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Estimation of a Swiss Input-Output Table for 2001

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Preface

The estimation of a new input-output table for Switzerland was a joint effort of two institutes of ETH Zurich in cooperation with Ecoplan, Bern. At the Centre for Energy Policy and Economics (CEPE) and the Energy and Climate Research Group of the Chair of Environmental Physics the main motivation was to use an input-output (IO) table for energy economic analysis. This intention coincided with a project of Ecoplan to update a social accounting matrix for Switzerland, thus leading to the present project team.

We decided not to update the existing IO table, which is available for 1995, but to estimate a new table. An update was seriously hampered by a change of the statistical industry classification in 1995 from ASWZ to NOGA, which is based on the European classification NACE Rev. 1. Furthermore in 1995 the tax system changed from a sales tax system to a value added tax system. And finally a significant part of the data underlying the existing IO table for 1995 reflects the situation of the mid 1980s. This led to the decision to estimate a new table using up-to-date original data where possible.

In the data collection and estimation process we had support from many sides. We would like to thank the staff members of the Swiss Federal Statistical Office (SFSO), especially of the national accounts section, and those of other federal agencies for supplying us with the necessary data and for discussing open questions. We are grateful to Prof. Antille Gaillard (University of Geneva) for her advice on data and the estimation procedure. We also would like to thank Martin Peter and Daniel Sutter (Infras) for their cooperation on the transport sector and Adrian Berwert (Rütter und Partner) for his cooperation on the tourism sector.

This project was partially funded by the SFSO. The resulting input-output table was reviewed by the national accounts section of the SFSO and positively evaluated, given the specific Swiss data limitations. Even though the resulting IO table is not an official table of the SFSO, the SFSO acknowledges it as appropriate for various applications, though the limitations of the underlying data basis and the estimation procedure - as documented in this report - should always be carefully considered.

We believe this work fills a significant gap in the data basis used for economic research and policy analysis in Switzerland and hope it will be useful for the respective communities.

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Summary

Input-output (IO) tables are important data sources for various applications in applied economic research and policy analysis, e.g. for energy and environmental economic research. They also form an important part of the system of national accounts and are a necessary input for computable general equilibrium (CGE) models. Therefore, in most developed countries IO tables are regularly compiled by the national statistical offices. The European Union has made their compilation mandatory for its member countries. In Switzerland IO tables are not published as a part of the official statistical program. Furthermore important data sources necessary for compiling such tables are lacking. Since the 1970s, IO tables for Switzerland have been estimated irregularly, partly by using data from other European countries. The most recently available IO table was generated for the year 1995, but important original data sources used for this estimation date back to 1985.

The aim of the project described in this report was to estimate a new input-output table for the year 2001, which – with restricted resources and the given Swiss data limitations - would be based on up-to-date data sources and would be consistent with the Swiss National Accounts and the European System of National and Regional Accounts (ESA) 1995. An important motivation was to generate an IO table which could be used for energy and environmental analysis.

For estimating the new IO table we mainly followed the procedure developed for generating the past IO tables. This implies a two step-procedure. Since the data sources for estimating a Swiss IO table are incomplete and inconsistent, in a first step prior estimates were generated for each module of the IO table by using a variety of data sources and methods. The result of this step was an unbalanced IO table where row and column sums did not necessarily match. Thus, in a second step the data were subjected to a balancing procedure which resulted in a balanced and consistent IO table.

Regarding the first step, a major challenge was to estimate the intermediate transactions matrix, where Swiss data are completely lacking. Here we used input structure data from other European countries' IO tables. In a country comparison, we compared the product mix of each Swiss manufacturing sector with the product mix of corresponding sectors in other European countries. Following the hypothesis that a similar product mix will correspond to a similar input structure, we used the input structures of sectors with a high degree of similarity as prior estimates for the input structures of the Swiss sectors. Data for final demand, imports and value added were available or could be compiled from Swiss statistical sources.

For the balancing procedure we used a cross entropy approach instead of the widespread RAS method. The main advantage of this approach is the possibility to account for the varying quality of data sources. For each entry of the IO table upper and lower bounds were identified in addition to the point estimate. We also controlled for the impact of alternative initial starting values on the estimation results.

The results of the balancing procedure show that changes in the intermediate input matrix account for around 80 % of total cross entropy. The highest relative changes though were necessary for investment demand and net inventories, which have a high level of uncertainty.

As a result of this project a new input-output table based on up-to-date data sources has been estimated, which - with few minor exceptions - is consistent with the Swiss national accounts as published by the Swiss Statistical Office. It is largely consistent with the ESA, though the data generation process necessarily differs due to the data restrictions. Due to time and resource constraints it was not possible to consider all available data. Though the table presents a good overall picture of the sectoral transactions within the Swiss economy, this does not necessarily hold for the representation of specific sectors or transactions. Here the uncertainties can be much higher. They can only be reduced by detailed sectoral studies which could not be carried out within this project. Studies on specific sectors should therefore not solely rely on this IO table but use additional information, wherever possible.

Future estimations of a Swiss IO table would strongly benefit from the introduction of commodity statistics and a harmonization of the value added tax statistics with the national accounts, i.e. value added statistics and production account. Information on intersectoral transactions, which also is essential, probably will remain a more long-term request.

Abbreviations

ASWZ: Allgemeine Systematik der Wirtschaftszweige

c.i.f.: cost, insurance, freight

COICOP: Classification of Individual Consumption According to Purpose

CPC: Central Product Classification

ESA: European System of National and Regional Accounts

EVE: Einkommens- und Verbrauchserhebung

FFA: Swiss Federal Finance Administration

fob.: free on board

HS: Harmonized Commodity Description and Coding System

ISIC: International Standard Industrial Classification of All Economic Activities

NACE: Nomenclature générale des activités économiques dans les Communautés européennes (Statistical Classification of Economic Activities in the European Community)

NOGA: Nomenclature Générale des Activités économiques

PPI: Producers' Price Index

SFSO: Swiss Federal Statistical Office

SIOT : Symmetrical Input-Output Table

SNA : System of National Accounts

SNB: Swiss National Bank

SSIS: Structural Statistics for Industry and Services

VAT: Value Added Tax

1 Introduction

In applied economic research and policy analysis input-output (IO) tables are widely used for descriptive and analytical purposes. They allow the description of sectoral interrelations in a national or regional economy. As such they form an important part of the system of national accounts. They also serve as an accounting framework for satellite accounts or in general for including additional sectoral information on indicators like employment, energy and resource use or various environmental pressures. IO tables can furthermore be used for structural economic analysis, economic impact assessment of policy measures or public expenditure projects, price impact analysis or the impacts of economic activities on employment, energy use or environmental pressures. In this field IO tables are also a prerequisite for more comprehensive economic models such as computable general equilibrium (CGE) models. Where time series of IO tables are available it is possible to perform structural decomposition of past economic development or to build econometric IO models for ex-ante policy evaluation (e.g. models of the INFORUM type, see Almon, 1991). Furthermore, IO tables are an important instrument to guarantee and enhance the quality of other statistics.

Due to the importance of input-output tables, the European Union has made their regular compilation - following certain standards - mandatory for its member countries. Even though several of the above-mentioned applications are also requested in Switzerland, especially in policy assessment, IO tables are not officially published by the Swiss Federal Statistical Office nor is this planned in the near future. Furthermore, important data sources usually available for compiling IO tables, such as commodity statistics or statistics describing the enterprises' cost structures or the use of intermediate inputs, are missing in Switzerland. Therefore, in the past IO tables have been estimated approximately every 5 - 10 years, pioneered by Antille in the early seventies (see Antille 2000 for an overview of the history of Swiss IO tables). The estimation of these tables was based on various domestic statistics and on information from foreign IO tables where necessary. Some of the Swiss IO tables were updated from prior tables by using the RAS method. The most recent IO table for 1995 was presented by Antille (1999) by updating the 1990 IO table, which was estimated by Antille et al. (1994). Schnewlin (1998) presented an IO table for 1995 in which the energy and transportation sectors were further disaggregated. Yet, a significant part of the original core data of these recent IO tables (e.g. the supply table or the use table) dates back to the second half of the 1980s.

The here presented work generally followed the approach laid out in Antille et al. (1990). It advances the approach in two aspects. First, we performed a country comparison for each manufacturing sector to find an appropriate first estimate for the intermediate input requirements. Second, for generating a balanced IO table in the last step, we used a cross-entropy approach instead of the commonly used RAS method. This allows us to consider differences in data uncertainties in the balancing procedure.

This report is structured as follows. In section 2 we introduce the system of input-output tables as defined by ESA 1995 (European System of National and Regional Accounts 1995) and present the methodological approach for estimating a Swiss IO table. Section 3 contains an overview of the data sources and assumptions for generating the elements of an unbalanced IO table. In section 4 the estimation model is stated algebraically. In section 5 we present and discuss the estimation results. The report closes with a short discussion of open points and critical assumptions made in the estimation of a Swiss IO table for 2001. The appendix contains the sectoral classification of the Swiss IOT.

2 Methodological approach for estimating a Swiss input-output table

2.1 The input-output table framework

An input-output table is an accounting framework displaying the supply and use of goods and of primary inputs in an economy with a rather high level of sectoral detail. The structure of IO tables and the methods for their compilation have been internationally harmonised in documents by the United Nations (System of National Accounts, SNA, 1993) or the European Union (ESA, 1995). In the case of the European Union the member states regularly publish IO tables according to the latter framework. In the present work we tried to follow the ESA framework as far as data availability and project resource restrictions allowed to. In the rest of this section the ESA framework is briefly described. For more details the reader is referred to UN (1999) or Eurostat (1996).

In the SNA 1993 and the related ESA 1995 two types of tables are differentiated, the supply/use tables and the symmetric IO tables. The following figure shows the structure of the supply/use tables.

Table 1: Structure of the supply/use tables

	Products	Industries	Final demand				Total
Products		Intermediate Use	Private consumption	Government consumption	Gross capital formation	Exports	Total use of commodities
Industries	Supply						Total domestic output
Taxes and subsidies	Commodity taxes and subsidies						
Value added		Value added					
Imports	Imported goods						
Total	Total supply of commodities	Total domestic output					

Source: Own illustration, based on Eurostat (1996)

In the **supply and use tables** industries and commodities are distinguished. The supply table shows the production of industries by commodity in basic prices. In a quadratic table the characteristic outputs of industries appear on the diagonal, whereas the other entries show the output of side activities. Adding imported goods shows the total supply of goods at basic and c.i.f prices, respectively. By allocating trade and transport margins from the trade and transport services to the traded and transported goods and by adding commodity taxes and subtracting commodity subsidies, the output of industries in purchasers' prices can be calculated.

The use table records the intermediate inputs of industries by commodity as well as the use of primary inputs (usually labour income, net production taxes and subsidies, depreciation and net operating surplus). It further comprises the use of commodities for final demand (i.e. consumption, gross capital formation and exports). The use of commodities usually includes both domestic and imported goods. In the use table commodities are valued at purchasers' prices, except for exports, which are in f.o.b. prices. The gross production value of industries as a sum of intermediate inputs and gross value added is in basic prices.

The supply and the use table have to fulfil several identity relations. The domestic output of industries in basic prices from the supply table should equal total (intermediate and primary) inputs from the use table. Total supply of commodities (domestic and imported) from the supply table in purchasers' prices should equal total deliveries from the use table.

The structure of a **symmetric input-output table** (SIOT) is similar to that of a use table. The term symmetric refers to two distinguishing aspects. First, whereas in a use table the number of industries does not necessarily have to equal the number of commodities, this is the case in a SIOT. Second, in a SIOT the producing units are either institutionally defined industries (in so-called industry-by-industry tables) or homogenous units characterised by producing certain commodity groups (in commodity-by-commodity tables). The discussion, whether industry-by-industry or commodity-by-commodity tables are preferable for analytical purposes, is still unresolved. The European Statistical Office Eurostat proposes the latter type. In both cases it comprises three sub matrices (see table 2),

- the intermediate consumption matrix containing the flows of goods between the producing units,
- the gross value added matrix showing the use of primary inputs by the producing units and
- the final demand matrix with the final use of goods.

Furthermore commodity taxes and subsidies and imported goods are included in additional rows.

Table 2: Structure of a symmetric input-output table

	Products	Final demand				Total
Products	Intermediate consumption	Private consumption	Public consumption	Gross capital formation	Exports	Total use of commodities
Taxes and subsidies	Commodity taxes and subsidies					
Value added	Value added					
Imports	Imported goods					
Total	Total commodity supply					

Source: Own illustration

All values are in basic prices, except for imports which are measured in c.i.f. prices and exports which are in f.o.b prices. Four versions of recording imports in a SIOT are usually distinguished,

- as an additional row showing imports by destination sector,
- as additional matrices showing imports by source (or commodity group) and by destination, distinguishing between imports for intermediate and final demand,
- by including imports in the deliveries to intermediate and final demand and subtracting them from the exports or
- by including imports in the deliveries to intermediate and final demand and additionally recording them in a separate row by commodity below gross production value as a part of total supply of commodities.

Eurostat publishes separate tables for domestic and imported goods (version two) as well as a combined table (version four).

2.2 General approach and available data

The aim of this project was to set up an input-output table for Switzerland according to the principles of the ESA as far as possible within the given restricted resources. This includes the supply and use tables and a symmetric IO table as well as some additional matrices needed in the compilation process. The symmetric IOT follows the fourth version described in the previous section, since information on the destination of imports is not available in Switzerland.

In Switzerland the following official statistical data sources are available, which can be more or less directly used in the process of generating the IO table:

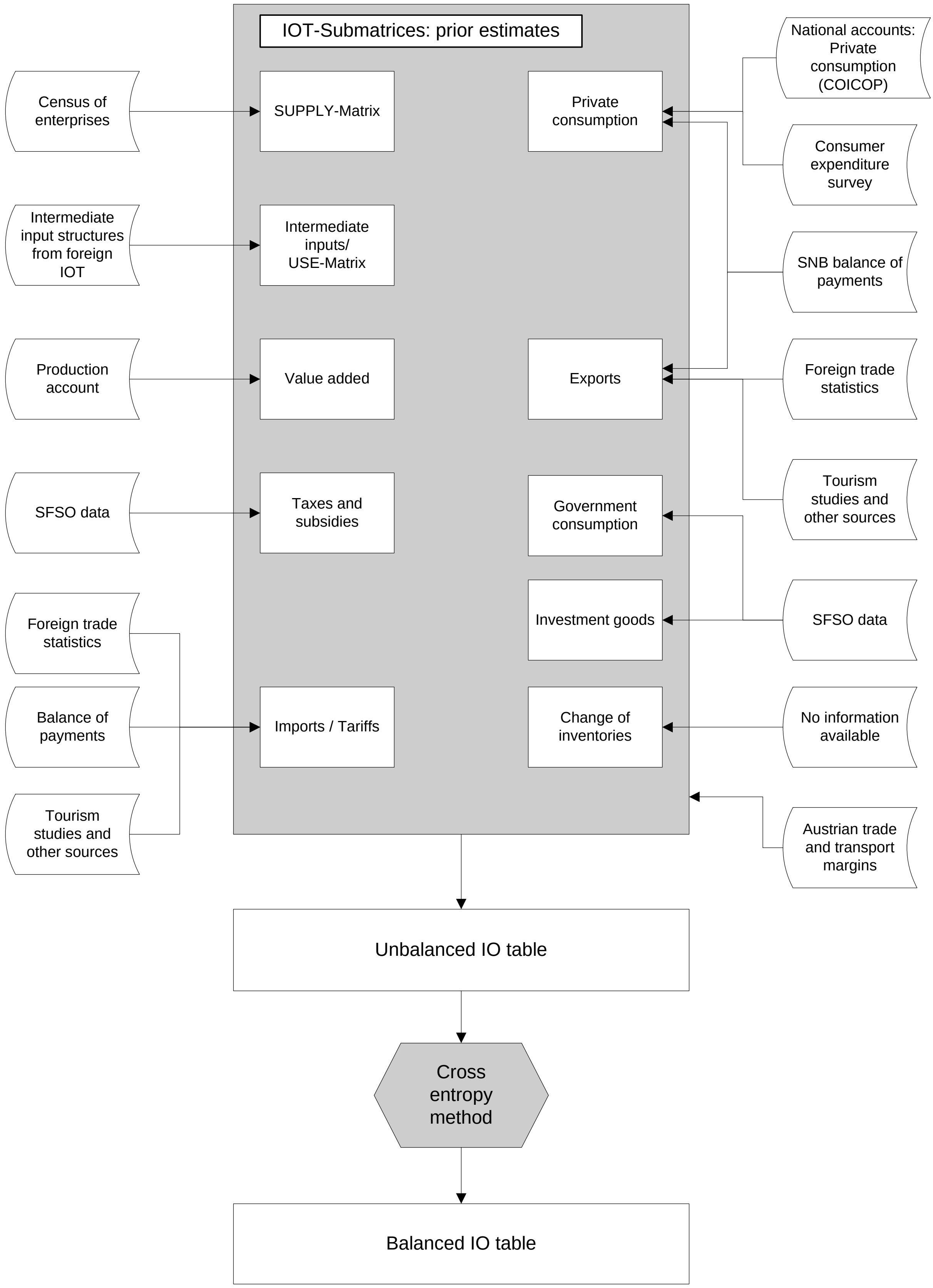
- the national accounts supplying various macroeconomic totals and data for final demand by expenditure category,
- the production account supplying gross production, value added and total intermediate inputs for 43 industries,
- foreign trade statistics and the balance of payment and
- statistics on taxes, tariffs and subsidies.

Yet, important statistical sources usually available for generating input-output tables are missing, especially concerning:

- the production of commodities,
- the breakdown of intermediate inputs,
- information on trade and transport margins,
- the components of value added or
- the breakdown of final demand categories by commodities.

Since it was not possible to generate the IO table from official statistical sources only, a two-step approach was chosen. In a first step each sub matrix of the IO table was set up, using specific methods and available data sources, which could be used within the time frame of this project. These are presented in detail in section 3. We aimed at a level of detail which corresponds to the production account (almost NOGA 2-digit level). Most of the IO table elements are subject to uncertainties, which partly can be high. The result of the first step was an unbalanced IO table showing several inconsistencies (see section 3.10). These inconsistencies were analyzed and reduced as far as possible with additional information. In a second step, an adaptation method based on the cross entropy concept was applied to generate a balanced version of the input output table. Figure 1 shows a scheme of the estimation process with the main data sources used. In principle this approach resembles that of the previous approaches by Antille (1983) and Antille et al. (1990). It mainly differs in the estimation of the use matrix and the adaptation or balancing method, which follows the cross entropy approach (see section 2.3.1) instead of the often used RAS approach (Miller and Blair 1985, pp. 276ff, among others).

Figure 1: Overview of the approach and main data sources for estimating an input-output table for Switzerland



Source: Own illustration

2.3 An estimation method based on the entropy concept

Since data sources are of different quality we need an approach which is able to represent these differences. The cross entropy approach[1], as described in this section, allows to represent the data generating process. In a first step, we compiled an estimate for each cell entry of the input-output table using statistical sources. In order to represent the heterogeneity in quality of different sources, we defined for each cell entry a lower and upper bound. Thus, the estimated value has to lie within the interval which has been determined by the lower and upper bound. If data quality is poor, the interval is relatively large and vice versa. Using this information we constructed a prior probability distribution which represents the data compiled during the first step (unbalanced IO table). This prior estimate violates macro restrictions which must be met by definition, e.g. equality of total supply and demand for each commodity. In the estimation process we imposed these additional restrictions and estimated the consistent IO table, which is "close" to the prior but inconsistent table as measured by the Kullback-Leibler cross entropy measure. In the following, we want to introduce this approach illustratively.

But first note the difference between the method applied here and the standard statistical interference approach. Since data is limited, partial and incomplete, our problem is underdetermined in the sense that given the available information, we are not able to estimate the coefficients of the IO table by using classical regression methods. To clarify this point, consider the deterministic pure-inverse linear problem: If we have a T-dimensional vector of observations $\mathbf{y}$, $\mathbf{X}$ as a T by K linear operator and $\boldsymbol{\beta}$ as a K-dimensional vector of unknowns, then we can write the problem as:

$$\mathbf{y} = \mathbf{X}\boldsymbol{\beta}$$

If the number of unknowns exceeds the number of observations we have to determine $(K - T)$ arbitrary parameters in order to determine one solution out of the entire class of solutions.

The remainder of this section introduces the estimation concept to handle such underdetermined problems. Particularly, we clarify the notion of entropy. Then we show in a simple example how this concept can be used to estimate an input-output table which is consistent with the macro restrictions and using prior information as a starting point of the estimation procedure.

2.3.1 The entropy concept

The Shannon entropy of the distribution $\mathbf{p}$ is defined by:

$$H(\mathbf{p}) = -\sum_k p_k \ln(p_k)$$

where $0 \ln(0) = 0$. In order to understand the concept of entropy, first assume a lottery with K different outcomes. If we repeat the lottery N times, then there exist K^N different outcomes. If we denote the number of times an outcome occurs in an experiment of the length N by N_k we have:

$$\sum_k N_k = N \text{, for all } k$$

1 For an overview of this method and different applications see Golan et al. (1996) and Golan (2002).

Hence, a particular set of frequencies **p**

$$p_k = \frac{N_k}{N}, \text{ for all } k$$

can be realized in *W* number of ways, where *W* is given by:

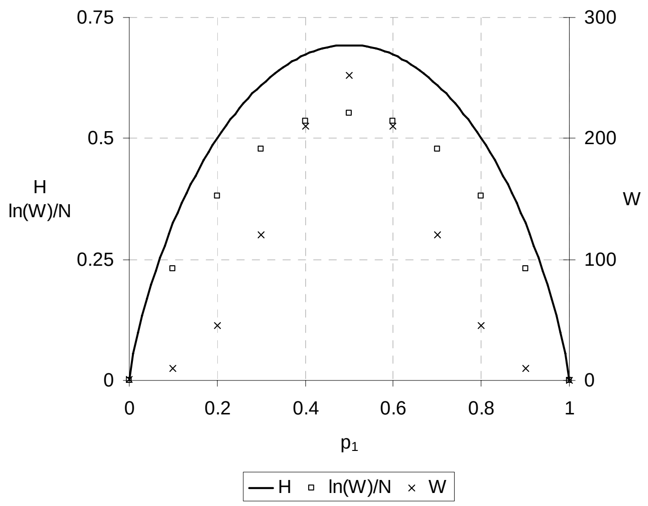
$$W = \frac{N!}{\prod_k N_k!} \text{ or } \ln(W) = \ln(N!) - \sum_k \ln(N_k!)$$

It can be shown that for $N \to \infty$ the Shannon entropy is approximately:

$$H(\mathbf{p}) = -\sum_k p_k \ln(p_k) \approx \frac{\ln(W)}{N}$$

Hence, the entropy measure *H* indicates in how many different ways a specific set of outcomes (i.e. a probability distribution **p**) can be realized. The higher the entropy is, the more ways exist to generate a specific probability distribution **p**, and therefore, the more uncertainty we have (see Figure 2). We can use the entropy measure *H* in order to determine an unknown probability distribution **p** given some moment restrictions, i.e. data.

Figure 2: Entropy *H* and realized number of ways *W* for the case of *K*=2 and *N*=10



Source: Own illustration

If we maximize the entropy measure *H* subject to moment restrictions (given data), we obtain the frequency set **p** which replicates the given data in the greatest number of ways. Consider for example a six sided dice that can take values $k = 1, 2, \ldots, 6$. We have to determine the probability distribution **p** and the only information available is the average outcome μ from a large number of independent rolls of the dice. We use the "maximum entropy principle" to determine the unknown distribution **p**. This principle chooses the distribution for which the information is just sufficient to determine the probability assignment. Formally, we have to maximize

$$H(\mathbf{p}) = -\sum_{k=1}^{6} p_k \ln(p_k)$$

subject to

$$\sum_{k=1}^{6} p_k z_k = \mu$$

$$\sum_{k=1}^{6} p_k = 1$$

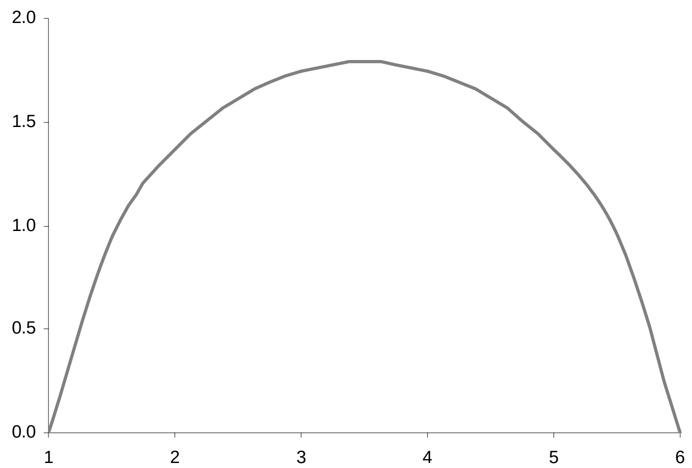
where $z_k = k$ for each k. There exists no closed form solution for $\mathbf{p}$. But we can solve the problem numerically. The following table shows the entropy measure H and the distribution $\mathbf{p}$ for different average outcomes μ. Figure 3 shows the entropy for alternative average outcomes.

Table 2: Estimation of the unknown probability distribution $\mathbf{p}$ for different average outcomes

μ	H	p_1	p_2	p_3	p_4	p_5	p_6
→ 1.0	→ 0.000	→ 100.0%	→ 0.0%	→ 0.0%	→ 0.0%	→ 0.0%	→ 0.0%
1.5	0.953	66.4%	22.4%	7.5%	2.5%	0.9%	0.3%
2.0	1.367	47.8%	25.5%	13.6%	7.2%	3.9%	2.1%
2.5	1.614	34.7%	24.0%	16.5%	11.4%	7.9%	5.4%
3.0	1.749	24.7%	20.7%	17.4%	14.6%	12.3%	10.3%
3.5	1.792	16.7%	16.7%	16.7%	16.7%	16.7%	16.7%
4.0	1.749	10.3%	12.3%	14.6%	17.4%	20.7%	24.7%
4.5	1.614	5.4%	7.9%	11.4%	16.5%	24.0%	34.7%
5.0	1.367	2.1%	3.9%	7.2%	13.6%	25.5%	47.8%
5.5	0.953	0.3%	0.9%	2.5%	7.5%	22.4%	66.4%
→ 6.0	→ 0.000	→ 0.0%	→ 0.0%	→ 0.0%	→ 0.0%	→ 0.0%	→ 100.0%

Source: Own calculations

Figure 3: Entropy of the dice problem for different average outcomes



Source: Own illustration

As already mentioned, the entropy H can be interpreted as an uncertainty measure. Since it measures the number of ways a frequency distribution **p** generates a specific set of outcomes, the higher the entropy is the more uncertainty is present. Hence, H is maximized if $p_k = 1/K$.

We can also include prior information **q** about the unknown probability **p**. According to the Kullback-Leibler information measure one would choose the estimate for **p** that can be discriminated from **q** with a minimum of difference. The Kullback-Leibler information measure or the cross-entropy between **p** and **q** is defined by:

$$I(\mathbf{p},\mathbf{q}) = \sum_k p_k \ln\left(\frac{p_k}{q_k}\right) = \sum_k p_k \ln(p_k) - \sum_k p_k \ln(q_k)$$

Consider again the case of a dice. We have prior information about the probability **p** given by **q**. Now, we get the information that the average outcome is $\hat{\mu}$. Which probability **p** is consistent with our prior belief and the new information? We can minimize

$$I(\mathbf{p},\mathbf{q}) = \sum_{k=1}^{6} p_k \ln(p_k) - \sum_{k=1}^{6} p_k \ln(q_k)$$

subject to

$$\sum_{k=1}^{6} p_k z_k = \hat{\mu}$$

$$\sum_{k=1}^{6} p_k = 1$$

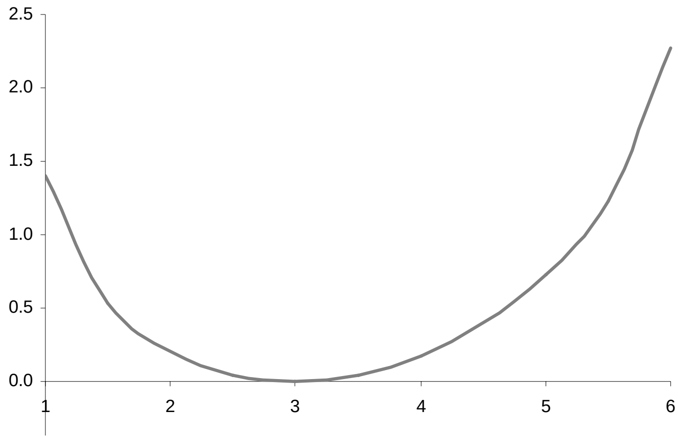
Again, there does not exist a closed form solution. If we choose **q** according to the values in Table 2 for $\mu = 3$ then we get for different values for $\hat{\mu}$ representing new information:

Table 3: Estimation of the unknown probability distribution **p** for different average outcomes using a prior **q**

$\hat{\mu}$	I	p_1	p_2	p_3	p_4	p_5	p_6
→ 1.0	→ 1.399	→ 100.0%	→ 0.0%	→ 0.0%	→ 0.0%	→ 0.0%	→ 0.0%
1.5	0.533	66.4%	22.4%	7.5%	2.5%	0.9%	0.3%
2.0	0.206	47.8%	25.5%	13.6%	7.2%	3.9%	2.1%
2.5	0.048	34.7%	24.0%	16.5%	11.4%	7.9%	5.4%
3.0	0.000	24.7%	20.7%	17.4%	14.6%	12.3%	10.3%
3.5	0.044	16.7%	16.7%	16.7%	16.7%	16.7%	16.7%
4.0	0.175	10.3%	12.3%	14.6%	17.4%	20.7%	24.7%
4.5	0.397	5.4%	7.9%	11.4%	16.5%	24.0%	34.7%
5.0	0.730	2.1%	3.9%	7.2%	13.6%	25.5%	47.8%
5.5	1.232	0.3%	0.9%	2.5%	7.5%	22.4%	66.4%
→ 6.0	→ 2.272	→ 0.0%	→ 0.0%	→ 0.0%	→ 0.0%	→ 0.0%	→ 100.0%

Source: Own calculations

Figure 4: Cross-entropy of the dice problem for different average outcomes



Source: Own illustration

The cross-entropy measure can also be interpreted as an information measure: If the posterior probability **p** due to the new information imposed differs substantially from the prior **q**, the measure increases. On the other hand, if the posterior probability **p** equals the prior **q**, we have no new information imposed to the problem. Figure 4 shows that the minimum of the cross-entropy measure I is reached at $\hat{\mu} = 3$, which is consistent with our prior probability **q**.

In order to estimate an input-output table for Switzerland we use a cross-entropy approach as described in Golan et al. (1994) and Robinson et al. (2000). First we generate a prior estimate for each entry in the IO table. The priors consist of the following information:

- lower bound of the IO table entry
- upper bound of the IO table entry
- prior value of the IO table entry

This information allows us to determine the support space **z** for each entry and to estimate a prior maximum entropy probability distribution **q** for each entry. Then we impose macro restrictions on aggregates and balance restrictions and estimate the posterior distribution **p** which is consistent with the restrictions. As a result we obtain a balanced IO table and the cross-entropy measure provides us information about the distance between our prior estimate and the posterior distribution. The following example shows the approach in a simple example.

2.3.2 Example: Cross entropy estimation of an input-output table

Suppose there are two activities A1 and A2, two commodities C1 and C2, one end-use activity FD and value added V. Furthermore, we determine a lower and an upper bound as well as a prior estimate for each cell in the IO table. Our prior estimates violate aggregate data (row and column sums) which is assumed to be known. The following table shows the data used for the illustrative example, where the first number indicates the lower bound, the second the prior estimate and the last number the upper bound:

Table 4: Inconsistent input-output table with lower bound, prior estimate and upper bound values

	A1	A2	G1	G2	FD	Σ
A1			(10, 12, 16)	(4, 5, 8)		18
A2			(1,3,4)	(35, 36, 37)		38
G1	(2,5, 6)	(4, 6, 8)			(4, 6 , 8)	16
G2	(2, 3, 6)	(9, 12, 14)			(18, 22, 26)	40
V	(8, 12,14)	(16, 19, 24)				30
Σ	18	38	16	40	30	

Source: Own illustration

We can now construct the support set $z_{i,j}$ for each cell entry $a_{i,j}$, where the set elements $z_{i,j,h}$ (h=1, 2, …, 5) lie equidistant within the interval which is determined by the lower and upper bound. Applying the maximum entropy method yields the prior probability distribution **q** for each IO table entry:

$$\text{Max } H(\mathbf{q}) = -\sum_i \sum_j \sum_h q_{i,j,h} \ln\left(q_{i,j,h}\right)$$

subject to

$$\sum_h q_{i,j,h} z_{i,j,h} = a_{i,j} \quad \forall i, j$$

$$\sum_h q_{i,j,h} = 1 \quad \forall i, j$$

Now we impose the aggregate data (row and column sums, r_i and c_j respectively) as new constraints and estimate the posterior probability **p** for each cell by using the cross entropy method:

$$\text{Min } I(\mathbf{p},\mathbf{q}) = \sum_i \sum_j \sum_h p_{i,j,h} \ln\left(p_{i,j,h}\right) - \sum_i \sum_j \sum_h p_{i,j,h} \ln\left(q_{i,j,h}\right)$$

subject to

$$\sum_j \sum_h p_{i,j,h} z_{i,j,h} = r_i \quad \forall i$$

$$\sum_i \sum_h p_{i,j,h} z_{i,j,h} = c_j \quad \forall j$$

$$\sum_h p_{i,j,h} = 1 \quad \forall i, j$$

The following table shows the estimation result. The cross entropy measure $I(\mathbf{p},\mathbf{q})$ is equal to 1.573.

Table 5: Consistent input-output table using the cross entropy method

	A1	A2	G1	G2	FD	Σ
A1			13.467	4.533		18
A2			2.533	35.467		38
G1	4.310	5.862			5.828	16
G2	2.989	12.839			24.172	40
V	10.701	19.299				30
Σ	18	38	16	40	30	

Source: Own calculation

Now consider an alternative prior estimate with the same upper and lower bounds as reported in the following table.

Table 6: Alternative prior estimate

	A1	A2	G1	G2	FD	Σ
A1			(10, 11, 16)	(4, 6, 8)		18
A2			(1 ,2, 4)	(35, 36, 37)		38
G1	(2, 4, 6)	(4, 7, 8)			(4, 7 , 8)	16
G2	(2, 4, 6)	(9, 13, 14)			(18, 24, 26)	40
V	(8, 10,14)	(16, 17, 24)				30
Σ	18	38	16	40	30	

Source: Own illustration

Applying the same procedure as above yields a cross entropy measure $I(\mathbf{p},\mathbf{q})$ of 3.024 and the following consistent IO table.

Table 7: Consistent input-output table using the alternative prior estimate

	A1	A2	G1	G2	FD	Σ
A1			13.473	4.527		18
A2			2.527	35.473		38
G1	3.160	6.398			6.442	16
G2	3.625	12.817			23.558	40
V	11.215	18.785				30
Σ	18	38	16	40	30	

Source: Own calculation

Since the cross entropy measure $I(\mathbf{p},\mathbf{q})$ is an indicator for the additional information imposed by the aggregate data in order to estimate a consistent table, we can conclude that the lower the cross entropy measure is the more consistent is our prior estimate, i.e. the estimate we yield without imposing aggregate regularity conditions. Thus, because the cross entropy measure $I(\mathbf{p},\mathbf{q})$ is higher for the second prior estimate (3.024 > 1.573) we choose the first prior estimate for the estimation of a consistent IO table.

3 Input data for the estimation model

In this section we describe the data sources and assumptions in the generation of each sub matrix of the input-output table. In most cases we had to derive the first estimates from secondary statistical sources. We defined the lower bounds by the allocation, which we could make unambiguously. In order to determine the upper bounds and the prior estimates we had to rely on considerations, which seemed plausible. We also briefly address open points and some shortcomings.

3.1 Supply table

As described in section 2.2 there are no commodity statistics available for Switzerland which could be used to determine a supply table. Similar to Antille (1990) we therefore used data from the census of enterprises 2001. The census distinguishes between enterprises as legal entities and establishments as productive entities (SFSO 2002a). One enterprise can consist of one or more establishments. Each enterprise and establishment is classified at NOGA level 5 according to their main economic activity and for each establishment the workforce in terms of full time equivalents is reported. We interpret an enterprise as an institutional entity (industry), an establishment as a functional entity (product). Further we include the gross production value as reported in the Swiss production account for 2001, which is available at NOGA level 2 (SFSO 2004a, augmented by SFSO 2004e). In order to estimate a supply table for Switzerland, we apply the following assumptions:

- the labour productivity to produce a specific good is homogenous between different sectors, and
- the price of a specific good is homogenous between different sectors.

Making these assumptions, we can set up the following estimation model. The supply table **Y** in terms of basic prices is defined as the product of physical output **Q** and basic prices **P:**

$$\mathbf{Y} = \mathbf{QP}$$

Physical output **Q** is the product of labour inputs **L** and labour productivity **Φ**:

$$\mathbf{Q} = \mathbf{L\Phi}$$

Gross production values as reported in the production account (**y**) is an aggregation of the supply table **Y**, where **G** denotes the aggregation matrix which maps each cell of the supply table into the aggregated sectors of the production account and **1** is a summation vector containing only ones:

$$\mathbf{y} = \mathbf{GY1}$$

According to our hypothesis, the matrices used have the following structure:

P: output prices of a specific good m=1, 2, …, M

$$\mathbf{P} = \begin{pmatrix} p_1 & \cdots & 0 \\ \vdots & \ddots & \vdots \\ 0 & \cdots & p_M \end{pmatrix}$$

L: labour input of sector n=1, 2, …, N to produce a specific good m=1, 2, …, M

$$\mathbf{L} = \begin{pmatrix} l_{11} & \cdots & l_{1M} \\ \vdots & \ddots & \vdots \\ l_{N1} & \cdots & l_{NM} \end{pmatrix}$$

Φ: labour productivity to produce a specific good m=1, 2, …, M (measured in physical units)

$$\mathbf{\Phi} = \begin{pmatrix} \phi_1 & \cdots & 0 \\ \vdots & \ddots & \vdots \\ 0 & \cdots & \phi_M \end{pmatrix}$$

G: sectoral aggregation matrix which maps sector n=1, 2, …, N at NOGA 5 level into the production account sector s=1, 2, …, S and where g_{sn}=1 if sector n belongs to the aggregated sector s and 0 elsewhere

$$\mathbf{G} = \begin{pmatrix} g_{11} & \cdots & g_{1N} \\ \vdots & \ddots & \vdots \\ g_{S1} & \cdots & g_{SN} \end{pmatrix}$$

1: an M by 1 vector containing ones as elements

Using the definitions we can write:

$$\mathbf{y} = \mathbf{GL\Phi P1}$$

where **y**, **G**, **L** and **1** are known and **ΦP** is unknown. Now, we can rewrite the problem in the following way:

$$\mathbf{y} = \mathbf{X\beta}\text{, where } \mathbf{X} = \mathbf{GL} \text{ and } \boldsymbol{\beta} = \mathbf{\Phi P1}.$$

Due to the special structure of **Φ** and **P**, **β** contains the diagonal entries of the **ΦP** matrix. In our case we have $S<N$, $S<M$ and $N \neq M$. Hence, it is not possible to take the inverse of the matrix **X** in order to calculate the unknowns **β**. But we can define the problem as a general maximum entropy pure inverse problem (see Golan et al., 1997):

$$\max_{\mathbf{p}} H(\mathbf{p}) = -\sum_m \sum_i p_{mi} \ln(p_{mi})$$

subject to

$$\sum_m \sum_i x_{sm} z_{mi} p_{mi} = y_s \quad for\ s = 1, 2, \ldots, S$$

$$\sum_i p_{mi} = 1 \quad \forall\ m$$

where $\mathbf{z}_m$ defines the conceptual playing field for each β_m in the support space containing I elements, consistent with our expectations for the unknown coefficients, and p_{mi} represents the probability that β_m takes the value z_{mi} (note: $\beta_m = \sum_i z_{mi} p_{mi}$). This gives us an estimation of **β**. Therefore, we can calculate the disaggregated make matrix as:

$$\mathbf{Y} = \mathbf{L\hat{B}},$$

where the diagonal in $\hat{\mathbf{B}}$ contains the estimated values of the $\mathbf{\Phi P}$ matrix and is zero elsewhere.

For three sectors we could not apply the described estimation procedure and had to analyze their output structure separately. It is not possible to capture the output of public administration (NOGA 75), since all activities of the public administration is classified as NOGA 75. Hence, goods and services provided by the public sector (e.g. rental services) can not be derived from the data given by the census. In order to estimate the market production we used information delivered by SFSO (2004h) and we also accounted for the provision of health services as reported in SFSO (2003a). Furthermore, a first analysis showed that the commodity balance for rental services is not balanced at all. We suppose that rental services provided by real estate funds (NOGA 65) and insurances (NOGA 66) are not represented in the data of the census.

The census does also not include the primary sector. However, the Swiss statistical office compiles sectoral accounts for the primary sector. Thus, we could use the production values of these production accounts (SFSO 2004b), implicitly assuming that these sectors are one-good sectors.

The estimation algorithm described in section 4 is sensitive to large off-diagonal entries in the supply table. The production account allocates public education to the administration sector (NOGA 75), which generates a huge off-diagonal entry in the supply table. Therefore, we switched expenses on public education from the administration sector to the education sector (NOGA 80) according to SFSO (2005b). This alters the gross production values of these sectors as reported in the production account.

The estimation of the make matrix could be enhanced by using more data or by expanding the approach. One could for example estimate the make matrix by making the assumption that the labour productivity does not differ within a specific sector (Antille et al. 1990). Then one could take the estimated labour productivities of the two alternative hypotheses and try to construct an interval for each labour productivity value and estimate the make matrix without making any assumption on homogenous labour productivities.

3.2 Imports

The data for the imports (and consequently exports) has been derived from three different sources:

- The Swiss Federal Customs Administration collects data on the import and export of goods and the customs paid at the border (see section 3.2.1).
- The Swiss National Bank (SNB) collects data on and estimates the import and export of services (see section 3.2.2).
- In order to breakdown imports and exports related to tourism, we drew on further information such as the tourism satellite accounts (see section 3.2.3).

3.2.1 Goods

Definition and valuation

The statistics of the Swiss Federal Customs Administration records general merchandise goods (incl. precious metal, gemstones, objects of art and antiques) as well as goods subject to on-site processing (an import not followed by an export or vice versa).[2] Compared to the Swiss National Account (SNA) there are however a series of goods not included (see Table 8). The statistics of

[2] For a more detailed definition see http://www.zoll.admin.ch/d/aussen/allgemein/konzept.php.

the Swiss Federal Customs Administration does therefore not cover all the imported and exported goods summarized under the SNA.

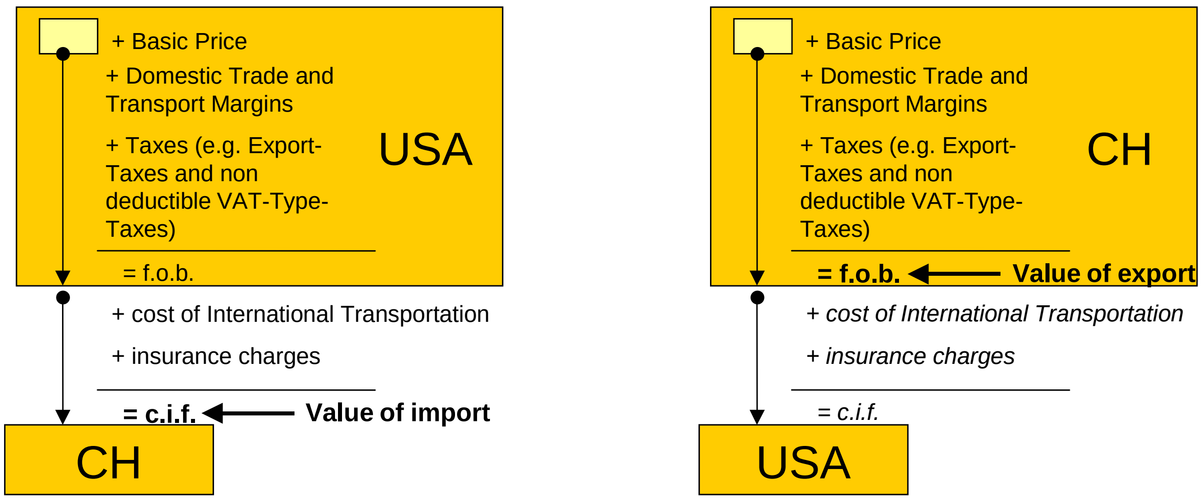
Table 8: Comparison between balance of payments of the SNA und the statistics of the Swiss Federal Customs Administration

Current account SNA (trade of goods)		Statistic of the Swiss Federal Customs Administration
Merchandise goods		Available
Electricity		Not available
Other goods	Precious metal, gemstones, objects of art and antiques	Available
	Goods for processing on the basis of a contract and for a fee	Not available
	Returned goods (unaltered goods being sent back to the country of origin)	Not available
	Purchase and sale of ships on the Rhine	Not available
	Private and other uncontrollable goods	Not available
	Import of industrial gold and silver	Not available
	Goods procured in ports	Not available

Source: Own illustration

Within the input-output framework the imports have to be valued at c.i.f. prices and exports in f.o.b. prices (see Figure 5). The statistics of the Swiss Federal Customs Administration uses this valuation concept and the values of the statistics can be directly used.

Figure 5: Valuation of the imported goods (on the left hand) and the exported goods (on the right hand)



Source: Own illustration

Allocation of the data to the NOGA classification

The allocation of the import and export of goods to the NOGA classification is done in two steps. In the first step we considered only the statistics of the Swiss Federal Customs Administration. In a second step we allocated the remaining trade flows of goods which are not included in this statistic.

First step: Allocation of the Swiss Federal Customs Administration to NOGA

The classification of the imported and exported goods is based on the "Harmonized System" (HS) which is being set by the World Customs Organisation and accepted throughout the world.[3]

3 For more detail see: http://www.wcoomd.org/ie/en/en.html

Based on a series of international correspondence tables it was possible to link each imported and exported good to the industrial classification (NOGA) used in Switzerland according to the following sequence of correspondence tables:

1. 1. HS2002 <=> CPCv11
2. 2. CPCv11 <=> ISIC Rev. 3.1
3. 3. ISIC Rev. 3.1 <=> NACE Rev.1.1
4. 4. NACE Rev.1.1<=> NOGA

The correspondence tables are being provided by RAMON (EUROSTAT Classification Server)[4] and by the UN Statistical Division.[5] Due to the ambiguousness of the correspondence tables the best way of interlinking them is to proceed backwards. That means first linking the Harmonized System (HS) with thee CPC (Central Product Classification). Afterwards linking the CPC with ISIC (International Standard Industrial Classification), this again will be linked with NACE, which in turn is related to NOGA. Using this procedure more than 99.5% of the trade flows could be allocated to the Swiss industrial classification (NOGA).

Second step: Allocation of the remaining trade flows of goods to NOGA

Except for electricity, which was allocated to NOGA 40, the remaining positions were allocated to NOGA sectors according to the share of the NOGA sectors in total imports.

3.2.2 Services

The allocation of the import and export of services to the NOGA-Classification is depicted in Table 9. It is based on the correspondence table of the IMF Balance of Payments Manual.[6] All those positions, which could not be matched unambiguously have been allocated according to the relative weight of the added value of the NOGA positions.

Table 9: Concordance table balance of payments SNB to NOGA

Current Account SNB (services)	Manual IMF	NOGA		Comments on the allocation
Fremdenverkehr	Travel		Tourism is defined from the demand-side. It can affect various industrial sectors.	See section 4.2.3 for more details.
Ferien- und Geschäftsaufenthalte				
Tages- und Transiverkehr				
Übriger Fremdenverkehr				
Konsumausgaben der Grenzgänger				
Privatversicherungen	Insurance services	66	Versicherungsgewerbe	Can not be further disaggregated.
		67	Mit Kredit-/ Versicherungsgew. verb. Tätigk.	
Transithandel	Merchanting and other trade related services	51	Handelsvermittlung und Grosshandel	We have only data for NOGA 51. The remaining ones can not be further disaggregated.
		65	Kreditgewerbe	
		67	Mit Kredit-/ Versicherungsgew. verb. Tätigk.	

4 See: http://europa.eu.int/comm/eurostat/ramon/
5 See: http://unstats.un.org/unsd/cr/registry/regdnld.asp?Lg=1
6 See IMF (1993), Balance of Payments Manual, pp148.

Current Account SNB (services)	Manual IMF	NOGA		Comments on the allocation
Transporte	Transportation	60	Landverkehr/Rohrfernleitungen	Allocation according to Antille/Morales (1996)
		61	Schiffahrt	
		63	Hilfs- und Nebentätigkeiten für den Verkehr	
Post-, Kurier- und Fernmeldeverkehr	Communication services	64	Nachrichtenübermittlung	
Sonstige Dienstleistungen				
Bankkommissionen	Financial Services	65	Kreditgewerbe	Can not be further disaggregated.
		67	Mit Kredit-/ Versicherungsgew. verb. Tätigk.	
Technologische Dienstleistungen (Bauleistungen, kaufmännische und technische Beratung, Lizenz- und Patenterträge inkl. Regiespesen)	Construction services	45	Baugewerbe	- There is information on the royalties and licences. Allocation to NOGA through stock of direct investment. - The construction and technical services amount to each 50% of the remaining amount.
	Royalties and license fees	-	No unambiguous allocation possible	
	Technical Services	-	No unambiguous allocation possible	
Übrige Dienstleistungen (Käufe von Gütern und Diensten durch ausländische Vertretungen in der Schweiz, durch schweizerische Vertretungen im Ausland sowie durch internationale Organisationen in der Schweiz, Verwaltung von Domizilgesellschaften, etc.)	Government sevices n.i.e.	99	No unambiguous allocation possible	- There is information on the government services and personal, cultural and recreational services. - The remaining amount consists of various items, wich can not be allocated to NOGA. Federal stamp duty has been allocated according to SFSO (2004d)
	Personal, cultural, and recreational services	92	Unterhaltung, Kultur, Sport	
		93	Persönliche Dienstleistungen	
	Computer and information services	72	Informatikdienste	
		80	Unterrichtswesen	
	Operational leasing services	71	Vermietung beweglicher Sachen	

Source: SNB

3.2.3 Tourism

In the balance of payments compiled by the SNB the expenditures of domestic inhabitants abroad (tourist traffic) is divided into the following positions (values for 2001).

Table 10: Positions of tourist traffic accounts (imports) in the Swiss balance of payments 2001

Positions of tourist traffic	Expenditures (Mio. CHF)
Vacations and business trips	9042
Daily and transit traffic	1097
Other tourist traffic	400
Consumption expenditures of cross border commuters	19
Total	10558

Source: SNB (2002)

The breakdown of these expenditures into NOGA 2-digit product groups is not available. Antille and Morales (1996) estimated such a breakdown for each of the positions for the year 1990. Since more recent data were not available, we applied the same breakdown to the expenditures for 2001. Price changes for the diverse product categories could not be considered, since this would have entailed knowledge on price changes of the specific goods bought in the vacation countries. Such information was also not available.

3.3 Intermediate demand

The use table and the intermediate consumption matrix of the SIOT contain the intermediate inputs of the producing sectors of the economy. Whereas in the use matrix the producing sectors are defined institutionally (product-by-industry matrix), in the SIOT they are defined functionally (product-by-product matrix). In the latter the sectoral activity spectrum or product mix is more homogeneous.

3.3.1 Construction of an intermediate input structure matrix by country comparison

The production account as a part of the Swiss national accounts contains information on the intermediate consumption of the various Swiss industries almost at a NOGA 2 level (SFSO, 2004a; see Appendix A for a list of sectors). Data sources for a comprehensive breakdown of intermediate inputs are not available for Switzerland. In the value added statistics selected inputs are recorded, but this information is not published (SFSO, 2002b). Even if it were published, it would not allow a complete breakdown of the intermediate inputs. Therefore, it was necessary to estimate these inputs by using information from foreign IO tables. This approach was also applied by Antille et al. (1990) for the estimation of the 1985 Swiss IO table, where information from German IO tables was used.

Here our approach differs from Antilles approach. Instead of using information from one country for estimating the inputs of all sectors of the Swiss IO table, we aimed at finding - where possible - for each Swiss IO sector another country's sector which was as similar as possible and to use the input structure of that particular sector as a first estimation for the Swiss sector's input structure. The main criterion for assessing similarity between a Swiss and a foreign sector was the sector's product mix. Typically a sector's output consists of several more or less homogenous products. Our hypothesis is that the input structures of two sectors will be the more similar, the more similar their product mix. Though product mix probably is a strong determinant for the intermediate input structure of a sector, our hypothesis still has to be regarded as a simplification, since the sectoral input structure is probably determined by a multitude of factors, which may include

- the average size of enterprises influencing scale effects and technology choice,
- the level of rationalization, possibly depending on workforce salaries in the countries or the relevant sectors,

- governmental regulation in particular markets,
- regional resource availability, e.g. for energy conversion, or
- transport costs possibly depending on the size and population density of the country.

Due to resource and time restrictions it was not possible to analyze these factors comprehensively. Therefore we concentrated on the sectoral product mix as an important influencing factor.

Using information from foreign input-output tables for estimating the Swiss intermediate consumption poses several questions. Which countries should be considered? Which IO tables should be used? A prerequisite for using foreign information is that the considered countries are comparable with regard to their state of economic development and their economic structure. Therefore the circle of considered countries was restricted to Western European countries. It was further restricted to countries which have published recent IO tables. With regard to the IO table format, we preferred to use IO tables with functionally defined sectors (product-by-product IO tables) as opposed to tables with institutionally defined sectors (product-by-industry use tables or industry-by-industry IO tables). This has the following advantages: Functionally defined sectors are more homogenous and thus more suitable for transfer between different countries, since there is less bias from differing levels and patterns of side activities. Furthermore in product-by-product tables (in basic prices) the trade and transport margins are already allocated to the respective trade and transport sectors. Data on trade and transport margins for intermediate demand would not have been available for Switzerland. These choices further restricted the group of suitable countries, since not all European countries have published recent product-by-product IO tables. Furthermore countries, whose IO tables were too highly aggregated, were not considered (e.g. Ireland). Table 11 gives an overview of the various Western European countries' IO tables available for the country comparison. Most of these tables were collected and supplied by Eurostat. In some cases we were able to use more disaggregated tables supplied by the national statistical offices.

Table 11: Overview of IO tables of Western European countries available for the country comparison

Country	Eurostat table	No. of sectors (without FISIM)	Table type (available year)		
			supply and use table	product-by-product IOT	industry-by-industry IOT
Austria		57	2001	2000	
Belgium	x	59	2001	2000	
Denmark	x	59	2000		2000
Finland	x	59	2000		2000
France	x	59	2001	2000	
Germany		71	2001	2000	
Greece	x	59	1999	1998	
Ireland		41		1993 ?[1)]	
Italy	x	59	2001	2000	
Netherlands		105	2001		2001
Netherlands	x	59	2001		2000
Norway	x	59	2001		2001
Portugal	x	59	1999	1999	

Country	Eurostat table	No. of sectors (without FISIM)	Table type (available year) supply and use table	product-by-product IOT	industry-by-industry IOT
Spain		71	2000	1995	
Sweden	x	57	2001	2000	
United Kingdom		123	2000	1995	
United Kingdom	x	59	2001	1995	

1) No information, whether product-by-product or industry-by-industry IOT

Source: Own illustration

In analogy to the use of functionally classified IO tables, the comparison of production structures between countries would ideally require data from product oriented statistics. These data were not available for Switzerland and not readily available for the considered Western European countries. The aim was to perform the country comparison at the NOGA 2-digit level.

For Switzerland such data are not available due to a lack of commodity statistics. As a proxy we used the weights of the producer price index (PPI), which probably describe the production of goods in Switzerland with the highest available detail (SFSO, 2003c). The PPI is used to measure the development of producers' prices. Since a product oriented statistic does not exist in Switzerland the Swiss federal statistical office determines the weights of the PPI by making use of several statistical sources (e.g. production account, value added statistic, VAT statistic) as well as information from enterprises and associations. Hence, the weights of the PPI are based both on sources with institutional as well as functional classifications. Down to the 4-digit level they probably largely follow an institutional classification.

The PPI is restricted to the primary sector, mining and quarrying and the industrial sector (NOGA 01, 02, 14 – 40). Especially the service industries are excluded from the PPI. They thus could not be considered in the country comparison. Some sectors are represented incompletely. Publishing companies as part of NOGA sector 22 (Printing and publishing) are missing. In NOGA sector 36 (Manufacture of furniture, manufacture n.e.c) only manufacturing of furniture is included whereas the rest is missing. We could close these data gaps with information from the SFSO and from trade associations. For some sectors (NOGA 32, 33, 34, 35) only 2-digit- and partly 3-digit-level data was available. In these cases we further disaggregated the data on the basis of employment data in the census of enterprises to the 3-digit level. We disaggregated according to employees in establishments (in full time equivalents) and thus implicitly assumed the gross production value per full time equivalent to be identical for all subsectors of a NOGA sector. For some sectors (NOGA 16 and 30) no further disaggregation was available beyond the 2-digit-level, so that these sectors could not be included in the comparison.

Product oriented statistics were not readily available for representing the production structure of the other European countries. The European product oriented database PRODCOM by Eurostat is not comprehensive. Thus, the necessary data would have had to be compiled on the basis of individual country data, which was not possible in this project due to time and resource restrictions. Instead we used data from the OECD data base SSIS[7] (OECD, 2003). It shows production in each of the member countries up to the 4-digit level of ISIC rev. 3 for the industry and the service sector. The primary sector (i.e. agriculture, forestry and fishing) is not covered. The completeness of the data varies between countries. The advantage of this data base lies in the harmonised method and a ready availability of the necessary data. On the other hand SSIS is an enterprise based and not a product based statistic. Hence the production values include side activities related to other sectors. Conceptually this classification largely corresponds to that of

[7] Structural Statistics for Industry and Services

the PPI weights. Even though product oriented statistics would be preferable, our dataset should provide a good indication of the production structure in the compared countries.

Where possible we used the year 2000 as a base year. The weights of the PPI 2003 reflect production of the year 2000. In the case of the SSIS data base there are data gaps for certain countries, years and sectors. As far as possible these gaps were filled with estimations based on time series of SSIS data between 1995 and 2000. The SSIS data are available at a given aggregation level, which differs between sectors. For some sectors no further disaggregation was available beyond the 2-digit-level, so that these sectors could not be included in the comparison. For the comparison the Swiss data were regrouped according to the classification of the SSIS data.

The aim of the country comparison was to find for each Swiss NOGA 2-digit-level sector (except for sectors 16 and 30) another country's sector with a maximum similarity regarding product mix. Since the maximum disaggregation is 3 digits for some sectors and 4 digits for other sectors, the comparison was performed for two data sets. The first contains data on the 3-digit level and the second additional data at the 4-digit level for selected sectors. In total the comparison was performed for 23 sectors, out of which 12 were described with 4-digit-level data. Table 12 shows the level of disaggregation available for the NOGA 2-digit-level sectors, which are covered both in the Swiss PPI and in SSIS. It also contains the production shares (w_i, see below) of the considered sectors in Switzerland out of their production total.

The similarity of the product mix between two countries' sectors was measured with the Euclidian metric. The Euclidian distance D_i^{bc} between two countries b and c with regard to sector i is defined as

$$D_i^{bc} = \sqrt{\sum_{k_i} (x_{k_i}^b - x_{k_i}^c)^2}$$

where

$i = 1,...,n$	as 2-digit level sectors
$b, c = 1,...,m$	as countries
$k_i = 1,...,l_i$	as 3- or 4-digit-level subsectors of sector i
$x_{k_i}^b$	as share of subsector k_i in production of sector i in country b,
	with $0 \leq x_{k_i}^b \leq 1$ and $\sum_{k_i} x_{k_i}^b = 1$

Table 12: Data availability for the country comparison of production structures

Country	ISIC level	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	40
		ISIC sector no.																								
Switzerland	3-digit	x	x		x	x	x	x		x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x
	4-digit		x		x		x	x	x	x		x		x		x	x				x					
Austria	3-digit	x	x		x	x	x	x		x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x
	4-digit				x		x	x	x	x		x		x		x	x				x					
Belgium	3-digit	x	x		x	x	x	x		x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x
	4-digit		x		x		x	x	x	x		x		x		x					x					
Denmark	3-digit	x	x		x	x		x		x			x	x	x	x	x		x	x	x	x	x	x		x
	4-digit				x			x	x	x						x	x				x					
Finland	3-digit	x	x		x	x	x	x		x		x	x	x	x	x	x		x	x	x	x	x	x	x	x
	4-digit		x		x		x	x	x	x				x		x	x				x					
France	3-digit	x			x	x	x	x		x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x
	4-digit				x		x	x	x	x		x		x		x	x				x					
Germany	3-digit	x	x		x	x	x	x		x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	
	4-digit		x		x		x	x	x	x				x		x	x				x					
Greece	3-digit		x		x	x	x	x				x	x	x	x	x	x		x	x	x	x	x	x		
	4-digit																									
Ireland	3-digit							x		x			x		x				x	x	x	x			x	
	4-digit							x													x					
Italy	3-digit	x	x		x	x	x	x		x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x
	4-digit		x		x		x	x	x	x		x		x		x	x				x					
Netherlands	3-digit	x	x		x	x	x	x		x		x	x	x		x	x		x		x	x	x	x	x	
	4-digit				x		x	x	x	x							x				x					
Norway	3-digit	x	x		x	x	x	x		x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	
	4-digit		x		x		x	x	x	x		x		x		x	x				x					
Portugal	3-digit	x	x		x	x	x	x		x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x
	4-digit				x		x	x	x	x		x		x		x	x				x					
Spain	3-digit	x	x		x	x	x	x		x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x
	4-digit		x		x		x	x	x	x		x		x		x	x				x					
Sweden	3-digit	x	x		x	x	x	x		x	x		x			x	x		x	x	x	x	x	x	x	x
	4-digit				x		x	x	x	x						x	x				x					
United Kingdom	3-digit	x	x		x	x	x	x		x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x
	4-digit		x		x		x	x	x	x		x		x		x	x				x					
Share of total production (CH)		0.9%	11.0%		1.4%	0.7%	0.2%	3.0%	2.2%	3.4%	1.5%	17.7%	3.0%	2.1%	2.4%	7.6%	14.9%		6.4%	2.8%	10.2%	0.6%	1.4%	1.6%	0.2%	4.8%

If Switzerland is indicated by b, then country c with a minimum Euclidian distance with regard to sector i has to be found.

$$\bar{D}_i = \min_c (D_i^{bc})$$

If for each sector the country with minimum distance has been determined, the average distance of the whole country selection can be calculated as:

$$\bar{D} = \sum_i \bar{D}_i w_i$$

with

w_i as weights describing the share of sector i in production of all considered sectors (in terms of gross production value), with $0 \leq w_i \leq 1$ and $\sum_i w_i = 1$

In the same way the average distance of any other selection of countries can be calculated, e.g. the selection of one single country for all sectors.

Thus, we can determine distance values for the 3-digit-level and the 4-digit-level datasets. These two comparisons focus on different information. The 3-digit-level comparison has a higher aggregation level, but more countries included. The 4-digit-level comparison can only be performed for fewer countries, but it includes more detailed information for selected sectors. In the latter case differences between 4-digit-level subsectors are weighted equally to differences between 3-digit-level subsectors. Since 3-digit-level subsectors are usually characterised by a higher heterogeneity than 4-digit-level subsectors, the differences between 3-digit-level subsectors should be assigned a higher weight in the country comparisons.

It seems reasonable to consider both comparisons in the country choice. To make the differing value scales of the two data sets comparable, for each sector the distance between two countries is normalised to the average distance across all countries:

$$\tilde{D}_i^{bc} = \frac{D_i^{bc}}{\frac{1}{m}\sum_c D_i^{bc}}$$

If the normalised results of the 3-digit-level and the 4-digit-level comparison are indicated separately and a weighting factor u is introduced, then a combined distance metric can be calculated as:

$$\hat{D}_i^{bc} = u\tilde{D}_i^{bc,3} + (1-u)\tilde{D}_i^{bc,4} \qquad \text{with } 0 \leq u \leq 1$$

In the following table the results of the country comparison are summarized. It includes the results of the 3-digit-level and the 4-digit-level comparisons as well as the combined results. The combined results were calculated for three different u-values, u = 0.3, u = 0.5 and u = 0.7. When the set of comparisons suggested more than one country for a sector, the combined result with u = 0.5 was decisive. The results are displayed irrespective of whether suitable IO tables were available for the countries with the minimum distance value. Since for the effective country choice this availability issue had to be taken into account, for some sectors it was not possible to choose a country, which was indicated by the mimimum distance. For some countries the necessary product-by-product symmetric IO tables were not available or the available tables were outdated or too highly aggregated. In one case (for ISIC 40) other sector specific aspects lead to a different country choice. Table 14 shows the countries which were effectively chosen for each sector. In those cases where the actual choice differed from the choice suggested by the comparison results, the reasons are explained in the column "Comments" of Table 14. The combined distance values of the chosen countries are also displayed (for u = 0.5).

A second set of countries was chosen following a different line of reasoning. Here the aim was to choose a selection of countries with as little different countries as possible. Where possible, this selection is based on the countries Germany and Austria, which show low distance values for several sectors. Only for NOGA sector 40 Sweden was chosen due to the similar fuel mix for electricity generation. In table 13 the list of selected countries is displayed (as set 2) as well as their combined distance values (for u = 0.5).

The loss of similarity associated with departing from the optimal country selection can be identified by comparing the average distance of each selection $\overline{D}$. Table 13 contains the average distances of the optimal country selection and the two other selections for the 3-digit-level and the 4-digit-level data sets. They show that the loss of similarity between the best country set and the chosen set 1 is relatively small. Regarding the chosen set 2 (DE/AT plus) the loss of similarity is higher. Here the average distance increases further by one third at the 3-digit level, whereas the increase at the 4-digit level is small.

Table 13: Average distances of the different country selections

	Average distance $\overline{D}$	
	3-digit level	4-digit level
Best country set	11%	18%
Countries of set 1	15%	21%
Germany and Austria plus (set 2)	20%	22%

Source: own calculation

As already mentioned the country comparison could only be performed for the manufacturing sectors. Due to a cooporation with the research institute Infras we could include input vectors based on Swiss data for the transport sectors 60 and 62-63. For the other sectors, Austria and Germany as "geographically and culturally close" countries were arbitrarily selected. For the sectors 45 - 95 (excluding the mentioned transport sectors) two alternative sets were selected, one with German data and one with Austrian data. For the agricultural sector the choice is supported by a comparison of the input structure of the Austrian agricultural sector (Statistik Austria, 2004) with the cost structure of the Swiss agricultural sector published in the agricultural production account (SFSO, 2005c).

Table 14: Overview of the country comparison results

	3-digit-level comparison		4-digit-level comparison		Combined and normalized distance values		Effective choice - set 1			Effective choice - set 2 (DE/AT plus)	
Sector	Best country	Distance 3-digit-level	Best country	Distance 4-digit-level	Best country	Distance with u=0.5	Chosen country	Distance with u=0.5	Comments	Chosen country	Distance with u = 0.5
14	SE	4.61%	SE	4.61%	SE	19%	DE	48%	IOT SE too high aggregation; DE next best with useable IOT	DE	48%
15	IT	4.22%	IT	8.54%	IT	48%	IT	48%		DE	72%
16							IT		following results for sector 15	DE	
17	DE	3.02%	ES	28.54%	DE	50%	DE	50%		DE	50%
18	NL	0.59%	NL	0.59%	NL	16%	DE	40%	only ii-SIOT available; DE next best with useable IOT	DE	40%
19	DE	1.33%	FR	6.88%	FR	25%	FR	25%		DE	28%
20	DK	0.16%	DK	13.66%	DK	15%	IT	53%	only ii-SIOT available; IT next best with useable IOT	DE	64%
21	AT	9.38%	AT	9.38%	AT	30%	AT	30%		AT	30%
22	BE	5.77%	BE	4.86%	BE	26%	BE	26%		AT	65%
23	NO	0.00%	NO	0.00%	NO	0%	IT	5%	Only ii-IOT for NO; nextbest PT and IT; IT preferred to PT	DE	53%
24	GR	6.15%	FR	22.92%	FR	58%	FR	58%		AT	74%
25	NO	7.00%	NO	7.00%	NO	35%	GR	37%	only ii-IOT for NO, GR second best	AT	101%
26	IT	1.78%	DE	10.49%	IT	54%	IT	54%		DE	78%
27	GR	19.56%	GR	19.56%	GR	63%	GR	63%		DE	84%
28	SE	1.36%	GB	16.94%	SE	46%	IT	56%	see above; IT next best with useable IOT	DE	87%
29	AT	3.32%	DE	15.29%	AT	49%	AT	49%		AT	49%
30							AT		due to aggregation with sector 31 in Swiss IOT	AT	
31	AT	10.50%	AT	10.50%	AT	37%	AT	37%		AT	37%
32	IE	2.56%	IE	2.56%	IE	4%	DE	60%	IOT for IE too old and aggregated; DE second best	DE	60%
33	PT	62.81%	BE	58.53%	IT	93%	IT	93%		AT	93%
34	AT	23.87%	AT	23.87%	AT	63%	AT	63%		AT	63%
35	DE	13.60%	DE	13.60%	DE	25%	DE	25%		DE	25%
36	GB	1.20%	GB	1.20%	GB	8%	AT	11%	old pp-IOT for GB from 1995; AT second best	AT	11%
37	BE	4.36%	BE	4.36%	BE	22%	DE	41%	zeroes in input vector BE/37; DE next best with useable IOT	DE	41%
40	BE	4.85%	BE	4.85%	BE	18%	SE	59%	due to similar fuels used in electricity generation	SE	59%

Abbr: ii-IOT: industry-by-industry input-output table; SUT: supply and use tables

Source: Own calculations

By combining the two country sets based on the comparison results and the two arbitrarily chosen sets we generated four different intermediate input structure matrices with the sector specific input vectors drawn from the respective countries' product-by-product IO tables[8] (see Table 15). Each column of an input structure matrix contains relative shares of total intermediate demand in basic prices for each functionally defined sector.

Table 15: Alternative intermediate input structure matrices used for estimation

Dataset	Industry (14-41)	Primary sector and services excl. transportation (NOGA 01-13, 45-55, 61, 64-95)	Transport sectors (NOGA 60, 62-63)
A	Best fit	Austria and Germany	Switzerland
B	Best fit	Austria	Switzerland
C	Austria and Germany	Austria and Germany	Switzerland
D	Austria and Germany	Austria	Switzerland

Source: Own illustration

3.3.2 Intermediate input matrix of the use table and the SIOT

As starting points for calculating the intermediate inputs of the use table and the SIOT we used the product-by-product input structure matrix in basic prices ($\rho_{i_1 i_2}^{BP}$) and total intermediate demand in purchasers' prices by institutional sectors from the Swiss production account. Thus, several further steps were necessary to obtain the desired matrices. First we calculated total intermediate demand by functional sector by using the commodity technology approach (UN, 1999), where the basic premise is that a given product uses the same input structure irrespective of the industry where it is produced.

Hence,

$$u_{ij} = \sum_k r_{ik} \sigma_{kj}$$

where u_{ij} is input i required by industry j, σ_{kj} is the share of product k produced by industry j in total production of this industry and r_{ik} is the input i required to produce product k in the intermediate input matrix (for the notation see section 4). This expression can be used to calculate total intermediate demand of a functional sector in purchasers' prices R_i, i.e.:

$$R_i = \sum_k U_k \sigma_{ik}^{-1}$$

where U_k denotes total intermediate demand of industry k and σ_{ik}^{-1} is an element of the inverted matrix $\mathbf{\Sigma}^{-1}$ with $\mathbf{\Sigma}$ containing all σ_{ki}.

In order to match the purchasers' price concept of total intermediate demand, the values of the input structure matrix have to include net commodity tax burdens (taxes minus subsidies). Thus, we calculated for each cell in the intermediate inputs matrix the relative tax burden $\tau_{i_1 i_2}$ (for details see section 4). The new values of the input structure matrix were calculated as:

[8] again excluding the mentioned transport sectors

$$\rho_{i_1 i_2}^{PP} = \rho_{i_1 i_2}^{BP} \frac{1+\tau_{i_1 i_2}}{1+\sum_{i_3} \rho_{i_3 i_2}^{BP} \tau_{i_3 i_2}}$$

The intermediate inputs matrix in absolute values follows now directly using the last two expressions and can be written as:

$$r_{i_1 i_2} = \rho_{i_1 i_2}^{PP} R_{i_2}$$

Now, the calculation of the intermediate inputs of the use table is straightforward (see above). The estimation model uses these relationships in equations (R-2) and (R-5) to (R-7) (see chapter 4).

3.4 Value added taxes, other commodity taxes and subsidies

The Swiss value added tax system exhibits numerous exceptions and special rates for certain activities. Hence, the calculation of the value added taxes within the estimation procedure is not straightforward and the peculiarities of the value added tax system have to be taken into account. First, we describe the data sources for other commodity taxes and subsidies. Second, we specify the data sources to calculate value added taxes within the input-output table and give an overview of related data problems.

3.4.1 Commodity taxes and subsidies (without value added taxes)

Commodity taxes (incl. import tariffs) and subsidies are raised and paid at different levels of the Swiss governmental system. Federal commodity taxes are well documented, whereas for taxes on cantonal or even municipal level statistics are more aggregated (see FFA 2003). Commodity taxes on federal level account for around 96 % of total commodity taxes raised in 2001 (12'440.74 Mio. CHF). We allocated commodity taxes and import tariffs to the different product groups using the following scheme:

Table 16: Allocation of commodity taxes

Commodity tax	Product group (NOGA)
Tax on hydrocarbon fuels (Mineralölsteuer auf Treibstoffen)	23
Additional tax on hydrocarbon fuels (Mineralölsteuerzuschlag auf Treibstoffen)	23
Tax on hydrocarbon combustibles (Mineralölsteuer auf Brennstoffen und anderen Mineralölprodukten)	23
Tax on vehicles (Automobilsteuer)	34
Import tariffs (Einfuhrzölle)	according to Swiss import statistics
Tariffs on tobacco products (Tabakzölle)	16
Tariffs on agricultural products (WTO zweckgebundene Zolleinnahmen Landwirtschaft und Weinbau)	01
Duty on casinos (Spielcasinoabgabe)	92
Profits of the Swiss Alcohol Board (Reingewinn Alkoholverwaltung)	15
Increase in circulation of coins (Zunahme Münzumlauf)	65
Federal stamp duty (Eidgenössische Stempelabgaben)	65 and 66[9]
Tax on tobacco products (Tabaksteuer)	16
Tax on beer products (Biersteuer)	15

[9] Division between NOGA 65 and 66 has been delivered by the SFSO (2004d).

Commodity tax	Product group (NOGA)
Tax on VOC products (Lenkungsabgaben auf VOC)	24
Tax on heating oil (Lenkungsabgaben auf Heizöl EL)	23
Duty on milk products (Überlieferungsabgabe der Milchproduzenten)	01
Cantonal stamp duty (kantonale Stempelabgaben)	75 and 93
Cantonal taxes on entertainment (kantonale Vergnügungssteuern)	92
Other cantonal taxes (übrige kantonale Steuern)	55 and 92
Taxes on water power (Steuern auf Wasserkräfte)	40
Taxes on gambling (Lotto, Spiel)	92
Municipal taxes on entertainment (kommunale Vergnügungssteuern)	55
Other municipal taxes (übrige kommunale Steuern)	55 and 92

Source: Own illustration

The data for commoditiy subsidies and the allocation to the different product groups has been delivered by the SFSO (2004f).

3.4.2 Value added taxes

Theoretically, value added taxes should only be paid on consumption. Due to various exceptions, some investments and intermediate demand is also subject to (non-deductible) value added tax payments. We defined, according to the Federal Law on the Value Added Tax and based on data supplied by Daepp (2004), for each demand entry in the IO table an appropriate tax rate. In order to account for non-deductible tax payments in intermediate demand for certain activities (e.g. banking and insurance) we defined a variable, which indicates the net tax burden for each activity. We applied the same approach for each investment good in order to account for non-deductible tax payments in investment demand. With our approach we estimated the following net value added tax payments:

Table 17: Estimated value added tax payments for 2001

Aggregate	VAT payments [Mio CHF]	VAT payments [%]	Daepp (2005) for 1995
Intermediate demand and FISIM	4808	28.2%	20.6%
Intermediate demand and FISIM	4626		
FISIM	182		
Final demand	12225		
Consumption	9496	55.8%	64.9%
Consumption of private households and of non-profit institutions serving households	8735		
Public consumption (government and social security system)	761		
Capital formation	2729	16.0%	14.5%
Equipment	1056		
Buildings	1370		
Net acquisition of valuables	303		

Source: Own calculations, Daepp (2005)

The results differ from the calculations made by Daepp (2005) for 1995. In order to identify the reasons one would have to analyze the statistics on value added taxes in detail. Unfortunately, these statistics are not directly comparable to the production account. Harmonized statistics on value added taxes would be a valuable source for the estimation of an IO table since it would be possible to use data on gross payments and deductible value added taxes and not only on net taxes which might improve the estimation of the tax burden for each good significantly.

3.5 Gross value added

Data on gross value added is available in SFSO (2004a). In order to estimate the input-output table, we received sectoral data at NOGA 2 digit level (SFSO 2004e). In the estimation procedure, we imposed published data as restrictions, whereas disaggregated values were used as starting values for the estimation procedure. Furthermore, we disaggregated value added into compensation of employees (wages and salaries including social contributions) and other value added (i.e. net production taxes and operating surplus) according to SFSO (2005d).

3.6 Consumption

3.6.1 Consumption of private households

The starting point for estimating the consumption of private households were the national accounts, which at the highest level of detail provide data for 112 COICOP categories. In most cases, these categories comprise goods from more than one NOGA 2-digit-level sector. Correspondence tables are available (e.g. from the UN) showing which goods the COICOP categories can contain, although the relevance of product groups will differ between countries. In order to allocate the expenditures to product groups we further used information from the consumer budget survey (Einkommens- und Verbrauchserhebung EVE, data supplied by the SFSO), which records private consumption with more detail. Here it was necessary to keep in mind that the EVE follows an expenditure oriented approach, whereas the national accounts follow a consumption oriented approach. Thus for selected consumption categories the two sources are not compatible. After using information from the EVE almost 300 consumption categories could be clearly allocated to a NOGA sector. Still for several categories the association with product groups was ambiguous. Where possible we used further information (e.g. supplied by other statistical sources, enterprises or trade associations). In some cases we could use the weights of the Swiss consumer price index (Konsumentenpreisindex, KPI) for a further allocation of consumption categories to product groups. For the remaining part of consumption categories, where no further information was available, the allocation was estimated. In these cases upper and lower bounds were also determined to reflect the uncertainties.

Regarding the consumption of collective households (e.g. student or old age residences, prisons) only the total value was available from the national accounts (approximately 3% of the private household consumption). We assumed the collective households to have an identical product mix as private households.

According to the national accounts private consumption (including collective households) amounted to 247.44 billion CHF in 2001. Out of this value 222.26 billion CHF (approximately 90%) could be clearly assigned to a NOGA sector. The rest is subject to partly high uncertainties. Table 18 shows the best estimates as well as the lower and upper bounds for the NOGA sectors. Even though the total uncertainty is low, for some sectors the uncertainty range is high (displayed bold and in italics).

Table 18: Overview of best estimates and uncertainty ranges for private consumption

NOGA	Description	Best estimate (mio CHF)	Lower bound (mio CHF)	Upper bound (mio CHF)
1 - 5	Products of agriculture, forestry, fishing and related service activities	6'235	5'264	8'774
10 - 14	Products from mining and quarrying	346	0	1'686
15 -16	Food products and beverages, tobacco products	31'056	30'706	31'406
17	Textiles	1'466	686	5'072
18	Wearing apparel, furs	8'232	8'075	8'978
19	Leather and leather products	2'500	1'949	3'744
20	Wood and products of wood and cork, except furniture	441	0	2'804
21	Pulp, paper and paper products	1'578	0	3'275
22	Printed matter and recorded media	3'520	3'096	5'070
23 - 24	Coke, refined petroleum products and nuclear fuel; Chemicals and chemical products	14'405	11'126	17'925
25	Rubber and plastic products	1'484	88	8'222
26	Other non-metallic mineral products	557	309	2'413
27	Basic metals	64	0	573
28	Fabricated metal products, except machinery and equipment	1'040	60	5'312
29	Machinery and equipment n.e.c.	2'688	1'688	6'543
30 - 31	Office machinery and computers; Electrical machinery and apparatus n.e.c.	1'261	776	4'114
32	Radio, television and communication equipment and apparatus	906	906	906
33	Medical, precision and optical instruments, watches and clocks	1'437	857	2'042
34	Motor vehicles, trailers and semi-trailers	5'503	5'282	6'034
35	Other transport equipment	776	627	1'552
36	Furniture; manufacturing n.e.c.	5'578	3'344	10'939
40 - 41	Electricity, gas, steam and hot water; Collected and purified water; Water services	5'049	4'851	5'049
45	Construction work	1'502	1'444	1'853
50	Sale, maintenance and repair of motor vehicles; retail sale of automotive fuel	1'391	1'277	1'419
52	Retail trade, except of motor vehicles; repair of personal and household goods	533	195	1'801
55	Hotel and restaurant services	21'003	21'003	21'999
60 - 62	Land transport and pipeline services; Water and air transport services	6'126	5'987	7'515
63	Supporting and auxiliary transport services; travel agency services	819	758	1'689
64	Post and telecommunication services	6'972	6'972	6'972
65	Banking services (includes part of NOGA 67)	2'722	0	5'444
66	Insurance services, except compulsory social security (incl. part of NOGA 67)	15'218	14'311	19'755
70	Real estate services	49'351	48'877	50'818
71	Renting services of machinery without operator and of personal and household goods	1'402	1'341	1'536
72	Computer and related services	523	383	623
74	Other business services	1'955	0	6'286
75	Public administration and defence services; compulsory social security services	334	0	1'099
80	Education services	2'708	2'471	3'183
85	Health and social work services	31'494	31'222	31'859
90	Sewage and refuse disposal services, sanitation and similar services	878	738	1'580
92	Recreational, cultural and sporting services	2'482	2'235	3'089
93	Other services	2'782	2'320	3'807
95	Services of households as employers of domestic staff	1'123	1'034	1'211

Source: Own calculation

3.6.2 Consumption of non-profit organisations

This subsection covers consumption of non-market production by non-profit organisations. That is, the goods and services are provided to the households for free or at prices which are not economically significant.[10] The non-market production is being calculated by the Swiss Federal Statistical Office for each affected industrial branch. Therefore there are no difficulties to allocate those consumptions to the NOGA. The affected branches are as follows:

- NOGA 85: Health and social work
- NOGA 91: Activities of membership organizations n.e.c.
- NOGA 92: Recreational, cultural and sporting activities

3.6.3 Consumption of the public sector (government and social security system)

Government consumption without social security

The government consumption includes the individual as well as collective consumption. The definitions are as follows:[11]

- Individual consumption: Consist of consumption incurred by government. The beneficiary must be determinable. This includes expenses on education, health etc.
- Collective consumption: Here the beneficiary is not determinable. This includes expenses on national defence, security or administration.

In order to allocate the government consumption to NOGA we drew on the functional division of the Swiss Federal Statistical Office (see Table 19). The functional division does not always correspond with the definition of the NOGA. Whenever there was an overlap with other branches, we included them in a secondary category (indicated as NOGA2). With the help of upper and lower bounds we left a discretionary space (see section 2.3.1).

Table 19: Concordance table for the functional allocation of government consumption to NOGA sectors

Functional Division	NOGA	NOGA2	Value (in billion CHF)
Defense (Landesverteidigung)	75	85	4.18
General administration (Allgemeine Verwaltung)	75	-	7.15
Education (Bildung/Erziehung)	80	75	19.21
Culture and recreation (Kultur/Freizeit)	92	75	1.91
Health system (Gesundheit)	85	75	0.46
Social work (Soziale Wohlfahrt)	85	-	0.62
Other public administration (Restliche öffentliche Verwaltung)	75	-	11.66

Source: Own illustration

Consumption of social security

The consumption of social security consists of social benefits and non-market production. The allocation to the NOGA sector is associated with much more difficulties than in the case of government consumption. In order to decide which industry is affected by each of the positions listed in Table 20, we drew on a regulation which describes who is eligible for social benefits and which expenses they cover.[12]

Most of the social benefits positions must be spent on a special purpose (e.g. “Pendlerkostenbeiträge”, which are being spent only for transportation). But there still remains a

10 See System of National Accounts (1993), p. 213.
11 See SFSO (2003b), p. 18.
12 See the relevant regulation: http://www.admin.ch/ch/d/sr/831_201/index.html.

high uncertainty, therefore we included other most probably affected industries under the category NOGA2.

Table 20: Concordance table for the allocation of social security consumption to NOGA sectors

Division	NOGA	NOGA2	Value (in milion CHF)
Rückerstattung Reisekosten AHV	60	55	0.10
Rückerstattung Reisekosten IV	60	55	91.30
Kursauslagen ALV	80	-	96.33
Pendlerkostenbeiträge ALV	60	-	0.71
Beiträge Wochenaufenthalter ALV	70	60	0.46
Hilfsmittel AHV	85	-	73.27
Medizinische Massnahmen IV	85	-	437.32
Massnahmen beruflicher Art IV	80	17	289.64
Beiträge Sonderschulung IV	80	60	354.77
Hilfsmittel IV	85	-	229.88
Betriebsbeiträge IV	85	-	1.16
Kosten für individuelle Massnahmen IV an nichtgebietsansässige Haushalte	Allocation according to beneficiary in Switzerland		1442.10
Non-market Production	75		804.27

Source: Own illustration.

3.7 Gross capital formation

The Swiss national account contains data on investments in equipment. For other components of gross investments no data are available and the structure of investment demand had to be estimated.

3.7.1 Buildings

The Swiss statistic on constructions contains information on investment into new and existing buildings and infrastructure. In order to calculate the structure of buildings investments we used the weights of the following price indices: cantonal price index for new apartment buildings in Zurich, Swiss price index for retrofitting of existing private buildings, Swiss price index for new office buildings and Swiss price index for the construction of new roads. The four price indices imply the following weights:

Table 21: Weights of the different price indices

NOGA	New dwellings	Retrofit of private buildings	New office buildings	New road infrastructure
45	83.5%	88.1%	86.3%	91.1%
65	3.0%	0.0%	0.1%	0.0%
66	0.0%	0.0%	0.4%	0.0%
70	0.3%	0.0%	0.0%	0.0%
74	13.2%	11.9%	13.3%	8.9%

Source: Own calculation

Based on the Swiss statistic on constructions we calculated total investment in building construction and civil engineering and distinguished between new constructions and retrofitting. Using the weights of the different price indices we calculated the structure of the investment demand according to the following scheme:

Table 22: Demand for investment in buildings and construction

	New constructions	Retrofitting
Building construction	Cantonal price index for new apartment buildings in Zurich / Swiss price index for new office buildings	Swiss price index for retrofitting of existing private buildings
Civil engineering	Swiss price index for the construction of new roads	

Source: Own illustration

3.7.2 Equipment

Data on investments into equipment are reported within the Swiss national account (SFSO 2004c). Disaggregated data for the sectors 28 and 29 were provided informally by SFSO (2004g).

3.7.3 Change in inventories and net acquisition of valuables

We did not calculate net changes in inventories for 2001. This would need a thorough analysis of the Swiss statistics on value added. We imposed only lower and upper bounds on net changes in inventories (+/- 10% of gross production value). The estimation procedure could choose any value within these bounds. Only total net change in inventories had to equal the value reported within the Swiss national account.

The net acquisition of valuables was allocated using the Austrian IO table for 2000. The shares are as follows:

Table 23: Prior shares on total net acquisition of valuables

Product category	Description	Share on total net acquisition of valuables
27	Manufacture of basic metals	9.6%
36	Manufacture of furniture; manufacturing n.e.c.	63.9%
92	Recreational, cultural and sporting activities	26.4%

Source: Austrian input-output table for 2000, Statistik Austria (2004)

3.8 Exports

The exports have been dealt with – except for a few distinctions, which will be described in the following section – in the same way as the imports (see section 3.2).

In the balance of payment published by the SNB the tourism expenditures of foreigners in Switzerland is divided into the following positions (values for 2001).

Table 24: Positions of tourist traffic (exports) in the Swiss balance of payments 2001

Positions of tourist traffic	Expenditures (Mio. CHF)
Vacations and business trips	7087
Study and hospital visits	1666
Daily and transit traffic	2569
Other tourist traffic	367
Consumption expenditures of cross-border commuters	988
Total	12677

Source: SNB (2002)

The breakdown of these expenditures into NOGA 2-digit goods is not available. From these expenditures some can directly be assigned to NOGA sectors (e.g. hospital visits to sector 85). The breakdown of consumption expenditures of cross-border commuters follows Antille and Morales (1996), who provided estimates for the year 1990. The other expenditures were allocated to product groups with information from the recent tourism satellite account (TSA), which was set up for the year 1998 (Antille et al., 2003; Berwert, 2004). Positions without allocation to NOGA sectors were assumed to have the same product breakdown.

3.9 Reallocation of trade and transport margins and transition from purchasers' prices to basic prices

The values for final demand and intermediate demand are usually estimated at purchasers' prices. This means they comprise trade and transport margins and net commodity taxes. In order to construct the input-output table, the trade and transport margins have to be reallocated to the trade and transport sectors. Since we have constructed the intermediate demand from other European country data, in which trade and transport margins already are reallocated, we only have to adjust the final demand components.

Information on trade and transport margins is hardly available. We therefore used relative margins from the Austrian IO tables (Statistik Austria 2004) as first estimates. In the Austrian tables trade and transport margins are recorded by product group and final demand sector. With the margins reallocated the final demand matrix was ready for the balancing procedure. In order to account for the high uncertainties we set the lower and upper bounds of the trade and transport margins on final demand at 50% resp. 150% of the prior estimates.

In order to calculate intermediate and final demand in basic prices we had to subtract net commodity taxes. Since taxes, subsidies and tariffs are known (see section 3.4) this step is quite straightforward.

3.10 Unbalanced input-output table

By comparing total supply and total demand for each good we can now calculate the imbalances. The following table shows total supply and its components as well as total demand and its components.

Table 25: Imbalances of original data (values in billion CHF)

Commod. category	Total supply	Dom. prod.	Imports	Net cmd. taxes	Total demand	Interm. demand	Con-sump-tion	Invest-ment	Exports	FISIM	Difference (D-S)	
											absolute	relative
G01-G05	16.077	12.888	3.138	0.052	15.655	11.086	3.773	0.357	0.44		-0.422	-2.6%
G10-G14	6.217	1.676	4.515	0.026	3.871	3.068	0.223	0.007	0.573		-2.346	-37.7%
G15-G16	37.846	27.938	7.637	2.272	36.099	10.902	20.399	0.117	4.681		-1.748	-4.6%
G17	6.361	3.028	3.231	0.102	4.947	2.118	0.762	0.013	2.054		-1.415	-22.2%
G18	6.632	1.506	4.682	0.444	6.408	0.809	4.566	0.006	1.027		-0.224	-3.4%
G19	2.741	0.393	2.236	0.111	2.352	0.339	1.365	0.002	0.646		-0.389	-14.2%
G20	7.369	5.88	1.458	0.031	5.574	4.674	0.252	0.025	0.623		-1.795	-24.4%
G21	7.739	4.71	2.94	0.089	10.108	6.642	0.931	0.02	2.515		2.369	30.6%
G22	15.375	11.684	3.559	0.132	10.389	6.997	1.925	0.048	1.419		-4.986	-32.4%
G23-G24	81.494	43.994	31.843	5.658	79.348	29.534	8.392	0.186	41.236		-2.146	-2.6%
G25	10.96	6.947	3.935	0.078	11.09	6.827	0.794	0.029	3.439		0.13	1.2%
G26	7.145	4.802	2.309	0.034	7.405	5.858	0.352	0.02	1.175		0.26	3.6%
G27	17.224	4.795	12.387	0.042	18.104	11.211	0.046	0.508	6.339		0.88	5.1%
G28	21.413	17.258	4.081	0.074	19.662	14.265	0.557	0.086	4.754		-1.752	-8.2%
G29	44.166	31.642	12.368	0.156	49.907	9.366	1.616	15.435	23.49		5.74	13.0%
G30-G31	29.92	17.479	12.058	0.384	25.487	8.628	0.781	7.414	8.664		-4.433	-14.8%
G32	10.981	5.503	5.404	0.074	11.221	5.099	0.588	2.785	2.75		0.241	2.2%
G33	31.666	24.992	6.24	0.435	29.862	5.389	0.661	5.293	18.52		-1.804	-5.7%
G34	13.504	1.537	11.255	0.711	9.752	1.848	4.445	1.775	1.684		-3.752	-27.8%
G35	6.947	3.753	3.074	0.12	7.904	1.847	0.613	3.791	1.652		0.957	13.8%
G36	14.5	6.009	8.006	0.485	13.564	1.436	3.308	3.261	5.559		-0.935	-6.5%
G37	1.918	1.417	0.501		1.253	0.564		0.005	0.684		-0.665	-34.7%
G40-G41	28.858	26.544	1.898	0.416	27.34	19.283	5.049		3.008		-1.517	-5.3%
G45	46.666	44.911	0.094	1.661	47.278	10.236	1.502	35.249	0.29		0.612	1.3%
G50	9.623	9.369	0.038	0.215	6.813	3.114	2.982	0.694	0.023		-2.81	-29.2%
G51-G52	70.885	68.552	0.284	2.048	75.028	22.199	32.783	9.428	10.618		4.143	5.9%
G55	29.191	22.208	5.546	1.437	30.092	3.029	20.871		6.191		0.901	3.1%
G60-G62	21.228	21.134	1.68	-1.586	19.235	8.541	7.377	0.238	3.078		-1.993	-9.4%
G63	15.997	12.142	3.797	0.058	13.402	8.22	0.769		4.412		-2.595	-16.2%
G64	20.391	18.005	1.81	0.576	19.749	11.091	6.972		1.685		-0.643	-3.2%
G65	66.524	60.515	2.179	3.83	65.718	18.821	2.722	0.384	15.137	28.654	-0.806	-1.2%
G66	41.878	35.489	5.173	1.217	33.329	11.263	15.218	0.028	6.82		-8.549	-20.4%
G70+G96	45.996	45.72	0.171	0.104	69.07	19.519	49.352	0.038	0.16		23.074	50.2%
G71+G74	54.108	52.309	0.155	1.644	62.422	52.701	3.357	4.82	1.545		8.315	15.4%
G72	14.152	13.75	0.004	0.398	16.096	9.044	0.523	6.467	0.062		1.944	13.8%
G73	6.947	6.91		0.037	3.869	3.869					-3.078	-44.3%
G75	24.847	24.72	0.008	0.119	27.011	1.381	25.425		0.205		2.165	8.7%
G80	22.93	22.185	0.184	0.561	22.112	0.574	21.085		0.453		-0.818	-3.6%
G85	40.506	39.81	0.642	0.054	40.571	0.601	38.824		1.146		0.064	0.2%
G90	2.657	2.533	0.016	0.109	3.034	2.123	0.878		0.034		0.377	14.2%
G91-G92	19.636	17.159	1.808	0.669	19.379	7.8	8.291	1.339	1.95		-0.257	-1.3%
G93-G95	4.973	4.724	0.001	0.247	4.847	0.911	3.905		0.031		-0.125	-2.5%

Source: Own calculation

We analysed the imbalances at NOGA-2 level and made the following changes in the input data:

- Tobacco products (G16): The figures for final demand for tobacco products originate from detailed Swiss statistics. According to SFSO (2004e) the value for the gross production value in the tobacco industry (S16) is insecure. We decided to adjust the gross production value, intermediate demand and gross value added for this sector. This seems appropriate since the aggregated deviations of G15 and G16 are rather small. Thus, it is likely that the error is due to an insecure disaggregation of the gross production value for the food products, beverages and tobacco product industries (S15 and S16).

- Refined petroleum products (G23): Since the gross production value for refineries seemed too low, we made an own crude estimate, starting with the value of crude oil imports in 2001, which amounts to approximately 1.6 billion CHF. Based on information from the German IO table and the foreign trade statistics, we estimated a gross production value of 2.5 billion CHF for this sector and an intermediate demand of 2 billion CHF.
- Motor vehicles (G34): The value of total supply of motor vehicles seems to be plausible. We assumed that financial leasing of motorcars and thus consumption demand and investment demand for motor vehicles are underestimated. We raised consumption of motor vehicles by 45% (and decreased rent payments by the same amount) and investment demand for motor vehicles by around 75% (and decreased investment demand for machinery and equipment).
- Wholesale trade margins (G51): Since trade margins are very insecure we decreased the total of wholesale trade margins by 20% in order to lessen the imbalance. Furthermore, errors might be caused due to an insecure disaggregation of the gross production value of retail and wholesale trade (S51 and S52).
- Real estate services (G70): We suppose the following reasons cause this major deviation. First, the method applied to estimate the supply table might give wrong results regarding the supply of real estate services. In the supply table the banking (S65) and insurance sectors (S66) do not supply any real estate services, which seems implausible. Unfortunately no data exist on real estate equity that is rented to third parties. We estimated that the banking and insurance sectors provide real estate services in the order of 3 billion CHF and 9 billion CHF, respectively. Furthermore, we corrected implausible high intermediate demand values for real estate services in the construction sector S45 (from 14% to 1% of total sectoral intermediate demand) and in the other business activities sector S74 (from 13% to 3% of total sectoral intermediate demand). Certainly, the market for real estate services would need a thorough analysis in order to get reliable estimates.
- Renting of machinery (G71): The value for gross production seems far too low. We corrected gross production, intermediate demand and gross value added by a factor of 10. Again, the error is likely to be caused because of an insecure disaggregation of the gross production value of renting of machinery and other business services (S71 and S74).
- Research and development (G73): According to our data there is no public demand for research and development. SFSO (2005a) reports that in 2000 the government allocated 2.5 billion CHF to research and development. We added public consumption of research and development and decreased demand for administration services (G75) by the same amount.

Furthermore, we also adjusted the values resulting from the use of foreign input structures for selected energy sectors and transactions, since it was possible to roughly estimate the values directly from Swiss data. Basically we used physical energy flow data and the available data on final energy expenditures from the Swiss energy statistics (SFOE 2002a and SFOE 2002b). The missing monetary data were estimated by using the foreign exchange statistics for selected monetary flows and for estimating producers prices from import prices. Table 26 shows the transactions that were adjusted. For each transaction a lower and an upper bound were set to account for the uncertainties.

Table 26: Overview of directly changed transactions in the unbalanced input-output table (values in mill. CHF)

Goods \ Goods	NOGA 21	NOGA 23	NOGA 24	NOGA 40
NOGA 02				0
NOGA 10				0
NOGA 11		1576		899
NOGA 20				0
NOGA 23		73	39	106
NOGA 37	50			
NOGA 40			474	11339

Source: Own calculation

The following table shows the imbalances after making the adjustment mentioned above.

Table 27: Imbalances after adjustment of original input data (values in billion CHF)

Commod. category	Total supply	Dom. prod.	Imports	Net cmd. taxes	Total demand	Interm. demand	Con-sump-tion	Invest-ment	Exports	FISIM	Difference (D-S)	
											absolute	relative
G01-G05	16.081	12.888	3.138	0.055	15.827	11.178	3.843	0.357	0.448		-0.254	-1.6%
G10-G14	6.217	1.676	4.515	0.027	5.39	4.579	0.227	0.007	0.577		-0.827	-13.3%
G15-G16	37.945	28.016	7.637	2.293	37.025	11.204	20.95	0.117	4.755		-0.92	-2.4%
G17	6.363	3.028	3.231	0.104	5.012	2.132	0.778	0.013	2.088		-1.351	-21.2%
G18	6.635	1.506	4.682	0.447	6.508	0.836	4.602	0.006	1.064		-0.126	-1.9%
G19	2.742	0.393	2.236	0.112	2.374	0.34	1.383	0.002	0.65		-0.368	-13.4%
G20	7.37	5.88	1.458	0.032	5.745	4.835	0.258	0.025	0.627		-1.625	-22.0%
G21	7.739	4.71	2.94	0.089	9.847	6.353	0.946	0.02	2.528		2.108	27.2%
G22	15.377	11.684	3.559	0.134	10.6	7.156	1.967	0.048	1.429		-4.777	-31.1%
G23-G24	81.498	43.995	31.843	5.66	78.585	27.905	8.7	0.186	41.795		-2.913	-3.6%
G25	10.964	6.949	3.935	0.08	11.197	6.889	0.816	0.029	3.463		0.233	2.1%
G26	7.146	4.802	2.309	0.034	7.853	6.291	0.359	0.02	1.183		0.707	9.9%
G27	17.224	4.795	12.387	0.042	18.232	11.305	0.047	0.508	6.372		1.008	5.9%
G28	21.415	17.258	4.081	0.076	19.927	14.481	0.575	0.087	4.785		-1.488	-6.9%
G29	44.171	31.642	12.368	0.161	49.616	9.54	1.666	14.614	23.796		5.445	12.3%
G30-G31	29.932	17.479	12.058	0.396	26.031	8.787	0.805	7.672	8.767		-3.9	-13.0%
G32	11.007	5.528	5.404	0.075	11.279	5.107	0.601	2.815	2.757		0.272	2.5%
G33	31.687	24.992	6.24	0.456	30.58	5.382	0.681	5.648	18.869		-1.107	-3.5%
G34	13.681	1.537	11.255	0.888	14.01	1.867	6.329	4.13	1.684		0.329	2.4%
G35	6.929	3.753	3.074	0.101	6.958	1.886	0.613	2.807	1.652		0.03	0.4%
G36	14.504	6.009	8.006	0.489	13.699	1.476	3.366	3.261	5.596		-0.805	-5.6%
G37	1.918	1.417	0.501		1.262	0.572		0.005	0.684		-0.657	-34.3%
G40-G41	28.859	26.544	1.898	0.417	27.45	19.392	5.049		3.008		-1.409	-4.9%
G45	46.7	44.911	0.094	1.695	48.255	11.214	1.502	35.249	0.29		1.555	3.3%
G50	9.667	9.371	0.038	0.258	8.101	3.38	3.432	1.267	0.023		-1.566	-16.2%
G51-G52	70.892	68.653	0.284	1.955	70.635	22.597	31.457	7.613	8.967		-0.256	-0.4%
G55	29.197	22.214	5.546	1.437	30.192	3.129	20.871		6.191		0.995	3.4%
G60-G62	21.231	21.134	1.68	-1.583	19.265	8.519	7.422	0.247	3.078		-1.964	-9.3%
G63	16.006	12.151	3.797	0.058	13.546	8.364	0.769		4.412		-2.46	-15.4%
G64	20.397	18.013	1.81	0.574	19.752	11.094	6.972		1.685		-0.645	-3.2%
G65	63.51	57.515	2.179	3.816	65.676	18.775	2.722	0.384	15.137	28.659	2.166	3.4%
G66	32.838	26.489	5.173	1.177	32.875	10.809	15.218	0.028	6.82		0.036	0.1%
G70+G96	58.01	57.72	0.171	0.119	63.223	16.006	47.019	0.038	0.16		5.213	9.0%
G71+G74	53.865	52.055	0.155	1.655	62.981	53.26	3.357	4.82	1.545		9.116	16.9%

Commod. category	Total supply	Dom. prod.	Imports	Net cmd. taxes	Total demand	Interm. demand	Con-sump-tion	Invest-ment	Exports	FISIM	Difference (D-S)	
											absolute	relative
G72	14.15	13.75	0.004	0.396	16.103	9.052	0.523	6.467	0.062		1.954	13.8%
G73	7.02	6.91		0.11	6.27	3.77					-0.749	-10.7%
G75	24.84	24.72	0.008	0.112	24.589	1.46	22.925		0.205		-0.251	-1.0%
G80	22.93	22.185	0.184	0.561	22.099	0.561	21.085		0.453		-0.831	-3.6%
G85	40.526	39.83	0.642	0.054	40.576	0.606	38.824		1.146		0.05	0.1%
G90	2.659	2.533	0.016	0.111	3.122	2.211	0.878		0.034		0.463	17.4%
G91-G92	19.637	17.159	1.808	0.669	19.19	7.611	8.291	1.339	1.95		-0.446	-2.3%
G93-G95	4.973	4.724	0.001	0.247	4.858	0.922	3.905		0.031		-0.114	-2.3%

Source: Own calculation

Regarding the remaining imbalances we do not have a reasonable explanation for those of the sectors paper products (G21) and printed products (G22). Concerning fabricated metal products except of machinery and equipment (G28) we suppose there exists a problem in investment demand data. First, the approach chosen does not account for some infrastructure investments such as railways or electricity transmission lines since no price indices for these investments exist. But also data delivered by SFSO (2004g) might be insecure for this product category since it is a disaggregated value of the national account that only reports investments for G28 and G29 together. Major imbalances also remained for some transport and services sectors. The input-output table with the remaining imbalances was subjected to the balancing procedure, which is described in detail in the following section.

4 Model to estimate a consistent input-output table for Switzerland

We used the data as described in section 3 to determine the support space **z** for each variable of the estimation model. The interval [z_1, …, z_h, …,z_5], which describes the support space, is defined by the lower and upper bounds derived during the data collection process. The support space is divided into four subintervals of equal length. The equations used in the estimation model can be classified into five different groups:

- the objective function (labelled by an "O"),
- estimation functions ("E"),
- relationships between different endogenous variables of the estimation model ("R"),
- macro conditions ("M"), and,
- unity conditions ("U").

These functions are used to estimate the following sub-matrices of the IO table, i.e.:

- use table,
- value added,
- net commodity taxes,
- consumption,
- gross capital formation, and,
- exports.

Note that the supply matrix has been estimated separately by using the procedure described in section 3.1. The estimation model is closed by formulating balancing conditions ("B") for each sector and each good. In the following we specify for each sub-matrix the equations as well as the balance conditions and the overall objective function, which has to be minimized.

The notation is as follows: a hat indicates that the variable is estimated, a bar denotes a parameter to the model, capital letters stand for aggregates, small letters (except "p" and "z") represent an entry of the IO table, relative shares or rates are written as small Greek letters. Probabilities and elements of the support set **z** for each IO table entry are denoted as "p" and "z" respectively. Prior probabilities are represented by "q".

Finally, the indices used are:

- "h" denotes an element of the support set,
- "i" represents a commodity,
- "j" is used for industries,
- "g" represents commodity taxes, subsidies and import tariffs,
- "l" denotes different consumption categories of private households,
- "w" is used to represent investment categories, and,
- "k" is used in the transformation from the commodity-by-commodity framework to the industry-by-commodity framework and represents either commodities or industries

In a first step we calculated the supply matrix using the procedure described in 3.1. Due to computational reasons and the sheer size of the problem we had to fix the values for the supply table in order to calculate a balanced IO table.

4.1 Imports

Estimation of the imports of commodity i

$$\hat{m}_i = \sum_h p_{ih}^m z_{ih}^m \tag{E-1}$$

Macro condition on total imports

$$\bar{M} = \sum_i \hat{m}_i \tag{M-1}$$

Unity condition

$$\sum_h p_{ih}^m = 1 \tag{U-1}$$

4.2 Use matrix

Estimation of the input coefficients of the commodity-by-commodity table in basic prices

$$\hat{\rho}_{i_1 i_2} = \sum_h p_{i_2 i_2 h}^{\rho} z_{i_2 i_2 h}^{\rho} \tag{E-2}$$

Estimation of the total intermediate demand of industry j

$$\hat{U}_j = \sum_h p_{jh}^U z_{jh}^U \tag{E-3}$$

Relationship between the input coefficients of the commodity-by-commodity table in basic prices and the input coefficients in purchasers' prices (see also section 3.3.2)

$$\rho_{i_1 i_2} = \hat{\rho}_{i_1 i_2} \frac{1+\tau_{i_1 i_2}}{1+\sum_{i_3} \hat{\rho}_{i_3 i_2} \tau_{i_3 i_2}} \tag{R-1}$$

Relative share of industry j_1 in total domestic supply of commodity i (the relative shares are given since the sectoral supply s_{ji} is fixed, i.e. has been calculated by using the model described in section 3.1)

$$\sigma_{j_1 i} = \frac{s_{j_1 i}}{\sum_{j_2} s_{j_2 i}} \tag{R-2}$$

Inverse of relative shares of industry j's supply in total domestic supply of commodity i (the inverse of the relative shares are given since the sectoral supply s_{ji} is fixed)

$$\sum_k \sigma_{jk} \sigma_{ki}^{-1} = \begin{cases} 1 & if\ i = j \\ 0 & if\ i \neq j \end{cases} \tag{R-3}$$

Total intermediate demand for the production of commodity i in purchasers' prices

$$R_i = \sum_{j_2} \hat{U}_{j_2} \sigma_{ij_2}^{-1} \qquad \text{(R-4)}$$

Intermediate demand for commodity i_1 in the production of commodity i_2 in purchasers' prices

$$r_{i_1 i_2} = \rho_{i_1 i_2} R_{i_2} \qquad \text{(R-5)}$$

Intermediate demand for commodity i by industry j in purchasers' prices

$$u_{ij} = \sum_k r_{ik} \sigma_{jk} \qquad \text{(R-6)}$$

Macro condition on total intermediate demand of aggregated industry j^*

$$\bar{U}_{j^*} = \sum_{j \in j^*} \hat{U}_j \qquad \text{(M-2)}$$

Unity conditions

$$\sum_{i_1} \hat{\rho}_{i_1 i_2} = 1 \qquad \text{(U-2)}$$

$$\sum_h p_{i_1 i_2 h}^{\rho} = 1 \qquad \text{(U-3)}$$

$$\sum_h p_{jh}^{U} = 1 \qquad \text{(U-4)}$$

4.3 Gross value added

Estimation of the total value added of industry j

$$\hat{V}_j = \sum_h p_{jh}^{V} z_{jh}^{V} \qquad \text{(E-4)}$$

Macro condition on total value added of aggregated industry j^*

$$\bar{V}_{j^*} = \sum_{j \in j^*} \hat{V}_j \qquad \text{(M-3)}$$

Unity condition

$$\sum_h p_{jh}^{V} = 1 \qquad \text{(U-5)}$$

4.4 Net commodity taxes

Estimation of commodity taxes and subsidies g on commodity i (without value added taxes)

$$\hat{t}_{gi} = \sum_h p^t_{gih} z^t_{gih} \tag{E-5}$$

Estimation of the share of non-deductable value added tax payments in total value added tax payments in the production of commodity i (the non-deductable value added taxes are calculated in the commodity-by-commodity table since tax exemptions can be modelled there as accurately as possible)

$$\hat{\alpha}^R_i = \sum_h p^{\alpha R}_{ih} z^{\alpha R}_{ih} \tag{E-6}$$

Estimation of the share of non-deductable value added tax payments in total value added tax payments in the consumption of commodity i in consumption category l (private households)

$$\hat{\alpha}^{CHH}_l = \sum_h p^{\alpha CHH}_{lh} z^{\alpha CHH}_{lh} \tag{E-7}$$

Estimation of the share of non-deductable value added tax payments in total value added tax payments in the consumption of non profit organizations

$$\hat{\alpha}^{CNP} = \sum_h p^{\alpha CNP}_h z^{\alpha CNP}_h \tag{E-8}$$

Estimation of the share of non-deductable value added tax payments in total value added tax payments in the consumption of the government

$$\hat{\alpha}^{CG} = \sum_h p^{\alpha CG}_h z^{\alpha CG}_h \tag{E-9}$$

Estimation of the share of non-deductable value added tax payments in total value added tax payments in the consumption of the social security system

$$\hat{\alpha}^{CSC} = \sum_h p^{\alpha CSC}_h z^{\alpha CSC}_h \tag{E-10}$$

Estimation of the share of non-deductable value added tax payments in total value added tax payments of investment demand for commodity i in category w

$$\hat{\alpha}^{INV}_{iw} = \sum_h p^{\alpha INV}_{iwh} z^{\alpha INV}_{iwh} \tag{E-11}$$

Estimation of the share of non-deductable value added tax payments in total value added tax payments of net acquisition of valuables

$$\hat{\alpha}^{NAC} = \sum_h p^{\alpha NAC}_h z^{\alpha NAC}_h \tag{E-12}$$

Estimation of the share of non-deductable value added tax payments in total value added tax payments of FISIM

$$\hat{\alpha}^{FISIM} = \sum_h p_h^{\alpha FISIM} z_h^{\alpha FISIM} \tag{E-13}$$

Relationship between commodity taxes and subsidies (including value added taxes) and net tax payment rates on intermediate demand

$$\tau_{i_1 i_2} = \frac{\sum_g \hat{t}_{g i_1}}{\sum_k s_{k i_1} + \hat{m}_{i_1} - \hat{d}_{i_1} - \frac{\overline{f}_{i_1}}{1 + \hat{\alpha}_{i_1}^{FISIM} \overline{\omega}_{i_1}^{FISIM}}} \cdot \left(1 + \hat{\alpha}_{i_2}^{R} \overline{\omega}_{i_1 i_2}^{R}\right) + \hat{\alpha}_{i_2}^{R} \overline{\omega}_{i_1 i_2}^{R} \tag{R-7}$$

Total value added tax payments (net) for commodity i_1 where $\hat{\alpha}\overline{\omega}$ denotes the effective value added tax rate, which is the product of the share of non-deductable value added tax payments $\hat{\alpha}$ and the value added tax rate $\overline{\omega}$

$$\begin{aligned} v_{i_1} = & \sum_{i_2} \frac{\hat{\alpha}_{i_2}^{R} \overline{\omega}_{i_1 i_2}^{R}}{1 + \hat{\alpha}_{i_2}^{R} \overline{\omega}_{i_1 i_2}^{R}} r_{i_1 i_2} + \sum_l \frac{\hat{\alpha}_l^{CHH} \overline{\omega}_{i_1 l}^{CHH}}{1 + \hat{\alpha}_l^{CHH} \overline{\omega}_{i_1 l}^{CHH}} \hat{c}_{i_1 l}^{HH} + \frac{\hat{\alpha}^{CNP} \overline{\omega}_{i_1}^{CNP}}{1 + \hat{\alpha}^{CNP} \overline{\omega}_{i_1}^{CNP}} \hat{c}_{i_1}^{NP} \\ & + \frac{\hat{\alpha}^{CG} \overline{\omega}_{i_1}^{CG}}{1 + \hat{\alpha}^{CG} \overline{\omega}_{i_1}^{CG}} \hat{c}_{i_1}^{G} + \frac{\hat{\alpha}^{CSC} \overline{\omega}_{i_1}^{CSC}}{1 + \hat{\alpha}^{CSC} \overline{\omega}_{i_1}^{CSC}} \hat{c}_{i_1}^{SC} + \sum_w \frac{\hat{\alpha}_{i_1 w}^{INV} \overline{\omega}_{i_1 w}^{INV}}{1 + \hat{\alpha}_{i_1 w}^{INV} \overline{\omega}_{i_1 w}^{INV}} \hat{n}_{i_1 w} \\ & + \frac{\hat{\alpha}^{NAC} \overline{\omega}_{i_1}^{NAC}}{1 + \hat{\alpha}^{NAC} \overline{\omega}_{i_1}^{NAC}} \hat{a}_{i_1} + \frac{\hat{\alpha}^{FISIM} \overline{\omega}_{i_1}^{FISM}}{1 + \hat{\alpha}^{FISIM} \overline{\omega}_{i_1}^{FISIM}} \overline{f}_{i_1} \end{aligned} \tag{R-8}$$

Macro condition of net commodity taxes (without value added taxes)

$$\overline{T}_g = \sum_i \hat{t}_{gi} \tag{M-4}$$

Unity conditions

$$\sum_h p_{gih}^{t} = 1 \tag{U-6}$$

$$\sum_h p_{ih}^{\alpha R} = 1 \tag{U-7}$$

$$\sum_h p_{lh}^{\alpha CHH} = 1 \tag{U-8}$$

$$\sum_h p_{h}^{\alpha CNP} = 1 \tag{U-9}$$

$$\sum_h p_{h}^{\alpha CG} = 1 \tag{U-10}$$

$$\sum_h p_{h}^{\alpha CSC} = 1 \tag{U-11}$$

$$\sum_h p_{iwh}^{\alpha INV} = 1 \tag{U-12}$$

$$\sum_h p_h^{\alpha NAC} = 1 \qquad \text{(U-13)}$$

$$\sum_h p_h^{\alpha FISIM} = 1 \qquad \text{(U-14)}$$

4.5 Final consumption

Estimation of consumption of commodity i in activity l (private households)

$$\hat{c}_{il}^{HH} = \sum_h p_{ilh}^{HH} z_{ilh}^{HH} \qquad \text{(E-14)}$$

Estimation of consumption of commodity i (non-profit organizations)

$$\hat{c}_i^{NP} = \sum_h p_{ih}^{NP} z_{ih}^{NP} \qquad \text{(E-15)}$$

Estimation of consumption of commodity i (government)

$$\hat{c}_i^{G} = \sum_h p_{ih}^{G} z_{ih}^{G} \qquad \text{(E-16)}$$

Estimation of consumption of commodity i (social security system)

$$\hat{c}_i^{SC} = \sum_h p_{ih}^{SC} z_{ih}^{SC} \qquad \text{(E-17)}$$

Macro condition on consumption of private households in category l

$$\bar{C}_{l^*}^{HH} = \sum_{l \in l^*} \sum_i \hat{c}_{il}^{HH} \qquad \text{(M-5)}$$

Macro condition on consumption of non-profit organizations

$$\bar{C}^{NP} = \sum_i \hat{c}_i^{NP} \qquad \text{(M-6)}$$

Macro condition on consumption of government

$$\bar{C}^{G} = \sum_i \hat{c}_i^{G} \qquad \text{(M-7)}$$

Macro condition on consumption of the social security system

$$\bar{C}^{SC} = \sum_i \hat{c}_i^{SC} \qquad \text{(M-8)}$$

Unity conditions

$$\sum_h p_{ilh}^{HH} = 1 \qquad \text{(U-15)}$$

$$\sum_h p_{ih}^{NP} = 1 \qquad \text{(U-16)}$$

$$\sum_h p_{ih}^G = 1 \tag{U-17}$$

$$\sum_h p_{ih}^{SC} = 1 \tag{U-18}$$

4.6 Capital formation

Estimation of investment demand for commodity i in category w (buildings and equipment)

$$\hat{n}_{iw} = \sum_h p_{iwh}^n z_{iwh}^n \tag{E-18}$$

Estimation of change in net inventories of commodity i

$$\hat{d}_i = \sum_h p_{ih}^d z_{ih}^d \tag{E-19}$$

Estimation of change in net acquisition of valuables of commodity i

$$\hat{a}_i = \sum_h p_{ih}^a z_{ih}^a \tag{E-20}$$

Macro condition on total investment demand in category w

$$\bar{N}_w = \sum_i \hat{n}_{iw} \tag{M-9}$$

Macro condition on total net inventories

$$\bar{D} = \sum_i \hat{d}_i \tag{M-10}$$

Macro condition on total net acquisition of valuables

$$\bar{A} = \sum_i \hat{a}_i \tag{M-11}$$

Unity conditions

$$\sum_h p_{iwh}^n = 1 \tag{U-19}$$

$$\sum_h p_{ih}^d = 1 \tag{U-20}$$

$$\sum_h p_{ih}^a = 1 \tag{U-21}$$

4.7 Exports

Estimation of export of commodity i

$$\hat{x}_i = \sum_h p_{ih}^x z_{ih}^x \tag{E-21}$$

Macro condition on total exports

$$\overline{X} = \sum_i \hat{x}_i \tag{M-12}$$

Unity condition

$$\sum_h p_{ih}^x = 1 \tag{U-22}$$

4.8 Balance conditions

Balance condition for each industry j (where $\hat{S}_j$ is given from the estimation of the supply matrix)

$$\hat{U}_j + \hat{V}_j = \hat{S}_j \tag{B-1}$$

Balance condition for each commodity i

$$\begin{aligned} &\sum_j s_{ji} + v_i + \sum_g \hat{t}_{gi} + \hat{m}_i \\ &= \sum_j u_{ij} + \sum_l \hat{c}_{il}^{HH} + \hat{c}_i^{NP} + \hat{c}_i^G + \hat{c}_i^{SC} + \sum_w \hat{n}_{iw} + \hat{d}_i + \hat{a}_i + \hat{x}_i + \overline{f}_i \end{aligned} \tag{B-2}$$

Note, that the macro condition, which equals the sum of the net value added tax payments for each commodity i, v_i, to the total value added tax payments, is implied by the balance conditions.

4.9 Objective function

The objective function, which has to be minimized, is defined by the Kullback-Leibler measure:

$$
\begin{aligned}
I = & \sum_i \sum_h p_{ih}^m \ln\left(p_{ih}^m\right) - \sum_h p_{ih}^m \ln\left(q_{ih}^m\right) \\
& + \sum_{i_1,i_2} \sum_h p_{i_1 i_2 h}^\rho \ln\left(p_{i_1 i_2 h}^\rho\right) - \sum_h p_{i_1 i_2 h}^\rho \ln\left(q_{i_1 i_2 h}^\rho\right) \\
& + \sum_j \sum_h p_{jh}^U \ln\left(p_{jh}^U\right) - \sum_h p_{jh}^U \ln\left(q_{jh}^U\right) \\
& + \sum_j \sum_h p_{jh}^V \ln\left(p_{jh}^V\right) - \sum_h p_{jh}^V \ln\left(q_{jh}^V\right) \\
& + \sum_{g,i} \sum_h p_{gih}^t \ln\left(p_{gih}^t\right) - \sum_h p_{gih}^t \ln\left(q_{gih}^t\right) \\
& + \sum_i \sum_h p_{ih}^{\alpha R} \ln\left(p_{ih}^{\alpha R}\right) - \sum_h p_{ih}^{\alpha R} \ln\left(q_{ih}^{\alpha R}\right) \\
& + \sum_l \sum_h p_{lh}^{\alpha CHH} \ln\left(p_{lh}^{\alpha CHH}\right) - \sum_h p_{lh}^{\alpha CHH} \ln\left(q_{lh}^{\alpha CHH}\right) \\
& + \sum_h p_h^{\alpha CNP} \ln\left(p_h^{\alpha CNP}\right) - \sum_h p_h^{\alpha CNP} \ln\left(q_h^{\alpha CNP}\right) \\
& + \sum_h p_h^{\alpha CG} \ln\left(p_h^{\alpha CG}\right) - \sum_h p_h^{\alpha CG} \ln\left(q_h^{\alpha CG}\right) \\
& + \sum_h p_h^{\alpha CSC} \ln\left(p_h^{\alpha CSC}\right) - \sum_h p_h^{\alpha CSC} \ln\left(q_h^{\alpha CSC}\right) \\
& + \sum_{i,w} \sum_h p_{iwh}^{\alpha INV} \ln\left(p_{iwh}^{\alpha INV}\right) - \sum_h p_{iwh}^{\alpha INV} \ln\left(q_{iwh}^{\alpha INV}\right) \\
& + \sum_h p_h^{\alpha NAC} \ln\left(p_h^{\alpha NAC}\right) - \sum_h p_h^{\alpha NAC} \ln\left(q_h^{\alpha NAC}\right) \\
& + \sum_h p_h^{\alpha FISIM} \ln\left(p_h^{\alpha FISIM}\right) - \sum_h p_h^{\alpha FISIM} \ln\left(q_h^{\alpha FISIM}\right) \\
& + \sum_{i,l} \sum_h p_{ilh}^{HH} \ln\left(p_{ilh}^{HH}\right) - \sum_h p_{ilh}^{HH} \ln\left(q_{ilh}^{HH}\right) \\
& + \sum_i \sum_h p_{ih}^{NP} \ln\left(p_{ih}^{NP}\right) - \sum_h p_{ih}^{NP} \ln\left(q_{ih}^{NP}\right) \\
& + \sum_i \sum_h p_{ih}^G \ln\left(p_{ih}^G\right) - \sum_h p_{ih}^G \ln\left(q_{ih}^G\right) \\
& + \sum_i \sum_h p_{ih}^{SC} \ln\left(p_{ih}^{SC}\right) - \sum_h p_{ih}^{SC} \ln\left(q_{ih}^{SC}\right) \\
& + \sum_{i,w} \sum_h p_{iwh}^n \ln\left(p_{iwh}^n\right) - \sum_h p_{iwh}^n \ln\left(q_{iwh}^n\right) \\
& + \sum_i \sum_h p_{ih}^d \ln\left(p_{ih}^d\right) - \sum_h p_{ih}^d \ln\left(q_{ih}^d\right) \\
& + \sum_i \sum_h p_{ih}^a \ln\left(p_{ih}^a\right) - \sum_h p_{ih}^a \ln\left(q_{ih}^a\right) \\
& + \sum_i \sum_h p_{ih}^x \ln\left(p_{ih}^x\right) - \sum_h p_{ih}^x \ln\left(q_{ih}^x\right)
\end{aligned}
\tag{O}
$$

5 Estimation results and discussion

The following table shows major adjustments (greater or equal to +/- 100 Mio. CHF and greater or equal to +/- 5% compared to the input value) from the unbalanced input-output table to a consistent table.

Table 28: Major differences of the balanced to the unbalanced input-output table (values in bill. CHF)

Good category	Total demand	Intermediate demand	Consumption	Gross capital formation	Exports	FISIM
G01-G05	-0.192	-0.175				
G10-G14	0.827	0.817				
G15-G16	0.360	0.745	0.348			
G17	1.392	0.667	0.560	0.140		
G18						
G19	0.390		0.324			
G20	1.627	1.431		0.177		
G21	-2.121	-1.771	-0.164	-0.180		
G22	4.809	3.889	0.134	0.774		
G23-G24	2.865	1.422	-0.245	0.932		
G25			-0.111			
G26	-0.709	-0.640				
G27	-1.009	-0.948				
G28	1.481	1.612				
G29	-5.457	-1.655	-0.147	-3.433		
G30-G31	3.880	2.682		0.937		
G32						
G33		0.681				
G34						
G35						
G36	0.830	0.190	0.354	0.169		
G37	0.656	0.555		0.100		
G40-G41	1.366	1.360				
G45		-1.675				
G50	1.593	0.808	0.281	0.504		
G51-G52	1.470	1.115				
G55		-0.421			-0.521	
G60-G62	1.965	1.676	0.285			
G63	2.465	2.391				
G64		0.651				
G65		-1.388	-0.455			
G66						
G70+G96	-5.247	-5.129				
G71+G74	-9.221	-8.753	-0.429			
G72	-1.974	-1.744				
G73	0.751	0.795				
G75		0.465				
G80		0.166				
G85			-0.197			
G90	-0.478	-0.425				
G91-G92		0.586				
G93-G95						

Source: Own calculation

Table 29 shows some statistics for the estimation made. Changes in the intermediate input matrix account for approximately 79% of total cross-entropy. Nevertheless, the average cross-entropy shows that changes are in a reasonable order of magnitude. A problem is the relative high average cross-entropy for change in inventories. A lot of data uncertainty is captured by adjusting the net inventories. Original Swiss data on inventories is needed in order to improve the whole estimation.

Table 29: Estimation statistics

Matrix	Cross-entropy	Share	Avg. cross-entropy	# nonzeros
Imports	0.052	0.093%	0.0011	48
Gross value added	0.004	0.008%	0.0003	14
Intermediate demand	0.019	0.034%	0.0014	14
Intermediate input matrix	43.722	78.590%	0.0192	2279
Consumption private households	5.407	9.719%	0.0146	370
Consumption NPISH	0.017	0.030%	0.0056	3
Consumption government	0.360	0.647%	0.0720	5
Consumption social security system	0.003	0.005%	0.0005	5
Investments	1.936	3.480%	0.1019	19
Change in inventories	2.899	5.211%	0.1074	27
Net acquisition of valuables	0.013	0.023%	0.0043	3
Exports	1.003	1.803%	0.0209	48
Value added taxes	0.199	0.359%	0.0071	28
Total	55.633	100.000%	0.0152	2863

Source: Own calculation

We used four different product-by-product matrices as prior estimates (see 3.3). For each starting set we calculated the cross entropy measure, the determinant of the Leontief matrix, the inverse of the spectral number (see Wolff 2005) as well as the maximal and the minimal multiplier. The inverse of the spectral number is a measure for the stability of the inverse of the Leontief matrix and lies in the interval between 0 and 1. The higher the inverse of the spectral number, the more stable the inverse of the Leontief matrix. The values calculated for the four estimates are high compared to other IO tables as reported in Wolff (2005). The following table shows the results for each starting set.

Table 30: Estimation results for alternative prior estimates

Prior estimate	Cross-entropy	Determinant		Inverse of spectral number		Range of multipliers	
		unbalanced	balanced	unbalanced	balanced	unbalanced	balanced
A	68.769	7.00E-05	6.14E-05	0.2973	0.3001	1.25 - 2.79	1.24 - 2.85
B	55.633	1.37E-04	1.15E-04	0.2956	0.3018	1.26 - 2.81	1.24 - 2.86
C	72.216	6.04E-05	5.36E-05	0.2970	0.3021	1.26 - 2.79	1.24 - 2.83
D	56.035	1.21E-04	1.03E-04	0.2961	0.3039	1.26 - 2.82	1.24 - 2.83

Source: Own calculation

According to the estimation results we chose starting point "B" as our prior estimate. Nevertheless, due to the estimation results, also the choice of starting point "D" would have been reasonable. In order to make an informed decision one would have to analyze the results of estimate "B" and "D" in more detail.

6 Conclusions

In order to estimate an input-output table for Switzerland with limited data, we used - compared to previous work - two new approaches. First, we carried out a country comparison in order to select the intermediate input vectors for the Swiss manufacturing sectors. Second, we used a cross entropy approach in order to estimate a consistent IO table based on inconsistent and incomplete prior estimates.

In order to improve the quality of sectoral intermediate input estimations, we performed a country comparison of sectoral product mix. We compared the product mix of each Swiss manufacturing sector with those of corresponding sectors in other European countries. Following the hypothesis that a similar product mix will correspond with a similar input structure, we used the input structures of sectors with a high degree of similarity as first estimates for the input structures of the Swiss sectors.

The application of the cross-entropy method has proven to be useful if initial data are scattered, inconsistent and incomplete. Indeed, if data can be represented as intervals, this approach is well suited. Nevertheless, due to time and resource constraints, our estimation of the IO table does not fully exploit all available data. Furthermore, our experience is that reducing the complexity of the estimation model pays off. First, it is easier to control the consistency of the input data, i.e. to check whether the constraints can be satisfied. Second, computational time decreases significantly and the model becomes easier to debug and to control.

Compared to the previous IO table for Switzerland, in many instances up-to-date and original data have been used for this estimation. Even though the estimation of a Swiss IO table still has to rely partly on data from other countries, the use of up-to-date information benefits the quality of the new table. Altogether the estimated IO table presents a good overall picture of the sectoral interrelations within the Swiss economy. This does not necessarily hold for the representation of single economic sectors, for which the uncertainties can be much higher. They can only be reduced by detailed sectoral studies, which could not be carried out within this project. Studies on specific sectors should therefore use additional information, wherever possible. The following sectors can be highlighted:

- For the paper products industry and the printing and publishing industry (NOGA 21 and 22) there are large unresolved imbalances in the prior data estimates.
- Such imbalances also exist for the motor vehicles sector, for which the distribution of deliveries is uncertain. Here the missing information on trade margins also contributes to the uncertainties.
- For the real estate service sector information on important service providers and users is largely missing.
- Some sectors are more dependent on state regulation, which may differ between countries. Therefore the method of using input data from foreign countries might misrepresent the input structure of these sectors. Examples might be the health-related industries or governmental sectors.

Given the time and resource constraints and therefore the need to simplify the data generation process at some points, we briefly summarize the major shortcomings and sources of uncertainty:

- The lack of a commodity statistic makes it difficult to estimate the supply of commodities and thus to reach a balance with their demand. Using the census of enterprises with the hypothesis of establishments as producing only one commodity is not very realistic. Yet this is a shortcoming, which is difficult to overcome without additional information.
- This shortcoming also affects the results of the country comparison for estimating the intermediate input structure, since the weights of the Swiss producers' price index as the

basis for representing the product mix of Swiss industries is not purely product related but also reflects enterprise information, especially on the NOGA 3-4 digit level. Overall the use of foreign data for estimating the intermediate inputs introduces a significant source of uncertainty. Again this uncertainty reflects the total lack of genuine Swiss data and can hardly be reduced.

- An important uncertainty also stems from the lack of information on trade and transport margins, which are needed for the transition from purchasers' to basic prices for the goods used in final demand.

Apart from refining existing statistics, we see – according to the conclusions made above – the following focal points for future research:

- The value added statistics contains some information about wages and salaries as well as capital remuneration. This information, which could not be used within this project, would allow to break down gross value added in more detail.
- In order to improve the estimation of the value added taxes, the analysis of this statistics is necessary. The difference in the classification of enterprises is the main obstacle to use this statistics for a better estimation of the value added tax burden on intermediate and final demand components
- Due to the lack of commodity statistics, the estimation of the make matrix remains a difficult problem. A detailed investigation of implied labor productivities and the application of several estimation approaches based on different assumptions (see section 3.1) might improve the quality of the estimation.
- In our project we have assumed that sectors with similar output structures have a similar input vector. In order to improve the performance and appropriateness of country comparisons this hypothesis has to be evaluated.
- Information on trade and transport margins in Switzerland is necessary to improve the estimation of the Swiss IO table. The margins are an important share of end user prices and misspecification leads to wrong relative prices.

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Appendix A: Row and column definition of the input-output table

The following tables give an overview of the identifiers used in the input-output tables. Commodity and industry classification follows NOGA. A commodity group is identified by the prefix "G", an industry by the prefix "S".

Table 31: Row and column identifiers for products and industries

ID	Description
01-05	Agriculture, hunting and related service activities; Forestry, logging and related service activities; Fishing, fish farming and related service activities
10-14	Mining and quarrying (includes also NOGA 10-13)
15-16	Manufacture of food products and beverages; Manufacture of tobacco products
17	Manufacture of textiles
18	Manufacture of wearing apparel; dressing and dyeing of fur
19	Tanning and dressing of leather; manufacture of luggage, handbags, saddlery, harness and footwear
20	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials
21	Manufacture of pulp, paper and paper products
22	Publishing, printing and reproduction of recorded media
23-24	Manufacture of coke, refined petroleum products and nuclear fuel; Manufacture of chemicals and chemical products
25	Manufacture of rubber and plastic products
26	Manufacture of other non-metallic mineral products
27	Manufacture of basic metals
28	Manufacture of fabricated metal products, except machinery and equipment
29	Manufacture of machinery and equipment n.e.c.
30-31	Manufacture of office machinery and computers; Manufacture of electrical machinery and apparatus n.e.c.
32	Manufacture of radio, television and communication equipment and apparatus
33	Manufacture of medical, precision and optical instruments, watches and clocks
34	Manufacture of motor vehicles, trailers and semi-trailers
35	Manufacture of other transport equipment
36	Manufacture of furniture; manufacturing n.e.c.
37	Recycling
40-41	Electricity, gas, steam and hot water supply; Collection, purification and distribution of water
45	Construction
50	Sale, maintenance and repair of motor vehicles and motorcycles; retail sale of automotive fuel
51-52	Wholesale trade and commission trade, except of motor vehicles and motorcycles; Retail trade, except of motor vehicles and motorcycles; repair of personal and household goods
55	Hotels and restaurants
60-62	Land transport; transport via pipelines; Water transport; Air transport
63	Supporting and auxiliary transport activities; activities of travel agencies
64	Post and telecommunications
65	Financial intermediation, except insurance and pension funding (includes also part of NOGA 67)
66	Insurance and pension funding, except compulsory social security (includes also part of NOGA 67)
70, 96-97	Real estate activities (incl. private households)
71, 74	Renting of machinery and equipment without operator and of personal and household goods; Other business activities
72	Computer and related activities
73	Research and development
75	Public administration and defence; compulsory social security
80	Education
85	Health and social work

ID	Description
90	Sewage and refuse disposal, sanitation and similar activities
91-92	Activities of membership organizations n.e.c.; Recreational, cultural and sporting activities
93-95	Other service activities; Activities of households as employers of domestic staff

Source: Own illustration

Table 32: Identifiers only used as row headers

Row ID	Description
LAB	Wages and salaries and social security contributions
PTX_OS	Net production taxes and operating surplus
VAT	Value added tax payments
O_NTX	Other net commodity taxes
TAR	Import tariffs
IMP	Imports c.i.f.

Source: Own illustration

Table 33: Identifiers only used as column headers

Column ID	Description
C01	Food and non-alcoholic beverages (COICOP 1)
C02	Alcoholic beverages, tobacco and narcotics (COIOCP 2)
C03	Clothing and footwear (COIOCP 3)
C04	Housing, water, electricity, gas and other fuels (COIOCP 4)
C05	Furnishings, household equipment and routine household maintenance (COIOCP 5)
C06	Health (COIOCP 6)
C07	Transport (COIOCP 7)
C08	Communication (COIOCP 8)
C09	Recreation and culture (COIOCP 9)
C10	Education (COIOCP 10)
C11	Restaurants and hotels (COIOCP 11)
C12	Miscellaneous goods and services (COIOCP 12)
C_NPISH	Consumption of non-profit institutions serving households
C_GOV	Consumption of government
C_SOCSEC	Consumption of the social security system
INV_EQ	Gross fixed capital formation in machinery and equipment
INV_BLD	Gross fixed capital formation in dwellings and buildings
D_INV	Changes in inventories
N_ACQ	Net acquisition of valuables
EXP	Exports f.o.b.
FISIM	Financial intermediation services indirectly measured

Source: Own illustration

Appendix B: Data file of the Swiss input-output table 2001

Table 34: Sheets contained in the file "swiss_iot_2001.xls"

Sheet	Description
LICENSE	Open source license agreement
README	Important remarks
SPEC	Specification of the Swiss input-output table 2001
SUPPLY	Supply matrix in basic prices, net commodity taxes and imports
USE	Use table in basic prices incl. net commodity taxes
SIOT	Symmetric input-output table in basic prices
FISIM	Financial intermediation services indirectly measured
VAT	Value added taxes on final demand

Source: Own illustration