary.

$$\ln\left(\frac{\mathcal{C}_i^1}{\mathcal{C}_\Sigma^1}\right)_t = \alpha_0 + \alpha_1 \ln\left(\frac{\mathcal{P}_i}{\mathcal{P}_{\text{CPI}}}\right)_t + \alpha_3 \ln\left(\frac{\mathcal{C}_i^1}{\mathcal{C}_\Sigma^1}\right)_{t-1} \tag{3.1}$$

As can be seen from 3.1, the starting point for estimation of the share of good i in total consumption, was to include as explanatory variables: a) the relative price of good i and b) the consumption share of the previous period. It is obvious that this specification implies homogeneity of degree zero in all prices, because only relative prices are considered. Furthermore, aggregate consumption (see equation (3.2) below) is independent of prices and homogenous of degree one in real income. Hence, there is no “money illusion” in demand in the sense that it is not affected by a proportional increase in all prices and nominal income. The endogenous lag accounts for possible habit persistence in consumption.

As indicated above the desired specification (3.1) was not always suitable. Hence, in the case of various goods the specification had to be adapted in one way or the other to achieve economically meaningful results. Table 3.1 presents an extensive list of the regression equations actually used in AEIOU II.[1]

Specification	used for good
$\ln\left(\frac{\mathcal{C}_i^1}{\mathcal{C}_\Sigma^1}\right)_t = \alpha_0 + \alpha_1 \ln\left(\frac{\mathcal{P}_i}{\mathcal{P}_{\text{CPI}}}\right)_t + \alpha_2 \ln\left(\frac{\mathcal{C}_i^1}{\mathcal{C}_\Sigma^1}\right)_{t-1}$	1, 4, 9, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23
$\ln\left(\frac{\mathcal{C}_i^1}{\mathcal{C}_\Sigma^1}\right)_t = \alpha_0 + \alpha_1 \ln\left(\frac{\mathcal{C}_i^1}{\mathcal{C}_\Sigma^1}\right)_{t-1} + \alpha_2 \ln\left(\frac{\mathcal{C}_i^1}{\mathcal{C}_\Sigma^1}\right)_{t-2}$	3, 42
$\ln\left(\frac{\mathcal{C}_i^1}{\mathcal{C}_\Sigma^1}\right)_t = \alpha_0 + \alpha_1 \ln\left(\frac{\mathcal{C}_i^1}{\mathcal{C}_\Sigma^1}\right)_{t-1}$	2, 6, 9, 10, 13, 18, 23, 25, 26, 28, 37, 39, 57, 60
$\ln(\mathcal{C}_{it}^1) = \alpha_0 + \alpha_1 \ln\left(\frac{\mathcal{P}_i}{\mathcal{P}_{\text{CPI}}}\right)_t + \alpha_2 \ln(\mathcal{C}_{\Sigma_t}^1) + \alpha_3 \ln(\mathcal{C}_{i,t-1}^1)$	33, 47

Table 3.1: Consumption functions estimated

3.3 Aggregate consumption of private households

To forecast consumption using the shares from the last step requires an estimate of aggregate consumption too. It is assumed that aggregate consumption in real terms is a function of real disposable income of private households, contemporaneous and lagged and the lagged value of the dependent variable:

$$\mathcal{C}_{\Sigma t}^1 = \beta_0 + \beta_1 Y_{D,t} + \beta_2 Y_{D,t-1} + \beta_3 \mathcal{C}_{\Sigma t-1}^1 \qquad (3.2)$$

The ARDL(1,1) process in equation (3.2) is hoped to capture the essentials of the dynamics of aggregate consumption. The specification, furthermore, can be shown to correspond to an unrestricted error correction model, which adds economic interpretability to the specification.[2]

[1] Occasionally an additional time dummy was used to capture an obvious structural break in the relevant series. This applies to 3 of our consumption equations and not to the ones, given as examples below. One of them, for example, is “Rental housing services”, where a new classification scheme was introduced in 1995.

[2] E.g. $-(1-\beta_3)$ would be the error correction coefficient, see **?**. For statistical properties of $beta_3$ with $I(1)$ variables like $\mathcal{C}_\Sigma^1$ and Y_D see **?**.

3.3.1 Further issues

The reader may have noticed that we do not impose cross equation restrictions in our consumption share system. As a consequence summing-up of commodity specific consumption levels implied jointly by equations (3.1) and (3.2) does not usually yield the value implied by equation (3.2). To solve this problem we employ a rescaling procedure which is commonly refered to as ”spreading”. After determination of consumption per good, the corresponding demands are summed up. The sum is a temporary variable which then is compared to the sum from the aggregate consumption estimate. The ratio between the latter and the former then serves to rescale original consumption per good. Proceeding in this manner guarantees the consistency between the aggregate and the disaggregated version of consumption demands.

3.4 Estimation results

Within national accounting frameworks one typically has the choice between COICOP and CPA classifications. The Austrian COICOP data are somewhat limited in detail compared to CPA data, but they are available for a period of over 30 years. On the contrary the CPA data, which we decided to use, has a rich cross-section of 57 goods, but only a very limited time dimension of 14 years.[3] The time series for prices used as regressors were simply constructed by contrasting nominal with real time series per good. A time series for real disposable income was made available by Statistics Austria. Of course, at least some of these time series seem to be unit root processes. But the power of standard stationarity tests (ADF) is extremely limited in a sample of 14 observations. As such we cannot reliably test for weak dependency, so the violation of the Gauss-Markov assumptions for time-series may potentially be violated. For aggregate consumption we have at least 32 observations at our disposal, which allows the application of more elaborate methods for estimating equation (3.2).

3.4.1 Consumption of private households per good

Since an exhaustive listing of the parameter estimates is impractical for all 60 goods, we shall only present a characteristic example for every equation in Table 3.2 here. The cited standard errors are based on Newey-West standard error estimates and thus are robust against potential heteroscedasticity and autocorrelation. But the latter, as the Durbin-Watson statistics[4] show, is of no practical importance.

The previous table describes the budget share of health services. The regression coefficient on the price variable suggests a significantly negative price elasticity of this consumption share of about -0.45%. The endogenous time lag is about 0.40, i.e. considerable inertia in health services expenditures. Table 3.3 suggests that the consumption share of other machinery depends strongly on the previous years share. Furthermore this equation serves as an example for a commodity for which we could not find significant price effects.

Table 3.4 suggests that the consumption share of data transmission technology is well

[3]The 60-goods-classification upon which this model is rests, was transfered to the relevant time series by invoking a proportionality assumption based on more detailed data for the base year 2005.

[4]More precisely: The corrected Durbin-Watson H-statistic whenever endogenous lags are used.

Example equation type 1:

	Coeff	SE	p-val
constant	-2.04	0.65	0.010
p_{85}	-0.45	0.15	0.012
$(\mathcal{C}^1_{85}/\mathcal{C}^1_{\Sigma})_{t-1}$	0.40	0.19	0.065
DF=10, $R^2 = 0.843$			

Table 3.2: Consumption share of health services $\mathcal{C}^1_{85}/\mathcal{C}^1_{\Sigma}$

Example equation type 2:

	Coeff	SE	p-val
constant	-0.98	0.49	0.073
$(\mathcal{C}^1_{29}/\mathcal{C}^1_{\Sigma})_{t-1}$	0.69	0.16	0.001
d_{2005}	-0.05	0.02	0.016
DF=10, $R^2 = 0.73$			

Table 3.3: Consumption share of other machinery $\mathcal{C}^1_{29}/\mathcal{C}^1_{\Sigma}$

descriped by an AR(2) process. Again price effects seem not to matter based on the information within our dataset. Table 3.5 suggests that the consumption of "Imputed rental services" depends significantly negative on the relative rental price index (-0.467%). Moreover it raises over-proportionally with aggregate consumption. The first order endogenous time-lag, although not very significant was also included in the equation, to account for habit persistence.

3.4.2 Aggregate consumption of private households

In order to establish consistent estimators of short-run and log-run dynamics in models with non-stationary time series, the econometric literature suggests the usage of error correction models. For ARDL models like the one in equation (3.2) the bounds-testing

Example equation type 3:

	Coeff	SE	p-val
constant	-0.66	0.26	0.030
$(\mathcal{C}^1_{64}/\mathcal{C}^1_{\Sigma})_{t-1}$	1.30	0.23	0.000
$(\mathcal{C}^1_{64}/\mathcal{C}^1_{\Sigma})_{t-2}$	-0.48	0.20	0.045
DF=10, $R^2 = 0.94$			

Table 3.4: Consumption share of data transmission technology $\mathcal{C}^1_{64}/\mathcal{C}^1_{\Sigma}$

Example equation type 4:

	Coeff	SE	p-val
constant	-12.62	4.14	0.014
p_{70AI}	-0.70	0.31	0.048
$\mathcal{C}^1_{\Sigma}$	1.34	0.26	0.001
$\mathcal{C}^1_{70AI,t\text{–}1}$	0.25	0.22	0.293
DF=9, $R^2 = 0.98$			

Table 3.5: Consumption of Imputed rental services$\mathcal{C}^1_{70AI}$

approach introduced by **?** seems to be most adequate to check for the required cointegration. Apart from being applicable particularly to mixtures of $I(0)$ and $I(1)$ variables, this approach has three additional virtues: Firstly, the test procedure is simple. As opposed to other cointegration techniques such as Engle and Granger, it can be carried out in one step only. Secondly, the bounds testing procedure does not require the pre-testing of the variables included in the model for unit roots unlike other techniques, such as the Johansen approach. Thirdly, the test is relatively more efficient in small or finite sample data sizes as is the case in this study.

The first step in the ARDL bounds testing approach is to estimate equation 3.2 by ordinary least squares (OLS) in order to test for the existence of a long-run relationship among the variables by conducting an F-test for the joint significance of the coefficients of the lagged levels of the variables (β_2 and β_3). In our case a corresponding value of 15.43 strongly suggests that a cointegrating relationship exists.

	Coeff	SE	p-val
constant	10.6-E6	4082160	0.029
Y_{Dt}	0.49	0.15	0.009
Y_{Dt-1}	-0.35	0.15	0.041
$\mathcal{C}^1_{\Sigma t-1}$	0.75	0.14	0.000
DF=9, $R^2 = 0.99$			

Table 3.6: Aggregate Consumption $\mathcal{C}^1_{\Sigma t}$

The estimates presented in Table suggest a disequilibrium correction of 0.25 per year. The short run impact of disposable income on aggregate consumption is 0.49 the long run effect is 0.56.

3.5 Other consumption

To determine “Private consumption expenditures, foreigners in Austria” ($\mathcal{C}^5$) we first calculated average growth rates from the last years per commodity. Then we applied the following scheme to come up with commodity specific growth forecasts: For a commodity with an average growth of more than 2% we started the forecast with this average in 2008 and then let if fade out linearly to 2% by 2030. For commodities with average growth rates between 0% and 2% we kept the growth rates fixed. Finally, for commodities with negative average growth rates in the past this average was used as start value for 2008 and then we let growth rates fade out linearly to 0% by 2030. This yields the growth figures shown in table 3.7, where the six most important items, accounting for roughly 80% of total tourists expenditures in Austria, are marked in red.

Forecast of “Government consumption” ($\mathcal{G}$) at the commodity level is based primarily on information about corresponding historical averages augmented by subjective jugdement of the likely future path of overall public expenditures. The latter is simply characterized by the expectation of an increasingly tighter budget constraint and, therefore, a slow-down in growth of government expenditures on average. The three dominating items within total government consumption are “Public administration services etc.”, “Education services” and “Health and social work services”. Together they account for almost 90% of government expenditures (marked in red in table 3.7). For these three items we stipulated average yearly growth rates of 0.41%, 1.51% and 1.87%, respectively. These correspond to the relevant averages over the past decade or a slightly downward corrected version thereof. The same logic was applied to determine growth rates for all other, minor items. Details are given again in table 3.7.

The composition of ”Non-profit organizations serving households” (NPISH) consumption ($\mathcal{C}^2$) has proven to be rather stable in the past. Therefore, we only calculated the average growth rate of aggregate NPISH consumption which is 1.01 for the last 10 years. Starting from this macro value we used a constant share vector based on the values of 2005 to split the sum into values per commodity.

Table 3.7

	PCE, foreigners in Austria			Gov. consumption		
CPA	Start	End	av.pa.	Start	End	av.pa.
01	0		0.00	1.00	1.00	1.01
02	0		0.00			
05	4.03	2.00	3.06			
10	-7.00		-3.44			
11						
14	2.46	2.00	2.25			
15	0.97	0.97	0.97	1.00	1.00	1.01
16	-1.14		-0.57			
17	-0.27		-0.13			
18	-0.36		-0.18			
19	0.40	0.40	0.40			
20			0.00			
21	3.34	2.00	2.70			
22			0.00	-0.01	0.00	0.00
23	1.00	1.00	1.01			
24	0.72	0.72	0.73	2.00	2.00	2.02
25	1.48	1.48	1.50			
26	2.48	2.00	2.26			
27						
28	3.00	2.00	2.53			
29	3.00	2.00	2.53			

Continued on next page

Table 3.7 – continued from previous page

	PCE, foreigners in Austria			Gov. consumption		
CPA	Start	End	av.pa.	Start	End	av.pa.
30	3.00	2.00	2.53			
31	1.23	1.23	1.23			
32	3.00	2.00	2.53			
33	3.00	2.00	2.53	2.00	2.00	2.02
34						
35	3.00	2.00	2.53			
36	2.34	2.00	2.20			
37						
40.1	0.91	0.91	0.91			
40.2u3	1.28	1.28	1.29			
41						
45	2.35	2.00	2.20			
50	3.00	2.00	2.53			
51						
52	3.00	2.00	2.53			
55	0.00	0.00	0.00	0.00	0.00	0.00
60	2.00	2.00	2.02	0.96	0.95	0.96
61	3.00	2.00	2.53			
62	3.00	2.00	2.53			
63	5.00	2.00	3.56	2.00	1.00	1.51
64	5.00	2.00	3.56			
65						
66	0.75	0.75	0.75			
67						
70 AM	3.00	2.00	2.53			
70 AI			0.00			
70 B	3.00	2.00	2.53			
71	3.00	2.00	2.53	2.07	2.00	2.06
72	3.00	2.00	2.53			
73				2.13	2.00	2.09
74			0.00	3.00	2.00	2.53
75			0.00	0.41	0.40	0.41
80	3.00	2.00	2.53	1.50	1.50	1.51
85	3.14	2.00	2.61	2.00	1.70	1.87
90				2.50	1.50	2.02
91			0.00	0.44	0.44	0.45
92	0.31	0.31	0.32	1.81	1.80	1.82
93	1.38	1.38	1.39	0.33	0.32	0.33
95	0.72	0.72	0.72			

Table 3.7: Assumed consumption growth rates for tourists and government expenditures (av.pa. = yearly average growth rate over 2010–2030

Chapter 4

Investment expenditures

Investment is a crucial part of any macromodel. To cite **?**: "Investment behavior is such an important part of the economic process - whether it be in the discussion of analysis of cycles, trend development, environmental improvement or restoration of disaster - and so much has been done on econometric study of investment". This importance stems not only from multiplier considerations but also from the high variability of investment and its quantitative importance within total final demand (in Austria roughly 35%).

Regarding specification, there are various relevant models discussed in the economic literature, reaching from the classic accelerator and flexible accelerator models, up to the neoclassical approach of **?**.

For the Austrian model we do not rely on a single theoretical base, but try to include those determinants discussed in the literature, which we find relevant judged by either econometric significance and/or economic plausibility. Once again, also this part of the modelling process is strongly influenced by the quality and availability of the Austrian data.

4.1 Data and variables

Statistics Austria publishes time series of capital formation ordered by investing industries, for each of six investment good classes separately. This implies that, theoretically, 6x56 investment expenditures series could be estimated.[1] In order to reduce complexity and homogenize underlying goods while ensuring full utilization of the available information, we start estimation by construction of 15 investment categories:

Each of these investment categories (see table 4.1) links expenditures of one or more NACE activities to a specific investment good class, which represents rather homogeneous types of investment as opposed to the broader original classification by 6 investment goods.[2] To estimate investment behavior the following time series were used:

[1]Statistics Austria publishes investments for only 56 goods, as the official data aggregate "Rental Housing", "Owner-occupied housing" and "Other real estate services" into one category ("Real estate services") and "Electricity" and "Other Energy" into one category ("Energy"). Furthermore no investments are reported for "Services of private households", as there can be none by nature. This explains the difference between our 60-goods-classification and the 56 goods for which separate time series are available.

[2]The original Statistics Austria tables for final demand distinguish between "Residential buildings", "Other buildings", "Machinery and equipment", "Transportation equipment", "Productive livestock"

- $\widetilde{\mathcal{I}}_j$ ($\widetilde{\mathcal{I}}_j^{nom}$) Gross real (nominal) investment expenditures by activity j from table VGR_BAI_2009.xls
- $\widetilde{P}_j^{inp}$: Investment price index of activity j calculated from $\widetilde{\mathcal{I}}_j$ and $\widetilde{\mathcal{I}}_j^{nom}$
- $\widetilde{\mathcal{X}}_j$ ($\widetilde{\mathcal{X}}_j^{nom}$): Real (nominal) gross production of activity j from Statistics Austria "Sonderauswertung"
- $\widetilde{P}_j^{out}$: Price index of gross production of activity j calculated from $\widetilde{\mathcal{X}}_j$ and $\widetilde{\mathcal{X}}_j^{nom}$
- δ_j : Depreciation Rate of activity j as estimated from equation (4.2)

The necessary aggregation procedure to come up with the 15 investment categories mentioned above can now be easily formulated. Let $S_k \;\; k = 1, ..., 15$ denote the set of investment categories with elements corresponding to a specific NACE group. For example $S_1 = \{60\}$ or $S_4 = \{40, 41\}$. Then the aggregated variables for investment category k can be written as:

$\approx\!\mathcal{I}_k = \sum_{j \in S_k} \widetilde{\mathcal{I}}_j$, the investment expenditures of investment category k

$\approx\!\mathcal{X}_k = \sum_{j \in S_k} \widetilde{\mathcal{X}}_j$, the gross output of investment category k

$\overset{\approx}{P}{}_k^{out} = \dfrac{\sum_{j \in S_k} \widetilde{\mathcal{X}}_j^{nom}}{\sum_{j \in S_k} \widetilde{\mathcal{X}}_j}$, the output price for investment category k

$\overset{\approx}{P}{}_k^{inp} = \dfrac{\sum_{j \in S_k} \widetilde{\mathcal{I}}_j^{nom}}{\sum_{j \in S_k} \widetilde{\mathcal{I}}_j}$, the input price for investment category k

The resulting categories of investments along with the corresponding investment levels are given in table 4.1.

4.2 Regression specifications and model integration

To capture the dynamics of the capital adjustment process, we rely again on ARDL formulations. Although the exact specification of investment demand varies from category to category, the typical equation can be described as:

$$\ln(\overset{\approx}{\mathcal{I}}_{k,t}) = \kappa_0 + \kappa_1 \ln\left(\overset{\approx}{P}{}_k^{out} \overset{\approx}{\mathcal{X}}_k \Big/ \overset{\approx}{P}{}_k^{inp}\right)_t + \kappa_2 \ln\left(\overset{\approx}{P}{}_5^{out} \overset{\approx}{\mathcal{X}}_5 \Big/ \overset{\approx}{P}{}_5^{inp}\right)_{t-1} + \ldots$$
$$+ \kappa_3 \ln(\overset{\approx}{\mathcal{I}}_{k,t-1}) + \kappa_4 \ln\left(\hat{\delta}_{j,t-1} \overset{\approx}{\mathcal{I}}_{k,t-1}\right) + \kappa_5 \ln(\overset{\approx}{\mathcal{I}}_{k,t-2}) \quad \text{for } k = 1, .., 15 \quad (4.1)$$

where k refers to a specific investment category (see above). The left-hand-side variable is the log of gross real investment by category k. To get ARDL processes, all equations include one or more lagged endogenous variables as regressors.

A further, but somewhat unusual regressor is the product of the depreciation rate and investment (lagged one period). This variable has proven in testing to perform much better

and "Intangible fixed assets". Time series information on these items from SAW is even reduced to five investment categories, mixing "Residential construction" and "Non-residential construction" into a single category "Buildings".

	Investment category	Mio Euro	%
1	Residential buildings	10731	20
2	Other buildings	17125	32
3	Machinery and equipment by activities NACE 01 to 37, NACE 45 (agriculture, manufacturing, construction)	4977	9
4	Machinery and equipment by activities NACE 40 and 41 (utilities)	1194	2
5	Machinery and equipment by activities NACE 50 to 55 (trade, hotel, restaurants)	1374	3
6	Machinery and equipment by activities NACE 60 to 64 (transportation)	2452	5
7	Machinery and equipment by other activities	4410	8
8	Transportation equipment by activities NACE 01 to 05 (agriculture, forestry)	405	1
9	Transportation equipment by activities NACE 10 to 55 (manufacturing, trade)	948	2
10	Transportation equipment by activities NACE 60 + 61 (transportation land, water)	1441	3
11	Transportation equipment by activities NACE 62 (transportation air)	244	0
12	Transportation equipment by other activities	3555	7
13	Productive livestock	149	0
14	Intangible fixed assets by NACE 92	290	1
15	Intangible fixed assets by all other activities	3509	7

Table 4.1: Investment by category, Austria 2005 (Mio Euros and %)

than capital stocks. One might interpret this variable as a proxy for replacement investment, which is the more valid, the faster the underlying depreciation process is. If capital equipment would have a life span of exactly one year, i.e. an associated depreciation rate of 100%, this interpretation would be perfect.

Additional regressors are the real output of the relevant category expressed in terms of inputs used.[3] This last term can be derived from a standard profit maximization problem (see **?**) and obviously implies homogeneity of degree zero in prices.

Since the depreciation rate δ is used in equation 4.1, specific δ_k's for all our 15 investment categories must be determined beforehand. For the sake of simplicity we model these as category-specific logarithmic time trends. It should be stressed, that these depreciation rates are not the ones used to calculate depreciation by activity, which are instead defined in chapter 7.

$$\delta_{jt} = \zeta_0 + \zeta_1 \log(t) + \varepsilon_{jt} \tag{4.2}$$

[3]See section 4.1 for further details on these price indices.

The reader will notice, that equation 4.1 does not include an interest rate term. Based on extensive prior testing, interest rates were found to be insignificant for all investment categories studied. The same was true for various user-cost of capital measures tested. Consequently these variables were not included in the final specification.

4.2.0.1 Capital stock calculations

Capital stocks do not serve as explanatory variables in our model. But it should be noted that the capital-stock for any activity j could easily be calculated by using the forecasted values of δ_{jt} and I_{jt}, since the initial capital stocks are also available frome Statistics Austria's special compilation of data for this project ("Sonderauswertung"). In prior tests capital stocks were included in the investment equations. However, we found that these lost their significance whenever an endogenous time lag was included in the regression. Therefore, also capital stocks were not considered in the final regression specifications.

4.2.0.2 Transformation into commodity classification at producer prices

In a next step the 15 gross investment flows I_{kt} estimated in 4.1 have to be translated into investment demand by commodity, i.e. into 60 commodity specific investment figures. For this purpose we rely, once again on fixed shares, contained in a matrix labeled S. It consists of 60x15 shares, constructed from the final use table. So S_{ik} denotes the share of good i in investment category k in the base year. Based on S we transform investment demand by category back into investment demand by commodity via:

$$\mathcal{I}_t = S\,\mathrm{diag}(\approx{\mathcal{I}}_t)\iota \tag{4.3}$$

where $\mathcal{I}_t$ denotes the 60x1 vector of total investment demands by commodity, $\mathrm{diag}(\approx{\mathcal{I}}_t)$ is a diagonal matrix formed from aggregate investment by category and ι denotes a vector of ones of appropriate length for summation across categories. One may consider it rather restrictive to rely on constant shares in this context. However, since the mix of goods within each category did not change significantly in the past, this simplification seems justified. The final step is to translate $\mathcal{I}_t$, which is in consumer prices, into producer prices. As with other final demand categories this translation is carried out with an appropriate bridge matrix, here the one constructed for investments and labeled $\mathbb{B}^{(I)}_{CP}$. This yields the desired vector of total investment at producer prices in commodities

$$I_t = \mathbb{B}^{(I)}_{CP}\mathcal{I}_t \tag{4.4}$$

4.3 Estimation results

This section takes a brief look at some typical regressions results for the investment categories defined above. As first example table 4.2 presents the estimation for category "Machinery and Equipment, NACE sectors 50–55". The positive sign on the first term, the real output expressed in input prices, implies, that investment depends positively on real output, positively on its own price and negatively on the respective investment good price index. The coefficient of the endogenous time lag of around 0.55 suggests that investment is higher if it was high in the previous period and the long-run impact is about twice as high as the short-run impact. LM statistics and the modified Durbin-Watson statistic suggest that autocorrelation is no issue for practical matters. Despite it's significance, the lagged depreciation rate had to be dropped from this specification, because earlier simulations showed a highly implausible implied investment behavior.

	Coeff	SE	p-val
constant	2.73	1.11	0.020
$\left(\widetilde{\widetilde{P}}{}_5^{out}\widetilde{\widetilde{\mathcal{X}}}_5 \Big/ \widetilde{\widetilde{P}}{}_5^{inp}\right)_t$	0.20	0.09	0.041
$\widetilde{\widetilde{\mathcal{I}}}_{5,t-1}$	0.55	0.15	0.001
DF=29, R^2=0.81, F=59.90, DW= 1.91			

Table 4.2: Investment "Machinery and Equipment, NACE 50–55"

Table 4.3 presents the regression results for investment in productive livestock. Again we find some evidence of a positive influence of the real output expressed in input prices with an elasticity of around 0.5 percent. Even more significant are the first and the second order time lag as is the depreciation term. From an equilibrium perspective the long-run impact multiplier can be calculated as usual as $1/(1-\kappa_3-\kappa_4-\kappa_5)$. Consequently, finite moments are ensured as long as this expression is smaller than one, which is the case for this regression.

	Coeff	SE	p-val
constant	-5.75	4.37	0.000
$\left(\widetilde{\widetilde{P}}{}_{13}^{out}\widetilde{\widetilde{\mathcal{X}}}_{13} \Big/ \widetilde{\widetilde{P}}{}_{13}^{inp}\right)_t$	0.56	0.42	0.094
$(\delta_{13}\widetilde{\widetilde{\mathcal{I}}}_{13})_{t-1}$	-4.83	1.32	0.001
$\widetilde{\widetilde{\mathcal{I}}}_{13,t-1}$	4.79	1.27	0.001
$\widetilde{\widetilde{\mathcal{I}}}_{13,t-2}$	-0.50	0.16	0.004
DF=27, R^2=0.61, F=10.07, DW=2.29			

Table 4.3: Investment "Productive livestock"

In table 4.4 the results concerning investment behaviour in non-housing construction are displayed. Also this specification has proven to work well in our simulations. The elasticity with respect to real output expressed in input prices is positive and significant and so is the elasticity with respect to the endogenous lag. Notably, we found the fifth-order lag to be significant and negative. The LM test and the modified Durbin-Watson test (H-statistic) suggest that the specification does not suffer from serial correlation.

Table 4.5 presents our estimation results of gross investment in "Machinery and equipment, NACE 01-37 and 45". Here we used the real output expressed in input prices twice, once contemporary and once with the first lag. Both variables are significant, but the results suggest that the immediate impact is considerably reduced after the first year.

	Coeff	SE	p-val
constant	1.72	0.99	0.094
$\left(\widetilde{\widetilde{P}}{}_2^{out}\widetilde{\widetilde{\mathcal{X}}}_2 \middle/ \widetilde{\widetilde{P}}{}_2^{inp}\right)_t$	0.33	0.10	0.004
$\widetilde{\widetilde{\mathcal{I}}}_{2,t-1}$	0.76	0.11	0.000
$\widetilde{\widetilde{\mathcal{I}}}_{2,t-5}$	-0.26	0.10	0.014
DF=26, R^2= 0.94, F= 120.3, DW = 2.09			

Table 4.4: Investment "Construction, non-housing"

The long-term elasticity implied by the lags of the endogenous variable is about 0.38%.

	Coeff	SE	p-val
constant	5.58	1.72	0.003
$\left(\widetilde{\widetilde{P}}{}_3^{out}\widetilde{\widetilde{\mathcal{X}}}_3 \middle/ \widetilde{\widetilde{P}}{}_3^{inp}\right)_t$	1.41	0.46	0.005
$\left(\widetilde{\widetilde{P}}{}_3^{out}\widetilde{\widetilde{\mathcal{X}}}_3 \middle/ \widetilde{\widetilde{P}}{}_3^{inp}\right)_{t-1}$	-1.17	0.51	0.032
$\widetilde{\widetilde{\mathcal{I}}}_{3,t-1}$	0.59	0.15	0.001
$\widetilde{\widetilde{\mathcal{I}}}_{3,t-3}$	-0.24	0.12	0.059
DF=25, R^2=0.76, F=22.4, DW=2.04			

Table 4.5: Investment "Machinery and Equipment, NACE 01 – 37, 45"

Chapter 5

Imports

5.1 Data and definitions

Available time series information on imports in commodity classification covers only imports of goods (M_G), but not services (M_S), the former accounting for the much bigger part of imports (84%). Therefore only imports of goods were estimated via regression equations (see section 5.2). Imports of services, instead, were determined via a constant share matrix (see section 5.3).[1]

For later use we define the share of imports for good i (no services!) relative to the variable "Total Use" (=$X_i + M_i$) as

$$m_i \equiv \frac{M_{Gi}}{X_i + M_i} \tag{5.1}$$

In estimating these import shares (see equation 5.5) we employ as additional regressor a (commodity specific) non-linear time trend, the Nyhus-Trend, defined as[2]

$$T_{Ni,t} \equiv T_{Ni,t-1} + 1 - m_{i,t-1} \quad \text{for } i = 1, 2, \ldots \text{ and } T_{Ni,0} = 0 \tag{5.2}$$

For the baseyear the trend variable is set to zero, ie $T_0 = 0$. This implies, that a rising import share generates a slowdown of its own rise. If it ever were to reach a value of one, import share growth would come to a halt.

Relative import prices per good are defined as

$$p^*_{it} = \frac{P^*_{Git}}{P_{it}} \tag{5.3}$$

where P_{it} denotes the domestic price level for good i. The reason for using only the price level of imported goods P^*_G rather than the price level for all imports (goods + services)

[1]Prior to the determination of the import share matrices $\mathbf{m}_Z$ and $\mathbf{m}_Y$, total imports $M \equiv M_G + M_S$ from the base table had to be adjusted slightly due to data inconsistencies: The time series information from "*Sonderauswertungen*" (SAW) for the baseyear lists M_G figures for some goods, which are larger than the corresponding total import figures from the IO-tables. In these cases $\min\{M^{\text{SAW}}_{Gi}, M^{\text{IOT}}_i\}$ was stipulated as imports of goods.

[2]The G7 function `@cum` (for cumulative) comes very handy to construct the Nyhus-trend variable T. The statement `f y = @cum(y,x,s)` generates a series of variables y_t according to formula $y_t = (1 - s)y_{t-1} + x_t$.

is the lack of time series information about the latter. [3]

Instead, P_G^* could be constructed consistently from SAW time series information as

$$P_G^* = \frac{\text{nominal imports of goods}}{\text{real imports of goods}} \tag{5.4}$$

Finally, we need a variable to distinguish imports estimated from regression equations and imports implicitly defined via import share matrices. For the latter we will use notation $\bar{M}$, while the former is simply denoted M.

5.2 Imports of goods

Imports of goods are modeled as shares of imports in total use. To restrict possible values of these shares to lie within the [0,1]-range a logit function is used for estimation. In the INFORUM realm such functions are used also for example in the IMPEC-Model of **?**. If necessary, the logit function can be easily adjusted for tighter ranges. For one good this option is actually used.

Based on definitions (5.2) and (5.3) the prototype regression equation for the (logit) share of imports of good i is defined as

$$\ln\left(\frac{m_i}{1-m_i}\right)_t = \alpha_0 + \alpha_1 \frac{P_G^*}{P} + \alpha_2 \ln(1 + T_{N\,t-1}) + \alpha_3 T_{N\,t-1} + \alpha_4 \ln\left(\frac{m_i}{1-m_i}\right)_{t-1} \tag{5.5}$$

Not all equations actually use all of the regressors stated in (5.5). In fact most equations use only relative import prices and the log-version of the Nyhus-trend variable. The latter is never used together with the linear version of the Nyhus trend. Results of these estimations for the biggest sectors are displayed in table 5.1. The value of the Durbin-Watson statistic therein again refers to the corrected H-statistic in cases with lags of the endogenous variable as regressor.

The first explanatory variable is the price relation between imported and domestic goods. The import prices are exogenously given from the BTM-Model, while the domestic prices are calculated as described in the chapter on prices. The estimated α_1 coefficients are always negative as expected. So, imports fall with rising relative importe prices, ceteris paribus. The second and third explanatory variables are one or the other variant of a Nyhus-trend (see 5.2). Both of these trend variables have a start off value of zero in the base year and from then on are calculated year by year with the following formula:

$$T_{Ni}(t) = T_{Ni}(t-1) + (1 - m_i(t)) \tag{5.6}$$

[3] Prices for imports (rather than for imported goods alone) can not be calculated directly, because SAW does not list corresponding import figures in real and nominal terms. Theoretically, prices for imports could be derived from combining information from IOT's and SAW. But inconsistency between SAW and IOT classifications preclude this possibility. Alternatively, one might consider calculating import prices via $P' = P'\mathbf{A}_D + P^{*\prime}\mathbf{A}_M + v'$, $P_{aux} = pshd \cdot P + pshm \cdot P^*$, where

$$pshd = \frac{\text{cons. of domestic products}}{\text{total cons.}} \text{ and } pshm = \frac{\text{cons. of imported goods}}{\text{total cons.}}.$$

But this approach was dismissed as unsatisfactory, because earlier testing showed the necessity to invoke some rather awkward assumptions about the constancy of certain variables to come up with meaningful results with this approach. However, since we stipulate constant shares of imports of services there is no need for such an attempt anyway.

CPA	constant	rel.imp.p.	log-trend	trend	lag	R^2	RHO	DW	DF
15	-0.84	-0.93	0.29			0.98	0.08	1.84	11
	-2.20	-2.54	23.5						
18	1.44	-0.91		0.09	0.38	0.99	0.21	1.06	10
	3.89	-3.52		1.46	2.17				
24	0.56	-0.55	0.16			0.95	0.02	1.96	11
	2.88	-3.53	5.60						
29	1.00	-1.28		-0.03		0.66	-0.16	2.33	10
	1.60	-2.21		-4.01					
34	1.31	-1.02	-0.19			0.92	0.07	1.85	9
	2.49	-1.61	-2.45						

For each CPA category: coefficients in first row, t-values below

Table 5.1: Import equations, regression results

The fourth explanatory variable is the lagged version of the logit transformed importshare. The parametrization chosen for the import equation for a particular good depends, as usual, on achieved significance levels in the prototype form and plausibility considerations.

5.3 Imports of services

Imports of services are calculated via import share matrices. Generic elements of these importshare-matrices are defined as:

$$\mathbf{m}_{Zij} = \frac{\mathbf{Z}_{Mij}}{\mathbf{Z}_{ij}}, \qquad \mathbf{m}_{Yik} = \frac{\mathbf{Y}_{Mik}}{\mathbf{Y}_{ik}} \tag{5.7}$$

But services are restricted to certain rows in these import share matrices. The coefficients in exactly these rows are kept constant at base year values for all forecasting periods. Thus, imports of services (after the base year) of commodity i are simply calculated as:

$$M_{Si} = \sum_j \mathbf{m}_{Zij}\mathbf{Z}_{ij} + \sum_k \mathbf{m}_{Yik}\mathbf{Y}_{ik} \tag{5.8}$$

5.4 Implementation

The implementation difficulty regarding imports is the mutual dependency of imports and outputs: Calculation of outputs can only take place **after** calculation of imports as $X = (I - \mathbf{A})^{-1}(Y - M)$. On the other hand, outputs are required **before** calculation of imports in order to transform import shares into imports of goods via $M_G = m(X + M)$. It should be pointed out, that m refers to the estimated import shares for goods from (5.5) rather than the import shares from (5.7).

Within an iterative framework this problem can easily be solved by employing "Total Use" (ie. $X + M$) from the last iteration step to calculate imports of goods. As the iterations converge, this use of the previous round variable rather than the contemporaneous "Total

Use” value becomes asymptotically irrelevant. Calculating “Total Use” as $\mathbf{A}X+Y$ finally enables to determine imports straightforwardly as

$$M = \check{m}(\mathbf{A}X + Y) + M_S \tag{5.9}$$

ie. without the need to know imports beforehand.[4]

5.5 Endogenous determination of import coefficients

The following text contains a description of the update algorithm which is implemented in the Austrian Inforum model. It is based on previous research documented in **?**, **?**, **?** and **?**. Being highly involved with foreign trade, imports play a crucial role in the Austrian INFORUM model. The product side needs total imports by goods to calculate the output 5.10 and the price side needs the import matrix to calculate domestic prices 5.11.

Only total imports (rather than there constituent parts relating to intermediate use and final demand) are being estimated. Therefore, the import matrix must be updated every year in order to keep the import matrix consistent with the estimated total imports. For imports of services the update is also made, but because of the way imports of services are calculated, the result of the rows from the import share matrix regarding services will always be the same as in the base year. For this update two different approaches (see below) may be used, both of which are already coded in the new Austrian Inforum model. By default the second approach is used, but the user may choose either approach by appropriate change of a switch in the `C++` code.

$$X = (I - \mathbf{A})^{-1}(Y - M) \tag{5.10}$$

$$P' = P'\mathbf{A}_D + P^{*\prime}\mathbf{A}_M + v' \tag{5.11}$$

To describe the updating of the import share matrices, more precisely: the updating of the rows within these matrices corresponding to goods rather than to services, some additional variables have to be defined. The import share matrices for intermediate use and for final demand are already defined in (5.7). But for any given vector X, these import share matrices by themselves would yield corresponding total imports, which we will refer to as implicit imports denoted $\bar{M}$ (over intermediate use and final demand). These implicit imports are derived as follows:

$$\begin{aligned}
\bar{M}_i &= \sum_j \mathbf{Z}_{Mij} + \sum_k \mathbf{Y}_{Mik} \\
&= \sum_j \mathbf{m}_{Zij}\mathbf{Z}_{ij} + \sum_k m^f_{ik}\mathbf{Y}_{ik} \\
&= \sum_j \mathbf{m}_{Zij}\mathbf{A}_{ij}\check{X}_j + \sum_k \mathbf{m}_{Yik}\mathbf{Y}_{ik} \\
&= \sum_j \mathbf{A}_{Mij}\check{X}_j + \sum_k \mathbf{m}_{Yik}\mathbf{Y}_{ik} \\
&= (\mathbf{A}_M X)_i + \sum_k \mathbf{m}_{Yik}\mathbf{Y}_{ik}
\end{aligned} \tag{5.12}$$

[4]The latter requirement would arise, applying, instead, the standard definition of “Total Use” $X_{\sum} = M + X = M + (I - A)^{-1}(Y - M)$ leading to equation $M = m(M + X)$. Clearly, also this issue could basically be solved within the iterative process in the very same manner as the first issue mentioned.

The problem arising here is, that implicit imports as calculated from 5.12 do not automatically equal total imports M as determined via regression equations (5.5) and definition (5.9). Therefore, the import share matrices (for intermediate use and final demand) have to be updated in a proper way to guarantee the equality ($M = \bar{M}$).

5.5.1 Iterative row scaling

The first of the above mentioned two approaches just uses row scaling to update the import coefficient matrix. Nevertheless, the algorithm must be iterative to guarantee that the constraints $0 \leq \mathbf{m}_{Zij} \leq 1$ and $0 \leq \mathbf{m}_{Yik} \leq 1$ are true $\forall$ i,j and k. Without these constraints one would have to calculate imports implied by the import matrices, then divide every row by implied imports and multiply it with actual imports. Imports implied by the import matrices in year t are calculated by following formula (where superscript ^{b} refers to base year):

$$\bar{M}_i^t = (\mathbf{A}_M{}^b * X_i^t)_i + \sum_k \mathbf{m}_Y{}_{ik}^b * \mathbf{Y}_{ik}^t \tag{5.13}$$

Scaling of import matrices is effected via:

$$M_i^t = \left(\sum_j \mathbf{A}_M{}_{ij}^b * X_j^t + \sum_k \mathbf{m}_Y{}_{ik}^b * \mathbf{Y}_{ik}^t) \right) \frac{M_i^t}{\bar{M}_i^t} \tag{5.14}$$

Summarizing, the row scaling algorithm works as follows:

1. Start algorithm
2. Calculate imports implied by the import matrices via equation (5.13)
3. Scale the import matrices so their sum is equal to M like show in equation (5.14)
4. Search the matrices $\mathbf{m}_Z$ and $\mathbf{m}_Y$ for violations of the conditions $0 \leq \mathbf{m}_Z \leq 1$ and $0 \leq \mathbf{m}_Y \leq 1$ and apply a correction according to the following rule:
   - If($\mathbf{m}_{ij} < 0$) Then $\mathbf{m}_{ij}$ is changed to $\mathbf{m}_{ij} = 0$
   - If($\mathbf{m}_{ij} > 1$) Then $\mathbf{m}_{ij}$ is changed to $\mathbf{m}_{ij} = 1$
5. Calculate imports implied by the import matrices via equation (5.13)
6. If $M_i = \bar{M}_i$ then the algorithm stops. Else go back to step 3.

5.5.2 Default approach

The second of the above mentioned two approaches, and the one applied in the source code by default, is based on **?**. Therein it was suggested to update the import coefficients with the following formula (superscript ^{b} again refers to base year):

$$\mathbf{m}_{ij}^t = \frac{\mathbf{m}_{ij}^b}{\mathbf{m}_{ij}^b + \lambda_i(1 - \mathbf{m}_{ij}^b)} \tag{5.15}$$

where λ_i is determined by finding the roots of the following nonlinear function: [5]

[5]Note, that the λ_i's for services are one by construction.

$$f(\lambda)_i = M_i - \bar{M}_i \tag{5.16}$$

where $\bar{M}_i := \sum_j \left(\frac{\mathbf{m}_{Z}{}_{ij}^{b}}{\mathbf{m}_{Z}{}_{ij}^{b} + \lambda_i(1 - \mathbf{m}_{Z}{}_{ij}^{b})} \right) * \mathbf{Z}_{ij}^{t} + \sum_k \left(\frac{\mathbf{m}_{Y}{}_{ik}^{b}}{\mathbf{m}_{Y}{}_{ik}^{b} + \lambda_i(1 - \mathbf{m}_{Y}{}_{ik}^{b})} \right) * \mathbf{Y}_{ik}^{t}$

To solve this equation we employ the bisection-algorithm, as described along with proofs for example in **?** or **?**.

5.5.3 Difficulties in calculations

One difficulty encountered during earlier calculations is due to unreasonable values of the importshare matrix for “Changes of valuables” and “Changes in inventories”. These unreasonable values are due to the fact that neither “Changes of valuables” nor “Changes in inventories” need to be positive, unlike other elements of the IO-table. Therefore, this part of the importshare matrix remained constant during the update process. This is not restrictive because “Changes of valuables” and “Changes in inventories” are both assumed to be zero after a few years and therefore changes of corresponding import shares are also zero.

Chapter 6

Labourmarket

6.1 Estimation of employment and wage rates

On of the innovative features of AEIOU II is its fully developed price side. A prerequisite for this is the determination of wages, described in this section. Here wages are meant gross, that is including social contributions of employers. As it in many other INFORUM style models we devided the process in two seperate steps. Firstly the persons employed per sector are estimated and secondly the corresponding wage rates in nominal terms. The product, of course is the ultimately desired wage bill per activity. Only after all other categories of value added are determined, will they be summed together and transformed into goods classification (see section 7.4 on this transformation). Upon this goods classification then a Leontief-price model adapted for imports will be applied as detailed in chapter 7.

6.1.1 Employment equations by activity

The starting point for estimation of sectoral employment is a regression equation to determine an inverse productivity term. As explanatory variables serve the relative output of sector j and the sectoral unit-labour-cost in this sector. As circumstances required we also added the first lag of unit-labour-costs to the list of regressors. Furthermore, the first lag of the endogenous variable was used.

$$\ln\left(\frac{\widetilde{L}_j}{\widetilde{X}_j}\right) = \beta_{0j} + \beta_{1j}\ln\left(\frac{\widetilde{X}_j}{\widetilde{X}_\Sigma}\right)_t + \beta_{2j}\ln\left(\frac{\widetilde{X}_j}{\widetilde{X}_\Sigma}\right)_{t-1} + \beta_{3j}\ln\left(\frac{\widetilde{W}_j}{\widetilde{X}_\Sigma}\right)_{t-1} + \beta_{4j}\ln\left(\frac{\widetilde{L}_j}{\widetilde{X}_j}\right)_{t-1} \tag{6.1}$$

Again all variables were log-transformed in a first step. It should be noted, that equation 6.1 is the most general specification of the employment equation used in AEIOU II. For many sectors it produced implausible simulation results. Hence, eventually terms had to be dropped from the right hand side of equation 6.1. In some extreme cases we had to modell inverse productivity simply as a simple AR(1) process. Although productivity then only depends on time [1], and is therefore exogenously determined, employment still

[1] One could think of it as a learning-by-doing model.

depends on output – the elasticity of employment with respect to output obviously being 1% in this case.

The actual employment level per sector to be used in iterations is then easily calculated from the estimate $\widehat{\ln\left(\frac{L_j}{X_j}\right)}$ as

$$L_j = \exp\left\{\widehat{\ln\left(\frac{L_j}{X_j}\right)}\right\} X_j \tag{6.2}$$

6.1.2 Wage rate equations by activity

The second step of our procedure begins with the assessment of the sectoral wage rate. As equation 6.3 below indicates, we assume the growth of the sectoral wage rate simply to be a proportional function of the overall wage rate growth. The interpretation of the single coefficient in this equation is straightforward: If $\beta_j > 1$ then the wage rate of sector j grows relatively faster than the average, if $\beta_j < 1$ the opposite is the case.

$$\Delta \ln\left(\frac{\widetilde{W}_j}{\widetilde{L}_j}\right)_t = \beta_j \Delta \ln\left(\frac{\widetilde{W}_\Sigma}{\widetilde{L}_\Sigma}\right)_t \tag{6.3}$$

where $\widetilde{W}_\Sigma$ is the overall wage sum (i.e. summed over all sectors) and $\widetilde{L}_\Sigma$ the overall employment figure.[2] To become operational equation 6.3 first requires an estimate of $\widetilde{W}_{\Sigma,t}/\widetilde{L}_{\Sigma,t}$. This estimate stems from regression equation 6.4 below. There we use as explanatory variables the change in the deflator for private household consumption $\mathcal{P}_{\text{CPI}}$ and the unemployment rate u. Consistent with a Philips-curve interpretation we would expect a positive sign for the coefficient of the price level, and a negative sign for the unemployment coefficient.

$$\Delta \ln\left(\frac{\widetilde{W}_\Sigma}{\widetilde{L}_\Sigma}\right) = \gamma_0 + \gamma_1 \Delta \ln(\mathcal{P}_{\text{CPI},t}) + \gamma_2 u_t \tag{6.4}$$

Combining 6.3 and 6.4 then yields the desired sectoral wage rate:

$$\widetilde{W}_j = \exp\left[\hat{\beta}_1 \left\{\gamma_0 + \gamma_1 \Delta \ln(\mathcal{P}_{\text{CPI},t}) + \gamma_2 u_t\right\} + \ln\left(\frac{\widetilde{W}_j}{\widetilde{L}_j}\right)_{t-1}\right] \widetilde{L}_j \tag{6.5}$$

The reason for splitting up the definition of the wage rate per activity in this fashion is the centralized type of wage bargaining in Austria. Wage demands in the various sectors are usually formulated relative to those of a sector functioning as bargaining leader. Econometrically, equations 6.3 and 6.4 could be estimated in one step but with the loss of identifiability of coefficients γ_1 and γ_2. The latter was introduced for possible future analysis of alternative wage bargaining policies.

[2]Clearly, in constructing sums of wages, employment or total output it does not matter, whether we sum over activities or over commodities, that is, $\widetilde{W}_\Sigma = W_\Sigma$, $\widetilde{L}_\Sigma = L_\Sigma$ and $\widetilde{X}_\Sigma = X_\Sigma$.

6.2 Estimating the unemployment rate

The unemployment rate in the traditional definition used here throughout is the share of unemployed persons in the total labour force minus the self-employed. Therefore, it seems tempting to just subtract the employed persons estimated above from the entire labour force minus the self-employed in order to end up with unemployed persons.

Unfortunately, this simple idea does not work for reasons. The first is that the regressions formulated above are specified in FTE's. The second is that we have no estimates for the number of self-employed persons. Clearly, to bridge between FTE's and the associated number of employed persons one could work with constant ratios between these two variables from the base year. But invoking this assumption of fixed ratios seems overly restrictive, as the amount of part time work is rapidly changing and so is the ratio of self-employed over dependent workers. In order to avoid this assumption we, therefore, decided to estimate the relationship between the unemployment rate u and employment $\widetilde{L}_{\Sigma}$ (in FTE's!) using as additional regressors a total population figure N and the share of population between 15-60 s_{wa} as a rough indicator for persons of working age within total population.[3]

$$u_t = \alpha_0 + \alpha_1 \widetilde{L}_{\Sigma,t} + \alpha_2 N_t + \alpha_3 s_{wa,t} + \alpha_4 u_{t-1} \tag{6.6}$$

It should be noted, that equation (6.6) estimates an unemployment rate counting persons (registered at the labour offices and) in training as unemployed and relating these to dependently employed and unemployed. This deviates from standard definitions, which exclude these persons when counting the unemployed (this applies to the labor force concept and the standard Austrian definition of unemployment alike!). Consequently our estimates of the unemployment rate for recent years lie roughly 2 percentage points above the figures according to the standard Austrian definition.[4]

6.3 Results

In the remainder of this section we shall have a look at some important estimation results. Table 6.2 shows the parameter estimates for equation 6.6 along with some statistics. The results suggest that if the sum of FTE rises by 1% the unemployment rate drops by 0.36 percentage points immediately. On the contrary the short-run semi-elasticities with respect to population and the population share between 15 and 60 are about 0.5 and 0.3 respectively. The endogenous lag coefficient of roughly 0.3 implies that elasticities are about 1.4 times higher in the long run and decline geometrically. LM-Statistics suggest that serial correlation should not be an issue. The mean absolute percentage error is about 3.2.

In table 6.1 the estimation results for the aggregate wage-rate growth are shown. The

[3]In forecasting the corresponding forecast figures for both of the latter variables from Statistics Austria are used.

[4]The standard Austrian definition excludes persons in training from the number of unemployed. The officially reported number of persons registered at the labour offices as "in training" increased considerably in the aftermath of the last crisis is about 73 thousand! Furthermore, in the standard Austrian definition the unemployment rate is defined as unemployed over dependently employed. These figures are calculated as yearly averages over corresponding end-of-month figures.

results suggest that the marginal effect of a higher price level on the wage-rate is 0.33, for the unemployment rate the estimated impact is about -0.63.

Tables 6.1 and 6.1 illustrate the sectoral estimation behaviour by showing the regressions results for employment and wage-rate for the communication sector.

Dependent Variable: $\Delta \ln \left(\widetilde{W}_{\Sigma,t} / \widetilde{L}_{\Sigma,t} \right)$**, Sample (adjusted): 1977 2008**

	Coeff	SE	p-val
constant	0.078	0.017	0.000
$\Delta \ln(\mathcal{P}^t_{\text{CPI}})$	0.331	0.203	0.064
u_t	-0.639	0.168	0.001
DF=29, $R^2 = 0.736$; F-Stat=40.34; DW = 1.51			

Table 6.1: Estimation of aggregate wage-rate growth

Dependent Variable: u_t**, Sample (adjusted): 1981 2008**

	Coeff	SE	p-val
const	-3.610	0.809	0.000
$\widetilde{L}_{\Sigma,t}$	-0.360	0.060	0.000
N_t	0.577	0.103	0.000
s_{wa}	0.282	0.071	0.001
u_{t-1}	0.309	0.117	0.014
DF=23, $R^2 = 0.947$; F-Stat=103.7; DW = 1.83			

Table 6.2: Estimation of the unemployment rate

Dependent Variable: $\ln(\widetilde{L}_{32}/\widetilde{X}_{32})_t$**, Sample (adjusted): 1977 2008**

	Coeff	SE	p-val
constant	-1.04	0.31	0.002
$\ln(\widetilde{X}_{32}/\widetilde{X}_{\Sigma})_t$	-0.13	0.06	0.040
$\ln\left(\widetilde{W}_{32}/\widetilde{X}_{32}\right)_{t-1}$	-0.35	0.13	0.013
$\ln\left(\widetilde{L}_{32}/\widetilde{X}_{32}\right)_{t-1}$	1.00	0.02	0.000
DF=28, $R^2 = 0.99$; F-Stat=1186; DW = 1.60			

Table 6.3: Inverse Productivity in the Communication Sector

Dependent Variable: $\Delta \ln\left(\widetilde{W}_{32}/\widetilde{X}_{32}\right)_{t-1}$**, Sample (adjusted): 1977 2008**

	Coeff	SE	p-val
$\Delta \ln\left(\widetilde{W}_{\Sigma}/\widetilde{X}_{\Sigma}\right)_{t}$	1.19	0.05	0.000
DF=31, $R^2 = 0.40$			

Table 6.4: Relative wage-rate growth in the Communication Sector

Chapter 7

Prices

Endogenous determination of prices one of the biggest improvements of AEIOU II compared to its predecessors. The key ingredient to this endogenization are nominal gross wages estimated from total output, the price level and the unemployment rate as desribed in chapter 6. But to deploy the Leontief-price model further variables are required: The operating surplus, depreciation and other taxes and subsidies on production. The derivation of these quantities plus their transformation into producer prices and consumer prices at the commodity level is described in this chapter.

7.1 Operating surplus

To determine the operating surplus we use a markup approach. More precisely, we base our markups upon the proportions of operating surplus in total output. These proportions are averaged over the past decade based on SAW data. The choice of a decade for averaging is motivated by the desire to neutralize the typical cyclical variation of profit shares. This is the general idea. For a few activities this led to figures which were impossible to reconcile with the corresponding values from IOT 2005, which we use as reference throughout. In these cases we look for a compromise between the averaged values and those from official IOT 2005 to avoid economically artifical breaks in the series. If, despite averaging, certain activities still display negative operating surplus, we decided, for forecasting purposes, to let the losses level out to zero by 2030, the end of our forecasting period. The rational behind this is simply that persisting losses are hard to imagine over such a long period.

The proportions calculated in this manner can be easily translated into traditional markups upon costs, which are used on a daily basis for industrial product pricing.[1] Table 7.1 lists the 2005 profit shares, calculated in the above described manner and the associated, implied mark-ups for all 60 industries.

Table 7.1

	$\widetilde{\Pi}_j/\widetilde{X}_j$	mark-up
Products of agriculture, hunting	37.03	58.80
Products of forestry, logging	39.66	65.73

Continued on next page

[1] If π denotes the proportion of operating surplus within total output, than the corresponding markup over costs is simply $\pi/(1-\pi)$.

Table 7.1 – continued from previous page

	$\widetilde{\Pi}_j/\widetilde{X}_j$	mark-up
Fish, other fishing products	13.83	16.05
Coal and lignite, peat	48.05	92.49
Crude petroleum, natural gas, metal ores	43.08	75.67
Other mining and quarrying products	12.30	14.02
Food products and beverages	9.94	11.03
Tobacco products	-0.59	
Textiles	5.33	5.63
Wearing apparel, furs	11.98	13.61
Leather and leather products	8.27	9.02
Wood and products of wood	6.35	6.78
Pulp, paper and paper products	7.52	8.13
Printed matter and recorded media	10.45	11.67
Coke, refined petroleum products	5.74	6.09
Chemicals, chemical products	17.49	21.19
Rubber and plastic products	7.21	7.77
Other non-metallic mineral products	11.56	13.07
Basic metals	10.29	11.47
Fabricated metal products	9.49	10.48
Machinery and equipment n.e.c.	9.85	10.93
Office machinery and computers	8.60	9.41
Electrical machinery and apparatus	7.87	8.54
Radio, TV and communication equipment	6.60	7.07
Med., precision, opt. instruments, watch	15.85	18.84
Motor vehicles, trailers and semi-traile	7.35	7.93
Other transport equipment	0.84	0.84
Furniture, other manufactured goods n.e.	9.87	10.95
Recovered secondary raw materials	19.54	24.29
Electricity	7.51	8.12
Gas, Steam and hot water	8.41	9.18
Water, distribution services of water	9.79	10.85
Construction work	18.19	22.23
Trade and repair services of motor vehic	14.73	17.28
Wholesale and comm. trade serv., ex. of	23.43	30.61
Retail trade serv., repair serv., exept	16.95	20.41
Hotel and restaurant services	26.10	35.31
Land transport and transport via pipelin	-2.67	
Water transport services	4.74	
Air transport services	-4.37	
Supporting transport services, travel ag	0.99	1.00
Post and telecommunication services	9.36	10.33
Financial intermediation services	9.09	10.00
Insurance and pension funding services	23.12	30.07
Services auxiliary to financial intermed	25.66	34.52
Real estate services, market	33.14	49.57
Imputed rental services	44.31	79.58
Other real estate services	16.19	19.32
Renting services of machinery and equipm	-5.64	

Continued on next page

Table 7.1 – continued from previous page

	$\widetilde{\Pi}_j/\widetilde{X}_j$	mark-up
Computer and related services	7.63	8.26
Research and development services	-4.11	
Other business services	17.31	20.94
Public administration services etc.	0.00	0.00
Education services	1.58	1.61
Health and social work services	4.13	4.31
Sewage and refuse disposal services etc.	0.34	0.34
Membership organisation services n.e.c.	-0.02	
Recreational, cultural and sporting serv	19.99	24.99
Other services	26.25	35.59
Private households with employed persons	0.00	0.00

Table 7.1: Share of profits (by activity) in total output (left column) and implied markups over costs (right column)

7.2 Depreciation

Instead of assuming sectoral depreciation to be a constant share of nominal output we estimated the level of depreciation per activity j using the following specification:

$$\widetilde{V}_{Dj,t} = \eta_0 + \eta_1 \widetilde{\mathcal{I}}_{j,t} + \eta_2 \widetilde{V}_{Dj,t-1} + \eta_3 \widetilde{V}_{Dj,t-2} \tag{7.1}$$

where $\widetilde{V}_{Dj,t}$ denotes the depreciation level per activity and $\widetilde{\mathcal{I}}_{j,t}$ the investment level of this activity. Eq. 7.1 produces highly plausible results for 42 NACE sectors, but fails to describe depreciation for the remaining industries. Hence for these sectors the constant share assumption had to be maintained. Table 7.2 shows a typical regression output. As can be seen the coefficients on the lagged endogenous variables and the sectoral gross investments are highly significant and almost perfectly determine the variability of the dependent variable. The results suggests a positive relationship between the level of investment and lagged depreciation. Durbin-Watson and LM-Tests suggest that serial correlation in the residuals is no serious issue.

7.3 Taxes and subsidies on production

Within our input-output framework, we basically distinguish between two kinds of taxes and subsidies:

Firstly, product taxes T and product subsidies S, which are based on traded quantities (like the gasoline tax = *Mineralölsteuer*) or values (like the most important tax, the value added tax). The vector of net amounts of these taxes shall be denoted T^{net}. It may be considered as component of the intermediary flow matrix (line 61 and 62). In 2005 the median of these net taxes was 0.66% of gross output, with a maximum share for good

Dependent Variable: $\widetilde{V}_D$, Sample (adjusted): 1977 2008

	Coeff	SE	p-val
constant	1447.61	2160.51	0.208
I_{it}	0.05	0.01	0.001
$\widetilde{V}_{Dt-1}$	1.51	0.14	0.000
$\widetilde{V}_{Dt-2}$	-0.56	0.14	0.000
DF=28, $R^2 = 0.99$, F-statistic=9544.485, DW=1.91			

Table 7.2: Depreciation for activity "Machinery construction"

"Membership organisation services" of 6.48% and a minimum for commodity "Private households services" of 0%.

Secondly, there are levies on production V_T and subsidies for production V_S, which are not based on traded quantities or values and which, therefore, are recorded as part of value added by convention. The vector of these net taxes is denoted V_{T-S}. This "Other production net duties" account for 9.64% of gross output on average with a maximum share in industry "Coal and lignite, peat" 48.05% and a minimum in "Renting services of machinery" -5.46%

For forecasting purposes we keep the shares of these taxes in total nominal output constant at their respective 2005 values. For the share of nettaxes on products we will use the symbol t^{net} and for the shares of netduties on production v_{T-S}.

7.4 Transform value added from activities to goods

Transforming the four value added components from activities to goods is not trivial. It is tempting to think that one just has to follow the documentation provided by the statistical offices. Unfortunately, the relevant transformation matrices cited therein, for many reasons are rarely ever published. This is also the case for Austria. Therefore, we had to calculate our own transformation matrix for value added based on the make matrix published by Statistics Austria. To that end, in a first step a modified make matrix ($\mathbf{V}_{\text{mod}}$) is calculated by updating matrix $\mathbf{V}_{\text{make}}$ to $\mathbf{V}_{\text{mod}}$. For that purpose we use the "Improved squared differences technique" explained in ?, ? and ?. Alternatively one could use a RAS procedure to transform the make matrix $\mathbf{V}_{\text{make}}$ into $\mathbf{V}_{\text{mod}}$.

Figure 7.1 contains an overview of relationships and notation used. Note in particular, that summation of the make matrix (denoted $\mathbf{V}_{\text{make}}$) along rows gives the vector of total output by activities $\widetilde{X}$ and summation along columns gives the (transposed) vector of total output by commodities X (picture A). Instead, summation of the modified value added matrix $\mathbf{V}_{\text{mod}}$ along rows yields the vector of value added by activities $\widetilde{V}$, whereas summation along columns gives the (transposed) vector of value added by commodities V (picture B). Clearly, the overall sums of entries in these two matrices are total output on one hand and total value added on the other. Using the same capital letter V in the labelling of both matrices (following standard text book notation) should not confuse the reader about their completely different nature.

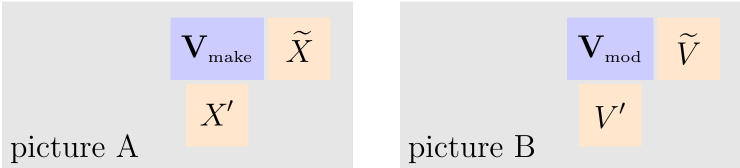

Figure 7.1: Overview of variables in transformation of value added

This leads to the modified C-Matrix

$$\mathbf{C}_{\text{mod}} = \mathbf{V}'_{\text{mod}} \check{\widetilde{V}}^{-1} \tag{7.2}$$

where the $\check{\widetilde{V}}$ notation indicates a diagonal matrix constructed from $\widetilde{V}$. The transformation matrix defined in (7.2) is calculated from base year values and kept constant for forecasting purposes. Hence the desired transformation of value added from activities to goods is carried out via

$$V = \mathbf{C}_{\text{mod}} \widetilde{V} = \mathbf{V}'_{\text{mod}} \check{\widetilde{V}}^{-1} \widetilde{V} = \mathbf{V}'_{\text{mod}} \iota \tag{7.3}$$

where ι denotes the summation vector of appropriate dimension. By the above described transformation the four types of value-added, labor income W, taxes T, depreciation D and profits Π, are transformed from the classification in activities into the corresponding classification in commodities.

7.5 Domestic prices

Total nominal value added by category next is summed to give total nominal value added $V = W + T + D + \Pi$. From this, unit value added v is computed simply by dividing total valued added by real output for each of the 60 goods, i.e. $v = V/X$ elementwise. If there were neither foreign trade nor other taxes on production or subsidies on production P could then be derived from the simple Leontief-price equation $P' = v'(I - A)^{-1}$,[2] from which the simplified version of the key national accounting identity follows: $P'Y = v'X$ (recall $Y = (I - A)X$): Nominal final demand equals value added.

7.5.1 Integration of product taxes and product subsidies

Starting point for this integration is the definition of the t^{net} variable

$$t_i^{\text{net}} = \frac{T_i - S_i}{X_i} \tag{7.4}$$

This variable is the difference between taxes minus subsidies on commodity i as share in commodity i's total output X. These shares will be calculated for the base year and then kept constant for forecasting purposes. Therefore, the level of net taxes on products T^{net} per commodity can be calculated from nominal output X^{nom} as

$$T_{it}^{\text{net}} = t_i^{\text{net}} X_{it}^{\text{nom}} \quad \forall\ t \tag{7.5}$$

[2]In Interdyme this calculation is taken care of by application of the iterative Gauss-Seidel procedure rather than resorting to a direct evaluation of the Leontief inverse.

7.5.2 Integration of Import prices

The simple version of the Leontief price equation stated above applied to an open economy would imply the same price for imports as for domestically produced goods and services. But for an open economy $\mathbf{A} = \mathbf{A}_M + \mathbf{A}_D$, where $\mathbf{A}_M$ is the matrix of direct input coefficients for imports and $\mathbf{A}_D$ the matrix of direct input coefficients for domestically produced goods. This brings import prices P^* into play, which of course can differ from domestic prices P. To integrate these import prices into an IO-model, the price equation has to be changed to

$$P' = P'\mathbf{A}_D + P^{*\prime}\mathbf{A}_M + v' \tag{7.6}$$

To show that this is still consistent with the input output framework let's restate the quantity equation of the Leontief-framework for an open economy:

$$X = \mathbf{A}_M X + \mathbf{A}_D X + Y_M + Y_D - M \tag{7.7}$$

Note, that by definition $\mathbf{A}_M X + Y_M = M$. If we premultiplie 7.7 with P', postmultiply 7.6 with X, and solve this system for GDP $v'X$ (see **?**) we end up with

$$v'X = P^{*\prime}Y_M + P'Y_D - P^{*\prime}M$$

which denotes the fundamental input-output theorem for an open economy. So it does not matter, whether one evaluates nominal GDP as total value added or as total final demand minus total imports and this, of course, must be true for any given import price vector.

7.6 From producer prices to consumer prices

Preceeding with equation (7.7) and adding net taxes on products defined in (7.5) finally yields desired domestic producer prices per commodity

$$P = (I - \mathbf{A}_D{}')^{-1}\left(\frac{V + T^{\text{net}}}{X} + \mathbf{A}_M{}'P^*\right) \tag{7.8}$$

These prices already reflect the influence of imports and consequently of import prices, but only by weights according to the imports relative weight in intermediate consumption. From these producer prices P we construct what we call, for lack of a better name, consumer mixed prices P_{aux}. They also reflect the imports going directly to final demand and are defined as

$$P_{aux} = P \times pshd + P^* pshm, \tag{7.9}$$

where multiplication is elementwise with the domestic and imported shares of final demand (see footnote 3 of chapter 5). Next we add the transport-, wholesale-trade- and retail-trade-margins to these mixed consumer prices by application of the appropriate bridge matrix $\mathbb{B}_{PC}$, i.e.

$$P_{aux2} = \mathbb{B}_{PC}{}'P_{aux} \tag{7.10}$$

To get the consumer price vector $\mathcal{P}$ we finally add margins for product taxes tax and product subsidies sub (calculated from baseyear IOT's and kept constant in the forecasts) to this intermediate price vector

$$\mathcal{P} = P_{aux2} + \check{\text{tax}}P_{aux2} + \check{\text{sub}}P_{aux2} \tag{7.11}$$

Relative consumer prices are then simply defined as

$$p = \mathcal{P}/\mathcal{P}_{\text{CPI}} \tag{7.12}$$

i.e., by dividing consumer prices through their weighted (by consumption quantities) average. These relative consumer prices then enter final consumption demand equations.

Investment demand equations instead are based on relative producer prices, which are analogously constructed from P, but where the weights used to calculate the average index are given by total domestic output per good. This completes the step from value added categories to all relevant prices used in other parts of the model.

Chapter 8

Linking AEIOU II to INFORUM world model

For forecasting purposes also this new Austrian input-output model derives important information from the INFORUM world model, more often refered to as the INFORUM "Bilateral Trade Model" (BTM). At the moment this relationship is onesided: AEIOU II uses BTM information as input, but not the other way round. But with the next regular update of BTM the forecasts from AEIOU II will be fed into BTM as input too. This chapter serves to describe the BTM and the necessary data manipulations to make BTM forecasts operational for the AEIOU II model.

8.1 The Bilateral Trade Model (BTM)

Rather than invent a new description for the Bilateral Trade Model maintained by the INFORUM group, we rely on the description from the INFORUM homepage. [1]

"The INFORUM system of macro econometric, dynamic, input-output models has been producing annual forecasts and analyses of public policy since 1979. The current system contains models for the United States, Canada, Mexico, Japan, Korea, China, Germany, France, United Kingdom, Italy, Spain, Austria and Belgium. Models of Denmark, Holland, Poland, Hungary, Russia, South Africa, India, and Thailand are underway, but not yet a part of the linked system.

Each of the models builds from industry detail to macroeconomic totals and has its own macroeconomic properties. The models produce all of the principal results of any aggregate model, such as GNP, the price level, the unemployment rate, and so on. In addition, they produce sectoral (product) forecasts for gross output, exports, imports, consumption, price indexes and value added. These sectoral series are internally consistent with each other and consistent with the macro results. Indeed, the macro results are, with the exception of household and government consumption, the sum of sectoral results. Thus, real GNP is the sum of final demands expressed in constant prices, nominal GNP is the sum of value added by industry; and, the GNP deflator is the ratio of the two.

Each of the models has as a basic building block an input-output table linking the various sectors of the entire economy in a consistent manner. The table is used for the calculation

[1] `http://inforumweb.umd.edu/services/models/isdetail.html` on 18.04.2011

of product outputs and product prices for each year of the forecast. The input-output coefficients have dynamic paths of change over time, which, in some instances, are responsive to changes in relative prices. Product outputs are determined using the familiar input-output calculation where the output of any one sector is the sum of sales to each of the other sectors and of sales to final demand. Likewise, prices are derived as the sum of the costs of intermediate goods and service inputs (including the cost of imported goods and services), and the costs of primary factors (labor, capital, etc.) per unit of real output. (...)

Each of the models is dynamic. That is, past levels of output, together with their pattern of change over time, will influence the level of investment and employment by industry.

Each of the country models is linked to the others bilaterally, by commodity, through trade flows and prices. The links are at both the macroeconomic and sectoral level. The macroeconomic side provides the exchange rate assumptions. All other links are at the sectoral level. Thus, steel imports in the USA influence steel exports of Japan; German auto prices affect the price of auto imports to the USA; and, USA grain prices affect Canadian exports of Grain. The model that links all of the country models is the Bilateral Trade Model BTM).

Exchange rates are exogenous. The system emphasizes the flows of goods and services at the industry level between countries together with the price impacts of such flows.

The models are linked together with a Bilateral Trade Model (BTM). BTM, as its name implies, shows bilateral trade flows between the countries in the system for some 120 commodities. The database used is Statistics Canada's World Trade Database. BTM uses country and sector specific data on prices and investment to estimate the import shares and then the importing country's imports to obtain the level of imports from each exporting country. Summing across the importers then yields the exports by country and commodity. These estimates are then used in the country models as indicators of exports. In addition, BTM gives the importing country information on its import prices by commodity.

Every six months, both macroeconomic and microeconomic model solutions are updated. In accordance, reviews of details and analysis are also performed in six-month intervals and are available upon request. Historical and forecast databases exist as part of the standard model data banks. Software for user operation of the system is available as is technical assistance by request."

8.2 Additional calculations

It takes quite some time to integrate a new model like AEIOU II into the BTM system. At the present stage the Austrian part of the BTM model is still based upon the old Austrian input-output model from 1978 but using updated data from Statistics Canada's World Trade Database. Only after the next update of BTM will the new Austrian AEIOU II model be more than a satellite to the BTM. At present we just use BTM forecast data for Austrian exports in constant prices and imports in constant and current prices in Million USD. The INFORUM group now has the code of AEIOU II and will integrate it into BTM, thereby replacing the old Austrian IO-subsystem.

8.2.1 Transformation BTM to CPA

To generate a transformation from BTM to CPA classification we use the existing transformation from BTM to SITC rev. 2 which is very rich on details as starting point. The full transformation from SITC rev. 2 to CPA required the following four steps:

1. From BTM to SITC rev. 2
2. From SITC rev. 2 to SITC rev. 3
3. From SITC rev. 3 to CN 2010
4. From CN 2010 to CPA 2002

The information necessary for these transformations are publicly available from the UN[2] and EUROSTAT[3] homepage. SITC rev. 2 is a 5 digit level and CPA a 6 digits level classificiation. So we did the transformation on a high disaggregation level even if we use at most 3 digits in our model. This approach has the advantage that even if the transformation might be imperfect at the 6 digit level, it makes no difference at the 3 digits level anyways.

8.2.2 Exports

Before using the data from the BTM model in CPA classification, further data preparation is necessary. The first concerns export quantities. The BTM export data (at constant prices) are in Million USD and first need to be transferred into Euro values. For this we use the exchange rate as reported by the "The Federal Reserve Bank" for the relevant year 2005. After their application the figures have yet to be multiplied by 1000, as our data are expressed in thousands of Euros. The resulting inaccuracies can safely be ignored, as forecasting error is likely to dominate rounding inaccuracy anyway. Next these exports in thousands of Euros had to be reindexed for consistency with Statistics Austria based on the historical values of 2008.

Symbol	**Description**	**Classification**
E	Exports provided by Statistik Austia in thousand Euro	Goods
$E^{\$}$	Export forcasts from the BTM in million \$	Goods
E^{Euro}	Export forcasts from the BTM in thousand Euro	Goods
E	Exports in thousand Euro based on the index of the BTM forecasts	Goods
exr	exchange rate (1 \$ = x Euro)	

$$E_t^{Euro} = E_t^{\$}\, exr_{2005}\, 1000 \tag{8.1}$$

[2]http://unstats.un.org/

[3]http://ec.europa.eu/eurostat/ramon/nomenclatures/

To make BTM forecasts consistent with the last observations from Statistics Austria we define

$$E_t = \frac{E_t^{Euro}}{E_{2008}^{Euro}} * E_{2008} \qquad \forall\ t \in [2009, 2030] \tag{8.2}$$

8.2.2.1 Import prices

Import prices are also provided via the BTM forecasts. The import prices were calculated by dividing imports at current prices through imports at constant prices. Exchange rates after 2009 were provided by INFORUM. As exchange rates before year 2000 were given in 1 USD to x ATS, figures for earlier periods were transformed into Euros with the fixed exchange rate 13.7603 ATS per Euro. In the BTM only imports at constant prices and import prices are calculated. To aggregate the relevant prices into CPA classification, therefore, imports at current prices were additionally calculated.

Symbol	**Description**	**Classification**
M	Imports provided by Statistik Austia in constant prices in thousand Euro	Goods
$M^{\$nom}$	Imports from the BTM in current prices	Goods
$M^{\$}$	Imports from the BTM in constant prices	Goods
E^{Euro}	Export forcasts from the BTM in thousand Euro	Goods
$P^{*\$}$	Importprices from the BTM	Goods
P^{*}	Importprices	Goods
exr	exchange rate (1 \$ = x Euro)	

$$M_i^{\$nom} = M_i^{\$} * P^{*\$} \qquad \text{i from BTM} \tag{8.3}$$

$$M_j^{\$nom} = \sum_i M_i^{\$nom} \qquad i \in I \subset \text{BTM and } j \in J \subset \text{CPA} \tag{8.4}$$

$$M_j^{\$} = \sum_i M_i^{\$} \qquad i \in I \subset \text{BTM and } j \in J \subset \text{CPA} \tag{8.5}$$

Calculate import prices

$$temp_j(t) = \frac{M_j^{\$nom}(t) * exr(t) * 1000}{M_j^{\$}(t) * exr(2005) * 1000} \tag{8.6}$$

$$P_j^*(t) = \frac{temp_j(t)}{temp_j(2005)} \tag{8.7}$$

Chapter 9

Accountant

What is commonly refered to as the "accountant" in the realm of input-output models serves to determine disposable household income from value added items. For this determination we follow the explicit derivation of disposable income in the private sector accounts (see table 9.1). Once determined, disposable income will then be used in turn as important regressor to determine aggregate consumption. Therefore, the accountant constitutes an indispensable link between the price side and the real side of any input-output model.

II.1	Primary income distribution	Payment	Receipt
B.2n	Operating surplus, net		6.507
B.3n	Mixed income, net		22.392
D.1	Compensation of employees		120.004
D.4	Property income, received		21.110
D.4	Property income, payed	2.953	
B.5n	**Balance of primary income, net**	167.060	

II.2	Secondary income distribution	Payment	Receipt
B.5n	Balance of primary income, net		167.060
D.62	Social benefits other than s.b. in kind		48.334
D.7	Other current transfers, received		7.047
D.5	Current taxes on income and wealth	25.581	
D.61	Social contributions	43.011	
D.7	Other current transfers, payed	6.676	
B.6n	**Disposable income, net**	147.173	

Table 9.1: Non-financial accounts, private households and NPISH's (S.14+S.15), Austria 2005, in Mio Euros

9.1 Disposable income of private households

The key problem in deriving disposable income of private households is lacking distinction between receiving sectors in the net operating surplus reported in the published input-output tables. There, instead, incomes arising in the corporate sector and in the household sector are mingled together. Furthermore, parts of incomes arising in the household sector should not be counted as profits, but rather as wages (below refered to as “Mixed income” following the international naming convention), because the two items receive different tax treatment. Fortunately we have a corresponding breakdown for 2005 into these required categories from the SAW data, which, once again, constitutes the basis for the subsequent calculations.

“Operating Surplus, net” (B.2n) and “Mixed Income, net” (B.3n)

Determination of these items starts off with the “Operating surplus of private households, net”, which is calculated as a share of total net operating surplus by activity based on the 2005 proportions:

$$\widetilde{\Pi}_{HHj} = \widetilde{\pi}_{HHj}\widetilde{\Pi}_j \qquad (9.1)$$

By definition, “Operating surplus of private households, net” is divided into “Operating Surplus, net” (B.2n) and “Mixed Income, net” (B.3n). These two types of income are derived from the corresponding shares of the ”Operating Surplus of private households, net” ($\widetilde{\Pi}_{HH}$) in 2005.

Compensation of employees (D.1)

The calculation of the compensation of employees per activity is described in detail in chapter 6. So the only remaining step for the purpose of determining disposable income is summing these compensations over all activities:

$$\text{compensation of employees} = \sum_j \widetilde{W}_j \qquad (9.2)$$

Net property income, received minus paid (D.4)

From the perspective of the household sector, property income received by far exceeds property income paid. Therefore, we did not determine the two items separately, but consider only the net amount received. This will be calculated as fixed shared of the operating surplus $\widetilde{\Pi}$ of the corporate sector:

$$\text{Property income} = \text{Property income rate}_{2005} \sum_j \widetilde{\Pi}_j \qquad (9.3)$$

Social benefits other than social benefits in kind (D.62)

Social benefits other than social benefits in kind are estimated from historical data as function of “Compensation of Employees” and of “Mixed Income, net”:

$$\text{Social benefits} = \beta_0 + \beta_1 (\sum_j \widetilde{W}_j + \text{Mixed income, net}) \qquad (9.4)$$

Estimation results are given in table 9.2.

Other current transfers, received and paid (D.7)

"Other current transfers, received" and "Other current transfers, paid" are of roughly equal size. Analyzing historical data we found the two items to grow roughly at the same rate as the CPI. Based on this observation we simply assumed both items (received and paid) to grow like the consumption deflator:

$$\text{Other current transfers} = \text{Other current transfers}_{2005}\mathcal{P}_{\text{CPI}} \tag{9.5}$$

Social contributions (D.61)

Social contributions are estimated dependent on "Compensation of employees" and "Mixed Income, net":

$$\text{Social contributions} = \beta_0 + \beta_1(\sum_j \widetilde{W}_j + \text{Mixed income, net}) \tag{9.6}$$

Corresponding estimation results are given in table 9.2.

Current taxes on income, wealth, etc. (D.5)

Current taxes on income, wealth, etc. are estimated as function depending on "Compensation of employees", "Net operating surplus", "Net mixed income" and "Social contributions":

$$\text{Social benefits} = \beta_0 + \beta_1(\sum_j \widetilde{W}_j + \text{OS, net} + \text{Mixed income, net - Social contributions}) \tag{9.7}$$

Again the estimation results are given in table 9.2.

Dep.var.	β_1	β_0	R^2	RHO	DW	DF
D.62	3656072	0.308	0.98	0.78	0.44	12
	(1.96)	(21.9)				
D.61	3769577	0.274	0.99	0.55	0.90	12
	(5.25)	(50.4)				
D.5	-1926714	0.271	0.94	0.57	0.93	12
	(-0.97)	(13.4)				

Table 9.2: Regression results for accountant equations (t-values in parantheses)

As can be seen from table 9.2, autocorrelation in the residuals remains an issue. For economic reasons we did not attempt to eliminate it by introducing lags of the endogenous variable: Clearly taxation and social contributions alike are related by law to current rather than past incomes. The issue of potentially flawed standard errors arising from autocorrelation could be easily remedied with HAC-robust estimators.

Data for all regressions above are taken from the sector accounts of private households from Statistics Austria, which were available for 1995-2008.[1] Furthermore, we used own calculations to derive a value added matrix (in activities) for 2005 including as separate item the "Operating surplus of private households". From the latter data the shares used in B.2n and B.3n are constructed.

9.2 Gross domestic product (GDP), nominal and real

Calculation of GDP (and of the associated GDP deflator) is a separate step of each periods forecast, effected after convergence of the iteration process. This process itself does not depend on either GDP or the GDP deflator, but on other income and price concepts. While the expenditure approach (see Table 9.3) and the income approach (see Table 9.4) to GDP calculation clearly should lead to the same results, the model setup lends itself to different uses of the two: To determine real GDP we use the expenditure approach as it is formulated in real terms. Nominal GDP, on the other hand, can be derived directly from the figures underlying the income approach, because in our model these figures are calculated in nominal terms only. This distinct use of the two approaches, therefore, arises most naturally from the model formulation. The GDP deflator then is simply derived as the ratio between the two, i.e. $P_{\text{GDP}} = Y^{\text{nom}}_{\text{GDP}}/Y_{\text{GDP}}$.

Final consumption expenditure by households
+ Final consumption expenditure by government
+ Final consumption expenditure by NPISH
+ Gross capital formation
+ Changes in valuables
+ Changes in inventories
+ Exports
- Imports
= **GDP real**

Table 9.3: GDP, expenditure approach, real

Compensation of employees
+ Taxes on production and imports less subsidies
+ Consumption of fixed capital
+ Operating surplus, net
= Value added at basic prices
+ Taxes on products less subsidies on products
= **GDP nominal**

Table 9.4: GDP, income approach, nominal

[1] More precisely *"Nichtfinanzielle Konten, Private Haushalte und Private Organisationen ohne Erwerbszweck"* (=S.14 + S.15)

Chapter 10

Iterative solution of the model

10.1 Intro

This chapter serves to describe the full estimation process underlying the AEIOU II model in mathematical terms. A verbal summary of key features of this process will facilitate the reading:

- Consumption, investment, imports, employment and prices are endogenously determined within the process
- Prices are determined via fixed markups upon unit costs (including wages)
- Depreciation rates are estimated as time trends
- A convergent iteration cycle gives quantities and prices of 60 commodities
- Exports and import prices are exogenous to the model, as are labor force forecasts
- Overall input coefficients are fixed, while imported input coefficients are time varying

Figure 10.1 might further ease comprehension of the model. The final year with a complete set of historical figures for all relevant variables is 2008. Therefore, all forecasts start in 2009. Implementation of certain alternative scenarios is postponed to later years for easier comparison with actual figures. Further information about the estimation, particularly on the values of the exogenous variables are to be found in chapter 11.

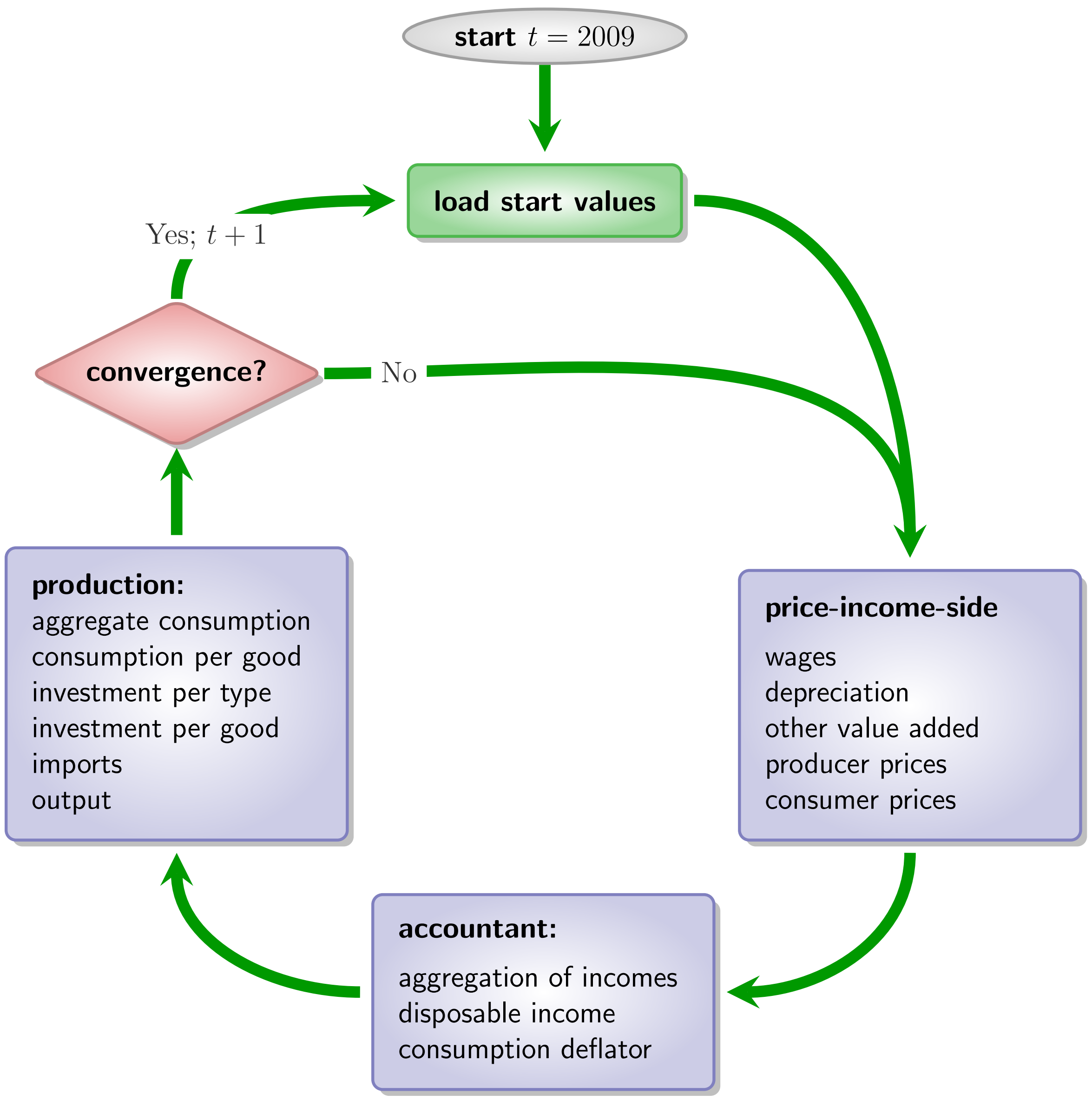

Figure 10.1: Model overview

10.2 Iterative solution of the model

Define (arbitrary) startoff values (iteration loop $s=0$) for $X_t^{(0)}$, $P_t^{(0)}$ and $\mathcal{P}_{\text{CPI}}^{(0)}$ and iterate for $s = 1, 2, \ldots$ until convergence (see below). Iteration step (s) can then be described as follows:[1]

Start loop priceside

1. $\widetilde{X} = \mathbf{D}\ X^{(s-1)}$
2. $X^{\text{nom}} = P_t^{(s-1)}\ X^{(s-1)}$
3. $\widetilde{X}^{\text{nom}} = \mathbf{D}\ X^{\text{nom}}$
4. $\widetilde{L}_{j,t} = \mathrm{f}\Big(\widetilde{X}_{j,t}, \widetilde{X}_{j,t-1}, \widetilde{X}_{\Sigma,t}, \widetilde{X}_{\Sigma,t-1}, \widetilde{W}_{j,t-1}, \widetilde{L}_{j,t-1}\Big)$ see equations (6.1) and (6.2)
5. $u_t = \mathrm{f}\Big(\sum_j \widetilde{L}_{j,t}, N, s_{wa}, u_{t-1}\Big)$ see equation (6.6)
6. $\widetilde{W}_{\Sigma t} = f\left(\mathcal{P}_{\text{CPI}}^{(s-1)}, u_t, \widetilde{L}_{\Sigma t}, \widetilde{L}_{\Sigma t-1}, \widetilde{W}_{\Sigma t-1}\right)$ see equation (6.4)
7. $\widetilde{W}_{j,t} = \mathrm{f}\Big(\mathcal{P}_{\text{CPI}}^{(s-1)}, u_t, \widetilde{L}_{j,t}, \widetilde{L}_{j,t-1}, \widetilde{W}_{j,t-1}\Big)$ see equation (6.3)
8. $\widetilde{V}_{T-Sj,t} = \tilde{v}_{T-Sj,t}\widetilde{X}_{j,t}^{\text{nom}}$ see section 7.3
9. $\widetilde{V}_{Dj,t} = \mathrm{f}\Big(\widetilde{\mathcal{I}}_{j,t}, \widetilde{V}_{Dj,t-1}, \widetilde{V}_{Dj,t-2}\Big)$ see section 7.2
10. $\widetilde{\Pi}_j = \tilde{\pi}_j \widetilde{X}_j^{\text{nom}}$ see section 7.1
11. $\mathbf{Z}_{Mij} = \sum_j m_{ij}^t Z_{ij}$ see section 5.5
12. $\mathbf{Y}_{Mik} = \sum_k m_{ik}^t Y_{ik}$ see section 5.5
13. $\widetilde{V} = \widetilde{W} + \widetilde{V}_{T-S} + \widetilde{V}_D + \widetilde{\Pi}$
14. $V = \mathbf{C}_{\text{mod}}\widetilde{V}$ see equation (7.3)

15. Update $P_t^{(s)} = (I - \mathbf{A}_D{}')^{-1} \cdot \Big((V + V_{T-S})\check{X}^{-1} + \mathbf{A}_M{}' P^*\Big)$
16. $Y_D^{\text{nom}} = \mathrm{f}(V \ldots)$ see section 9
17. $Y_D = Y_D^{\text{nom}} \Big/ \mathcal{P}_{\text{CPI}}^{(s-1)}$

Start loop productside

18. $P_{aux,t} = bP_t^{(s)} + (1-b){P^*}_t$
19. $\mathcal{P} = \mathbb{B}_{CP}^{(p)}{}' P_{aux} + \widehat{tax}\, \mathbb{B}_{CP}^{(p)}{}' P_{aux} + \widehat{sub}\, \mathbb{B}_{CP}^{(p)}{}' P_{aux}$
20. $p = \mathcal{P} \Big/ \mathcal{P}_{\text{CPI}}^{(s-1)}$
21. $\mathcal{C}_\Sigma^1 = \mathrm{f}\big(Y_{Dt}, Y_{Dt-1}, \mathcal{C}_{\Sigma t-1}^1\big)$
22. $\mathcal{C}_i^1 = \mathrm{f}\left(p_i, \dfrac{\mathcal{C}_{i,t-1}^1}{\mathcal{C}_{\Sigma t-1}^1}, \dfrac{\mathcal{C}_{i,t-2}^1}{\mathcal{C}_{\Sigma t-2}^1}\right)$
23. $C^1 = \mathbb{B}_{CP}^{(C)} \mathcal{C}^1$

[1] For improved readability, time subscripts are skipped whenever only the contemporaneous values of a variable occur in any equation. But of course, since almost all variables are time varying, they have an imaginary timesubscript attached. Iteration loop superscripts are only employed for variables which are being updated during an iteration loop. To stress, that certain items are calculated at the commodity or activitiy level, sometimes scalar rather than vector definitions were used.

24. $C^2 = \mathbb{B}^{(C)}_{CP}\mathcal{C}^2$ ($\mathcal{C}^2$ exogenous)

25. Update $\mathcal{P}^{(s)}_{\text{CPI}} = (\sum_i \mathcal{C}^1_i \mathcal{P}_i) \Big/ \sum_i \mathcal{C}^1_i$

26. $G = \mathbb{B}^{(G)}_{CP}\mathcal{G}$ ($\mathcal{G}$ exogenous)

27. ${C^5}_i = {\mathcal{C}^5}_i$ ($\mathcal{C}^5$ exogenous)

28. $C = C^1 + C^2 + G + C^5$

29. $\widetilde{\mathcal{I}} = \mathrm{f}\Big(P^{(s-1)}_t, \widetilde{X}, \widetilde{\mathcal{I}}_{t-1}, \widetilde{\mathcal{I}}_{t-2} \ldots\Big)$ see section 4

30. $I = \mathbb{B}^{(I)}_{CP}\widetilde{\mathcal{I}}$

31. E from the BTM model

32. $Y = C + I + E$

33. $M = \mathrm{f}\left(M_{t-1}, X^{(s-1)}_t, Y\right)$ see equations (5.5) – (5.9)

34. Update $X^{(s)}_t = (I - \mathbf{A})^{-1}(Y - M)$

If $|X^{(s)}_t - X^{(s-1)}_t| < \epsilon$ end loop productside

Else replace $X^{(s-1)}_t$ by $X^{(s)}_t$ and $\mathcal{P}^{(s-1)}_{\text{CPI}}$ by $\mathcal{P}^{(s)}_{\text{CPI}}$ and return to 18

If $P^{(s)}_t - P^{(s-1)}_t| < \epsilon$ and $|X^{(s)}_t - X^{(s-1)}_t| < \epsilon$ end loop priceside

Else replace $P^{(s-1)}_t$ by $P^{(s)}_t$ and return to 1

Chapter 11

The reference scenario (base case)

This chapter gives a brief overview of estimation results for our base case. In describing the three alternative scenarios below this base case will be used as reference. The exposition follows the logic of the model, starting with the demand side, continuing with employment and prices and ending with disposable income.

11.1 Exogenous variables

Some important variables in the present model are exogenous. Their future development is either forecasted by other research (like importprices and exports) or, when lacking other sources, is simply stipulated by the members of the project team (like government consumption). The list of these exogenous variables includes in particular the following ones (figures are per year percentage changes averaged over the period 2010 – 2030):

- Real exports +3.12% (estimates from the INFORUM world model; see chapter 8 and figure 11.1).
- Import prices +1.63% (INFORUM world model; see chapter 8 and figure 11.7 and table11.2)
- Exchange rate EURO/USD +1.72% (INFORUM world model, see table 11.3)
- Government consumption 1.21% (stipulated based on recent trend)
- Shares of net operating surplus in total output (per activity; stipulated by using the corresponding average over the last business cycle, see chapter 7)
- Population and laborforce forecasts (estimates from Statistics Austria; see chapter 6)
- Tax rates (see chapter 9)

All of these variables are explained in more detail in the cited chapters. In combination with the estimated behavioral relationsships these exogenous variables clearly exert major influences upon the results. This must be kept in mind when interpreting the estimation results presented in the sequel.

11.2 Final demand

Regarding final demand (see figure 11.1) we expect a yearly average increase of overall consumption by 1.21% for the period (2010–2030). This figure is an aggregate over private consumption of Austrians (1.23%), public consumption (1.21%) and consumption of tourists in Austria (1.01%). At the commodity level consumption developments display some noteworthy variability: Telecom services (64) 3.07%, Computers (72) 4.55% motor vehicles (34) -0.40%, gasoline (23) 0.54% to cite the largest deviations from the average development of consumption.

Corresponding predictions for the three major government consumption items (not shown) are: “Public administration services etc.” (75) 0.41%, “Education services” (80) 1.51% and “Health and social work services” (85) 1.85%. These add up to around 96% of total government consumption or 47 Bio Euros in 2010. But also in total consumption they constitute a large share of 23.8% in 2010.

Investment, develops more favorably than consumption rising by 1.66% per year on average. Again it should be noted, though, that the composition of investment changes considerably during the forecast period, as certain types (see the classification in chapter 4) exhibit highly varying growth rates: Other intangible assets 4.41%, other buildings and structures 1.65%, dwellings 0.82%, transport equipment NACE 62 = 3.97%, to give but a few examples. The real driving force of GDP growth turns out to be exports, which are forecast by the BTM model to rise by an average of 3.12% per year.

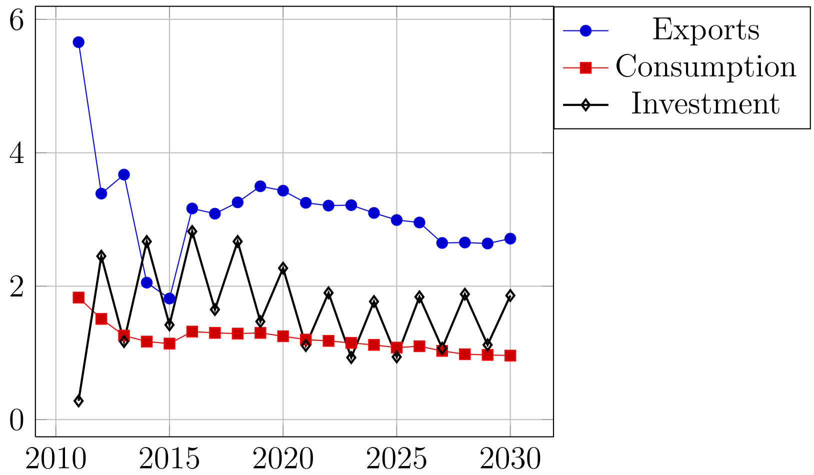

Figure 11.1: Growth of final demand components, real

11.2.0.2 Imports

Imports are predicted to grow at a rate of around 2.38% per year. Comparing this import growth figure with the average yearly increase in exports of 3.12% provides evidence of a forthcoming considerable improvement of the Austrian trade balance over the course of the next 20 years.

11.2.0.3 GDP

The particular development pattern of exports also dominates the development of GDP (see figure 11.2). We expect GDP-growth to fall continuously from the 2011 estimate of around 2.3% until 2015 when it reaches a lower turning point of 1.4%. It then recovers to reach roughly the 2011 figure again by 2020 followed by a continous but soft decline down to around 1.7% in 2030.

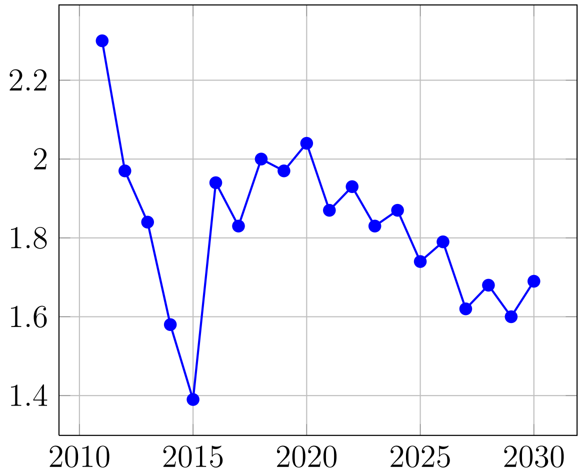

Figure 11.2: GDP growth

11.3 Employment

Employment expressed in full time equivalents (FTE's) is expected to increase from around 3.11 Mio in 2011 to around 3.46 Mio by 2030. The corresponding employment-growth estimates by and large match the those for GDP in shape, albeit the pace of growth is far smaller owing to productivity growth. Yearly growth rates for employment are expected to be 0.89% in 2011, but smaller thereafter, reaching the bottom in 2015 with 0.18%, climbing up again to around 0.7% by 2020 and then fall continuously to 0.4% by 2030. At the level of activities the main groups develops as described in table

Combining employment figures, laborforce forecasts and estimation equation 6.6 yields the expected unemployment rates depicted in figure 11.4. It starts off with an estimated 9.2% in 2010. It should be stressed that this estimate implicitly counts persons in training as unemployed, while in official statistics (whether based on the labor force concept or on the older Austrian definition) these persons are not counted as unemployed. This together with newer data (which were not available at the time of our regression estimations) accounts for the difference between this figure and the published figure of 6.9% unemployment by the standard Austrian definition (see section 6.2).

Statistics Austria forecasts the change of the labor force between 2010 and 2030 to be practically zero, starting with a yearly growth rate of around 0.64% in 2011 followed by a continuous decline reaching -0.20% by 2021 and remaing there more or less until 2030. Thus, even the modest increases in employment stated above would suffice to lower the unemployment rate after 2015 continously from 9.4% down to 5.75% in 2030. Clearly, this depends much upon the validity of Statistics Austria's assumptions regarding labor

NACE	Activity	2010	2030	Δ% pa
45	Construction work	230.395	213.390	-0,38
51	Wholesale and comm. trade serv.	177.685	197.046	0,52
52	Retail trade serv.	252.196	300.383	0,88
55	Hotel and restaurant services	184.447	232.609	1,17
60	Land transport	112.739	129.558	0,70
74	Other business services	215.888	327.176	2,10
75	Public administration services	250.115	230.954	-0,40
80	Education services	220.213	260.721	0,85
85	Health and social work services	306.745	352.978	0,70

Table 11.1: Employment by major activities

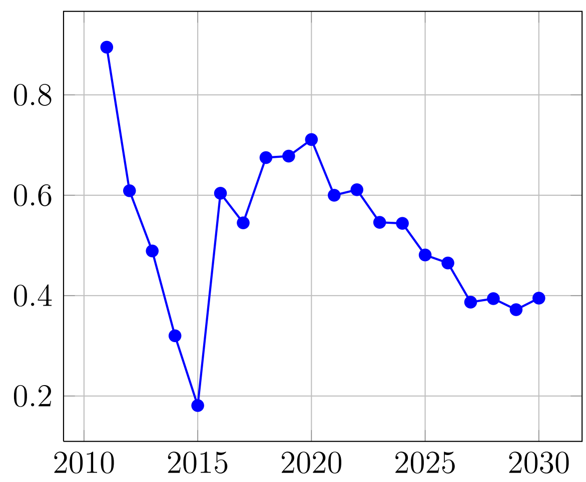

Figure 11.3: Employment growth (yearly, percentages)

market participation rates and immigration policy. Given this qualification, one should, therefore, refrain from overinterpreting the unemployment figures given here. We prefer to use them only in comparing scenarios rather than taking them at face value.

11.4 Value added

Wages and profits develop as displayed in Figure 11.5.[1] Following the tendency of the last three decades, profits continue to grow consistently faster than wages. So the wage share in GDP falls from 49.1% in 2010 to 46.7% in 2030. As mirror image of this we expect an

[1] Note that wages and profits in Figure 11.5 are measured in real terms, based on the GDP Deflator with prices of 2010 set equal 1. The GDP figures in Figure 11.2 instead are given for prices in 2005 equal to 1. Therefore, these two Figures can not be compared directly.

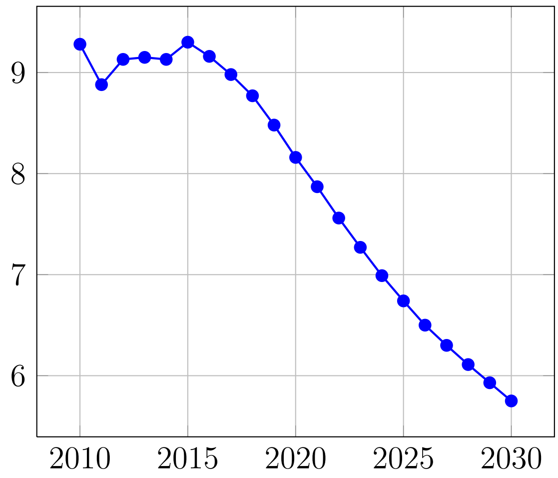

Figure 11.4: Unemployment rate (Austrian definition plus persons "in training")

increase in the share of the net operating surplus in GDP from 25.4% in 2010 to 29.3% in 2030. If this would affect the distribution of disposable personal income by increasing inequality, it might have an impact on the overall marginal propensity to consume. But the latter in our model is not depending on the income distribution. So our estimates of consumption demand might turn out to be too optimistic compared to estimation based on a more elaborate demand system.

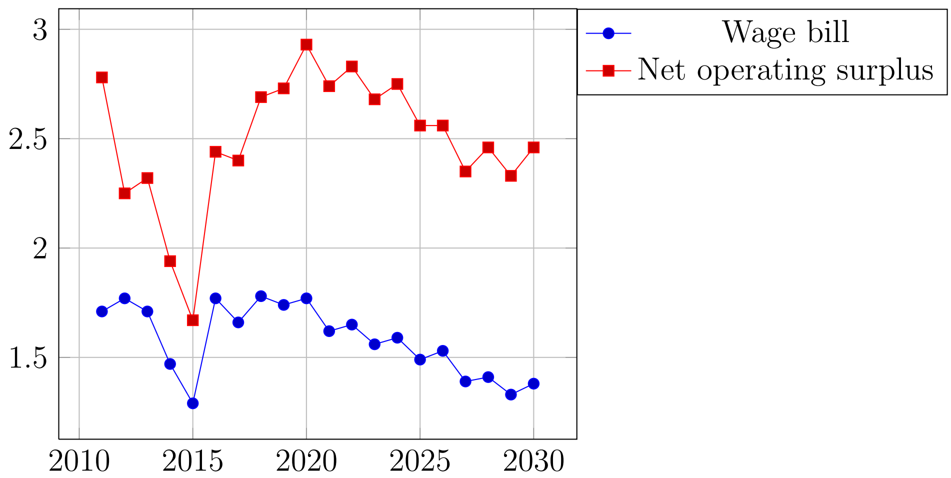

Figure 11.5: Growth rates of value added components (percentages)

The development of labor productivity along with wages per employee and GDP per employee is depicted in Figure 11.6.[2] All are evaluated at full time equivalents (FTE's). As labor productivity in our model is mainly determined by output growth (see chapter 6) it is not surprising to find the development pattern of labor productivity following that of output growth. Over the forecast horizon we expect labor productivity to rise by an average of 1.38% per year.

[2]The figures are calculated from real gross output, real GDP and real wage sum (using GDP-deflator 2005=1), all at prices of 2005. The employment figures are the ones from Figure 11.3.

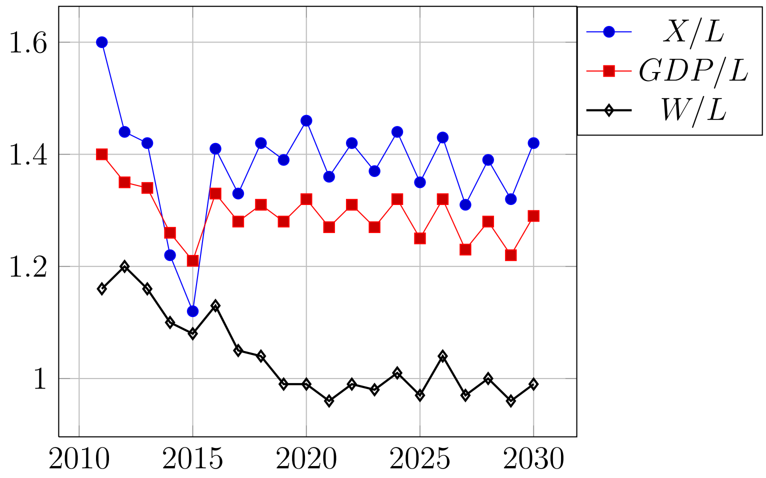

Figure 11.6: Labor productivity (X/L, GDP/L) and real wage rates (W/L)

11.5 Prices

Prices are endogenous in the present model, mainly driven by productivity estimates and a markup-procedure for profits. As can be seen from figure 11.7), domestic producer prices are expected to rise on average by 1.24% over the next 20 years. Compared to that, import prices, which are forecasts of export prices from the perspective of the INFORUM world model, initially grow modestly slower than domestic prices but rise significantly faster after 2016, averaging at 1.63% for the full period 2010-2030. Given the large share of imports in consumption we consequently find CPI growth to exceed producer price growth. More specifically, the CPI (as usual constructed by aggregating goods-specific consumer prices weighted by consumption shares) is estimated to rise by 1.45% per year on average.

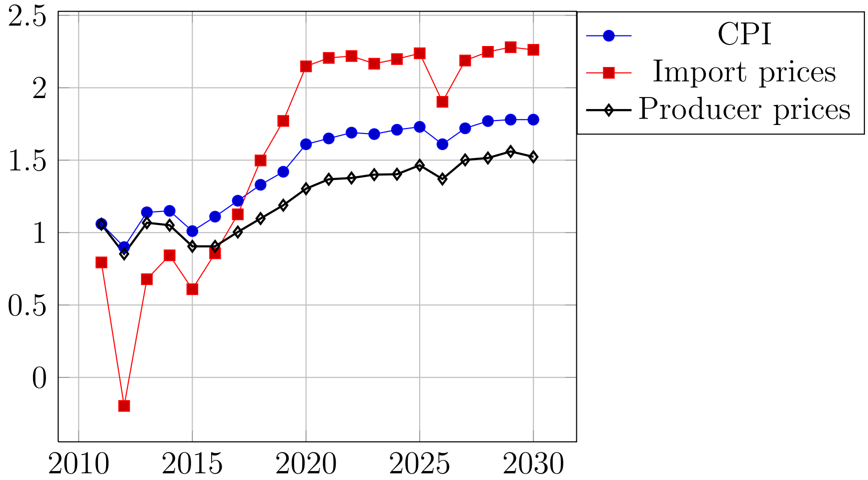

Figure 11.7: Inflation rates in %

11.6 Disposable income

The yearly average increase in real personal disposable income by 1.26% does not keep pace with the increase in GDP of 1.82%. This difference is the result from a less pronounced rise of the GDP deflator (0.94%) compared to that of the CPI, which increases by 1.45% per year on average (see figure 11.7).

The compound impact over the 20 years forecast horizon of the difference between 1.21% yearly increase in consumption and the 1.26% yearly increase in real personal disposable income is a slight increase in the savings rate from 15.2% in 2010 to 15.8% in 2030.

CPA	Commodity	Δ% pa	CPA	Commodity	Δ% pa
01	Products of agriculture, hunting	0.65	40.2	Gas, Steam and hot water	2.18
02	Products of forestry, logging	2.09	41	Water, distribution services of water	2.08
05	Fish, other fishing products	1.35	45	Construction work	2.14
10	Coal and lignite, peat	0.67	50	Trade and repair services of motor vehicles etc.	2.24
11	Crude petroleum, natural gas, metal ores (1)	3.48	51	Wholesale and comm. trade serv., ex. of motor vehicles	2.08
14	Other mining and quarrying products	1.08	52	Retail trade serv., repair serv., exept of motor vehicles	1.39
15	Food products and beverages	1.70	55	Hotel and restaurant services	2.31
16	Tobacco products	3.57	60	Land transport and transport via pipeline services	2.08
17	Textiles	1.23	61	Water transport services	1.39
18	Wearing apparel, furs	-0.54	62	Air transport services	2.37
19	Leather and leather products	1.22	63	Supporting transport services, travel agency services	1.88
20	Wood and products of wood	-1.12	64	Post and telecommunication services	-0.12
21	Pulp, paper and paper products	0.92	65	Financial intermediation services	0.18
22	Printed matter and recorded media	1.59	66	Insurance and pension funding services	-0.42
23	Coke, refined petroleum products	3.11	67	Services auxiliary to financial intermediation	0.61
24	Chemicals, chemical products	1.73	70AM	Real estate services, market	2.22
25	Rubber and plastic products	1.34	70AI	Imputed rental services	2.26
26	Other non-metallic mineral products	1.48	70B	Other real estate services	2.25
27	Basic metals	2.33	71	Renting services of machinery and equipment	0.46
28	Fabricated metal products	1.50	72	Computer and related services	0.40
29	Machinery and equipment n.e.c.	1.72	73	Research and development services	1.52
30	Office machinery and computers	1.00	74	Other business services	2.07
31	Electrical machinery and apparatus	0.71	75	Public administration services etc.	1.15
32	Radio, TV and communication equipment	1.55	80	Education services	1.46
33	Med., precision, opt. instruments, watches, clocks	1.42	85	Health and social work services	0.74
42 34	Motor vehicles, trailers and semi-trailers	1.43	90	Sewage and refuse disposal services etc.	2.81
35	Other transport equipment	0.23	91	Membership organisation services n.e.c.	1.82
36	Furniture, other manufactured goods n.e.c.	1.08	92	Recreational, cultural and sporting services	0.60
37	Recovered secondary raw materials	2.60	93	Other services	2.14
40.1	Electricity	2.55	95	Private households with employed persons	2.27

Table 11.2: Import price growth 2010 – 2030, yearly averages

year	rate
2010	0.76
2011	0.73
2012	0.69
2013	0.65
2014	0.62
2015	0.60
2016	0.58
2017	0.57
2018	0.56
2019	0.55
2020	0.55
2021	0.55
2022	0.55
2023	0.54
2024	0.54
2025	0.54
2026	0.54
2027	0.54
2028	0.54
2029	0.54
2030	0.54

Table 11.3: Exchange rate EURO/USD. Source: INFORUM forecast

Chapter 12

Scenario A: Increased tourism expenditures in Austria

12.1 Introduction

In line with an old and well established tradition expenditures of foreign tourists are shown as a separate category of final demand in the model. This isolation of non-resident private households permits to treat their consumer expenditure different from the expenditure of resident (Austrian) households.

In AEIOU II foreign tourists' expenditure are treated exogenously. As in the case of other exogenous variables in final demand the base case (see chapter 11) relies on the assumption that the future development will correspond to the average development in real terms in the recent past.

In the study of **?** published by the Austrian Institute for Economic Research it is argued that under certain conditions there is a good chance that foreign tourists' expenditure might grow faster than in the recent past. Two scenarios are presented which are based on annual growth rates of 1,7% and 3% for the period 2009 to 2015.

The findings and considerations included in this study were taken as a starting point for carrying out two simulation exercises with the help of AEIOU II. Both simulations are devoted to the quantification of the implications of such an additional growth on the Austrian economy as a whole and on the various industries and products.

The simulations are of analytical nature and are inter alia meant to demonstrate the potential of a dynamic multisectoral model which does not only take the various interdependencies between the production processes into account but which also pays due attention to the domestic income effect (and its impact on consumption expenditures) and the effects of changes in output levels on investment because of a change of foreign demand. The implications on prices and relative prices (and their feedback to the real side) are also simulated simultaneously. In order to show the implication more clearly the time horizon of the exercise was extended to 2030.

Because of their analytical orientation the simulations do not aim at providing what might be called a "plausible picture" of future development. The accent is laid on the identification of the differences between the alternatives relative to the base case. These deviations are considered much more interesting than the outcomes of the simulations themselves.

The two alternatives presented here differ – compared to the base case – only with respect to the assumptions on expenditures of foreign tourists in Austria and with respect the input structure of industry NACE 55 "Hotels and restaurants".

All the other exogenous assumptions and relationships are the same in all three alternatives (base case, Alternative A and Alternative B) .

12.2 Base case

12.2.1 Assumptions

As already mentioned foreign tourists' expenditure are treated exogenously. The base case relies on the hypothesis that the future development will correspond to the average development in real terms over the last 10 to 13 years, taking the pronounced commodity specific differences in growth into account. In addition it was assumed that unusually high growth rates observed in this period will level out to a growth rate of 2% in the medium term. Such a levelling-out effect was in particular introduced for the commodity groups

05 Fish, other fishing products[1]
21 Pulp, paper and paper products
62 Air transport services
63 Supporting transport services, travel agency services
64 Post and telecommunication services
80 Education services
85 Health and social work services

It deserves mentioning that for CPA commodity group 55 "Hotel and restaurant services" – the commodity group with the highest share in total foreign tourists' expenditure – no growth or decline was assumed for the entire simulation period up to 2030.

The consumption of gasoline and diesel by non-residents is to a high degree dependent on the differences in prices between neighbouring countries. In the past strong upward and downward movements were observed. The scenario relies on the assumption that the price relations between Austria, Germany and Italy remain more or less stable at the present level. The underlying hypothesis for the period up to 2030 is a very moderate growth.

For a detailed description of the base case see chapter 11.

12.3 Alternative A – Higher Growth

For the purpose of the present simulations the results of the base case, presented in chapter 11, serve as a reference solution of the model.

[1]The numbers correspond to CPA classification.

12.3.1 Assumptions

This alternative scenario takes the base scenario of **?** as a starting point. This scenario assumes an annual growth of foreign tourists' expenditures of 1,7% in real terms for the period 2009 to 2015. As is argued in this paper this somewhat higher growth than in the recent past should be possible if Austria could at least keep the market shares in major source countries of tourists in Austria constant. More precisely: on the level observed in 2009. This growth rate can still be considered rather moderate, given that most tourists in Austria come from Germany, the Netherlands, Switzerland and Italy, countries with below average growth rates in tourism expenditures of households.[2]

For the purpose of the present simulation a few small modifications in the exogenous estimate of foreign tourists' expenditure were made. In particular we assumed slightly higher growth of expenditures than in the base case for:

60 Land transport and transport via pipeline services
62 Air transport services
63 Supporting transport services, travel agency services
64 Post and telecommunication services
85 Health and social work services
92 Recreational, cultural and sporting services

These modifications were introduced to pay more attention to the trend towards more short term visits and towards trips because of health and wellness considerations and because of cultural events.[3]

The small increase in expenditure for services of hotels and restaurants (+1% per annum in contrast to the zero growth in the base case) is almost sufficient to arrive at the growth rate of the base case of the Smeral study.

Very high commodity specific growth rates observed in the past were only accepted for the period up to 2015, the end year of the Smeral study. For the period 2016 to 2030 the standard levelling-out procedure was applied (=linear decline of the growth rate from the +3% in 2015 to 2% in 2030; recall that 2% growth is the standardt assumption in the base scenario)

The additional growth compared to the base case is associated with a higher utilization of existing capacities, primarily in hotels and restaurants and an increase in quality of services. These two tendencies had to be translated into changes in the input structure of industry NACE 55 "Hotels and restaurants".

The tendency towards higher quality is reflected in small increases in the technical coefficients for the following commodity groups:

17 Textiles
26 Other non-metallic mineral products
36 Furniture, other manufactured goods n.e.c.
45 Construction work
64 Post and telecommunication services
72 Computer and related services
85 Health and social work services

[2] For details see **?**, chapter 4.2

[3] For details see **?**, chapter 5.2.2.4

92 Recreational, cultural and sporting services
93 Other services

The need to make more use of information and communication technology was also taken into account.[4]

Some of the inputs are relatively independent of the level of the output of industry NACE 55 "Hotels and restaurants". Consequently better capacity utilization will lead to a decrease in the relevant input coefficients. Such a development was in particular assumed for:

70AM Real estate services - market
74 Other business services
91 Membership organisation services n.e.c.

Also, due to better capacity utilization it was assumed that the share of operating surplus will rise; in the case of labor compensation it was supposed that the effect of better capacity utilization and the trend towards better qualified staff will cancel out.

12.3.2 Results

Table 12.1 shows the main macro results as percentage deviations of Alternative A from the base case. The entries for 2008 (shown for control purposes), the last year with observed values, therefore need to be zero.

When interpreting the results in Table 12.1 it should be kept in mind that the orders of magnitude of the absolute numbers behind the differences in % are quite different. In 2008 *Private Consumption Expenditure, Foreigners in Austria* (Tourism) was less than 10% of *Private Consumption Expenditure, Austrians in Austria*, just to give one example.

	2015	2030
PCE, Austrians in Austria	0.23	0.86
PCE, Foreigners in Austria (Tourism)	4.30	12.67
Final consumption expenditure by government	0.00	0.00
Final consumption expenditure by NPISH	0.00	0.00
Gross fixed capital formation	0.15	0.71
Exports (excl. Tourism)	0.00	0.00
Imports (excl. Tourism)	0.11	0.37
GDP	0.29	0.84
Employees (in full time equivalent)	0.21	0.56

Table 12.1: Alternative A. Macro variables in 2005 constant prices. Deviations from base case in % (PCE= Private Consumption Expenditures)

No differences can be seen for the results for *Final consumption expenditure by government*, *Final consumption expenditure by NPISH* and *Exports* (excl. Tourism). According to the scenario design the hypotheses for these sets of exogenous variables are identical in all three scenarios.

The differences with respect to *Private consumption expenditure, Foreigners in Austria*

[4]See **?**, chapter 5.2.3.2

(Tourism) are the direct result of the assumptions made.

Compared to the results of the base case private consumption of Austrian households is stimulated for all commodity groups distinguished. In cases in which consumption in real terms is going down in the base case this trend is less marked than in alternative A.

The effects on domestic prices are very moderate for all commodity groups, the impact on relative prices (vis a vis import prices) therefore is also low.

Employment is stimulated in all industries, although to a very different extent. In total, higher growth according to alternative A would create more than 19000 additional jobs (in full term equivalents), about 8000 of them in industry NACE 55 "Hotels and restaurants".

Additional growth in a final demand category with a very specific composition by products necessarily leads to structural change in the economy. The direct effects stemming from additional tourists expenditure on commodities such as 37/ 55 *Hotel and restaurant services* and all the transport services are amended by all the indirect effects via the production chain, induced by additional disposable income, by changes in prices, by additional capital formation, higher imports, etc.

A small part of this structural change induced by higher expenditures of foreign tourists is illustrated in Table 12.2 which is devoted to the effect on output by products. The range of differences in 2030 is quite remarkable.

As can be seen from Table 12.2 a number of product groups which have no direct link to foreign tourists' expenditure are affected considerably. Examples for such product groups are among others:

27 Basic metals
37 Recovered secondary raw materials
73 Research and development services

Table 12.2

	2015	2030
01 Products of agriculture, hunting	0.34	0.92
02 Products of forestry, logging	0.22	0.38
05 Fish, other fishing products	0.48	1.58
10 Coal and lignite, peat	0.00	0.00
11 Crude petroleum, natural gas, metal ores (1)	0.00	0.00
14 Other mining and quarrying products	0.22	0.64
15 Food products and beverages	0.35	0.97
16 Tobacco products	-0.05	-0.41
17 Textiles	0.20	0.40
18 Wearing apparel, furs	0.20	0.50
19 Leather and leather products	0.19	-0.07
20 Wood and products of wood	0.16	0.33
21 Pulp, paper and paper products	0.07	0.16
22 Printed matter and recorded media	0.05	0.31
23 Coke, refined petroleum products	0.25	0.70
24 Chemicals, chemical products	0.04	0.07
25 Rubber and plastic products	0.08	0.20
26 Other non-metallic mineral products	0.20	0.55
27 Basic metals	0.02	0.07
28 Fabricated metal products	0.08	0.25

Continued on next page

Table 12.2 – continued from previous page

	2015	2030
29 Machinery and equipment n.e.c.	0.03	0.09
30 Office machinery and computers	0.02	0.22
31 Electrical machinery and apparatus	0.06	0.18
32 Radio, TV and communication equipment	0.08	0.20
33 Med., precision, opt. instruments, watches, clocks	0.02	0.12
34 Motor vehicles, trailers and semi-trailers	0.04	0.19
35 Other transport equipment	0.10	0.21
36 Furniture, other manufactured goods n.e.c.	0.13	0.40
37 Recovered secondary raw materials	0.05	0.15
40.1 Electricity	0.25	0.64
40.2 Gas, Steam and hot water	0.16	0.57
41 Water, distribution services of water	0.30	0.80
45 Construction work	0.29	0.97
50 Trade and repair services of motor vehicles etc.	0.07	0.63
51 Wholesale and comm. trade serv., ex. of motor vehicles	0.12	0.38
52 Retail trade serv., repair serv., exept of motor vehicles	0.18	0.74
55 Hotel and restaurant services	1.89	5.11
60 Land transport and transport via pipeline services	0.39	0.85
61 Water transport services	0.21	0.61
62 Air transport services	1.40	3.06
63 Supporting transport services, travel agency services	0.31	0.91
64 Post and telecommunication services	0.31	1.13
65 Financial intermediation services	0.16	0.44
66 Insurance and pension funding services	0.11	0.63
67 Services auxiliary to financial intermediation	0.12	0.54
70AM Real estate services, market	-0.11	-0.13
70AI Imputed rental services	0.65	1.47
70B Other real estate services	0.00	0.17
71 Renting services of machinery and equipment	0.18	0.61
72 Computer and related services	0.06	0.34
73 Research and development services	0.02	0.07
74 Other business services	0.01	0.15
75 Public administration services etc.	0.00	0.01
80 Education services	0.02	0.07
85 Health and social work services	0.04	0.18
90 Sewage and refuse disposal services etc.	0.23	0.65
91 Membership organisation services n.e.c.	0.00	0.01
92 Recreational, cultural and sporting services	0.61	1.82
93 Other services	0.43	1.38
95 Private households with employed persons	0.25	0.79

Table 12.2: Alternative A: Output by commodities in 2005 constant prices. Differences relative to the base case in %

12.4 Alternative B – Higher Growth

12.4.1 Assumptions

Alternative B is based on the high growth scenario (scenario 2) presented by **?**. An annual growth of 3% in real terms might be realized if Austria could become more attractive for tourists coming from countries with booming tourism expenditures of their residents. In this context countries like the new EU member countries, Brazil, China, Russia and India might play a much bigger role than in the past. In order to motivate more tourists from these countries to spend some time in Austria will however require a considerable reorientation of the Austrian tourism policy. There is a need for increasing the quality of tourism related services and the supply of new services.[5]

For Alternative B the exogenous foreign tourists' expenditures had to be changed considerably. The starting points were again the commodity specific developments in real terms over the last 10 to 13 years. Most of the estimates of the base case Scenario had to be increased in order to arrive at the 3% growth of the Smeral study. As in the case of Alternative A even higher growth of expenditures was assumed for:

60 Land transport and transport via pipeline services
62 Air transport services
63 Supporting transport services, travel agency services
64 Post and telecommunication services
85 Health and social work services
92 Recreational, cultural and sporting services

These modifications were again introduced to reflect the trend towards more short term visits and towards health and wellness motivated trips and because of cultural events into account.

The increase in nights spent in Austria (+2% per annum) according to the Smeral study was augmented by a quality factor.

Also in analogy to Alternative A very high commodity specific growth rates were only accepted for the period up to 2015. For the period 2016 to 2030 the standard levelling-out procedure was applied (see above). The average growth rates for the entire period 2008 to 2030 are therefore the result of very high growth and strong structural change in the period up to 2015 and lower growth and reduced structural change for the rest of the period.

The marked additional growth compared to the base case is associated with a higher utilization of existing capacities, primarily in hotels and restaurants and an increase in quality of the services. These two tendencies again had to be translated into changes in the input structure of industry NACE 55 *Hotels and restaurants*.

A move towards higher quality is seen as one of the conditions on which the high growth scenario of the Smeral study rests. The changes introduced in the input structure of industry NACE 55 were much more pronounced than in the case of Alternative A but they refer to the same commodity groups as mentioned above.

In the Smeral study a higher qualification of the employees in tourism is seen as one of

[5] See in particular**?**, p. 48

the necessary conditions for a better performance. Therefore it was assumed that the share of staff with a higher qualification will rise. This tendency will increase the wages and salaries per head independent of all other factors governing the development of labor income. As described in chapter 6 labor income is an endogenous variable in AEIOU II. In order to cover the effect of additional qualification an exogenous addition on top of the labor income derived from the model was introduced.

12.4.2 Results

The structure of Table 12.3 is identical to the one of Table 12.1 and the entries can be interpreted in an analogous way. The table again displays the main macro results as perecentage deviations from the corresponding base case figures.

	2015	2030
PCE, Austrians in Austria	0.69	2.53
PCE, Foreigners in Austria (Tourism)	13.96	40.52
Final consumption expenditure by government	0.00	0.00
Final consumption expenditure by NPISH	0.00	0.00
Gross fixed capital formation	0.56	2.31
Exports (excl. Tourism)	0.00	0.00
Imports (excl. Tourism)	0.43	1.32
GDP	0.88	2.53
Employees (in full time equivalent)	0.65	1.62

Table 12.3: Alternative B: Macro variables in 2005 constant prices. Differences relative to the base case in %. (PCE=Private consumption expenditures)

It is worthwhile mentioning that the much higher annual growth rate assumed in Alternative B leads to a level of *Private consumption expenditure of foreigners in Austria* which is 40% higher than in the base case in 2030.

This considerable (positive) stimulus affects the endogenous *Private consumption expenditure of Austrians in Austria*, *Gross fixed capital formation* and *Imports* in a significant way. In 2030 GDP at 2005 prices would be 2.5% higher compared to the base case.

Compared to the results of the base case private consumption is again stimulated for all commodity groups distinguished. The differences with respect to the base case are considerably bigger than in the case of Alternative A.

The effects on domestic prices are higher than in Alternative A but still quite limited for all commodity groups. As a consequence the impacts on relative prices and on the competitive position of Austria in the world market are low.

Employment is stimulated in all industries, although again to a very different extent. In a number of branches the additional demand is to some extent compensated by a higher labor productivity than in the base case. In total a higher growth according Alternative B would create more than 55000 additional jobs (in full term equivalents) in 2030.

The higher level of activities in all branches would be associated with higher compensation of employees in all industries. This additional increase in wages and salaries in all industries is in the order of magnitude of 1% to 3%.

As expected the effect of higher expenditures of foreign tourists on the structure of domestic production is more pronounced than in the case of Alternative A. Table 12.4 shows the deviations from the base case for Alternative B.

Table 12.4

	2015	2030
01 Products of agriculture, hunting	1.29	3.38
02 Products of forestry, logging	0.57	0.95
05 Fish, other fishing products	1.62	5.09
10 Coal and lignite, peat	0.00	0.00
11 Crude petroleum, natural gas, metal ores (1)	0.00	0.00
14 Other mining and quarrying products	0.62	1.82
15 Food products and beverages	1.28	3.50
16 Tobacco products	0.08	-0.41
17 Textiles	0.49	1.07
18 Wearing apparel, furs	0.50	1.39
19 Leather and leather products	0.31	-1.16
20 Wood and products of wood	0.46	0.97
21 Pulp, paper and paper products	0.28	0.58
22 Printed matter and recorded media	0.47	1.55
23 Coke, refined petroleum products	0.88	2.29
24 Chemicals, chemical products	0.14	0.23
25 Rubber and plastic products	0.27	0.65
26 Other non-metallic mineral products	0.58	1.60
27 Basic metals	0.07	0.23
28 Fabricated metal products	0.25	0.81
29 Machinery and equipment n.e.c.	0.12	0.33
30 Office machinery and computers	0.20	0.95
31 Electrical machinery and apparatus	0.21	0.61
32 Radio, TV and communication equipment	0.29	0.67
33 Med., precision, opt. instruments, watches, clocks	0.12	0.46
34 Motor vehicles, trailers and semi-trailers	0.23	0.73
35 Other transport equipment	0.29	0.57
36 Furniture, other manufactured goods n.e.c.	0.44	1.29
37 Recovered secondary raw materials	0.16	0.47
40.1 Electricity	0.76	1.96
40.2 Gas, Steam and hot water	0.62	1.96
41 Water, distribution services of water	0.86	2.42
45 Construction work	0.85	2.83
50 Trade and repair services of motor vehicles etc.	0.89	2.99
51 Wholesale and comm. trade serv., ex. of motor vehicles	0.44	1.27
52 Retail trade serv., repair serv., exept of motor vehicles	0.70	2.53
55 Hotel and restaurant services	5.03	13.14
60 Land transport and transport via pipeline services	1.49	3.21
61 Water transport services	1.16	2.68
62 Air transport services	3.91	8.03
63 Supporting transport services, travel agency services	1.11	2.92
64 Post and telecommunication services	1.40	3.96
65 Financial intermediation services	0.51	1.40
66 Insurance and pension funding services	0.63	2.20
67 Services auxiliary to financial intermediation	0.56	1.84

Continued on next page

Table 12.4 – continued from previous page

	2015	2030
70AM Real estate services, market	0.23	0.90
70AI Imputed rental services	1.00	2.68
70B Other real estate services	0.39	1.35
71 Renting services of machinery and equipment	0.80	2.22
72 Computer and related services	0.27	1.19
73 Research and development services	0.10	0.24
74 Other business services	0.33	1.05
75 Public administration services etc.	0.01	0.02
80 Education services	0.07	0.25
85 Health and social work services	0.15	0.58
90 Sewage and refuse disposal services etc.	0.71	2.02
91 Membership organisation services n.e.c.	0.05	0.18
92 Recreational, cultural and sporting services	2.75	7.42
93 Other services	2.05	6.14
95 Private households with employed persons	0.68	2.30

Table 12.4: Output according to alternative B relative to base case in %

12.5 Overview of results

The following tables offer some comparisons of results expressed in average annual growth rates over the forecast horizon.

	Base	Alt A	Alt B
PCE, Austrians in Austria	1.14	1.18	1.26
PCE, Foreigners in Austria (Tourism)	1.01	1.55	2.58
Final consumption expenditure by government	1.21	1.21	1.21
Final consumption expenditure by NPISH	0.87	0.87	0.87
Gross fixed capital formation	1.45	1.48	1.56
Exports (excl. Tourism)	2.71	2.71	2.71
Imports (excl. Tourism)	2.13	2.14	2.19
GDP	1.65	1.69	1.77
Employees (in full time equivalent)	0.37	0.40	0.45

Table 12.5: Macro variables. Average annual growth rates at constant prices 2005. PCE=Private consumption expenditure

At a first glance one might conclude that the differences presented in Table 12.5 are not very big. Because all the growth rates refer to a quite long period, the differences are however by no means negligible as shown in Tables 12.1 and 12.3.

The growth rates are much more dissimilar if the analysis is done on the level of industries and product groups rather than the macro level. The following tables provide some insight into the various effects.

The results displayed in Tables 12.6 are of completely indirect nature. The differences in *Private consumption expenditure, Austrians in Austria* result from the changes in real disposable income of Austrian households and the differences in relative prices. Because the income elasticities and the price elasticities differ by products the outcome of the two alternatives is quite distinct from the base case.

The differences in import demand as shown in Table 12.8 result from the differences in the activity levels of industries and thus from different needs for imported intermediate inputs. Import demand is also stimulated by imports for final demand. Additional investment in vehicles for example will induce additional imports; additional private consumption will stimulate the demand also for products which are not produced domestically. The breakdown shown in Table 12.8 is by types of commodities not by receiving industries.

Table 12.6

	base	Alt A	Alt B
01 Products of agriculture, hunting	0.07	0.11	0.23
02 Products of forestry, logging	0.81	0.83	0.86
05 Fish, other fishing products	1.56	1.64	1.80
10 Coal and lignite, peat	0.00	0.00	0.00
11 Crude petroleum, natural gas, metal ores (1)	0.00	0.00	0.00
14 Other mining and quarrying products	0.91	0.94	0.99
15 Food products and beverages	1.16	1.21	1.33
16 Tobacco products	-11.84	-11.86	-11.86
17 Textiles	1.44	1.46	1.49
18 Wearing apparel, furs	-2.88	-2.86	-2.82
19 Leather and leather products	-2.48	-2.49	-2.53
20 Wood and products of wood	2.29	2.31	2.34
21 Pulp, paper and paper products	1.97	1.98	2.00
22 Printed matter and recorded media	1.15	1.16	1.22
23 Coke, refined petroleum products	-0.20	-0.17	-0.10
24 Chemicals, chemical products	1.95	1.96	1.96
25 Rubber and plastic products	1.82	1.83	1.85
26 Other non-metallic mineral products	1.78	1.80	1.85
27 Basic metals	0.96	0.97	0.98
28 Fabricated metal products	1.35	1.36	1.39
29 Machinery and equipment n.e.c.	1.33	1.34	1.35
30 Office machinery and computers	3.27	3.28	3.32
31 Electrical machinery and apparatus	1.34	1.34	1.36
32 Radio, TV and communication equipment	2.82	2.83	2.85
33 Med., precision, opt. instruments, watches, clocks	1.50	1.50	1.52
34 Motor vehicles, trailers and semi-trailers	1.36	1.37	1.40
35 Other transport equipment	2.55	2.56	2.57
36 Furniture, other manufactured goods n.e.c.	1.30	1.31	1.36
37 Recovered secondary raw materials	0.01	0.02	0.03
40.1 Electricity	1.05	1.08	1.14
40.2 Gas, Steam and hot water	0.37	0.39	0.46
41 Water, distribution services of water	2.19	2.23	2.30
45 Construction work	1.21	1.26	1.34
50 Trade and repair services of motor vehicles etc.	1.88	1.91	2.02
51 Wholesale and comm. trade serv., ex. of motor vehicles	2.08	2.09	2.14
52 Retail trade serv., repair serv., exept of motor vehicles	1.05	1.08	1.17
55 Hotel and restaurant services	1.33	1.57	1.98

Continued on next page

Table 12.6 – continued from previous page

	base	Alt A	Alt B
60 Land transport and transport via pipeline services	2.53	2.57	2.69
61 Water transport services	1.68	1.70	1.80
62 Air transport services	2.91	3.05	3.30
63 Supporting transport services, travel agency services	1.96	2.00	2.09
64 Post and telecommunication services	2.69	2.75	2.88
65 Financial intermediation services	2.29	2.32	2.36
66 Insurance and pension funding services	3.21	3.24	3.31
67 Services auxiliary to financial intermediation	0.93	0.96	1.02
70AM Real estate services, market	1.55	1.54	1.59
70AI Other real estate services	1.50	1.57	1.62
70B Imputed rental services	1.61	1.62	1.68
71 Renting services of machinery and equipment	1.40	1.43	1.51
72 Computer and related services	4.25	4.27	4.31
73 Research and development services	3.82	3.82	3.83
74 Other business services	2.17	2.18	2.22
75 Public administration services etc.	0.47	0.47	0.47
80 Education services	1.49	1.49	1.50
85 Health and social work services	1.70	1.71	1.73
90 Sewage and refuse disposal services etc.	2.30	2.33	2.40
91 Membership organisation services n.e.c.	0.82	0.82	0.83
92 Recreational, cultural and sporting services	1.35	1.43	1.70
93 Other services	1.32	1.39	1.62
95 Private households with employed persons	0.68	0.72	0.79

Table 12.6: Output by commodities. Average annual growth rates at constant prices in %.

Table 12.7

	base	Alt A	Alt B
01 Products of agriculture, hunting	1.17	1.20	1.29
02 Products of forestry, logging	-0.34	-0.31	-0.24
05 Fish, other fishing products	-0.23	-0.22	-0.14
10 Coal and lignite, peat	-0.80	-0.79	-0.70
11 Crude petroleum, natural gas, metal ores (1)			
14 Other mining and quarrying products	0.70	0.74	0.81
15 Food products and beverages	0.92	0.96	1.03
16 Tobacco products	-1.55	-1.55	-1.55
17 Textiles	0.92	0.96	1.03
18 Wearing apparel, furs	1.05	1.09	1.16
19 Leather and leather products	1.24	1.27	1.35
20 Wood and products of wood	1.18	1.22	1.29
21 Pulp, paper and paper products	1.32	1.35	1.42
22 Printed matter and recorded media	1.52	1.52	1.63
23 Coke, refined petroleum products	0.50	0.53	0.61
24 Chemicals, chemical products	1.01	1.04	1.12
25 Rubber and plastic products	1.28	1.31	1.39

Continued on next page

Table 12.7 – continued from previous page

	base	Alt A	Alt B
26 Other non-metallic mineral products	0.93	0.97	1.04
27 Basic metals	0.11	0.14	0.22
28 Fabricated metal products	1.16	1.19	1.27
29 Machinery and equipment n.e.c.	0.62	0.65	0.73
30 Office machinery and computers	-1.35	-1.32	-1.24
31 Electrical machinery and apparatus	1.33	1.37	1.44
32 Radio, TV and communication equipment	-0.36	-0.33	-0.25
33 Med., precision, opt. instruments, watches, clocks	1.00	1.04	1.11
34 Motor vehicles, trailers and semi-trailers	-0.54	-0.51	-0.44
35 Other transport equipment	0.62	0.65	0.73
36 Furniture, other manufactured goods n.e.c.	1.06	1.10	1.17
37 Recovered secondary raw materials			
40.1 Electricity	0.96	1.00	1.08
40.2 Gas, Steam and hot water	-0.08	-0.05	0.04
41 Water, distribution services of water			
45 Construction work	1.79	1.88	2.03
50 Trade and repair services of motor vehicles etc.	1.79	1.81	1.92
51 Wholesale and comm. trade serv., ex. of motor vehicles			
52 Retail trade serv., repair serv., exept of motor vehicles	1.24	1.26	1.32
55 Hotel and restaurant services	0.71	0.74	0.81
60 Land transport and transport via pipeline services	1.00	1.04	1.11
61 Water transport services	-0.29	-0.25	-0.18
62 Air transport services	-1.27	-1.16	-0.86
63 Supporting transport services, travel agency services	0.92	0.95	1.03
64 Post and telecommunication services	3.76	3.80	3.90
65 Financial intermediation services	1.36	1.40	1.47
66 Insurance and pension funding services	3.00	3.04	3.14
67 Services auxiliary to financial intermediation			
70AM Real estate services, market	0.95	0.98	1.03
70AI Imputed rental services	1.61	1.67	1.73
70B Other real estate services	1.02	1.05	1.11
71 Renting services of machinery and equipment	0.23	0.25	0.33
72 Computer and related services	4.37	4.38	4.43
73 Research and development services			
74 Other business services	1.14	1.16	1.23
75 Public administration services etc.	1.90	1.91	1.97
80 Education services	0.92	0.96	1.02
85 Health and social work services	1.56	1.58	1.65
90 Sewage and refuse disposal services etc.			
91 Membership organisation services n.e.c.	0.71	0.75	0.81
92 Recreational, cultural and sporting services	1.05	1.09	1.17
93 Other services	1.27	1.30	1.38
95 Private households with employed persons	0.72	0.75	0.82

Table 12.7: Private consumption expenditure, Austrians in Austria, average annual growth rates at constant prices in %

Table 12.8

	base	Alt A	Alt B
01 Products of agriculture, hunting	3.67	3.72	3.83
02 Products of forestry, logging	2.42	2.44	2.48
05 Fish, other fishing products	0.01	0.08	0.26
10 Coal and lignite, peat	1.12	1.15	1.21
11 Crude petroleum, natural gas, metal ores (1)	1.55	1.57	1.62
14 Other mining and quarrying products	3.27	3.30	3.37
15 Food products and beverages	1.48	1.53	1.64
16 Tobacco products	-1.72	-1.74	-1.74
17 Textiles	1.28	1.30	1.35
18 Wearing apparel, furs	0.69	0.72	0.77
19 Leather and leather products	2.19	2.20	2.25
20 Wood and products of wood	2.51	2.52	2.56
21 Pulp, paper and paper products	2.64	2.64	2.67
22 Printed matter and recorded media	3.50	3.51	3.56
23 Coke, refined petroleum products	2.63	2.66	2.74
24 Chemicals, chemical products	2.50	2.51	2.53
25 Rubber and plastic products	2.59	2.60	2.63
26 Other non-metallic mineral products	2.12	2.14	2.20
27 Basic metals	1.21	1.22	1.23
28 Fabricated metal products	1.15	1.17	1.21
29 Machinery and equipment n.e.c.	1.42	1.44	1.47
30 Office machinery and computers	2.43	2.45	2.49
31 Electrical machinery and apparatus	2.12	2.13	2.15
32 Radio, TV and communication equipment	1.72	1.74	1.78
33 Med., precision, opt. instruments, watches, clocks	1.81	1.82	1.86
34 Motor vehicles, trailers and semi-trailers	-0.02	-0.01	0.03
35 Other transport equipment	7.99	8.00	8.02
36 Furniture, other manufactured goods n.e.c.	1.52	1.54	1.58
37 Recovered secondary raw materials	1.20	1.21	1.22
40.1 Electricity	4.14	4.16	4.22
40.2 Gas, Steam and hot water	0.37	0.39	0.46
41 Water, distribution services of water	0.68	0.69	0.70
45 Construction work	1.29	1.34	1.43
50 Trade and repair services of motor vehicles etc.	2.16	2.20	2.31
51 Wholesale and comm. trade serv., ex. of motor vehicles	1.83	1.85	1.89
52 Retail trade serv., repair serv., exept of motor vehicles	1.05	1.08	1.17
55 Hotel and restaurant services	1.92	1.96	2.06
60 Land transport and transport via pipeline services	3.30	3.31	3.34
61 Water transport services	3.00	3.01	3.03
62 Air transport services	2.86	2.88	2.93
63 Supporting transport services, travel agency services	2.81	2.86	2.97
64 Post and telecommunication services	2.75	2.79	2.92
65 Financial intermediation services	2.01	2.03	2.09
66 Insurance and pension funding services	3.09	3.12	3.20
67 Services auxiliary to financial intermediation	2.04	2.06	2.12
70AM Real estate services, market	1.98	1.97	2.01
70AI Imputed rental services			

Continued on next page

Table 12.8 – continued from previous page

	base	Alt A	Alt B
70B Other real estate services	1.59	1.59	1.64
71 Renting services of machinery and equipment	1.92	1.97	2.08
72 Computer and related services	4.56	4.58	4.63
73 Research and development services	2.16	2.17	2.19
74 Other business services	1.98	1.99	2.04
75 Public administration services etc.	0.47	0.47	0.47
80 Education services	1.13	1.14	1.17
85 Health and social work services	1.60	1.64	1.72
90 Sewage and refuse disposal services etc.	1.81	1.84	1.91
91 Membership organisation services n.e.c.	0.82	0.82	0.83
92 Recreational, cultural and sporting services	1.06	1.10	1.23
93 Other services	1.29	1.35	1.54
95 Private households with employed persons			

Table 12.8: Imports (excl. Tourism). Comparison of average annual growth rates at constant prices in %

12.6 Concluding remarks

Taking a study published by the Austrian Institute for Economic Research as background the implications of two alternative growth paths for foreign tourists' expenditures were analyzed. The exercIncrease in tourism expenditureise showed very positive effects of additional growth in tourism on all relevant variables of the Austrian economy. The exercise for the period 2008 to 2030 also made it very clear that it is not sufficient to limit the analysis to the effects on the macro level. The implications on the level of industries and products groups are much more pronounced and deserve special attention. The range of differences by industries and/or product groups is quite remarkable.

The investigation underlined that in order to study the various effects induced by changes in a particular final demand category with very specific commodity structure, a disaggregated approach is indispensable. The high degree of division of labor within an economy like Austria asks for an input-output approach to trace the indirect production related effects on nearly all branches in the economy. The problem under consideration also requires an instrument which has all the properties of a well developed macro model as regards the effects on income, capital formation, imports and prices. As the results presented in the above tables show, the indirect effects via changes in income, in activity levels etc. affect all the major variables considerably.

Last but not least the exercise proved that the AEIOU II model is ready for carrying out such simulations in a meaningful way.

Chapter 13

Scenario B: Electricity tax (A.electricity)

This chapter introduces a scenario affecting the Austrian electricity market in order to demonstrate the reliable operability of the developed AEIOU II-Model. The scenario is based on developments in the tax-systems concerning the promotion of green and renewable energies. In brief, Scenario A.electricity analyses the overall effects of an increase of the energy tax on electricity within the model framework of AEIOU II.

Based on existing studies, the scenario follows the idea of "ecologogical tax reforms" which shall be discussed in the course of the scenario-development. Two simulations will be conducted assuming different refunding-scenarios for the additional revenues generated by an electricity tax increase. The development of the scenario as well as the simulation results will be presented in the following sections.

This chapter is organised as follows: A *first section* offers some explanatory comments on environmental taxes and environmental tax reforms on which the scenario is based. A *second section* formally presents the development and implementation of the scenario. A *third section* presents and comments on the simulation results and a final *fourth section* offers a few concluding remarks.

13.1 Environmental taxes and tax reforms in Austria

Generally, the Austrian electricity generation mainly depends on hydroelectric power which constitutes over 60% of the electricity produced nationally (see **?**). In line with European-Climate Change policies, Austria's energy-legislation also aims at the **promotion of renewable energy** which is manifested by the 2003 Green-Energy-Law (Ökostromgesetz - BGBl. I Nr. 149/2002) and the, among others, resulting financial subsidies for green-energy producers. Thus, environmental taxes are part of the Austrian tax system. Their general definition and idea will be outlined in the following paragraphs.

An **"environmental tax"** is "a tax that is of major relevance for the environment, regardless of its specific purpose or name" according to the OECD's sustainable development glossary [1]. Statistik Austria adds to this general definition that taxes count as environmental taxes whose basis of taxation are physical values (such as MWh) of an

[1] `http://www.oecd.org/glossary/0,3414,en_2649_37425_1970394_1_1_1_37425,00.html`

element and the usage/emission of which implies negative ecological consequences (see [?, 5]).

Thus, an **ecological tax reform** generally aims at the transfer of a tax burden from the factor "labour" to the consumption of resources / wastage of natural resources (see [?, 1]) or as defined by the OECD: "Green tax reform has usually been introduced in a revenue-neutral context: that is taxes have been shifted to pollution while distortionary taxes on labour or capital have been cut." ([?, 1]) Hence the introduction of environmental taxes should firstly, lead to *environmental improvements* and secondly, to (conditionally) *positive employment effects*. The occurrence of positive employment effects mainly depends on the way fiscal revenues resulting from the introduction of environmental taxes are redistributed (see [?, 960]).

As suggested by research, the revenue from an environmental tax can be used to reduce labour taxes and thereby attaining the so-called *"double-dividend"* of positive environmental effects and higher employment. Studies aiming at the assessment of the previously described effects were able to verify a positive - though in its size only modest - impact of environmental taxes on private consumption, GDP and employment. (see [?, 962]) A study conducted by the Austrian Institute of Economic Research (WIFO) - "Optionen für eine Ökologisierung des österreichischen Steuersystems" by Kletzan, Köppl and Kratena - also suggests positive effects on employment resulting from an additional revenue of one billion euro generated by a tax increase of environmental taxes.

A detailed description of environmental taxes and their effects on the macroeconomic performance of an economy would be beyond the scope of this exercise. The purpose of Scenario A.electricity is merely to analyse the overall effects of an increase of the energy tax on electricity within the model framework of AEIOU II. More comments on the results of a similar study by WIFO shall be made at a later point. With respect to Scenario A.electricity a few key facts on environmental taxes in Austria will be presented. Environmental taxes can be divided into four categories: energy-, transport-, pollution- and resource-taxes. In 2008 the revenues generated by environment taxes in Austria were approximately 7.404 Bio Euro, which equal an increase of approximately 73% compared to the environmental fiscal revenues in 1995. This positive trend is graphically depicted in figure 13.1 (Datasource: Statistik Austria).

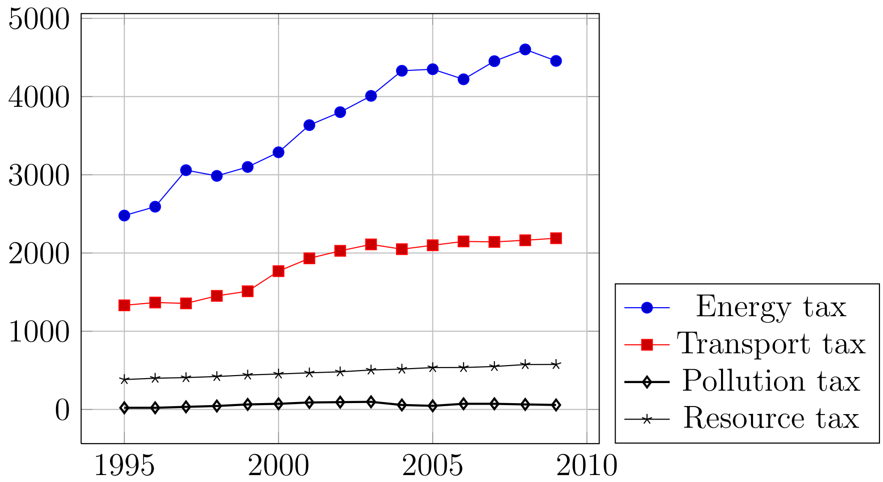

Figure 13.1: Environmental tax revenues 1995 – 2009 (Mio Euro)

Approximately 60% of the fiscal revenues by environmental taxes are generated by energy taxes, which is the overall term for the group of taxes consisting of the mineral oil tax (Mineralölsteuer) and the energy tax on electricity and natural gas (Elekrizitäts- und Erdgasabgabe). With respect to Scenario A.electricity the energy tax on electricity and legal regulations on the refunding system thereof will be presented in greater detail in the following section.

Table (13.1) provides a quantitative assessment of total tax revenues in millions of Euros generated by energy- (E), transport- (T), resource- (R) and pollution taxes (P) in 2008 and 2009. Furthermore, the tax burden per sector is presented in Table (13.1). With respect to the energy tax, the majority thereof is paid by private households (source: ?).

Table 13.1: Ecotax Revenues in Mio Euro - 2008 & 2009[1]

	Steuereingänge in Mio. EURO[2]									
	E		T		R		P		Gesamt	
Sector	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009
Eisen- und Stahlerzeugung	67.6	72.6	1.2	1.2	1.4	1.4	0.8	0.8	71.1	76.0
Chemie, Mineralölwirtschaft und Kokerei	57.5	53.0	3.5	3.5	3.5	3.5	0.8	0.8	65.2	60.8
Steine und Erden, Glas	73.9	69.9	6.7	6.9	13.0	12.0	0.8	0.8	94.5	89.6
Fahrzeugbau	15.1	14.2	5.3	5.0	3.1	3.1	0.8	0.8	24.4	23.0
Maschinenbau	75.8	74.0	14.2	14.2	9.5	9.5	2.7	2.4	102.3	100.1
Bergbau	21.4	18.1	3.2	3.2	1.6	1.6	-	-	26.2	22.9
Nahrungs- und Genussmittel, Tabak	69.6	68.4	14.8	15.3	8.1	8.1	1.5	1.4	94.0	93.2
Papier und Druck	80.5	76.8	2.5	2.5	3.3	3.3	-	-	86.3	82.6
Holzverarbeitung	30.6	28.0	7.6	7.8	3.4	3.4	0.8	0.8	42.4	40.0
Bau	254.7	248.7	21.7	22.2	11.5	11.5	1.7	1.5	289.6	284.0
Textil und Leder	12.2	11.6	3.6	3.7	2.0	2.0	-	-	17.8	17.3
Sonst. Produzierender Bereich	32.5	30.7	8.1	8.3	4.5	4.5	1.7	1.5	46.8	45.0
Landverkehr	839.1	820.5	44.3	45.1	9.5	9.4	1.2	1.1	894.0	876.1
Binnenschifffahrt	4.3	4.1	-	-	0.1	0.1	-	-	4.4	4.2
Flugverkehr	0.4	0.4	0.2	0.2	0.1	0.1	-	-	0.6	0.6
Öffentliche und Private Dienstleistungen	839.1	781.1	338.3	335.0	154.6	155.7	50.5	44.9	1382.5	1316.8
Energieversorgung	9.7	9.7	4.6	4.9	12.6	12.6	0.8	0.8	27.8	28.0
Private Haushalte[3]	1871.7	1832.2	1672.2	1699.3	321.9	322.5	-	-	3865.7	3854.1
Landwirtschaft	247.4	242.2	10.4	10.2	9.9	10.2	-	-	267.7	262.6
Öko-Steuern insgesamt (im Sinne der VGR)	4603.0	4456.2	2162.2	2188.7	573.7	574.8	64.4	57.3	7403.3	7276.9

Source: Statistik Austria. As found in http://www.statistik.at/web_de/static/projektbericht_oeko-steuern_1995_bis_2009_055503.pdf

[1] EUROSTAT Doc.Eco-taxes/98/1: *"A tax whose tax base is a physical unit that has a proven specific negative impact on the environment."*
[2] Rundungsdifferenz nicht ausgeglichen. P: Umweltverschmutzungssteuer (Pollution tax), E: Energiesteuer (Energy tax), T: Transportsteuer (Transport tax), R: Ressourcensteuer (Resource tax)
[3] in ihrer Eigenschaft als Konsumenten

13.2 Developing A.electricity

The main idea of Scenario A.electricity is the analysis of overall effects of an increase of the energy tax on electricity within the model framework of AEIOU II. With respect to previous studies on "ecologization of tax systems" the impact of the tax increase on prices, the CPI, the GDP, income and employment are of particular interest. This section details the development and implementation of Scenario A.electricity into AEIOU II.

13.2.1 Overview

For modelling an increase of the energy tax on electricity, the division of the energy sector 40 into sector 40.1 (Electricity) and sector 40.2-3 (Other Energy) was a vital fact. In a first step, the energy tax on electricity had to be extracted from the aggregate taxes on goods for each sector. In order to estimate the electricity tax burden of each sector, the

intermediary **electricity consumption in MWh** at the industry level was estimated. The estimated electricity consumption in MWh[2] at the industry level serves as the basis for the calculation of the electricity tax burden of each sector. The **legal regulations on the refunding of the electricity tax** were taken into account in the calculations of the electricity tax at the industry level and will be described in more detail below. Furthermore, the consistency of the calculations of the electricity tax with the data of the IO-Tables was ensured at any time.
In brief, the **implementation of the scenario** followed the following steps:

1. Calculation of intermediary electricity consumption in MWh per sector: $ele = f(\widetilde{X}, time)$. The MWh per sector were generally estimated as a function of the sector's output and a time trend.
2. Calculation of the electricity tax burden per sector based on the estimated intermediary electricity consumption in MWh as outlined in step 1: $eletax = 0.015 * ele$.
3. Calculation of electricity tax refunds per sector.
4. Calculation of the effectively paid electricity tax per sector.
5. Calculation of the electricity tax burden of private households.
   The "Energieabgabenvergütungsgesetz" does not apply to private households. Thus the energy/electricity tax paid by private housholds is calculated as outlined in Step 2.
6. Endogenous Determination of Technology Coefficients.
   The dynamic estimation of electricity consumption per sector in MWh assumes a specific relationship between a sector's real output and its demand for electricity. Hence, this dynamic relationship between MWh and real output requires that the implied changes in the input coefficients are taken account of.

13.2.2 Implementation of an adjusted base case

In the following the legal background on the electricity tax and its refunding will be discussed in greater detail as it represents the basis for Steps 2-4.
The electricity tax is a "quantity-tax". Thus its scope depends on the MWh / kWh consumed. Currently (as of June 2011) the tax on electricity amounts to 0.015 Euro per kWh. [3].

In 1996 the **"Energieabgabenvergütungsgesetz"** (BGBl. Nr. 201/1996) was passed, which aimed at the easing of the energy tax burden for energy-intensive enterprises by adopting an upper limit for paid energy taxes with reference to the net-productionvalue. Over the years the "Energieabgabenvergütungsgesetz" was subject to various amendments, the latest of which considering the reduction of businesses benefiting from the tax refunding. Thus, the latest amendment provided for the refunding system to be applicable to businesses engaged in the production of physical assets only and thus, it excludes the service industry. As this amendment is still subject to further debate, the scenario does

[2]The tax of 0.015 Euro is paid per kWh. As all values are presented in 1,000s of Euros, the estimation of the electricity consumption in MWh and their multiplication by 0.015 equals the tax burden on electricity consumption in 1,000s of Euros.

[3]Source:`https://www.bmf.gv.at/steuern/tippsfrunternehmeru_7722/sonstigeabgaben/sonstigeabgaben.htm`

not account for this latest development and applies the "Energieabgabenvergütungsgesetz" to all sectors, and thus, still includes the service industry in the refunding system.

In the following passage the **refunding of the energy / electricity tax** will be briefly described as it appears in the legal text and as it is modelled in Scenario A.electricity:

1. Calculation of the *sum of energy tax excess (Mindestselbstbehalt)* on electricity and natural gas.
   Electricity: 0.0005 Euro / kWh
   Natural Gas: 0.00598 Euro / m^3
2. Calculation of the *sum of energy tax* paid for electricity and natural gas consumption.
   Electricity: 0.015 Euro / kWh
   Natural Gas: 0.066 Euro / m^3
3. Calculation of the *energy tax refunds*.
   The amount of refunds is calculated by comparing a) the sum of energy taxes paid minus 0.5% of the net-productionvalue and b) the sum of energy taxes paid minus the sum of energy tax excess (Mindestselbstbehalt). The smaller amount minus the minimum tax excess (Mindestselbstbehalt) of 400 Euro equals the effective refund.
4. Calculation of the *effectively paid electricity tax* per sector.
   The effectively paid energy/electricity tax equals the sum of energy tax (Step 2) minus the sum of energy tax refunds (Step 3)

The base case of the scenario models the electricity tax paid at the industry level and the refunding thereof as previously described.

13.2.3 Implementation of an increased electricity tax

Here, an increase of the electricity tax from 0.015 Euro/kWh to 0.030 Euro/kWh will be modelled. Compared to the base case (0.015 Euro/kWh), changes due to the electricity tax increase occur at two points:

- Changes in the calculation of domestic prices.
- Changes in the amount of VAT paid by VAT-taxable sectors.

13.2.3.1 Changes in the calculation of domestic prices P.

The base case calculation of domestic producer prices P as described in chapter 7 has to be modified slightly to implement the envisaged electricity tax. More precisely, we now have to work with an adjusted tax on products vector T^{adj}, where the only changing entry relative to the previous tax on products vector concerns commodity "Electricity", which now includes the energy tax on electricity calculated in section (13.2.2).

Variables used

The relevant definitions, analogous to those from the base case price determination from chapter 7 are:

Symbol	**Description**	**Classification**
T	Taxes on products	Goods
S	Subsidies on products	Goods
t	Taxes on products shares	Goods
s	Subsidies on products shares	Goods
X	Output at constant prices	Goods
X^{nom}	Output at current prices	Goods
V	Value added	Goods
P	Domestic prices	Goods
P^{*}	Import prices	Goods
$\mathbf{A}_D$	Domestic coefficient matrix	Goods × Goods
$\mathbf{A}_M$	Import coefficient matrix	Goods × Goods
T^{adj}	Adjusted Taxes on products	Goods
t^{adj}	Adjusted Taxes on products shares	Goods
T^{El}	Energytax on electicity	Goods

$$(t^{\text{adj}} - s)(i) = \frac{T(i) - T^{\text{El}} - S(i)}{X(i)} \quad \forall t \tag{13.1}$$

$$(T^{\text{adj}} - S)(i)_t = (t^{\text{adj}}(i)_{2005} - s(i)_{2005}) \cdot X^{\text{nom}}(i)_t \tag{13.2}$$

Domestic prices are then calculated as:

$$P = (I - \mathbf{A}_D{}')^{-1} \cdot \left(\frac{V + T^{\text{adj}} - S + T^{\text{El}}}{X} + \mathbf{A}_M{}' * P^{*} \right) \tag{13.3}$$

13.2.3.2 Changes in the amount of VAT paid by VAT-taxable sectors

As the energy tax on electricity is now endogenously computed based on the estimated electricity consumption in MWh per sector, the changes of the amount of VAT paid by VAT-taxable sectors have to be accounted for. Thus, the taxes on products in the sectors concerned have to be amended by endogenously calculated electricity taxes according to equation (13.4). Equation (13.4) depicts the calculation of the adjusted VAT for the respective sectors formally. $Mwst^{korr}$ can be interpreted as the additional VAT paid as a result of the increase in the electricity tax. The VAT-taxable sectors can be taken from the tax-tables provided by Statistik Austria.

$$Mwst_t^{korr} = (T^{\text{El}}{}_t(i) - (t(i)_{2005} - t^{\text{adj}}(i)_{2005}) \cdot X^{\text{nom}}(i)_t) \cdot 0.2 \tag{13.4}$$

As a result, equation (13.3) is changed accordingly to:

$$P = (I - \mathbf{A}_D{}')^{-1} \cdot \left(\frac{V + T^{\text{adj}} - S + T^{\text{El}} + Mwst^{korr}}{X} + \mathbf{A}_M{}' * P^* \right) \tag{13.5}$$

The modelling of the changes in the amount of VAT-revenues resulting from the electricity-tax rise is necessary, but will be of no further importance in the simulations applied in section (13.3).

13.2.4 Endogenous Determination of Technology Coefficients.

By estimating the consumption of eletricity in MWh per sector, we already implicitly assume a specific relation to sectoral real outputs, and therefore input coefficients. The dynamic structure of our equations causes these MWh-coefficients to change over time. In order to make our technology matrix consistent with this evolution, the input coefficients related to sector 40.1 CPA (electricity) will be updated dynamically. For that purpose, we calculate the implicit growth rate of sectoral MWh per unit of output with respect to the previous period in a *first step.*

$$growth_i = \frac{\mathcal{E}_{it}/\widetilde{X}_{it}}{\mathcal{E}_{it-1}/\widetilde{X}_{it-1}} \tag{13.6}$$

In a *second step* the sectoral growth rate of MWh/Ouput is applied to the corresponding line of the technology Matrix. It should be noted, that we apply growth rates computed on the activity level to technology coefficients, which are defined for the commodity level. However, this practice is justified in this specific case as sector 40.1 produces to a 98% a homogenous commodity (electricity), suggesting that the potential error of treating activities and goods identically is negligible. Equation (13.7) describes the update of the technology matrix:

$$\mathbf{A}_{(30,j)} = \mathbf{A}_{(30,j)}(t-1) * growth_j \tag{13.7}$$

13.3 Applying A.electricity

The previous section presented the implementation of A.electricity in the AEIOU II-Model. This generally implied the endogenous modelling of the electricity tax burden at industry level and for private households based on legal backgrounds. In the following, two simulations (starting in 2012[4]) with respect to the previously mentioned "double-dividend"-effect will be analysed:

- Sim A: The additional tax revenues (additional electricity tax and VAT) are used for repayments of the government's debt.
- Sim B: The additional electricity tax revenues are redistributed to private households by lowering income taxes and thereby increasing disposable income.

[4] 2012 was chosen as a starting date for the simulations as we aim at the modelling of future effects of the implied tax refrom.

Furthermore, it is assumed that Sim A, implying the usage of the additional tax income for government's debt repayments, does not have any further redistributional effects. One may argue that debt repayments may be percieved as additional income. In that particular case, Sim A would generate similar results to Sim B, which we couldn't observe as will be presented below. It should be noted, that Sim B, assuming redistribution measures of the additional tax revenue is the more relevant case with respect to the mentioned "double dividend" effect.

The following figures present the **simulation results** as percentage differences relative to the base case for some selected macroeconomic variables. In order to demonstrate the operability of the AEIOU II-Model, a more or less comparable study conducted by WIFO will be used as a reference. Köppel et al (2008) analysed the effects of an additional one billion tax revenue generated by an increase of traffic-taxation (50%), an increase of the electricity tax (20%) and an increase of the CO_2-Tax (30%) over the time in Austria. 55% of the additional tax revenue were redistributed to private households, 35% to the business sector and 10% were used as environmental subsidies. Köppel et al (2008) applied the PROMETEUS-Modell. (see **?**) The PROMETEUS-Modell by WIFO constitutes a disaggregated macroeconomic model of the Austrian economy, which was developed with the particular aim to simulate economic effects of changes or shocks in the energy system. [**?**, see 187] The PROMETEUS-Modell is the extension of the MULTIMAC-Modell by WIFO, which is also an input-ouput model. Although both simulations (WIFO and A.electricity) were conducted with IO-models,it should be noted that a comparison of the results is only possible to a certain point as different redistribution-scenarios were assumed. Nevertheless, the results presented by WIFO will be used as references for the scope and direction of the predicted effects by AEIOU II assuming redistribution measures (Sim B).

In the following, it will be differentiated between the simulation results generated by Sim A and Sim B, which assume different redistribution mechanisms of the additional tax revenue from the electricity tax increase.

13.3.1 Simulation A: No redistribution of tax revenues

Here it is assumed, that additional electricity tax revenues are not redistributed, e.g. via lower personal taxes. This would correspond to a setting, were these additional tax revenues were only used to lower the budget deficit.

As can be seen from figure (13.2) *GDP in real terms* will decrease by less than 0.04% compared to the values predicted by the base case. Also, *aggregate investment* will decrease by approximately 0.04% at the most compared to the base case. Furthermore, the tax increase will lead in Sim A to a reduction of *consumption of private households* by less than 0.07% compared to the base case.
In sum, if no redistribution measures of the additional tax revenues are assumed, real GDP, aggregate investment and private consumption will all modestly decrease compared to the base case.

13.3.2 Simulation B: Redistribution of tax revenues

Now it will be assumed, that the additional revenues from the electricity tax redistributed via lowering personal taxes, such that personal disposable income raises by the same

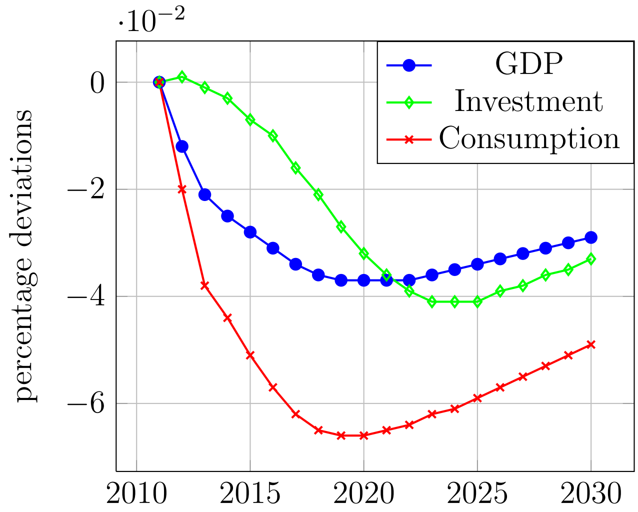

Figure 13.2: Simulation A. Percentage deviations from base case

amount. So, this variant would be deficit neutral.

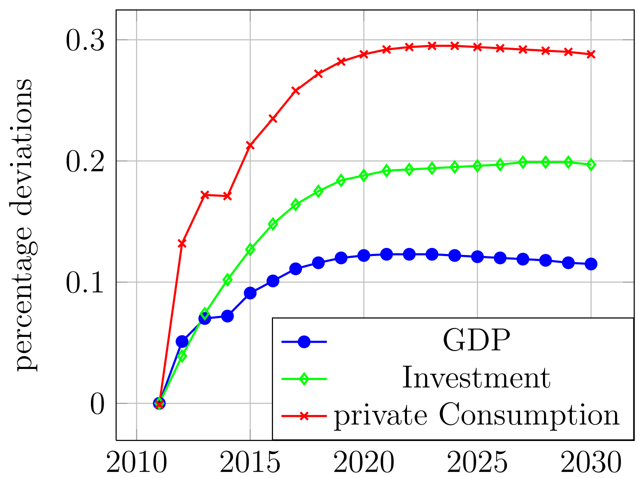

Figure 13.3: Simulation B. Percentage deviations from base case

In this scenario *GDP in real terms* will increase by up to approximately 0.12% compared to the base case. The PROMETEUS-Modell also predicts positive effects in the size of 0.10% of the tax reform on GDP in real terms assuming the previously outlined redistribution. ([**?**, 14]) Also, *aggregate investment* will rise up to approximately 0.2% compared to the base case. Köppl et al (2008) on the contrary predicted negative effects (-0.06%) of the tax reform on aggregate investment. As mentioned earlier, an exact comparison is due to model differences and different assumptions with respect to the tax reform and redistribution measures not possible. Köppl et al (2008) assume only a redistribution of 55% of the additional tax revenue to private households whereas in A.electricity/Sim B a 100% redistribution is simulated. The consumption of private households will also rise up to approximately 0.3% compared to the base case. Köppl et al (2008) also predicted positive effects of the tax reform on private consumption.

13.3.3 Consumer Price Inflation (CPI)

In this section the impact of the two scenarios upon the CPI will be described.

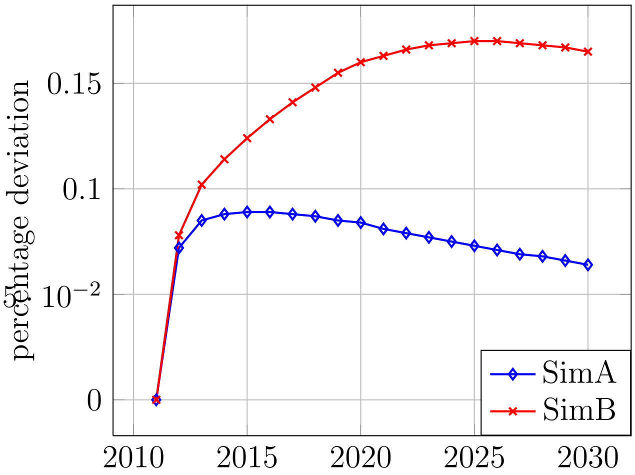

Figure 13.4: CPI. Percentage deviation from base case

In both simulations (Sim A and Sim B) increases in the CPI can be observed, which implies that the increase in the electricity tax, leads to an increase in prices and by that to inflatory tendencies. Köppl et al (2008) also predict: "Die Besteuerung hat inflationäre Effekte, die jedoch durch die Entlastung der Haushalte mehr als kompensiert werden, sodass das Realeinkommen leicht steigt." ([**?**, 13]) The same effects can also be observed in Sim B of AEIOU II.

13.3.4 Income per capita

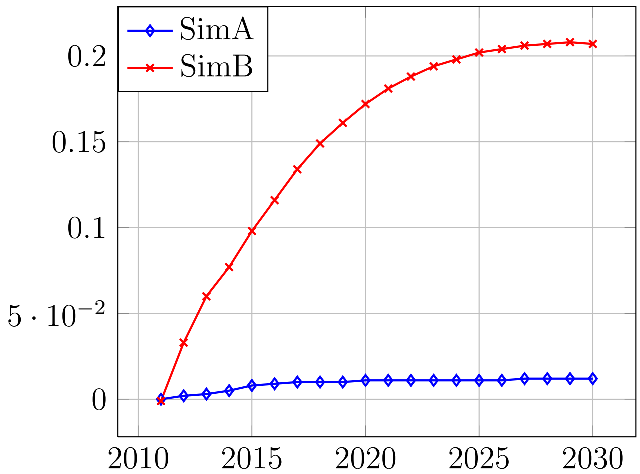

Figure 13.5: Income per capita. Percentage deviation from base case

Both simulations, A and B, predict positive effects of the tax-reform on per-capita income. Sim B predicts greater effects (up to 0.2%) than Sim A, which is not surprising as Sim B assumes a 100% redistribution of the additional electricity-tax revenue to private households.

13.3.5 Unemployment Rate.

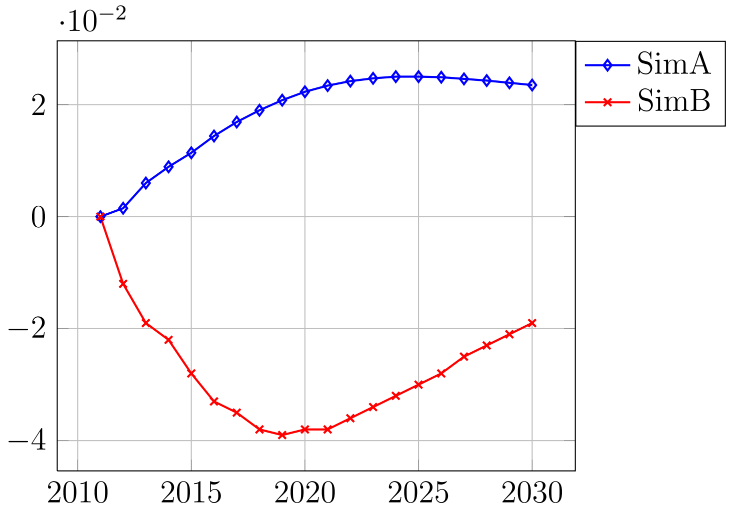

Figure 13.6: Unemployment rate. Deviation in percentage points from base case

Note, that figure 13.6 depicts the difference in percentage points (rather than in percentages) between the unemployment rate implied by the base case and the one implied by Sim B.

Bearing in mind the "double-dividend"-effect, the consequences of the tax-reform simulations are of greater interest. As can be seen from figure 13.6 assuming no redistribution-measures (Sim A), the tax-increase will lead to an increase in the unemployment rate up to 0.03 percentage-points compared to the base case. On the contrary, assuming redistribution measures (Sim B), the tax-reform leads to a reduction in the unemployment rate up to 0.04 percentage points. Köppl et al (2008) also predicted positive effects on the unemployment rate (-0.05%). As stated in literature, the occurence of "double-dividend"-effects (positive employment effects and environmental improvements), especially employment effects, depends on the design of the tax-reform and possible redistribution measures.

13.4 Conclusion

This chapter presented the development and implementation of Scenario A.electricity. A first section provided an overview of environmental taxes in Austria with respect to the scenario. Furthermore, the implementation of A.electricity was outlined, which implied the endogenization of the electricity tax-calculation on industry level and for private households, taking into account legal regulations. As the estimation of MWh consumed implies changes in the technology matrix, an update of the input coefficients of sector 40.1 (electricity) was dynamically taken into account.
In sum, two simulations were conducted, both based on a doubling of the electricity-tax from 0.015 Euro/kWh to 0.030 Euro/kWh. In Sim A the additional tax revenue from the increase in the electricity tax was used for government's debt repayment, whereas in Sim B the additional revenues were redistributed to private households and thereby increasing their disposable income. The start-date for the simulations was 2012 as outlined previously.

The effects presented in section (13.3) were small but their scope and direction can be compared to existing studies. In sum, the quality of the performance of the AEIOU II was once more proven, especially as the simulations results (Sim B) are comparable in scope and direction to the extended IO-Model by WIFO (PROMETEUS). Thus, the AEIOU II-model offers starting points for further modelling of the environmental policies and their economic-consequences in Austria.

Chapter 14

Scenario C: Object- vs. subject-oriented housing subsidies

14.1 Introduction

Housing subsidies can most generally be classified into object- and subject-oriented housing subsidies. Object-oriented subsidies are granted on the basis of certain required characteristics of the planned building (maximum floor space, implementation of energy-saving features etc.). Subject-oriented subsidies, instead, are granted depending on characteristics of the recipient of the benefits (typically regarding income). The predominant form in Austria are object-oriented subsidies accounting for roughly 90% of all housing related subsidies, while other countries, like Germany, have made major efforts in recent decades to transform their housing subsidy systems towards more subject-orientation.

Figure 14.1 shows a breakdown of overall Austrian housing subsidies in 2008 (see **?**) As mentioned above, only a small 10% fraction of these subsidies is subject-oriented (*"Wohnbeihilfe"*). These will subsequently be refered to as means-tested housing subsidies. The major part instead is object-oriented and comes in various forms: 52% on non repayable housing loans (*"nicht rückzahlbare Darlehen"*), 13% repayable annuity subsidies (*"rückzahlbare Annuitätenzuschüsse"*), 25% non repayable annuity subsidies and other non-repayable subsidies (*"Nicht rückzahlbare Annuitätenzuschüsse"* and *"Sonstige verlorene Zuschüsse"*).

Obviously, therefore, Austrian housing policy does not restrict beneficiaries from housing policy measures to low income households. Subsidies are granted to large parts of the population, the vast majority thereof being owner-occupiers. On the other hand it is the objects (single family homes, appartments) which are primarily targeted rather than individuals. To put it differently: Rather than subsidizing demand, the main emphasis is on promoting a high level of new construction. The idea is, that object-oriented subsidies produce affordable dwellings for a large part of the population. However, **?** state that specifically this conjecture is completely flawed since there seems to be no significant relationship between housing investment and object-oriented subsidies at all.

Housing policy throughout Europe is increasingly targeted specifically at low income households. For that purpose means-tested housing benefits are predominantly regarded as the most efficient instrument. The social rented sector as well, becomes more and more restricted to people considered most in need. Apart from these social considerations

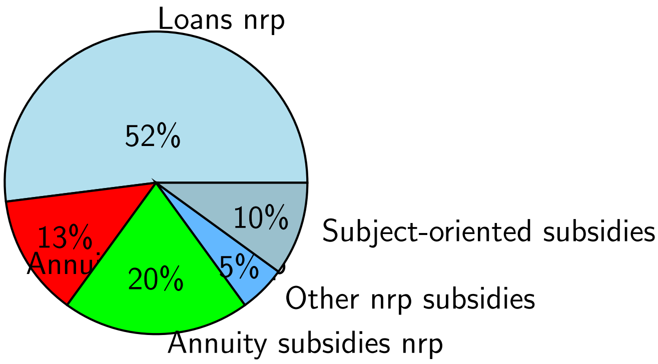

Figure 14.1: Breakdown of Austrian housing subsidies (rp=repayable, nrp=non repayable)

it is commonly argued that subject-oriented subsidies create incentives for increased investment into rental buildings via demand pull mechanisms. **?**, for example, urges the complete conversion of the Austrian subsidy system to the subject-oriented subsidies. Although relevant empirical evidence is scarce a study carried out by the *Wüstenrot-Foundation* 1995 (as cited in **?**) finds some evidence for this hypothesis, albeit the relationship in question seems to be very indirect and associated with a significant time lag between cause and effect. It has also been argued, that in comparison to social housing the immediate negative impact of subject-oriented subsidies on the public administration's liquidity is considerably smaller. Generally, subject-oriented subsidies are considered just because individuals in need have a fair chance to enjoy housing allowances based on legal entitlement.

A major argument against higher subject-oriented subsidies is that they will be largely absorbed by higher rental prices, i.e. higher profits, but unchanged quantities. Along these lines **?** argues, that this outcome is all the more likely if benefits are granted to a wide range of households. Unsurprisingly, therefore, the question of the proper type of housing subsidy policy is far from settled and, particularly in Austria, subject-oriented subsidies remain a highly controversial topic.

The following sections will provide a closer look at the real benefits of means-tested housing benefits by simulating a structural change in the Austrian housing subsidy scheme. In order to carry out this kind of analysis we need to extend the existing AEIOU II model with some additional behavioural equations. The exact specification and estimation results will be described in section 2 of this chapter. Section 3 is devoted to the scenario description and the discussion of the outcomes of the simulation.

14.2 Housing-specific equations

AEIOU II is not very detailed when it comes to housing. Nevertheless the basic model allows for the distinction between "Real estate services, market" (70AM) and "Imputed rental services" (70AI). This distinction is vital for the subsequent analysis. Furthermore, we know that construction investment by NACE activity 70 is the only activity with housing investment. So the latter, by definition of corresponding investment categories is already identified within our basic configuration. This is also true for consumption expenditures of private households on "Real estate services, market": They comprise rents for residential real estate only, because expenditures for rents on commercial or industrial real estate is recorded completely as intermediate consumption.

14.2.1 Residential investment

The preceding analysis suggested that on a theoretical basis housing subsidies should encourage housing investment, since they considerably lower building cost. This point is also enforced by the fact that altogether about 80% of newly built housing units are co-financed by the public (**?**). In order to account for this presumption we included object-oriented subsidies into our housing investment equation, which then takes the following form:

$$I_t = \beta_0 + \beta_1 S_{\text{obj}} + \beta_2 \overset{\approx}{P}{}^{inp}_{t\text{–}1} + \beta_3 Y_{perm} + \beta_4 Ten + \beta_5 I_{t\text{–}1} + \beta_6 I_{t\text{–}5} \tag{14.1}$$

Throughout this sections all variables are in log-form so the estimates may be interpreted as elasticities. In equation (14.1) I denotes the investment of NACE activity 70 (= housing investment) and S_{obj} denotes total object-oriented housing subsidies, calculated simply as total housing subsidies minus expenditures on *"Wohnbeihilfe"*. The latter is considered as subject-oriented subsidies.[1]

Additional regressors include the one year lagged price index for housing investment $P_{t\text{–}1}$, a permanent income variable Y_{perm} and a variable Ten to capture tightness on the housing market. Permanent income was simply constructed as a 5-year moving average of personal disposable income. The proxy Ten should take account of the intuition that housing investment will increase if population grows faster than the supply of housing, measured as “Imputed rental services” in real terms.

In order to remove autocorrelation in the residuals we augmented the equation with lagged terms of the endogenous variable. Since housing investment follows a rather pronounced cyclical pattern we had to go back up to the fifth order lag to achieve this. We also tried to include subject-oriented subsidies as explanatory variable, but it turned out to be highly insignificant. The same was true for the long-term interest rate, last years housing capital stock, and the depreciation rate. All of these variables are therefore omitted from further analysis.

The results suggest that raising object-subsidies by 1% raises housing investment immediately by 0.26%. The short-term elasticity on the lagged price term, the permanent income and the tension variable are -0.26, 0.52 and 0.27 respectively. **?** and **?** estimate a similar specification, and report elasticities of 0.05% and 0.27% with respect to housing subsidies.

14.2.2 Rental housing consumption

The second AEIOU II equation of crucial importance which had to be extended (compared to the base case formulation in chapter 11 is real consumption of “Rental housing services” C_{70}. As can be seen from equation 14.2 we used the share of C_{70} in total consumption of private households C_{70} as dependent variable. The data source for the regression are again the CPA timeseries reported by Statistik Austria, which are limited to 14 periods of observations.

[1] This is a simplification, because *"Wohnbeihilfe"* is often tied to prior eligibility of households to one or the other form of object-oriented subsidies. Therefore, applying stricter standards, only a fraction of *"Wohnbeihilfe"* would count as true subject-oriented subsidies.

$$\left(\frac{C_{70AM}}{C_{\Sigma}}\right)_t = \beta_0 + \beta_1 \left(\frac{\mathcal{P}_{70AM}}{P_{\Sigma}}\right)_t + \beta_2 S_{\text{sub}} + \beta_3 \left(\frac{C_{70AM}}{C_{\Sigma}}\right)_{t-1} \tag{14.2}$$

In equation (14.2) $\frac{P_{46}}{P_{\Sigma}}$ denotes the relative price of rental housing services and S_{sub} the real means-tested housing benefits respectively. In order to measure S_{sub} we aggregated the corresponding expenditures reported by the Austrian federal states *"Länder"* and augmented them with the item "General means tested housing benefits" (*"Allgemeine Wohnbeihilfe"*). Again an endogenous lag was added to the specification. In order to address endogeneity issues related with the relative price we used a TSLS estimator, with unit-labour costs of 70AM as the instrument.

According to equation 14.2 a 1% raise in real subject-oriented subsidies increases rental housing consumption by about 0.07% in the short term. This effect might seem small in magnitude, but it should be remembered that it applies to a rather large share in total consumption. So, despite the fact that we operate on a high level of aggregation, and therefore can not analyse the rich structure and variety within the rental market,

However, this effect is highly significant and indicates a clearly positive relation between the demand for "Rental housing services" and subject-oriented subsidies. This finding is in line with the official intention of strengthening demand in the rental market with these subsidies.

14.2.3 Profits in the rental housing sector

The third equation in our model describes to profit setting behaviour in the housing sector, which was included to abolish the restrictions involved in assuming constant markups. Theory suggests that a notable share of the increased willingness to pay triggered by higher subject-oriented subsidies will directly be absorbed by higher profits of the supply side. In equation 14.3 we take account of this hypothesis and try to explain profit per unit of real output $\frac{\Pi_{70AM}}{X_{70AM}}$ as a function of contemporary and lagged Output X_{70AM} and two endogenous lags.

$$\left(\frac{\Pi_{70AM}}{X_{70AM}}\right)_t = \beta_0 + \beta_1 X_{70,t} + \beta_2 X_{70,t-1} + \beta_3 \left(\frac{\Pi_{70AM}}{X_{70AM}}\right)_{t-1} + \beta_4 \left(\frac{\Pi_{70AM}}{X_{70AM}}\right)_{t-2} \tag{14.3}$$

As can be seen from the estimation results for equation 14.3 a 1% increase in output can be expected to increase the profit share by 2.73%. Remarkably though, this effects seems to be only temporary since the lagged output has the opposite sign and is similar in magnitude.

14.2.4 Units of finished houses

The last equation necessary to analyze the present scenario translates the real housing investment flows into units of finished houses. As dependent variables we used the number of finished units of housing as reported by Statistics Austria.[2] As explanatory variables

[2] Data are combined from two sources: `http://www.statistik.at/web_de/statistiken/wohnen_und_gebaeude/errichtung_von_gebaeuden_und_wohnungen/fertigstellungen/index.html` and **?** to get the longest consisten series possible.

we utilized the housing investment flows I as defined in equation (14.1) and an investment price index $\overset{\approx}{P}^{inp}$. The latter serves two purposes: On one hand a changing price level might lead to a different pace of official registration of housing starts (that is, when housing units are recorded as finished) relative to housing investments. On the other hand a changing price level might be associated with a composition effect: Higher investment prices might not only influence the amount but also the kind of housing investment. With high investment prices, investment flows may rather go into renovation and refurbishment then into new construction.

$$F_t = \beta_0 + \beta_1 I_t + \beta_2 I_{t-1} + \beta_3 F_{t-1} + \beta_4 \overset{\approx}{P}^{inp}_{t-2} \tag{14.4}$$

Eq. 14.4 suggests a short term elasticity of finished units with respect to housing investment of about 1%, the long run elasticity being about 1.8% respectively. Consistent with expectations we find the effect of the lagged price index to be negative and highly significant.

14.3 Implementation in AEIOU II and Results

Now the stage is set for the implementation of our housing scenario. As already mentioned in the introduction of this chapter, the relation of object and subject-oriented subsidies and their influence on economic activity is the main purpose of the our analysis. More specifically, we want to provide evidence for the likely the effects of increased means-tested housing benefits, holding the total amount of housing subsidies constant. This particular implementation allows us to neglect level-effects of housing subsidies as a whole, in particular those upon public debt.

In the sequel we will compare the following two scenarios:

Base scenario

- S_{sub} and S_{obj} are held constant on their 2008 level.

Alternative scenario

- S_{sub} is doubled
- S_{obj} is correspondingly reduced to ensure that $S_{\text{obj}} + S_{\text{sub}}$ is constant.

14.3.1 Real effects

In Figure 14.2 we present the percentage deviations of some key housing variables from the base scenario. First and foremost we recognize that the effect of a relative increase in subject-oriented subsidies on housing investment is strikingly negative. An initial 3% drop relative to the base scenario in the first year of our simulation is followed by another five years of increasing losses in housing investment. The maximum difference to the base scenario is reached 7 years after introduction with minus 11%. Then the gap between the two scenarios continously narrows down to about 7% by 2025. The immediate impact is primarily due to the strong 260 Mil. cut in object-oriented subsidies, which corresponds roughly to a 10% decrease.[3] Furthermore, as detailed below, disposable income is lower and the investment price is higher than in the base scenario which aggravates the negative effects on housing investment. The geometric lag structure implied by equation 14.1 accounts for the negative trend until 2014,[4] which then is softened by the negative coefficient for I_{t-5}.

From the policy maker's point of view not only housing investment but also the development of finished housing units is of interest. The base scenario suggests that when holding 2008 subsidies constant about 40.000 units will be finished per year on the average. The changed subsidy scheme in the alternative scenario causes finished housing units to plummet by -1000 units in 2009 tending downwards to -7580 per year in 2016. Although qualitativly similary, these results deviate considerably from the findings in the related empirical study by **?**. Also using input-output analysis they simulated the effects of a 520 Mio decrease in object-oriented subsidies, keeping subject-oriented subsidies untouched. Remarkably, they report similar reductions in finished constructions (about -4400 in 2006 and -7180 in 2010), although their subsidy cutback is about twice as high as investigated here. This suggests that neglecting price-feedback effects causes their results to be biased downwards.

Secondly, the simulation indicates that doubling subject-oriented subsidies increases consumption of rental housing by about 4%, with slightly diminishing magnitude over time. The mirror image of this is a decrease in the consumption of owner occupied housing services. This makes sense intuitively since increased subject-oriented subsidies render owner occupied housing relatively more expensive. Also aggregate consumption declines slightly in comparison to the base scenario, with the difference peaking in 2016 at about 1%. To understand this result one has to bear in mind that aggregate consumption in AEIOU II is a function of real disposable income. As figure 14.2 suggests the pronounced decline in housing investment of about -300 Mio. in combination with a rising overall price level drags down real disposable income, and consequently aggregate consumption.

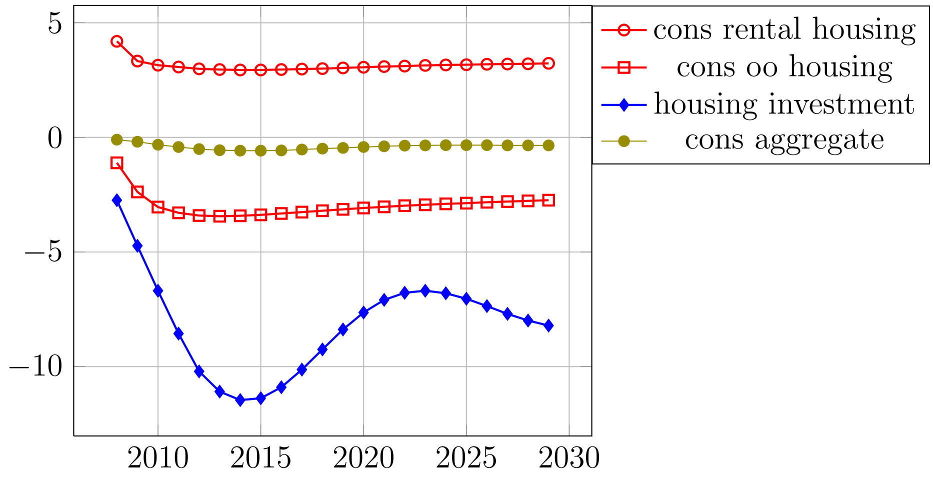

Figure 14.2: Yearly percentage deviations from base scenario (cons=consumption, oo=owner-occupier)

[3]The 10% cut multiplied with the subsidy elasticity of 0.26% approximately accounts for 2.6% of the initial impact.

[4]The estimation results suggest that long term effects are about 2.5 times higher, than the short term effects.

14.3.2 Price effects

The structure of AEIOU II also allows a closer investigation of the price effects involved in our scenario which, as mentioned above, influence real disposable income and, a forteriori, aggregate consumption. Figure 14.3 compares the percentage changes for some important prices indices, namely the CPI, the rental prices index and the construction price index.

In the introductory section we stated a typical concern regarding the price effects of subject-oriented subsidies, namely their absorption by higher rents. According to Figure 14.3 this concern is well justified: The rental price rises significantly, a direct consequence of the altered profit equation 14.3. This results is perfectly in line with **?** who pointed out that in some countries a high rise in subject-oriented subsidies led to considerable price increases.

Moreover the construction price climbs moderately. The chain of causation therefore runs as follows: Decreasing housing investment causes lower output of the construction sector. This lowers productivity of construction workers and consequently rises unit-labour-costs. This in turn rises the overall construction price index, for which these unit labour costs are the dominating ingredient. Here a vicious circle sets in: Higher construction prices drive house prices up, consequently housing investment decreases and construction output falls even lower.

The third and final price index of interest is the CPI, which can be seen to rise by about 0.5% as result of the changing subsidy structure. The major driver behind this movement is of course the elevated rental housing price, since these expenditures form a main component of the consumer basket (about 11%). Keep in mind, that rental housing prices are of outmost importance to the CPI, because these prices are imputed to assess prices of owner-occupied housing services.

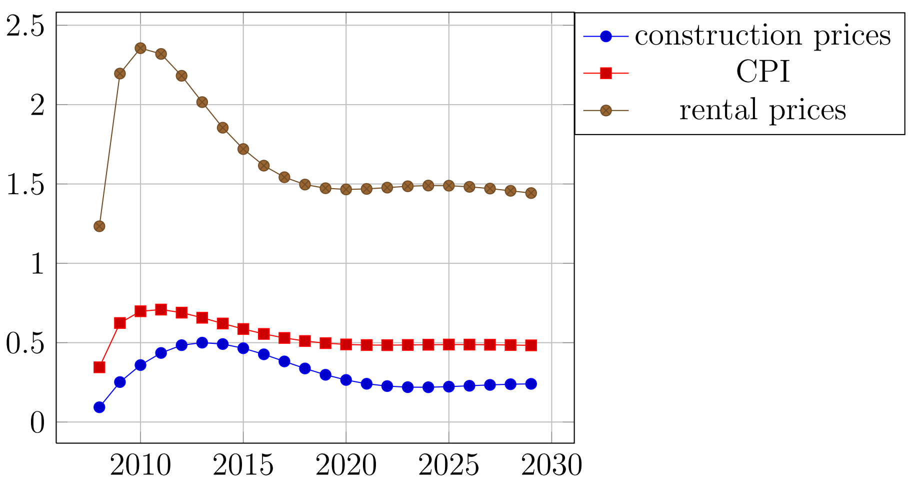

Figure 14.3: Yearly percentage deviations from base scenario.

14.3.3 Consequences for the construction sector

Figure 14.4 focuses on the effects upon the construction sector, which is relatively important in Austria compared to other industrialized countries.[5] The consequences of the alternative subsidy scheme for the construction sector are striking: Construction's real output decreases steadily from about -0.5% (-235 Mio) in 2009 to -3% (1.4 Bio) in 2014 compared to the base scenario. The drop in construction sectors profits and nominal wage sum follows the same pattern but not as pronounced as the drop in terms of output. Measured in full-time-equivalents (FTE's) employment declines relative to the base scenario by -1500 units in 2009, while the difference peaks in 2016 at about -6900 units. Altogether value added in the construction sector is 110 Mio. Euros lower in 2009, and about 250 Mio in 2014 with the major burden being carried by wages.

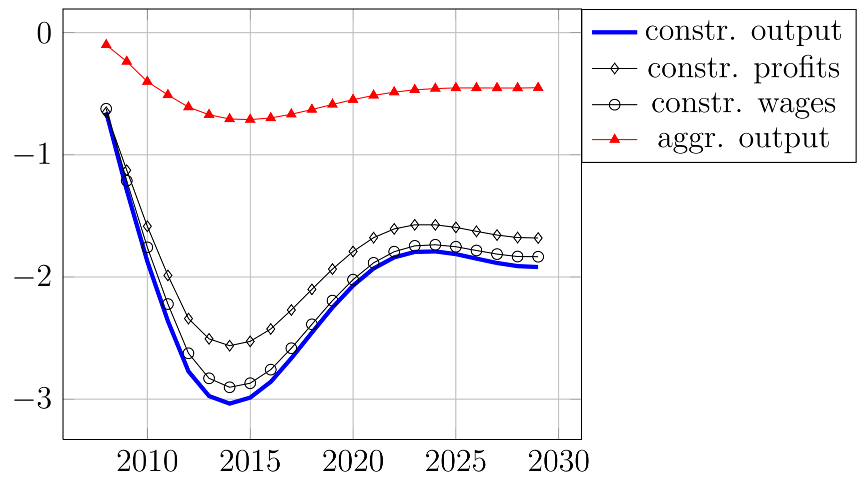

Figure 14.4: Yearly percentage deviations from base scenario (constr=construction, aggr=aggregate)

14.3.4 Overall impact

As can also be seen from figure 14.4, aggregate output too would drop as consequence of the changing housing subsidy policy. The biggest loss compared to the base scenario materializes 2015, i.e. 8 years after introduction of the alternative scenario, with a minus of 0.7% which translates into roughly -3.5 Bio. Euros. Thereafter the loss becomes a bit smaller and levels out at around -0.5% after 2025, still an impressive loss of 2.5 Bio. Euro per year compared to the base scenario. However, this negative development of aggregate output is not exclusively due to the recession of the construction sector: Also the associated plunge in the consumption of "Real estate services, market" (3.2% of Austria real gross output) contributes to this considerably.

The GDP difference (similar to total output deviation) is about −0.1% in 2009, continues to rise (in absolute value) until 2015 (−0.7%) and levels out at about −0.5%. Also unemployment is slightly elevated in the alternative scenario: The results suggest a minor initial increase compared to base case of +0.04% in 2009 which rises to +0.4 by 2016.

[5]The value added of the construction sector, employing over 250000 full time equivalents, accounts for about 8% of Austrian GDP.

The corresponding decline in FTE employement is -3000 persons in 2009 and -18900 in 2016.

14.4 Concluding remarks

The specific structuring of housing subsidies seems to matter a lot in the context of our model. As preliminary testing of the regression specification indicates, the two type of housing subsidies affect housing investment quite differently: While object-oriented subsidies significantly increase housing investment, the subject-oriented subsidies leave them unaffected. Increasing the latter in favour of the former while keeping overall subsidies constant, therefore, lowers housing investment. As the simulations show, this is not compensated by induced increase in the demand for rental housing services – the opposite is the case: These subject-oriented subsidies elevate the price level, which exerts a further negative influence upon aggregate economic activity by lowering real disposable income. These findings substantiate earlier claims, that subject-oriented subsidies, if not accompanied by other measures like price ceilings for rental housing, are largely absorbed into higher prices of the corresponding services. This does not contradict the finding, that there is indeed a positive effect of subject-oriented subsidies on the consumption of rental housing – it simply is not large enough.

Because we only modelled a few of the relevant relationships explicitly and time series information to estimate these relationships is scarce, our results should be considered tentative. Given this qualification, our key finding is that concentrating financial means on the demand side of the rental market is the right answer to future challenges in the housing sector.

Chapter 15

Outlook

Instead of a summary of this research project, which is already provided at the top of this report ("Executive summary"), a few topics for future improvement of AEIOU II are listed below. Clearly, this list at the same time also indicates some of the weak spots of the present analysis ordered by importance.

- Deploying COICOP data on consumption (available for many more years than CPA data) to improve consumption function estimation
- Improving the mark-up procedure to determine operating surplus
- Full integration of the new AEIOU II model into the BTM (this work is done by the INFORUM colleagues at the University of Maryland)
- Updating the model with data from the most recent Austrian input-output table
- Reorganizing the rather complex code base for AEIOU II or a complete switch of the codebase from Interdyme to a more common and user friendly software base (Mathematica?, R?)
- Breakdown of commodity "Real estate services, market" into "Residential rental services" and "Non-residential rental services" as the determinants of the two are obviously different.

Appendix A

List of variables

For reference purposes we shall give a full list of variables used in the AEIOU II model with description below. Most of these variables are also used in the *vectors–and–matrices*–file `vam.cfg`, which contains all necessary data for the Interdyme program. In these cases we also provide the corresponding variable name employed in the various `C++` code files plus the associated dimensionality of the variable. This, of course, is intended as reference for internal project use and is of no interest to the external reader. The latter will encounter only a few of these variables while reading this report.

A.1 Principles

- as parsimonious as possible
- if possible only one main character per variable (plus subscripts and/or superscripts)
- simpler notation for variables more often used in model description
- bold characters like $\mathbf{X}$ for matrices from basetable
- set notation $\mathbb{B}$ for bridge matrices
- consumption categories numbered consecutively 1-5 (include government consumption!)
- investment categories numbered consecutively 1-18 (include, apart from fixed capital formation, also assets and stock changes)
- calligraphic characters like $\mathcal{C}$ for variables in consumer prices (rather than producer prices)
- capital P denote price levels, small p are relative prices
- unique character for each type of variable; specific moldings through different font types
  (like the various prices P, $\widetilde{P}$, $\mathbb{P}$, p, P^*)
- Basic distinction 1: goods (= commodities = products) vs. activities (= sectors = industries)
- Basic distinction 2: producer prices (= basic prices = *Herstellpreise*) vs. consumer prices (=*Anschaffungspreise*)

A.1.1 Use of subscript Σ

The sum subscript generally serves to distinguish a vector version from a scalar version of the same variable. This, for example, distinguishes the scalar $\mathcal{P}_{\Sigma t}$, an aggregate consumer price level, from its vector counterpart $\mathcal{P}_t$, containing prices of all goods. Or, the aggregate consumption over all types of goods $\mathcal{C}_{\Sigma t}$ from the vector of consumption levels of all goods $\mathcal{C}_t$. In the latter case there is indeed a simple underlying summation, namely $\mathcal{C}_{\Sigma t} = \sum_j \mathcal{C}_{jt}$. With prices, instead, the underlying summation is a weighted one.

In all of the following tables, the columns, from left to right, contain:

Mathematical notation for variable (if any is used in this report)
Name of variable in `C++` source code (if it is part thereof)
Dimension of variable
Brief description of variable plus eventual additional info

A.2 Matrices

Matrices from Basetable 2005

$\mathbf{Z}$	`FMA`	62 62	intermediate consumption (Version A, incl. imports $= \mathbf{Z}_D + \mathbf{Z}_M$)
$\mathbf{Z}_D$	`FMB`	60 60	intermediate consumption (Version B, excl. imports)
$\mathbf{Z}_M$	`FMM`	60 60	intermediate consumption (imports only, $\mathbf{Z}_M = \mathbf{Z} - \mathbf{Z}_D$, not used in vam-file)
$\mathbf{A}$	`AMA`	62 62	direct input coefficients (Version A, incl. imports)
$\mathbf{A}_D$	`AMB`	60 60	direct input coefficients (Version B, excl. imports)
$\mathbf{A}_M$	`AMM`	60 60	import coefficients ($\mathbf{A}_M = \mathbf{A} - \mathbf{A}_D$)
$\mathbf{Z}_M$	`MFM`	60 60	imports for intermediate use (used in vam-file)
$\mathbf{m}_Z$	`MSM`	60 60	import shares in intermediate use
$\mathbf{Y}_M$	`FDM`	62 25	final demand at producer prices
$\mathbf{Y}_M$	`MFD`	60 25	imported final demand
$\mathbf{m}_Y$	`MSFD`	60 25	import shares in final demand
$\mathbf{V}_{\text{make}}$	`VMA`	60 60	make matrix
$\mathbf{D}$	`DVM`	60 60	market shares $\mathbf{D} = \mathbf{V}_{\text{make}}\check{X}^{-1}$
$\mathbf{D}^{-1}$	`DVI`	60 60	inverted market shares matrix $\mathbf{D}$
$\mathbf{C}$	`CMA`	60 60	product mix C $C = \mathbf{V}_{\text{make}}{}'\check{\tilde{X}}^{-1}$
$\mathbf{C}^{-1}$	`CMI`	60 60	inverted product mix matrix $\mathbf{C}$
$\widetilde{\mathbf{V}}$	`VAA`	60 6	value added in activities
$\mathbf{V}$	`VAP`	60 6	value added in goods
$\widetilde{\mathbf{L}}$	`EMA`	60 6	employment in activities
$\mathbf{L}$	`EMP`	60 6	employment in goods
$\mathbf{R}_A$	`LINV`	62 62	Leontief inverse (Version A)
$\mathbf{R}_B$	`LINVB`	60 60	Leontief inverse (Version B)

Bridges from consumer prices CP to producer prices PP

$\mathbb{B}_{CP}^{(C)}$	`B1CON6062HP`	62 60	private consumption: CP 60 good to PP 62 goods (use BONECON)
$\mathbb{B}_{CP}^{(G)}$	`B2CON6062HP`	62 60	public consumption: CP 60 good to PP 62 goods (use BTWOCON)
$\mathbb{B}_{CP}^{(E)}$	`BEXP6062HP`	62 60	exports: CP 60 good to PP 62 goods (use BEXP)
$\mathbb{B}_{CP}^{(I)}$	`BINV6062HP`	62 60	investment: CP 60 good to PP 62 goods (use BINV)
$\mathbb{B}_{CP}^{(\Delta)}$	`B2CHAN6062HP`	62 60	stock changes: CP 60 good to PP 62 goods (use BCHAN)

Bridges from producer prices PP to consumer prices CP

$\mathbb{B}_{PC}^{(C1)}$	`BCON6260AP`	60 62	consumption of Austrians in Austria (use BCONAP)
$\mathbb{B}_{PC}$	`BpHPtopAP`	60 60	producer to consumer price vector = $\mathbb{B}_{CP}^{(C)}[1:60,.]$ (use BHTOAP), $(\mathcal{P} = \check{P}\mathbb{B}_{PC})$;

Bridges between goods and activities at producer prices

$\mathbb{B}_{GA}$	`BG60S`	60 60	goods to activities (use BGONES)
$\mathbb{B}_{AG}$	`BS60G`	60 60	activities to goods (use BSONEG)
$\mathbb{B}_{GA}^{(57)}$	`BG57S`	57 57	goods to activities (use BGTOWS)
$\mathbb{B}_{AG}^{(57)}$	`BS57G`	57 57	activities to goods (use BSTWOG)

Bridge between investment by category and by good

$\mathbb{B}_{CG}$	`invshare`	60 15	bridge from investment by category to investment by good

A.3 Vectors

Final demand items at procuder prices

Y	`fd`	62	final demand including imports ($Y = C + I + I_\Delta + E$)
C	`cons`	62	consumption ($C = C^1 + C^2 + G + C^5$)
I	`inv`	62	investment
I_Δ	`chan`	62	changes in inventories and valuables
E	`ex`	62	exports
X	`out`	62	output $X = (1 - \mathbf{A})^{-1}(Y - M)$
X_B	`outb`	62	output version B
X^{nom}	`outnom`	60	output nominal (=out60v/P)
	`out60v`	60	output $= X_{1:60}$
G	`cgov`	62	government consumption ($G = C^3 + C^4$)
$X_\sum$	`gverw`	62	total use ($X_\sum = X + M$)
$\widetilde{X}$	`outac`	60	output by activities
$\widetilde{X}^{\text{nom}}$	`outacn`	60	output by activities, nominal

Labourmarket

$\widetilde{L}$	`empla`	60	employees by activity
$\widetilde{W}$	`wasca`	60	wages + soc.ins. by activity
	`wasca1L`	60	wages + soc.ins. by activity with LAG(1)
ζ_{FTE}	`emplTOvze`	60	transformation FTE = employees * emplTOvze
	`wape1L`	62	wages + soc.ins. by activity per employee with LAG(1)
	`empla1L`	62	employees with LAG(1)

Investment

$\widetilde{\widetilde{K}}$	`cstac`	15	capital stock by category
$\widetilde{\widetilde{I}}$	`invac`	15	investment expenditure by category

Consumption

C^1	`cpen`	62	private consumption, Austrians in Austria
$C^{1\text{nom}}$	`cpenn`	62	private consumption, Austrians in Austria, nominal
C^2	`cpef`	62	private consumption, Foreigners in Austria
C^3	`cgovc`	62	government, collective
C^4	`cgovi`	62	government, individual
C^5	`cnipsh`	62	NIPSH (non-profit institutions serving households)

Investment: Dwellings (use inv(s) + subscript)

I_{01}	`inv01v`	62	Investment Dwellings Market
I_{02}	`inv02v`	62	Investment Dwellings non Market(=owner occupiers)
I_{03}	`inv03v`	62	other buildings and structures

Investment: Machinery (use inv(s) + subscript)

I_{04}	`inv04v`	62	Machinery NACE 1-37 and 45
I_{05}	`inv05v`	62	Machinery NACE 40 and 41
I_{06}	`inv06v`	62	Machinery NACE 50-55
I_{07}	`inv07v`	62	Machinery NACE 60-65
I_{08}	`inv08v`	62	other Machinery

Investment, Transport Equipment (use inv(s) + subscript)

I_{09}	`inv09v`	62	Transport Equipment NACE 1-5
I_{10}	`inv10v`	62	Transport Equipment NACE 10-55
I_{11}	`inv11v`	62	Transport Equipment NACE 60 and 61
I_{12}	`inv12v`	62	Transport Equipment NACE 62
I_{13}	`inv13v`	62	other Transport Equipment

Assets (use inv(s) + subscript)

I_{14}	`inv14v`	62	Cultivated assets
I_{15}	`inv15v`	62	Intangible fixed assets NACE 92
I_{16}	`inv16v`	62	Other intangible fixed assets

Changes in stock (use inv(s) + subscript)

I_{17}	`chanv`	62	Changes in valuables
I_{18}	`chani`	62	Changes in inventories

Investment shares

$i_1 - i_{18}$	`---`	62	shares in the sum of the investment categories from above

Exports

E_G	`egood`	62	Exports Goods
E_S	`eserv`	62	Exports Services

Taxes and subsidies on goods

T	`gtax`	60	taxes on products, intermediate use only
S	`gsub`	60	subsidies on products, intermediate use only
tax	`Btax`	60	product taxes as shares of corresponding items (see section 7.6)
sub	`Bsub`	60	product subsidies, shares of corresponding items (see section 7.6)
T^{net}	`gotax`	60	taxes − subsidies on products, intermediate use only
t^{net}	`gotaxs`	60	as above but shares in total output ($t^{\text{net}} = (V_T - V_S)/X^{\text{nom}}$)

Final demand at consumer prices

$\mathcal{Y}$	`fdcp`	60	final demand ($\mathcal{Y} = \mathcal{C} + \mathcal{I} + \mathcal{I}_\Delta + \mathcal{E}$)
y	`fds`	62	final demand , shares
$\mathcal{C}$	`conscp`	60	consumption ($\mathcal{C} = \mathcal{C}^1 + \mathcal{C}^2 + \mathcal{G} + \mathcal{C}^5$)
c	`conss`	62	consumption , shares of relevant consumption column
$\mathcal{I}$	`invcp`	60	investment ($I = \mathbb{B}_{CP}^{(I)}\mathcal{I}$)
$\widetilde{\mathcal{I}}$	`invcpa`	60	investment by activity ()
$\approx\mathcal{I}$	`invcpc`	60	investment by category (15) (see ch. 4,)
i	`invs`	62	investment, shares
$\mathcal{G}$	`cgovcp`	60	consumption by government
$\mathcal{I}_\Delta$	`chancp`	60	change of inventories and valuables
i_Δ	`chans`	62	change of inventories and valuables, shares
$\mathcal{E}$	`exfob`	60	exports fob ($E = \mathbb{B}_{CP}^{(E)}\mathcal{E}$)
e	`exs`	62	exports, shares of relevant investment columns (no extra command)
$\mathcal{E}_G$	`exfobwa`	60	export of goods, fob
e_G	`egoods`	62	export of goods, shares (no extra command)
$\mathcal{E}_S$	`exfobdl`	60	export of services, fob
e_S	`eservs`	62	export of services, fob, shares (no extra command)
$\mathcal{X}$	`outcp`	60	output
$\widetilde{\mathcal{X}}$	`outcpa`	60	output by activity ()
$\approx\mathcal{X}$	`outcpc`	60	output by investment category()

Consumption at consumer prices

$\mathcal{C}^1$	`cpencp`	60	private consumption expenditure, Austrians in Austria
c_1	`cpens`	62	private consumption expenditure, Austrians in Austria, shares (no extra command)
$\mathcal{C}^2$	`cpefcp`	60	private consumption expenditure, foreigners in Austria
c_2	`cpefs`	62	private consumption expenditure, foreigners in Austria , shares (no extra command)
c_3	`cgovcs`	62	collective consumption by government, shares (no extra command)
c_4	`cgovis`	62	individual consumption by government, shares (no extra command)
$\mathcal{C}^5$	`cnipshcp`	60	consumption by NIPSH (Non-profit institutions serving households)
c_5	`cnipshs`	62	consumption by NIPSH (Non-profit institutions serving households) , shares (no extra command)

Imports, cif

M	`imp`	62	imports (intermediate plus final demand)
m	`imps`	62	import shares ($M \overset{\leftarrow}{=} mX_{\sum}$)
M_{60}	`impcif`	60	imports ($M_{60} = M_{1:60}$)
$Z_M^{\downarrow}$	`impf`	60	imports, column sums of intermediate consumption
$Y_M^{\downarrow}$	`impfd`	25	imports, column sums of final demand
M_S	`impdl`	60	imports of services
M_G	`impwa`	60	imports of goods

Value added items (nominal and by goods if nothing else indicated)

V	`va`	60	value added, aggregate ($V = V_W + V_{Soc} + V_T - V_S + V_D + V_\Pi$)
$V_{\sum}$	`vag`	60	value added
$\widetilde{V}$	`vaac`	60	value added by activities
	`va60g`	60	value added
	`va60a`	60	value added by activities
V_W	`vwage`	60	wages and salaries
v_W	`vlabis`	60	wages and salaries, shares (no extra command)
V_{Soc}	`vsoci`	60	employers' social contributions
v_{Soc}	`vsocis`	60	employers' social contributions, shares (no extra command)
V_W	`vwaso`	60	wages + employers' social contributions ($V_W = V_W + V_{Soc}$)
$\widetilde{W}$	`wasca`	60	wages + employers' social contributions by activities
V_T	`votax`	60	other taxes on production
v_T	`votaxs`	60	other taxes on production, shares
V_S	`vosub`	60	other subsidies on production
v_S	`vosubs`	60	other subsidies on production, shares
$\widetilde{V}_{T-S}$	`vataxsub`	60	other net taxes on production by activities
$\tilde{v}_{T-S}$	`vataxsubs`	60	as above in shares of total nominal output
V_D	`vcoca`	60	consumption of fixed capital
v_D	`vcocas`	60	consumption of fixed capital, shares
$\widetilde{V}_D$	`vacoca`	60	consumption of fixed capital by activities
$\widetilde{v}_D$	`vacocas`	60	as above in shares of total nominal output
V_Π	`vosur`	60	net operating surplus
v_Π	`vosurs`	60	net operating surplus, shares
$\widetilde{\Pi}$	`vaosur`	60	net operating surplus in activities
$\tilde{\pi}$	`vaosurs`	60	shares of the above in total nominal output
$\widetilde{\Pi}_{HH}$	`vaosph`	60	net operating surplus of private households in activities
$\widetilde{\pi}_{HH}$	`vaosphs`	60	shares of the above in

A.4 Extra variables for time series

Auxiliary variables

bpwg	60	gross output by goods at producer prices)
bpwa	60	gross output by activity
bpw60g	60	gross output by good
bpw60a	60	gross output by activity
bpwanom	60	gross output by activity nominal
bpw57v	57	gross output at producer prices
bpwac57v	57	gross output at producer prices
bpw60v	60	gross output at producer prices
bpw62v	62	gross output at producer prices
exwa	60	exports of goods
exdl	60	exports of services

Prices

P_{aux}	`p`	60	mixed prices of consumption goods (consumer prices after imports but before margins)
P	`pd`	60	domestic prices (pd=outn/outr) immediate result of application of Leontief inverse
P^*	`pm`	60	import prices (no extra command)
$\mathcal{P}$	`pcph`	60	price of consumption of private households by good = P, see 7.11
p	`rpri`	60	relativ prices ($p = \mathcal{P}/\mathcal{P}_{\text{CPI}}$) by good
p^*	`rpm`	60	relativ importprices rpm = pm / pd (no extra command)
p^*_G	`rpmw`	60	relativ importprices of goods rpmw = pmwa / pd
P^*_G	`pmwa`	60	import prices of goods
P^*_S	`pmdl`	60	import prices of services (actually used: domestic prices of services)
$\mathcal{P}_{\text{CPI}}$	`fddefl`	1	CPI ()
P_{GDP}	`gdpdefl`	1	GDP deflator ()
$\stackrel{\approx}{P}{}^{out}$	`piout`	15	output prices for each of 15 investment categories
$\stackrel{\approx}{P}{}^{inp}$	`piinp`	15	input prices for each of 15 investment categories
$P_I^{(15)}$	`iresi`	15	price index for each of 15 investment categories

Auxiliary variables

	`ny`	60	auxiliary variable
T_N	`ntrend`	60	Nyhus trend
	`ntrend1L`	60	Nyhus trend with 1 Lag
	`outfd`	62	output (real) of last iteration step
	`x`	62	auxiliary variable
	`vi`	60	auxiliary variable
	`vm`	60	auxiliary variable
Y_{GDP}	`gdp`	1	Gross domestic product, real
$Y_{\text{GDP}}^{\text{nom}}$	`gdpnom`	1	Gross domestic product, nominal

Appendix B

The role of prices in Input-Output models

The emergence of traditional input-output models dates back to **??**. A distinguished feature of these models is the assumption of fixed input coefficients, i.e. the models assume that the inputs are bought by producers in fixed proportions. This assumption allows for modelling the impact of a given final demand change on the total production. Since the final demand is the driving force in the model, the Leontief model is also labelled "demand-driven".

While Leontief's model is a "quantity" model and was originally formulated in terms of physical units, it is possible to introduce prices into consideration. First, for practical applications, it might be convenient to reformulate the model into monetary terms. Also, the dual to the original model gives rise to its "price" version that can be used to simulate cost-push inflationary processes. The interpretation of prices in this price model depends on whether the quantities in the model are formulated in physical or monetary units. If physical units are used, the prices in the dual model are true economic prices. If, however, a monetary formulation is used, the prices in the price model are only "index" prices.

The existence of both quantity and price Leontief models raised the question of their interdependence. While **?** points out that the two models work independently, he also introduces a pair of functions (called "final demand function" and "output function") that relate the two models making them interdependent. A number of modern input-output models work with a generalized or modified version of this approach.

An alternative input-output model was presented by **?**. As opposed to the traditional assumption of fixed input coefficients, Ghosh considers the case of fixed output coefficients. While this model is admittedly plausible for only a limited array of applications[1], a further research of Ghoshian input-output models proves relevant as it introduces new pricing concepts. Specifically, some variations of the Ghosh model work with a concept of "input prices" as opposed to standard "output prices" employed in Leontief models. While the traditional "output price" is a price of commodity sold by sellers and affecting the whole row of the input-output table, the "input price" is a price that is controlled by buyer and that affects the whole column of the input-output table.

Similarly to the Leontief model, the Ghosh model comes in both the quantity and the

[1] For the discussion on plausibility of the Ghosh model, we refer the reader to the discussion represented by **?**, **?**, **?** and **?**.

price version. A summary of all four models is given in ?. Furthermore, ?, working with a slightly different interpretation of the Ghosh models, develops an iterative process to arrive to a general equilibrium.

The rest of this paper is organized as follows. In Sections 1 and 2, we discuss the theoretical developments outlined above more in detail. In Sections 3 to 6, we briefly discuss selected pricing aspects of the following INFORUM models:

- The TIDY model of the Thai economy as explained in the dissertation ?.
- The LIFT model of the U.S. economy as described in ? and ?. An older version of the LIFT model can be found in ?.
- The MuDan model of the Chinese economy as presented in the dissertation ?.
- The INFORGE model of the German economy as outlined in ?.

  dissertation ?.

B.1 Notation and the Leontief model

While we assume the reader to be familiar with the standard Leontief model, we find it useful to briefly introduce the concept in order to establish the notation used throughout the theoretical part of the paper. For convenience, we introduce the monetary version of the model which works with index prices. We make reference to a model formulated in terms of physical units whenever appropriate. Schematically, the notation used for the economy's input-output table in monetary terms is introduced in Figure B.1.

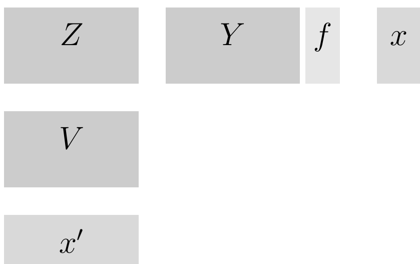

Figure B.1: General structure of the I-O table in monetary units

Specifically, we assume a closed economy with n intermediate sectors (industries), q final sectors (final demand categories) and r primary sectors (value added categories). We let Z be an $n \times n$ matrix of inter-industry flows, Y an $n \times q$ matrix of final demand uses and V an $r \times n$ matrix of flows between primary inputs and industry sectors. All variables are assumed to be in monetary units. Finally, we assume x to be an n-vector of total output. Then, the central accounting identity of the Leontief model (for a given base year) reads:

$$x = Z\,\mathbf{e}_n + Y\,\mathbf{e}_n = Z\,\mathbf{e}_n + f \tag{B.1}$$

where $\mathbf{e}_n$ is a summation vector (i.e., an n-vector of ones) and f denotes the n-vector of total final demand in monetary units. Simply put, for any industry i, its gross output x_i is equal to the industry's sales to other sectors, $\sum_j z_{ij}$, plus industry's output to final uses, $f_i = \sum_k y_{ik}$.

In compliance with standard input-output literature, we define direct input coefficients matrices A and C as follows:

$$A = Z\,\hat{x}^{-1}, \tag{B.2}$$
$$C = V\,\hat{x}^{-1}, \tag{B.3}$$

where $\hat{x} = Diag(x)$. In words, the input coefficient $a_{ij} = z_{ij}/x_j$ measures the value of output of sector i consumed by sector j as a fraction of buyer's total output. Under the assumptions of the Leontief model, this coefficient remains stable[2]. Using (B.2), it is possible to rewrite initial accounting identity (B.1) in terms of input coefficients A. We get

$$x \;=\; A\,x + f. \tag{B.4}$$

We note that (B.4) can be viewed both as a simple accounting identity evaluated at a given base year or (under the assumption that the input coefficients remain stable) as an equilibrium condition relating final demand and total output. To highlight this relationship, we rewrite the identity as follows

$$x = (I - A)^{-1}\,f. \tag{B.5}$$

The expression above is referred to as the first fundamental input-output identity. Assuming fixed input coefficients A and exogenous final demand f, equation (B.5) models the total amount of production necessary to meet this demand. In this interpretation, total production x becomes endogenous variable. Similarly, using equation (B.3), the value added matrix can be evaluated endogenously.

While the Leontief quantity model is based on the accounting identity along rows of the input-output table, its price version is based on the accounting identity along its columns. Specifically, the identity reads

$$p'\hat{x} = p'\,Z + p_v'\,V \tag{B.6}$$

where p is an n-vector of sectoral "index" prices and p_v is an r-vector of index prices for primary inputs (such as index price of labor, etc.)[3]. Using definition of direct input coefficients A and C, we rewrite the right-hand side of the above identity to $p'\,A\,\hat{x} + p_v'\,C\,\hat{x}$. Then, by post-multiplication of the expression by $\hat{x}^{-1}$, we obtain

$$p' = p'\,A + p_v'\,C \tag{B.7}$$

and finally

$$p' = p_v'\,C\,(I - A)^{-1}. \tag{B.8}$$

[2]We note that the assumption of the input coefficients stability is arguably better substantiated for the model expressed in physical terms. Using $\bar{z}_{ij} = z_{ij}/p_i$ and $\bar{x}_j = x_j/p_j$ as "physical units" counterparts to monetary variables z_{ij} and x_j, the direct input coefficient for the "physical units" model is defined as $\bar{a}_{ij} = \frac{\bar{z}_{ij}}{\bar{x}_j} = a_{ij}\frac{p_j}{p_i}$. The economic interpretation of $\bar{a}_{ij}$ is straightforward (i.e., the number of units of commodity i necessary to produce one unit of commodity j) and the stability of $\bar{a}_{ij}$ appears to be more warranted than the stability of a_{ij}.

[3]Since the model is formulated in monetary rather than physical terms, it is required to use index prices rather than true prices. In particular, had we be using physical units variables $\bar{Z}$, $\bar{x}$ and $\bar{V}$ instead of monetary variables Z, x and V, the total cost identity would have been formulated $\bar{p}'\,\hat{\bar{x}} = \bar{p}'\,\bar{Z} + \bar{p}_v'\,\bar{V}$ with $\bar{p}$ and $\bar{p}_v$ vectors of true prices of commodities and factors, respectively. In the present formulation, however, we use index prices that relate the magnitudes of current and base-period prices. A comparison of formulations of different input-output models both in monetary and physical terms is given by **?**. We note that index prices are sometimes referred to as "latent" prices – such as in **?**.

The expressions above are also referred to as the second fundamental input-output identity. Assuming fixed A and C and given exogenous factor prices p_v, the solution to (B.8) determines endogenously output prices p. The logic here is straightforward. An exogenous price change to primary inputs (such as labor) affects directly production unit costs where the magnitude of the change is determined by the primary input coefficients matrix C. This price change further propagates in the system as the prices of intermediate inputs change. The cumulative effect of these secondary changes is accounted for by the "Leontief-inverse" matrix, $(I - A)^{-1}$. Put together, the total "cost-push" process is described by equation (B.8). We summarize both Leontief models below.

Leontief quantity ("demand-driven") model:			
exogenous f	$\rightarrow$	$x = (I - A)^{-1} f$	(assuming fixed A)
		$V = C\,\hat{x}$	(assuming fixed C)
Leontief price ("cost-push") model:			
exogenous p_v	$\rightarrow$	$p' = p_v'\, C\,(I - A)^{-1}$	(assuming fixed A and C)

Table B.1: Summary of Leontief models

To shed some light on the relationship between Leontief price and quantity models, we multiply (B.8) by f. We obtain

$$p' f \;=\; p_v'\, C\,(I - A)^{-1} f \;=\; p_v'\, C\, x \;=\; p_v'\, V \mathbf{e}_n \tag{B.9}$$

since $C\,x = C\,\hat{x}\,\mathbf{e}_n = V\mathbf{e}_n$. We note that (B.9) can be interpreted in two ways. On one hand, it demonstrates the equality of the total value of final output and the total value of primary inputs. On the other hand, it shows the independency of the price and quantity model. Despite being linked through (B.9), we have p determined from p_v via (B.8) and x and V determined separately from f via (B.5). This independence was pointed out by **?**. In order to bridge this gap, Yamada suggested a pair of functions (called "final demand function" and "output function") relating the models. We discuss these developments below.

B.1.1 Yamada integrated (equilibrium) model

First, we note that Yamada works with the initial input-output table formulated in physical quantities. Using the notation introduced in footnotes 2 and 3, the Leontief quantity and price models in "physical units" terms take the following form[4]:

$$\bar{x} = \bar{A}\bar{x} + \bar{f} \quad \Leftrightarrow \quad \bar{x} = (I - \bar{A})^{-1} \bar{f}, \tag{B.10}$$

$$\bar{p}' = \bar{p}'\,\bar{A} + \bar{p}_v'\,\bar{C} \quad \Leftrightarrow \quad \bar{p}' = \bar{p}_v'\,\bar{C}\,(I - \bar{A})^{-1}. \tag{B.11}$$

Recall that $\bar{x}$ and $\bar{f}$ are n-vectors of total output and total final demand, respectively, measured in physical units, $\bar{p}$ and $\bar{p}_v$ are vectors of actual (true economic) prices of com-

[4]For full disclosure, Yamada's exact price model formulation slightly differs from (B.11). This is because he does not consider factor prices $\bar{p}_v$ explicitly. Rather, he assumes a single primary input with its price implicitly equal to 1.

modities and factors and $\bar{A} = \bar{Z}\,\hat{\bar{x}}^{-1}$ and $\bar{C} = \bar{V}\,\hat{\bar{x}}^{-1}$ are direct input coefficients matrices corresponding to the model in physical units.

To integrate the two separate models, Yamada introduces two additional relationships. First, to relate prices and final demand, he introduces a "final demand function". In particular, each final demand component $\bar{Y}^k = (\bar{y}_{1k}, \ldots, \bar{y}_{nk})'$, is assumed to be expressed as a linear function of prices. As a result, it is assumed that the total final demand, $\bar{f} = \sum_{k=1}^{q} \bar{Y}^k$ can be expressed as a linear function of prices. In symbols, we have

$$\bar{f} \;=\; \alpha^0 + \sum_{i=1}^{n} \alpha^i\,\bar{p}_i \tag{B.12}$$

where α^0, α^1, ..., α^n are all n-vectors of parameters to be estimated. Specifically, α^0 is the intercept vector and α^i for any $i \in \{1, \ldots, n\}$ is a vector of marginal final demands with respect to price $\bar{p}_i$. It is suggested by Yamada that these parameters can be estimated using ordinary least-squares method from past statistical data.

Similarly, Yamada introduces an "output function" to model the relationship between prices and total output. Specifically, he formulates total output $\bar{x}$ as a linear function of prices. We have

$$\bar{x} \;=\; \beta^0 + \sum_{i=1}^{n} \beta^i\,\bar{p}_i \tag{B.13}$$

Again, β^i for $i \in \{0, \ldots, n\}$ are n-vectors of parameters to be estimated by ordinary least-squares method from past statistical data.

Yamada observes that the whole model then consists of four systems of equations, (B.10)–(B.13) with four endogenous variables, $\bar{x}$, $\bar{f}$, p and $\bar{p}_v$. From (B.10), (B.12) and (B.13), it is possible to derive a closed-form solution for $\bar{p}$ that can be then plugged back to other formulas to derive solutions for $\bar{x}$, $\bar{f}$ and $\bar{p}_v$.

B.2 Ghosh model and its implications

As an alternative to the traditional Leontief "demand-driven" input-output model, **?** introduced a model that is often referred to as "supply-driven"[5] by the input-output literature. While the underlying assumption of the Leontief model is that the inputs are bought by producers in fixed proportions, the Ghosh model assumes a fixed allocation of sectoral outputs over sectors. This assumption allows to model total input endogenously given exogenous primary inputs.

of each unit of output in sector i allocated to sector j.

features: ("latent") prices is required.

We note that the Ghosh model also comes with an alternative notion of prices. Recall that the prices (index or true) in the Leontief model are defined along the rows so that p_i (or p_i) is the (index) price of commodity i sold to other sectors and to final demand. By contrast, the prices in the Ghosh model are by default defined along columns of the input-output table. To distinguish between the two methods, **?** coins the term "input prices" for the Ghoshian approach and "output prices" for the approach used in standard

[5]Ghosh himself used the term "allocation model".

Leontief model. We interpret the input price p_j^d as the index price to which sector j buys all its inputs[6].

To make this interpretation work, **?** points out that other variables from the Leontief model need to be re-interpreted as well. Most importantly, the model with input prices requires considering a single homogenous input and multiple outputs for each sector – as opposed to a single homogenous output and multiple inputs characteristic for each sector of the Leontief model. Furthermore, **?** offers the following interpretations for relevant variables:

- z_{ij} = the value of the flow of commodity j bought by agent j from agent i;
- x_j = the value of the total input of agent j;
- y_{ik} = the value of a residual $(n+k)$-th commodity bought by a residual $(n+k)$-th agent from agent i;
- p_{y_k} = the price of the agent "k-th final demand category" where $p_y = (p_{y_1}, \dots, p_{y_q})'$.

The starting point of the Ghosh model is the following base-year accounting identity for total input

$$x' \;=\; \mathbf{e}_n' Z + \mathbf{e}_r' V \;=\; \mathbf{e}_n' Z + v' \tag{B.14}$$

where $v' = \mathbf{e}_r' V = (v_1, \dots, v_n)$ is an $1 \times n$ row vector of total value of primary inputs. The basic assumption of the Ghoshian "supply-side" approach is that the allocation coefficients b_{ij} are stable so that any change to the output of sector i is followed by a corresponding proportional change of sales from sector i to all other sectors. We define the allocation coefficients as follows:

$$B = \hat{x}^{-1} Z, \tag{B.15}$$

$$D = \hat{x}^{-1} Y. \tag{B.16}$$

Substituting (B.15) back to (B.14) yields $x' = \mathbf{e}_n' \hat{x}\, B + v' = x'B + v'$. This gives rise to the Ghosh quantity model:

$$x' \;=\; v'(I - B)^{-1}. \tag{B.17}$$

The formula above models the relationship between exogenous variable v and endogenous variable x. In particular, the Ghosh model assumes exogenous primary inputs and via (B.17) produces a solution for endogenous total inputs. Furthermore, using (B.16), the model is capable of obtaining endogenous final demand as well.

Just as for the Leontief model, there exists a price version of the Ghosh model. To this aim, we consider the accounting identity for the value of total revenue. Keeping the interpretation of the input prices in mind, we have

$$\hat{x}\, p^d = Z\, p^d + Y\, p_y \tag{B.18}$$

where p^d denotes the n-vector of input index prices and p_y the q-vector of index prices for final demand categories. Substituting both (B.15) and (B.16) into (B.18), we obtain $\hat{x}\, p^d = \hat{x}\, B\, p^d + \hat{x}\, D\, p_y$ which can be simplified into

$$p^d = B\, p^d + D\, p_y. \tag{B.19}$$

[6]The Ghosh model is by default formulated in monetary terms and hence the use of index prices is required. The use of superscript d is due to **?** who refers to input prices as demand prices.

Solving the above equation for p^d we obtain

$$p^d = (I - B)^{-1} D\, p_y. \tag{B.20}$$

Equation (B.20) models the cumulative effects of changes in final output prices on the sectoral input prices. Therefore, the model above is referred to as "demand-pull input-output price model". For future reference, we summarize the two Ghosh models below.

Ghosh quantity ("supply-driven") model:			
exogenous v	$\rightarrow$	$x' = v'(I - B)^{-1}$	(assuming fixed B)
		$Y = \hat{x}\, D$	(assuming fixed D)
Ghosh price ("demand-pull") model:			
exogenous p_y	$\rightarrow$	$p^d = (I - B)^{-1} D\, p_y$	(assuming fixed B and D)

Table B.2: Summary of Ghosh models

We note that the plausibility of the Ghosh (quantity) model has been suspect in the input-output literature. The debate between **??** and **?** and **?** illustrates this point. The main issue with the Ghosh formulation is that an increase to any single primary input, such as j, is transmitted forward to all sectors that buy from j without any corresponding primary input increases. **?** tries to overcome the criticism by reinterpreting the Ghosh (quantity) model as a price model. However, **?** shows that this result was obtained under simplified assumptions and does not apply in general. Also, **?** and **?** argue that much of the implausibility debate was caused by misunderstanding of Ghosh's original findings. In fact, they claim that Ghosh was well aware of the limitations of his model and envisioned it to be applied only to "an economic system of the central planning type where the issue was coherent distribution of output rather than the efficient allocation of inputs".

B.2.1 Davar's General Equilibrium

Despite reservations voiced above, **?** presented a general equilibrium model combining the two Leontief and the two Ghosh models. To proper understand his reasoning, we list Davar's interpretation of the four models in Table B.3.

Model's type	Equation	Davar's interpretation
Leontief quantity	(B.5)	Demand I-O Model
Leontief price	(B.8)	Supply Price I-O Model
Ghosh quantity	(B.17)	Supply I-O Model
Ghosh price	(B.20)	Demand Price I-O Model

Table B.3: Interpretation of the models according to **?**

Furthermore, to differentiate between supply and demand quantities and prices, it is necessary to introduce additional notation. The expanded notation is schematically depicted in Figure B.2.

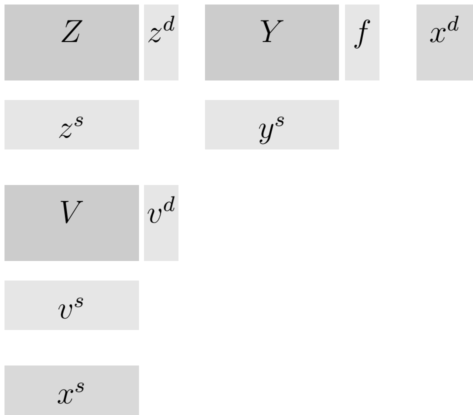

Figure B.2: Graphical representation of (modified) Davar's notation

For instance, we have x^d the column vector of gross output (total production) in order to meet final demand and x^s the row vector of gross input (total production), in order to use primary inputs. Other new variables have similar interpretations. We note that Davar explicitly assumes all variables to be in monetary terms.

Using this notation, Davar works with the following models:

- **Leontief's quantity ("demand") model:** Assuming $A = Z(\hat{x}^d)^{-1}$ and $C = V(\hat{x}^d)^{-1}$ are fixed direct input coefficients, the model prescribes

$$x^d = (I - A)^{-1} f. \tag{B.21}$$

  for exogenous f. Furthermore, this implies $v^s = \mathbf{e}_r V = \mathbf{e}_r C \hat{x}^d$.

- **Leontief's price ("supply") model:** For exogenous p_v, we have

$$p^s = p_v' C (I - A)^{-1}. \tag{B.22}$$

  Furthermore, Davar derives identity $\hat{p}^s f = Y p_y$ which, under certain conditions of regularity, implies unique price vector p_y for a given exogenous p^s.

- **Ghosh quantity ("supply") model:** Assuming $B = (\hat{x}^s)^{-1} Z$ and $D = (\hat{x}^s)^{-1} Y$ are fixed direct output coefficients, the model prescribes

$$x^s = v^s (I - B)^{-1}. \tag{B.23}$$

  for exogenous v^s. Furthermore, this implies $Y = x^s D$ or $f = x^s D \mathbf{e}_q$.

- **Ghosh price ("demand") model:** For exogenous p_y, we have

$$p^d = (I - B)^{-1} D p_y. \tag{B.24}$$

  Furthermore, Davar derives identity $v^s \hat{p}^d = p_v' V$ which, under certain conditions of regularity, implies unique price vector p_v for a given exogenous p^d.

Model's type		"Exogenous" variable						Derived variable
"Demand"	Leontief quantity	goods demand from a "demand curve"	$f(\cdot)$	$\xrightarrow{(I-A)^{-1}f=}$	x^d	$\xrightarrow{\mathbf{e}_r C\hat{x}^d=}$	$\tilde{v}^s$	implied factor demand
	Ghosh price	demand's "price" from a "demand curve"	$p_y(\cdot)$	$\xrightarrow{(I-B)^{-1}Dp_y=}$	p^d	$\xrightarrow{v^s\hat{p}^d=p_v'V}$	$\tilde{p}_v$	implied factor price
"Supply"	Ghosh quantity	factor supply from a "supply curve"	$v^s(\cdot)$	$\xrightarrow{v^s(I-B)^{-1}=}$	x^s	$\xrightarrow{x^s D\mathbf{e}_q=}$	$\tilde{f}$	implied final demand
	Leontief price	factor "price" from a "supply curve"	$p_v(\cdot)$	$\xrightarrow{p_v'C(I-A)^{-1}=}$	p^s	$\xrightarrow{\hat{p}^s f=Yp_y}$	$\tilde{p}_y$	implied demand's price

Table B.4: Davar's equilibrium model

All four models with their implications are summarized below.

Davar suggests a two-stage iterative procedure to attain the general equilibrium. In the first stage, the two "demand" models are executed. The starting values $f(\cdot)$ and $p_y(\cdot)$ are chosen according to (not clearly specified) demand curves, presumably evaluated at the current price/quantity estimates. At the conclusion of this stage, new estimates $\tilde{v}^s$ and $\tilde{p}_v$ are calculated and compared with the values implied by the "supply curves". If they are consistent, the equilibrium is reached. Otherwise, the second stage is triggered. In the second stage, the two "supply" models are run. Starting with initial values $v^s(\cdot)$ and $p_v(\cdot)$, the stage returns implied estimates $\tilde{f}$ and $\tilde{p}_y$. Again, if these are consistent, the procedure stops. Otherwise, the iteration gets back to stage 1.

Finally, we note that the default conditions for the general equilibrium require $x^s = (x^d)'$ and $p^s = p^d$. However, Davar claims that it is sufficient for the algorithm to reach one of the following two conditions:

(1) $\tilde{V}^{(t)} = V^{(t)}$ and $|\tilde{p}_v^{(t)} - p_v^{(t)}| < \varepsilon$ for all $\tilde{p}_v^{(t)} < p_v^{(t)}$, or

(2) $\tilde{Y}^{(t)} = Y^{(t)}$ and $|\tilde{p}_y^{(t)} - p_y^{(t)}| < \varepsilon$ for all $\tilde{p}_y^{(t)} > p_y^{(t)}$,

for some iteration t and a given precision measure ε.

We conclude this section by noting that while Davar's equilibrium concept seems interesting, we are not aware of any application of the model in reality. Similarly, we are not aware of any INFORUM model that would make use of the Ghosh model. All models discussed below use standard Leontief framework with the assumption of fixed input coefficients.

B.3 The TIDY model of the Thai economy

In this section, we discuss the Thailand Interindustry Dynamic model (TIDY) as introduced in ?. The model works with the standard Interdyme framework featuring three main components: the real side, the price-income side and the accountant.

The real side of the model is concerned with estimating final demand components and calculating sectoral outputs. Some of this estimation relies on prior guesses (or estimates) on prices, outputs and disposable income. After final demand components are established, the model iteratively estimates sectoral outputs of the economy by solving the first fundamental input-output identity of the following form[7]:

$$x^R = A^R x^R + f^R. \tag{B.25}$$

Then, for calculated sectoral outputs, corresponding labor productivity and labor requirements (employment) are established. Finally, the real side of the model concludes with estimation of unemployment. The data are then passed on to the price-income side of the model.

The price-income side of the model is concerned with estimating value-added components and calculating prices of sectoral outputs. First, the value-added components (factor payments to primary inputs) are estimated. Then, the sectoral prices are calculated by iteratively solving the second fundamental input-output identity[8]

$$p' = p' A^R + v'. \tag{B.26}$$

The final part of TIDY is the accountant. It aggregates sectoral variables from both the real and price-income side to macro variables according to national income accounting. Real and nominal GDP, personal disposable income and personal savings are among the macro variables calculated by the accountant. The model loop ends here. If the calculated results are consistent with the initial guesses, the model proceeds to next time period. If the data is inconsistent, a new iteration is initiated with improved guesses.

Figure B.3 depicts the main components of the model as well as the simulation procedure for time period t. In what follows, we briefly describe the main components of the model, while emphasizing the parts that are concerned with prices. We first take a look on how prices affect sectoral outputs and other variables in the real-side of the economy, and then proceed to the issue of price calculation in the price-income side.

B.3.1 The real side of the TIDY model

As depicted in Figure B.3, the principal tasks of the real side are:

(a) Estimate final demands at time period t.

(b) Calculate sectoral outputs at time period t using (B.25).

(c) Estimate employment-related variables at time period t.

[7] We use the "real terms" (or "constant price") notation for quantitative variables as the I-O tables in TIDY are formulated in "real" terms (specifically, in constant 1990 prices) which is equivalent to measuring products in physical units. We note that in order to avoid the "double deflation" approach, **?** calculates all "constant-price" value added components by deflating their nominal counterparts by the same price index, the GDP deflator.

[8] We use p rather than $\bar{p}$ to denote prices as TIDY works with relative prices with respect to the base year 1990. Also, we note the TIDY version of price identity (B.26) slightly differs from its theoretical counterpart (B.7). We defer the discussion of this difference to Section B.3.2.

The direct input coefficients matrix A^R is derived from a 26×26, product-to-product, input-output table(s) of Thailand economy. These tables are produced every 5 years[9]. While the tables are initially provided in purchaser prices, they are transformed into producer prices by subtracting trade and transportation margins from the original table. Furthermore, the input-output tables are adjusted to constant 1990 prices. As a result, real outputs are obtained when solving identity $x^R = A^R x^R + f^R$. To get there, we need to estimate (exogenous) variable f^R. The TIDY model works with the final demand categories listed in Table B.5.

Final demand category	Sectors	Influences
Private consumption	33	personal disposable income, **relative prices**, time trend
Fixed investment	11	(change in) product outputs, capital stocks
Inventory change	26	(change in) final sales
Government expenditures	26	exogenous
Exports	26	exogenous
Special exports	26	exogenous
Imports	26	output

Table B.5: Final demand categories in the TIDY model

We note that some of the components are explicitly or implicitly dependent on output. This creates a need to introduce additional loops when solving identity $x^R = A^R x^R + f^R$. However, since we are primarily concerned with the role of prices in the Inforum models, we refrain from analyzing this phenomenon. Rather, we discuss estimation of consumption – the only final demand category explicitly dependent on (relative) prices.

B.3.1.1 Estimating Private Consumption

The personal consumption is modelled by the Perhaps Adequate Demand System (PADS). The approach along with its possible modifications and extensions is discussed in detail in **?**, **?** and **?**.

In short, the PADS assumes that personal per capita consumption of a given good is a function of real income, change in real income, time trend, good's own price, relative prices of complementary goods and relative prices of substitute goods.

Specifically, for $\tilde{c}_k^R$ per capita consumption (in 1990 prices) in consumption category k, we have

$$\begin{aligned} \tilde{c}_{k,t}^R = & \left(\alpha_k(t) + \beta_k \left(\frac{y^N}{P} \right) + \gamma_k \, \Delta \left(\frac{y^N}{P} \right) + \delta_k \, t \right) \left(\frac{p_k}{P} \right)^{-\lambda_i} \\ & \times \prod_l \left(\frac{p_k}{p_l} \right)^{-\lambda_l \, s_l} \left(\frac{p_k}{P_G} \right)^{-\mu_G} \left(\frac{p_k}{P_g} \right)^{-\nu_g} \end{aligned} \tag{B.27}$$

where

[9] Consequently, exact direct input coefficients are only available once every 5 years. For years within any of these 5-year intervals, **?** estimates A^R by linear interpolation. For years beyond the range of published data, the coefficients are projected by a logistics curve – cf. pages 17 and 37–39 of **?**.

y^N = nominal income per capita,

p_k = the price (index) of good k,

s_l = budget share of product l in the base period,

P = overall consumption price index, i.e. $P = \prod_k p_k^{s_k}$,

P_G = the price index of consumption group G, i.e. $P_G = \left(\prod_{k \in G} p_k^{s_k}\right)^{1/\sum_{l \in G} s_k}$,

P_g = the price index of consumption subgroup g, i.e. $P_g = \left(\prod_{k \in g} p_k^{s_k}\right)^{1/\sum_{l \in g} s_k}$,

λ_k = individual good k price response parameter,

μ_G = group G price response parameter,

ν_g = subgroup g price response parameter.

The consumption sectors are categorized into groups and subgroups so that "highly-related" ones (either complements or substitutes) are bundled together. As argued in **?**, this method significantly reduces the number of price response parameters. We observe that while the estimates of λ_k are individual, the estimates of μ_G and ν_g are common within the same group or subgroup. Consequently, the number of λ_k's to be estimated equals the number of consumption sectors, while the number of μ_G's and ν_g's is equal to the number of groups and subgroups, respectively. Finally, we note that positive (negative) μ_G or ν_g implies a substitution (complementarity) within group G or subgroup g, respectively.

In TIDY, the PADS equations are estimated for 33 consumption expenditure sectors (categories). The consumption data according to this sectoring is released annually in the national accounts. Since this sectoring does not coincide with the 26 input-output sectors, one needs to employ a 26×33 **consumption bridge matrix**, denoted BMC, to transform the consumption data into the desired sectioning. As a result, we are able to transform consumption estimates $(\tilde{c}_k^R)_{k \in \{1,\ldots,33\}}$, into consumption estimates for the desired input-output sectioning, $(c_i^R)_{i \in \{1,\ldots,26\}}$. By multiplying the per capita estimates by the population number we obtain consumption component of total final demand, f^R.

The "real side" of the model then continues by estimating other elements of f^R, necessary for solving identity (B.26).

B.3.1.2 Labor productivity

As indicated in Figure B.3, the "real side" of the model does not terminate with estimation of final demand and sectoral outputs. Specifically, it proceeds by estimating labor productivity and corresponding labor requirements (employment). The unemployment rate is also calculated. For future reference, the labor productivity estimation is discussed below.

We note that the labor productivity ρ in TIDY is defined as the level of output per worker, i.e. $\rho_i = x_i^D / L_i$ where x_i^D is the level of output in sector i deflated by a GDP deflator and L_i is the employment in sector i. Estimation of x_i^D, however, comes with an obvious difficulty. In particular, to construct $x_{i,t}^D$, the real output deflated by the GDP deflator, one needs to know sectoral prices and the aggregate GDP deflator. This is because $x_{i,t}^D$ is given by

$$x_{i,t}^{D} = x_{i,t}^{R}\,\frac{p_{i,t}}{p_t^{\text{gdp}}} \tag{B.28}$$

where $x_{i,t}^{R}$ is the "real" sectoral output (i.e. in constant prices) at time t obtained from the solution to identity (B.25), $p_{i,t}$ is the sectoral price at time period t and p_t^{gdp} is the GDP deflator at time t. This would suggest that labor productivity and prices have to be estimated simultaneously. Fortunately, there is a simpler approach to this issue. Since the ratio of sectoral price to GDP deflator is relatively constant over time, one can approximate this ratio at time period t by its estimate at period $t-1$. We have

$$x_{i,t}^{D} = x_{i,t}^{R}\,\frac{p_{i,t-1}}{p_{t-1}^{\text{gdp}}}. \tag{B.29}$$

Using these sectoral outputs, the labor productivity equation takes the following simple functional form:

$$\ln(\rho_{i,t}) = \ln\left(\frac{x_{i,t}^{D}}{L_{i,t}}\right) = \alpha_{i,0} + \alpha_{i,1}\,t + \alpha_{i,2}\,\ln\left(\frac{x_{i,t}^{D}}{x_{i,t-1}^{D}}\right) + \varepsilon_{i,t}, \tag{B.30}$$

where t is the time trend. We note that the output growth captures the pro-cyclical behavior of labor productivity over the business cycles. Thus, the expected sign of the coefficient $\alpha_{i,2}$ is positive and less than 1.

Noting that prices do not affect (directly) the calculation at this point, we conclude the discussion of the real side of the model. To sum, personal consumption is the only final demand category directly affected by prices. However, other final demand components are not entirely independent of prices either. This is because some of these components (i.e. fixed investment, inventory change, import) depend one way or another partially on consumption, which accounts for significant portion of total output.

B.3.2 Price-income side

The main task of this part of the model is to estimate value-added components and then calculate sectoral prices by solving the second fundamental input-output identity, i.e.

$$p' = p'A^{R} + v' \tag{B.31}$$

where p is a vector of unit sectoral prices, A^R is the matrix of input-output coefficients introduced in the real part of the model, and v is a vector of sectoral value-added per unit of output. The identity stipulates the price level in a given sector is equal to the sum of per unit intermediate production costs plus the per unit value-added.

We note that (B.31) differs from the theoretical price identity (B.8), $p' = p'A + p_v'\,C$, from Section (B.1). In particular, TIDY price identity does not work explicitly with factor (index) prices p_v and direct input coefficients C. Instead, it works with v, the "per unit of output" monetary value of primary inputs. Let us derive the relationship between the two approaches. We have

$$(p_v'\,C^R)_j = \sum_k (p_v)_k\,C_{k,j}^{R} = \frac{\sum_k (p_v)_k\,V_{k,j}^{R}}{x_j^{R}} \tag{B.32}$$

The numerator on the right-hand side can be interpreted as (current) monetary value of primary inputs to sector j. Hence, by dividing this quantity by the total sectoral output, we obtain "per unit of output" value added v_j. This explains equation (B.31).

TIDY model considers four value-added components:

(1) Wages and salaries,
(2) Operating surpluses (profits),
(3) Depreciation,
(4) Net indirect taxes (business taxes minus subsidies).

Then, we can rewrite (B.31) as follows:

$$p' = p'\bar{A} + v'_w + v'_\pi + v'_d + v'_\tau \tag{B.33}$$

where:

$p =$ vector of unit sectoral prices (26×1),

$v_w =$ vector of wages per unit of output (26×1),

$w_\pi =$ vector of profits per unit of output (26×1),

$v_d =$ vector of depreciation per unit of output (26×1),

$v_\tau =$ vector of net indirect taxes per unit of output (26×1).

In principle, there are two approaches to estimating sectoral prices. The first approach estimates prices directly from the regression rendering value-added calculation residual. **?** applied this approach in the interindustry model for transition economies. Here, we adopt a second approach that estimates value-added components first and then obtains sectoral prices from the input-output identity (B.31). Other examples of this approach can be found in **?**, **?** and **?**. We note that tax rates are regarded as exogenous and discuss the sectoral regressions estimating the remaining value-added components below.

The value-added components in TIDY are estimated in constant prices, i.e. deflated by GDP deflator. This comes with two benefits. First, it allows to maintain the consistency between the real GDP obtained from the income side and the one obtained from the expenditure side. Second, this allows the model builder to avoid using the debateable "double-deflation" approach.

We note that indirect taxes are assumed to be exogenous and proceed by discussing the individual sectoral regressions for the other three value added components (wages, profits and depreciation).

B.3.2.1 Wages and salaries

TIDY considers two types of wage rate equations: (1) aggregate wage rate equation, and (2) sectoral wage rate equations. First, the aggregate wage rate is estimated. Then it is employed in sectoral wage rate estimation. The consistency between the estimated sectoral wage rates and the aggregate wage rate is maintained by scaling factors at the end of the simulation.

The aggregate wage rate equation in TIDY is motivated by the conventional Phillips curve with acceleration that relates the behavior of wage rates to expected inflation, unemployment, and labor productivity. The equation reads:

$$\ln w_t = \alpha_0 + \alpha_1 \ln \rho_t + \alpha_2 U_t + \alpha_3 t + \varepsilon_t \tag{B.34}$$

where:

w_t = aggregate wage rate (i.e. wage per worker) deflated by GDP deflator,

ρ_t = labor productivity (real output per worker),

U_t = unemployment rate,

t = time trend.

Naturally, the expected sign for the coefficient on labor productivity is positive. On the other hand, the expected sign for α_2 is negative as the bargaining power of employees is negatively related to the unemployment rate.

Before proceeding, we note that we assume labor productivity to be known at this stage. Recall that the "real-side" of the model estimated sectoral labor productivities ρ_i. Then, we can calculate total labor productivity from the sectoral productivities using the following formula

$$\rho = \frac{\sum_i x_i^D}{\sum_i L_i} = \frac{\sum_i x_i^D}{\sum_i \frac{x_i^D}{\rho_i}} \tag{B.35}$$

where x_i^D's are known from the real-side of the model, see (B.28). Having established aggregate wage rate, the model proceeds by estimating sectoral wage rates. These are assumed to be affected both by the aggregate and industry-specific factors. The industry-specific factors are represented by sectoral labor productivity. The functional form reads:

$$\ln w_{i,t} = \alpha_{0,i} + \alpha_{1,i} \ln w_t + \alpha_2 \ln \rho_{i,t} + \alpha_3 t + \varepsilon_{i,t} \tag{B.36}$$

where:

$w_{i,t}$ = wage rate in sector i at time t deflated by GDP deflator,

w_t = aggregate wage rate at time t deflated by GDP deflator,

$\rho_{i,t}$ = labor productivity (real output per worker) in sector i at time t,

t = time trend.

Both $\alpha_{1,i}$ and $\alpha_{2,i}$ are expected to have positive signs.

The labor market data are classified by the International Standard Industrial Classification (ISIC) that works with 9 main industries and 379 detail industries. TIDY makes uses of the highly disaggregate nature of data and maps it to the 26 input-output sectors before estimating the wage rate equations. As a result, no more sector transformation is needed after wage rates are estimated.

We note that multiplying the sectoral wage rate w_i by the sectoral employment L_i yields total sectoral wage bill, W_i. The sectoral employment L_i can be derived as a ratio of sectoral output and sectoral productivity as estimated in the real part of the model. Furthermore, by dividing the sectoral wage bill W_i by total sectoral output, we obtain sectoral wages per unit of output, $(v_w)_i$, necessary for solving (B.33).

B.3.2.2 Profits

As opposed to **?** and **?**, the sectoral profit equations in TIDY contain only industry-specific factors. Primary explanatory variables include real sectoral output, its difference and sectoral wage bills. Sectoral output represents business cycle and demand conditions that influence profits. In addition, wage bills fluctuations are factored in as they affect firm's profit in the short-run. This is because firms are usually reluctant to adjust prices charged to consumers whenever production costs change. Rather the firms accept the variation of their profit in the short-run. Consequently, there's an inverse relationship between wages and profits. Put together, TIDY considers the following sectoral profit equation

$$\Pi_{i,t} = \alpha_0 + \alpha_1\, x^D_{i,t} + \alpha_2\, \Delta x^D_{i,t} + \alpha_3\, W_{i,t} + \alpha_4\, t + \varepsilon_{i,t} \tag{B.37}$$

where:

$\Pi_{i,t}$ = level of profit in sector i at time t deflated by GDP deflator,

$x^D_{i,t}$ = level of output in sector i at time t deflated by GDP deflator,

$\Delta x^D_{i,t}$ = output change in sector i at time t,

$W_{i,t}$ = level of total wage bill in sector i at time t deflated by GDP deflator,

t = time trend.

By the discussion above, we expect α_1 and α_2 positive and α_3 negative. A time trend variable is included in order to capture extraneous effects – those other than output and labor cost.

Finally, by dividing the estimated $\Pi_{i,t}$ by the total sectoral output, we obtain $(v_\pi)_i$ necessary to solve the identity (B.33).

B.3.2.3 Depreciation

Depreciation estimation follows the approach suggested by ?. Hence, sectoral depreciation is primarily explained by the level of capital stock from the previous period. However, this simple approach is complicated by the fact that there are no capital stock measures classified by 26 input-output sectors. By contrast, capital stock data are published for 11 investment sectors. As a result, it is impossible to establish exact sectoral capital stocks in the desired sectioning. To resolve this issue, capital stock from the related "broad" sector is used. Then, the regression reads

$$D_{i,t} = \alpha_0 + \alpha_1\, K_{j(i),t-1} + \varepsilon_{i,t} \tag{B.38}$$

where:

$D_{i,t}$ = level of capital depreciation in the input-output sector i at time t, deflated by GDP deflator,

$K_{j(i),t-1}$ = level of capital stock in the broad investment sector $j(i)$ at time $t-1$ deflated by GDP deflator.

As before, in order to obtain v_d necessary to solve identity (B.33), we only need to divide estimated sectoral depreciation values by total sectoral outputs.

B.3.2.4 Price calculation

After all value-added components are calculated, they are transformed into per unit of output quantities v_w, v_π, v_d and v_τ and plugged into identity

$$p' = p'A + (v'_w + v'_\pi + v'_d + v'_\tau). \tag{B.39}$$

The prices are then estimated by the Seidel procedure.

B.4 The LIFT model of the U.S. economy

The Inforum LIFT (Long-term Interindustry Forecasting Tool) is an input-output model of the U.S. economy. As a member of the INFORUM family of models, it shares the basic framework with the TIDY model. However, there are some differences that we hightlight below in no particular order:

(1) LIFT uses slightly refined final demand classification with more categories being estimated endogenously. In particular, private construction is a separate final demand category and is endogenous to the model. Similar to investment, it is also dependent on outputs.

(2) As opposed to the TIDY model, real side of LIFT tries to achieve output consistency before turning over to the price income side. Recall that in TIDY all of imports, inventory changes and fixed investments were dependent on outputs. However, only imports were calculated simultaneously with outputs during the Seidel iteration. The other two variables were left potentially inconsistent, waiting for the model to go through the whole loop. By contrast, LIFT estimates inventory change along with imports simultaneously with outputs during the Seidel iteration and introduces an additional loop within the real-side module to achieve consistency with investment and private construction.

(3) Advanced versions of LIFT consider export endogenous as well.

(4) The estimation of several variables, including private consumption and fixed investment, is more sophisticated. More importantly, however, fixed investment in LIFT is dependent on prices.

(5) LIFT uses more refined value-added classification. Furthermore, the categories for value-added are compiled at industry levels which are different from input-output sectoring. Hence, a product-to-industry bridge is necessary to obtain value-added data according to desired sectoring.

(6) An additional loop is introduced into the price-income side of the model to attain price consistency within the module. This is because some of the value-added components require price estimates during estimation. In TIDY, this was not an issue as it used very simple value-added classification with less sophisticated estimation methods.

(7) LIFT is more structured. While TIDY uses 26 input-output categories, LIFT uses 97. LIFT also works with 92 personal consumption categories, 55 equipment investment categories and 25 private construction categories.

The main flow of the model (for any year) is depicted in Figure B.4. Again, we stress the presence of the two additional loops, one within the real side module to achieve output consistency, and the second within the price income module to achieve price consistency.

Otherwise, LIFT proceeds similarly to TIDY. The whole process starts with initial estimates on disposable income, prices and outputs. The real side then uses these guesses to estimate final components and calculate sectoral outputs. Prices affect final demand primarily through personal consumption and equipment investment. The real side concludes with estimating labor productivity, total employment, and unemployment rate. Having established all real variables, the model turns over to the price income module. First, all value added components are calculated. Then prices are established from the second fundamental input-output identity, $p' = p'A + v'$. Finally, the accountant determines disposable income, at which point the model loop is closed. If necessary, the model returns to the real side with new estimates (guesses) of prices and disposable income. We discuss the details of relevant estimations below.

B.4.1 The real side

As mentioned above, LIFT uses a slightly different final demand sectoring as TIDY. The categories of final demand are listed below along with the estimation method.

Final demand category	Estimation method	Notable factors
Personal Consumption	endogenous – PADS	prices, disposable income, demographics
Exports	exogenous – BTM	(possibly endogenous)
Equipment Investment	endogenous	factor prices, output, capital stock
Private Construction	endogenous	disp. income, int rate, output, demographics
Govt Consumption & Investment	exogenous	
Govt Capital Allowances	endogenous	government capital stock
Imports	endogenous – Seidel	
Inventory change	endogenous – Seidel	

Table B.6: Final demand categories in the LIFT model

Similarly to TIDY, all GDP components are calculated in 1987 constant dollars. Again, consumption estimation is the most interesting from the viewpoint of prices. We discuss it below.

B.4.1.1 Personal Consumption Estimation

In comparison to TIDY, the LIFT model uses an improved version of the PADS. In particular, the consumption estimation is performed in two stages. In first stage, a cross-sectional equation is used to capture the impacts of income and demographic variables and to estimate the Engel curve for each good. In second stage, a time series equation is used to capture cyclical factors and the influence of relative price changes. The time series equation here takes a similar form as its counterpart in TIDY (B.27) with the exception that the per capita income term y^N is replaced by the term obtained from the first stage of estimation. For details of the estimation procedures, we refer the reader to **?** and dissertation ?.

In the first stage, cross sectional household consumption data are regressed on income, demographic and age relevant variables. For any consumption good k, we have:

$$c_k^h = \left(\alpha_k + \sum_j \beta_{k,j}\, y_j^h + \sum_l \delta_{k,l}\, D_l^h\right)\left(\sum_g \omega_{k,g}\, n_g^h\right) + \varepsilon_k^h \tag{B.40}$$

where

c_k^h = household h consumption expenditures on good k,

y_j^h = per-capita income of household h within income bracket j,

D_l^h = dummy variable indicating the membership of household h to the l-th demographic group,

n_g^h = number of household h members in age category g,

$\omega_{i,g}$ = adult equivalency weights (to be estimated)

The demographic categories include region of residence, college education, spouse employment status, age of household head and family size. Equation (B.40) suggests that the dependent variable, c_k^h, is a product of two factors. The first factor corresponds to the per-capita consumption within household and is estimated by a constant, a piecewise-linear Engel curve, and the demographic term. The second factor is a weighted sum of family members. In particular, unique weights are assigned to members of each age group while weights of age group 31-40 are normalized to unity.

After estimating parameters α_k, $\beta_{k,j}$, $\delta_{k,l}$ and $\omega_{k,g}$, one can use regression (B.40) to calculate c_k^*, per capita predicted consumption of good k. We note that while this prediction captures the effects of demographic, income and age relevant variables, it ignores price effects and dynamics. These factors are introduced in the second stage, which is estimated with time series data. In particular the second stage (PADS) equations take form:

$$\begin{aligned}\tilde{c}_k(t) = {} & \left(\alpha_k(t) + \beta_k \left(\frac{c_k^*}{P}\right) + \gamma_k\, \Delta \left(\frac{c_k^*}{P}\right) + \delta_k\, t\right) \left(\frac{p_k}{P}\right)^{-\lambda_i} \\ & \times \prod_l \left(\frac{p_k}{p_l}\right)^{-\lambda_l\, s_l} \left(\frac{p_k}{P_G}\right)^{-\mu_G} \left(\frac{p_k}{P_g}\right)^{-\nu_g}.\end{aligned} \tag{B.41}$$

The consumption products have been organized into groups and subgroups to reduce the number of (price response) parameters. We note that c_k^* estimate in the equation above serves as a measure of spending within a given category. In earlier versions of the model, as well as in TIDY, disposable income or total consumption expenditure were used instead.

The PADS equations are estimated for 92 consumption expenditure categories, divided into 9 groups. After consumption by category has been solved for the model, this resulting vector is passed through a consumption bridge to obtain consumption by 97 input-output commodities.

B.4.2 Price-income side

In general, it comprises of the following three steps

(1) The value added (per unit of output) of each industry is calculated.

(2) The value added is converted to the commodity level through the product-to-industry bridge.

(3) The commodity prices are calculated through the input-output identity

$$p' = p'A + v. \tag{B.42}$$

We note that the second step was not necessary in TIDY as the estimation of value-added components were done in input-output categories. As apparent from Table B.7, the value-added categories considered by LIFT are more detailed than in TIDY:

Value added component	Estimation method / Notable factors
Labor compensation	
Wages and Salaries	Labor productivity, excess money growth
Supplements	
Return to Capital	
Corporate Profits	labor compensation, change in industry output, etc.
Proprietor's Income	measures of tightness, change in industry output, etc.
Capital Consumption Allowances	book value estimates of capital stock
Inventory Valuation Adjustment	aggregate equations
Net Interest Payment	aggregate equations
Business Transfer Payments	aggregate equations
Rental Income of Persons	aggregate equations
Government Subsidies Less Output	aggregate equations
Indirect Business Taxes	output, exogenous tax rates
Excise and Sales Tax	
Value Added Tax	
Energy Tax	
Other Indirect Taxes	

Table B.7: Value added components in the LIFT model

We discuss the estimation specifics below.

B.4.2.1 Labor compensation

The central part of estimating labor compensation is the following "wage rate" equation:

$$dw_{i,t}^h = \beta_1 \mu_t + \beta_{2,i} d\rho_{i,t}^h \tag{B.43}$$

where

$dw_{i,t}^h = \ln(w_{i,t}^h) - \ln(w_{i,t-1})$ and $w_{i,t}^h$ is the (hourly) labor compensation for industry i at time t,

μ_t = a 5-year weighted average percent changes in the growth of M2 per real GDP at time t,

$d\rho^h_{i,t} = \ln(x_{i,t}/h_{i,t}) - \ln(x_{i,t-1}/h_{i,t-1})$ is the percent change in industry labor productivity ρ^h. Here, x stands for output and h stands for hours worked.

We note that the motive behind introducing the monetary aggregate into this equation is twofold: First, it provides a mechanism whereby money affects prices. Second, it is supported by the anecdotal evidence suggesting that rapidly increasing money supply creates pressure in the labor markets by stimulating aggregate demand. As in TIDY, the productivity ρ^h is estimated during the "real-side" of the model. In contrast to TIDY, however, we are not interested in product per worker but in product per hour worked. We expect both β_1 and $\beta_{2,i}$ positive.

? does not specify explicitly the procedure necessary to transform dw^h_i estimates from (B.43) into value added wage component $(v_w)_i$ necessary to solve identity (B.42). Presumably, the hourly sectoral wage rate w^h_i is extracted first and then multiplied by the total sectoral hours worked which, in turn, are obtained as a ratio of the total sectoral output and the sectoral labor productivity. Finally, the total sectoral wage bill obtained by this multiplication is divided by sectoral output to obtain the "per unit of output" quantity $(v_w)_i$.

B.4.2.2 Profits

In general, the profits in the LIFT model are modelled as a mark-up over labor compensation, where the markup rate is affected by variables representing both demand and unit cost changes. The demand effect is measured by both industry-specific and aggregate measures of demand. Specifically, the corporate profits equations relate the ratio of economic profits over labor compensation to a measure of aggregate tightness (the GNP gap), changes in industry output and the prices of oil and agriculture as supply variables. We have

$$\frac{\Pi^E_i}{W^T_i} = f\big(dx_{i,t},\, dx_{i,t-1},\, Y_{\text{gap}},\, \left[\tfrac{u^*}{u}\right]^2,\, dz_{i,t},\, dz_{i,t-1},\, dp_{\text{oil}},\, dp_{\text{ag}}\big) \tag{B.44}$$

where

Π^E_i = "economic" profits in industry i,

W^T_i = total labor compensation in industry i,

dx_i = the percent change in industry i output,

Y_{gap} = the GNP gap,

u^* = the natural rate of unemployment,

u = the actual rate of unemployment,

dz_i = the percent change in unit intermediate cost in industry i,

dp_{oil} = the percent change in oil prices,

dp_{ag} = the percent change in agricultural prices.

For proper understanding of the relationship above, **?** explains the suggested concept of "economic" profits. In particular, he notes that "economic" profits differ from "corporate profits before taxes" that are provided by national accounting. As argued, in order for "corporate profits" to make economic sense (i.e. in order to relate them to total labor compensation), one has to account for inventory valuation adjustment and capital consumption allowance (depreciation) adjustment. Then, for Π_i^E economic profits of industry i, we have

$$\Pi_i^E = \Pi_i^G + I_i^A + \frac{D_i}{\sum_i D_i} D^A \qquad \text{(B.45)}$$

where

Π_i^G = corporate profits before tax per industry i,

I_i^A = inventory valuation adjustment per industry i,

D_i = corporate capital consumption allowance (depreciation) per industry i,

D^A = aggregate capital consumption allowance adjustment.

We note that the sectoral capital consumption allowance adjustment is not available from national accounting directly and hence is estimated by the term $\frac{D_i}{\sum_i D_i} D^A$ where D^A, the aggregate depreciation adjustment, is obtained from national accounting.

Neither **?** nor **?** specifies the exact procedure that transforms estimated sectoral economic profit Π_i into v_π, i.e. a "per unit of output" value added component necessary to solve identity (B.42).

B.4.2.3 Remaining value added components

- **Proprietors' Income:** According to **?**, typical explanatory variables for proprietors' income are measures of tightness, the change in industry output, the change in GNP and the change in the aggregate deflator.
- **Capital Consumption Allowance:** The main explanatory variables are book value estimates of capital stock, which are formed by cumulating current price investment.
- **Net interest, rental income, business transfer payments, inventory valuation adjustment and government subsidies:** Determined by aggregate equations, which are then split to individual industries based on the share in the last year of data.
- **Indirect business taxes:** Determined by multiplying exogenous indirect tax rates by output by industry.

B.5 The MuDan model of the Chinese economy

The basic structure of the MuDan model closely resembles TIDY and LIFT models. Again, the model consists from the production module, the price-income module and the accountant. The production module estimates final demand, output and labor requirements. The price-income side determines value added (factor income) and estimates prices. The accountant computes economic aggregates based on sectoral variables.

The MuDan is built based on a 59×59 commodity-to-commodity input-output table of the Chinese economy. A unique feature of MuDan is that it considers different number of consumption categories for urban and rural residents. In particular, for urban residents we have 24 categories, while for rural residents we have only 10.

guessed (or assumed) values of disposable income (both rural and urban residents) as well as prices paid by rural and urban residents. Then, savings function is called to estimate savings and consumption in current prices. Total consumption is then deflated into constant prices and PADS is employed to calculate per capita consumption in constant prices by each category. The resulting demands are then converted through bridge matrices into producing sectors. Investment function estimation is next with results converted into correct sectors by another bridge matrix. Inventory changes by I-O sectors are computed next while exports, governmental expenditures and other final demand components are specified exogenously. All the estimated final demand components are then added together and a Seidel iterative algorithm determines outputs and imports simultaneously. Having established output, labor productivity and requirements are computed. This concludes the real side part of the model.

Dividing the sum of all these components by real output yields the "value added in current prices per unit of real gross output". Using Seidel procedure, producer prices are solved for. However, since prices are used in determining profits and taxes, one has to repeat price-income computation until price consistency is established.

In what follows, some other notable differences with the LIFT and TIDY models are discussed.

B.5.1 Real side module

MuDan considers the following 6 components of the final demand: Consumption, investment, government expenditures, imports, exports and other final demand. We note that export and government consumption are assumed to be exogenous whereas imports are determined simultaneously with output based on import shares. Out of the remaining final demand categories, only consumption is directly related to prices. Hence, we discuss its estimation below.

B.5.1.1 Personal Consumption

Similarly to TIDY and LIFT, the MuDan employs PADS to determine consumption expenditures. However, there are two important differences:

(i) Due to a significant consumption expenditure gap between urban and rural residents, the per capita consumption is modelled separately for the two groups. In particular, the 24 urban categories are divided into 4 groups and several categories that are not in any group. At the same time, the 10 urban categories are divided in 2 groups and several un-grouped categories.

(ii) The model uses the original (i.e. simpler, see TIDY) version of PADS:

$$\tilde{c}_k = \left(\alpha_k + \beta_k \left(\frac{y^N}{P}\right) + \gamma_k \,\Delta \left(\frac{y^N}{P}\right) + \delta_k\, t\right) \left(\frac{p_k}{P}\right)^{-\lambda_0} \times \prod_l \left(\frac{p_k}{p_G}\right)^{-\lambda_l\, s_l} \left(\frac{p_k}{p_G}\right)^{-\mu_G} \left(\frac{p_k}{p_g}\right)^{-\nu_g} \tag{B.46}$$

In contrast to the LIFT model, the $c^a st$ term is again replaced by y^N, the nominal income per capita. The total expenditures are predetermined as equal to the disposable income minus savings. Again, we note that the above consumption estimates $\tilde{c}_k$ are subject to a consumption bridge in order to get consumption estimates c_i for correct input-output sectioning.

B.5.2 Price module

The price-income module of MuDan works with four types of income

(1) Labor Income,

(2) Profits,

(3) Depreciation,

(4) Taxes.

These are evaluated for the 59 producing sectors at current prices. Unit value added is obtained by dividing total value added by real output for each of the 59 sectors. Then, the prices are solved from the identity $p' = p'A + v'$ by a Seidel procedure. Consequently, we have

$$p' = (v_\pi + v_w + v_d + v_\tau)' \, (I - A)^{-1} \tag{B.47}$$

where

$p =$ a vector of domestic prices,

$v_\pi =$ a vector of profits per unit of real output,

$v_w =$ a vector of wages per unit of real output,

$v_d =$ a vector of depreciation per unit of real output,

$v_\tau =$ a vector of taxes per unit of real output.

The specifics of calculating the value added components are given below.

B.5.2.1 Labor compensation

The MuDan model uses two aggregate wage equations, one for agriculture and the other for non-agriculture sectors. Both these equations can be interpreted as variants of the Phillips curve where the wage rate is modelled as a function of labor productivity, expectation of inflation and the unemployment rate. For non-agriculture sectors, we have the following equation for the aggregate wage rate:

$$\ln w_t^{\text{nag}} = \alpha_0 + \alpha_1 \, \ln \rho_t^{\text{nag}} + \alpha_2 \, \ln p_{t-1}^{\text{uc}} + \alpha_3 \, u_t^{\text{u}} \tag{B.48}$$

where

$w^{\text{nag}} =$ the average annual labor income for non-agriculture worker,

$\rho^{\text{nag}} =$ the average labor productivity for all non-agricultural sectors,

$p^{\text{uc}} =$ the urban consumption price index,

u^{u} = the urban unemployment rate.

As in TIDY and LIFT, the labor productivity is estimated in the "real-side" of the model after sectoral outputs are estimated. Furthermore, we note that the above wage rate equation is similar to its TIDY counterpart (B.34) with one notable exception. In particular, the MuDan version includes an additional term, p^{uc}. This term is included in order to model expected inflation. Therefore, we expect α_2 to be positive.

Similarly, for agriculture sector, we have the following wage rate equation

$$\ln w_t^{\text{ag}} = \alpha_0 + \alpha_1 \ln \rho_t^{\text{ag}} + \alpha_2 \ln p_{t-1}^{\text{rc}} + \alpha_3 u_t \tag{B.49}$$

where

w^{ag} = the average annual labor income for agricultural worker,

ρ^{ag} = the average labor productivity in agriculture,

p^{rc} = the rural consumption price index, and

u = the unemployment rate.

We note that both (B.48) and (B.49) estimate aggregate wage rates. Using aggregate wage rate estimates, one can estimate sectoral wage rates by employing sectoral wage rate equations. Specifically, we have

$$\ln\left(\frac{w_{i,t}^{\text{nag}}}{w_t^{\text{nag}}}\right) = \alpha_0 + \alpha_1 \ln\left(\frac{L_{i,t}}{L_t^{\text{nag}}}\right) + \alpha_2 t \tag{B.50}$$

where

$w_{i,t}^{\text{nag}}$ = the wage rate for a (non-agricultural) sector i,

w_t^{nag} = the aggregate wage rate for non-agricultural sectors,

$L_{i,t}$ = employment for sector i,

L_t^{nag} = total employment for all non-agricultural sectors, and

t = a simple time trend.

We note that coefficient α_1 is the elasticity of the relative wage rate $\frac{w_{i,t}^{\text{nag}}}{w_t^{\text{nag}}}$ with respect to the employment ratio $\frac{L_{i,t}}{L_t^{\text{nag}}}$ and thus is expected to be positive and preferably close to one. The employment ratio $\frac{L_{i,t}}{L_t^{\text{nag}}}$ is intended to explain the market demand conditions for labor. All other determinants for the sectoral wage rate is summarized by the time trend variable.

B.5.2.2 Profits

Profits in MuDan include net profits, proprietor income and net interest payment by business. The profits are modelled as markup over all costs as **?** argues that this provides better fit as modelling the profits as markups over either labor costs (such as in the LIFT) or factor costs (such as in the Spanish INFORUM model MIDE by **?**). Specifically, we have

$$\frac{\Pi_{i,t}}{x_{i,t}^N} = \alpha_0 + \alpha_1 \, dx_{i,t}^N + \alpha_2 \, \tilde{u}_t^2 + \alpha_3 \, t \tag{B.51}$$

where

$\frac{\Pi_i}{x_i^N}$ = sectoral profit divided by output in current prices,

dx_i^N = the percentage change of sectoral output in current prices,

$\tilde{u}^2$ = the inverse of unemployment rate ratio squared,

t = a simple time trend.

The dependent variable represents a markup over the full cost. The change in output, $dx_{i,t}$ is intended to capture the pro-cyclical movements of profits at sectoral level, and thus α_1 is expected to have a positive sign. The impact of the overall slackness of the economy on sectoral profitability is explained by the unemployment variable, $\tilde{u}^2$. Thus, its corresponding coefficient is also expected to have a positive sign. A simple time trend is used to account for everything else that is not explicitly identified.

B.5.2.3 Depreciation

The depreciation equation is specified as a function of capital stock of the following form

$$D_{i,t} = \alpha_0 + \alpha_1 K_{i,t-1}^N + \alpha_3 \delta \qquad \text{(B.52)}$$

where

D_i = current value of depreciation in sector i,

K_i^N = real capital stock in sector i inflated by output prices,

δ = a dummy variable, equal to 1 for $t \leq 1992$ and 0 otherwise.

B.6 The INFORGE model of the German economy

While still considered a member of INFORUM family, INFORGE (INterindustry FORecasting GErmany) model presents a modification to the traditional demand-oriented approach to the input-output modelling. Although production is still determined by the demand through the Leontief-inverse equation, the distinctive feature of INFORGE is that all components of demand depend on relative prices which, in turn, depend on firms' unit costs and import prices. The pricing mechanism can then be described as follows: Companies set their prices based on their cost situation and the prices of competitive goods. Potential customers then adjust their decisions accordingly thereby affecting the rate of production.

A few other remarks are in place.

- The model is consistent with two crucial principles of the INFORUM philosophy: a "bottom-up" approach to construction and complete integration. The model contains 59 sectors and its disaggregated structure is fully integrated with the System of National Accounts.

- The model exhibits high level of endogeneity and, as opposed to the models discussed so far, the whole system is solved simultaneously. Parameters of the model have been estimated econometrically using OLS.

- The model does not employ price identity (B.8) to estimate prices. Rather the (relative) prices in the model are set with respect to unit costs of businesses reflecting the price-setting hypothesis.

As noted above, INFORGE model is characterized by a high degree of disaggregation. To demonstrate this, we outline the procedure necessary to obtain $\bar{C}_i^R$, the (private) consumption expenditure on commodity i in "basic" (=producer's) and constant prices. We note that this is one of the components necessary to estimate total final demand – which, in turn, we need in order to run the Leontief demand model. The procedure goes as follows:

(1) Estimate total consumption demand in constant prices as $C^R = f(Y^d/P, r)$ where Y^d is nominal disposable income, P is the index of consumer prices and r is the interest rate for consumers credits.

(2) Estimate the share of total consumption that is used for utilization purpose k as $s_k = f(\tilde{p}_k/P, r_b, t)$, so that $\sum_k s_k = 1$ where $\tilde{p}_k$ is the price index for utilization purpose k, r_b is the 10 year treasury bond rate and t corresponds to the time trend.

(3) Calculate consumption expenditure for k-th utilization purpose. In constant prices, we have $\tilde{C}_k^R = s_k\, C^R$ and in current prices, we have $\tilde{C}_k^N = \tilde{C}_k^R\, \tilde{p}_k$.

(4) Using bridge matrix from year 2000 to calculate consumption demand for input-output commodities (rather than for "utilization purposes"). We have $C_i^N = \sum_k CPX_{ik}(2000)\, \tilde{C}_k^N$.

(5) Calculate the consumption for commodity i in "basic" (producer) prices as opposed to market (purchaser) prices by accounting for trade and transportation, H_i, value added taxes, T_i, the other taxes on products, N_i and the subsidies, S_i:

$$\bar{C}_i^N = C_i^N - H_i - T_i - N_i + S_i \qquad \text{(B.53)}$$

where $H_i = C_i^N \kappa_{i,2000}$, $T_i = C_i^N \tau_{i,2000}$, $N_i = C_i^N \eta_{i,2000}$ and $S_i = C_i^N \sigma_{i,2000}$.

(6) Calculate its "constant prices" counterpart, $\bar{C}_i^R = \bar{C}_i^N / \bar{p}_i$.

Having derived $\bar{C}_i^R$, the next step would be to derive other final demand components as well (in current prices), so that the Leontief inverse could be applied. While we refrain from doing that, we note that other final demand components are also highly disaggregated and their derivation involves relative prices as well as unit costs.

B.6.1 Price estimation

In contrast to previously discussed models (TIDY, LIFT and MuDan), the prices in INFORGE are not established by solving identity (B.8). Instead, the relative prices in the model are determined from unit costs of production in the form of a price-setting hypothesis. In particular, businesses choose their selling prices on the basis of their cost situation and the price of competing imports.

We demonstrate the basic principles of price creation in INFORGE on prices encountered during the process of estimating C_i^R. The following price indices were discussed:

- $\tilde{p}_k$, the price index for utilization purpose (category) k. This price index is given by

$$\tilde{p}_k = f(p_1, \ldots, p_n), \tag{B.54}$$

  i.e. it is determined with respect to market prices $(p_i)_{i \in \{1,\ldots,n\}}$ of the consumer product included in the category k.

- p_i, the market price of consumer product i, is given by:

$$p_i = f\big((1+\tau_i)\bar{p}_i, (1+\tau_i)(N_i - S_i)/\bar{C}_i^R\big), \tag{B.55}$$

  i.e. it is explained by "basic" price $\bar{p}_i$ and the rate of the respective taxes on products levied on it.

- $\bar{p}_i$, the basic (producer) price of product i, is given by:

$$\bar{p}_i = f(\ell_i, p_i^*) \tag{B.56}$$

  where ℓ_i corresponds to the sectoral unit costs and p_i^* reflects prices of competing imported goods.

We observe that all prices encountered during private consumption estimation can be tracked down to ℓ_i, the sectoral unit production costs, and p_i^*, the sectoral price proxy for competing imported goods. Similar pattern is observed when estimating other categories of final demand, such as government consumption, equipment investment or exports. We note that p_i^* values for the model are estimated within international INFORUM system. On the other hand, the sectoral unit costs ℓ_i are determined endogenously in the model. We discuss the relevant relationships below.

First, we note that **?** only discusses the evaluation of $\tilde{\ell}_j$, the unit cost corresponding to industry j, as opposed to input-output sector i. This is because the value added components in INFORGE are sectored according to industries. Assuming $\tilde{}$ notation accompanied with a subscript j for industries (as opposed to using i for input-output sectors), we estimate the unit costs from the following identity

$$\tilde{\ell}_j = \frac{\tilde{X}_j^N - \tilde{\Pi}_j^N}{\tilde{X}_j^R} \tag{B.57}$$

where $\tilde{X}_j^N$ and $\tilde{X}_j^R$ are nominal and real gross production, respectively, of industry j. The output values per industry were obtained from their sectoral counterparts X_i^N and X_j^R by employing a "make-matrix" transformation, whereas the sectoral outputs were estimated during the "real-side" of the model. On the other hand, $\tilde{\Pi}_j^N$ in (B.57) stands for gross operating surplus ("profit") in current prices and is estimated from the following identity:

$$\tilde{\Pi}_j^N = \tilde{V}_j^N - \tilde{N}_j^N - \tilde{W}_j^N - \tilde{D}_j^N. \tag{B.58}$$

Here,

- $\tilde{D}_j^N$ stands for industry consumption of fixed capital in current prices and is estimated in "real-side" of the model. (Thought the exact estimation requires "make-matrix" transformation as well.)

- $\tilde{V}_j^N$ is the industry gross value added in current prices. Its corresponding sectoral value added $(V_i^N)_{i \in \{1,\dots,n\}}$ in current prices is estimated as a residual from a completed input-output table, i.e. is directly related to the results from the "real-side" of the model.

- $\tilde{N}_j^N$ stands for industry "other production charges minus governmental subsidies" in current prices. It is estimated directly from $\tilde{X}_j^N$, i.e. $\tilde{N}_j^N = f(\tilde{X}_j^N)$.

- $\tilde{W}_j^N$ stands for industry gross wages and salaries in current prices. This quantity is given by the product of industry labor cost per employee (total annual "wage rate") w_j^N and industry number of employees L_j.

From the equations above, we can summarize

(1) Final demand categories are dependent on relative prices that are, in turn, dependent on sectoral unit prices.

(2) On the other hand, the sectoral unit prices are dependent on selected final demand categories.

By the mechanism suggested above, the quantities and prices in the INFORGE model are interconnected. The exact relationships are estimated by the model.

Figure B.3: A sketch of the TIDY model flow

Figure B.4: A Sketch of the LIFT model flow