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IOR – NIER's Input-Output Model of the Swedish Economy

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Abstract

The present paper introduces a new version of an input-output model of the Swedish economy (IOR). The model is used at NIER for short term forecasts of imports and sectoral production. It is also used for structural analysis of the Swedish economy. The economy is divided into about 30 products/industries and about 40 final demand categories. For each demand category, it is possible to trace back the supply provided by value added of different industries, including trade margins and merchanting trade, public sector production, imports, taxes and subsidies. This paper presents calculated supply shares for the main components of final demand for the year 2012. An adjustment for the tourist consumption in Sweden is made in such a way that the supply share for household consumption is valid for Swedish households, and the supply shares for exports includes exports to incoming tourists.

JEL classification code: C67, D57, E17

Keywords: Input-output, forecasting and simulation, import shares.

Sammanfattning

Denna studie beskriver en ny version av Konjunkturinstitutets input-outputmodell för den svenska ekonomin (IOR). Modellen används för att göra kortsiktiga prognoser på import och branschfördelad produktion. Den används även för strukturell analys av ekonomins funktionssätt. Hela ekonomin delas upp i ungefär 30 olika produkter och branscher, och cirka 40 efterfrågekomponenter. För varje komponent i slutlig efterfrågan kan man spåra tillförseln från förädlingsvärdet i olika branscher inklusive handelsmarginaler och trepartshandel, offentliga myndigheters produktion, import, skatter och subventioner. Tabeller med beräknade tillförselandelar för efterfrågekomponenterna i försörjningsbalansen för år 2012 presenteras. Andelarna är justerade för inkommande turisters konsumtion i Sverige på ett sätt som gör att andelarna för hushållens konsumtion är rättvisande för svenska hushåll, och att andelarna för exporten är rättvisande för all export inklusive export av resevaluta.

Contents

1 Introduction

This document describes the input-output model used at the National Institute of Economic Research (NIER) in Sweden. The model is called IOR. An input-output model is a matrix representation of intersectoral flows in the economy that, among other things, permits analysis of the effects of changes in final demand on production, imports and product taxes and subsidies in different sectors of the economy. The model is based on an assumption of Leontief production functions and zero supply restrictions. The main use of the model at the NIER is to aid in the forecast of imports and production.

1.1 Historical Background

Research into, and usage of input-output models is widespread.[1] The models are often used for regional impact analysis and environmental impact analysis. In Sweden input-output models have been in use for a long time. For example, a project to construct an input-output model for the Swedish economy was initiated as a joint project by several Swedish institutes in 1957, including the NIER (Höglund, 1958). Moreover, an input-output model with eight sectors was at the core of NIER:s short run econometric model for the macroeconomy, *KOSMOS*, that was developed 1986-1988 (Ensäter and Rosenberg, 1989). *Långtidsutredningen 1975* was largely based on an input-output model with 23 sectors. A 45 sector model was presented at a seminar held by Maria Lind at the NIER in October 1997 (Lind, 1997). The current version of IOR derives from a free-standing input-ouput model implemented using Aremos software with 19 sectors. It was in use at the NIER from around year 2005 until 2013 when it was replaced by a similar model written with Eviews software. The current version, also programmed in Eviews has recently been expanded to cover 29 industries in the business sector.

Input-output data can also be used to construct a model for costs, prices and profits in the economy. Such a model has been used extensively both at NIER and the Swedish ministry of finance during a number of years, at least since the early 1980:s (Jonsson, 1981). At the moment, no such model is being used and this report focuses on the input-output model for volumes.

1.2 Outline of the Paper

The rest of the paper is organized as follows. The model is presented in the next chapter. Chapter 3 contains some results from the model.

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[1] Se for instance the list of abstracts and papers submitted to the international input-output conferences at www.iioa.org.

2 The Model

2.1 Notation, Theory and Terminology

The input-output model IOR is based on the assumption of fixed coefficients and industry technology. The reader is referred to chapters 2 and 5 of Miller and Blair (2009) for a background to input-output analysis. The notation in this report partly follows that used in the book. However, since the IOR model is more complicated than the standard model described in Miller & Blair, there is a substantial amount of new notation used here. The main elements are summarized below:

$\mathbf{x}$ is a vector of products (lowercase bold letters denote column vectors). The term products is synonymous to the term commodities used by Miller & Blair (2009), and refers to both goods and services in the economy.

$\hat{\mathbf{x}}$ The hat denotes a diagonalized vector (a matrix with the vector along the main diagonal).

$\mathbf{Z}$ is a matrix of inter-industry transactions (bold capitals denote matrices).

$\odot$ denotes the elementwise multiplication operator (Hadamard product).

$\mathbf{X}^{\odot -1}$ denotes elementwise power operator, in this example the inverse of each element of $\mathbf{X}$.

$\mathbf{i}$ is a unit vector, generally assumed to have the appropriate number of rows for the expression at hand.

Subscripts denote sources of supply. Superscripts denote the time in years. The time superscript is omitted in expressions that are valid for all time periods.

“Industries” refers to branches of the business sector, both producers of goods and of services.

IOR differs from standard input-output models in one important way. Final demand is divided into a matrix, $\mathbf{E}$, rather than a total vector $\mathbf{e}$. The columns of $\mathbf{E}$ are different categories of demand, such as household consumption and exports. Most of the vector expressions of a standard model as described by Miller & Blair easily translate to the matrix expressions used in IOR. The expansion of the input-output model to matrix form allows for an analysis of which components of demand are driving imports and production in the forecast. It also makes it possible to calculate import and other supply shares for different components of demand.

2.2 Basics

In line with the national accounts, at any point in time, assume that the supply of any product equals the total demand of the product. Total demand is divided into demand from intermediate use (input) and final demand. Final demand is the sum of consumption, investment and exports. In the simplest input-output model with no distinction between products and industries, and no imports or taxes, the main equations summarizing the model are:

$$\mathbf{x} = \mathbf{Zi} + \mathbf{f}$$

where **x** is a vector of production of *n* products and **f** is a vector of final demand for the same products. **Z** is the transactions matrix of input use of products in the production process.

Let

$$\mathbf{A} = \hat{\mathbf{x}}^{-1}\mathbf{Z}$$

be the matrix of input use coefficients. Then the vector of production that satisfies final demand is

$$\mathbf{x} = (\mathbf{I} - \mathbf{A})^{-1}\mathbf{f}$$

where $(\mathbf{I} - \mathbf{A})^{-1}$ is the so called Leontief inverse, and $\mathbf{I}$ is the identity matrix. IOR is based on data from an industry by product transactions matrix, and the assumption of industry technology. The product by product input coefficient matrix with industry technology is given by

$$\mathbf{A} = \mathbf{BD}$$

where $\mathbf{D}$ is the market shares matrix, and $\mathbf{B}$ is the product by industry input coefficient matrix. Let $\mathbf{q}$ be the vector of domestically produced products and $\mathbf{e}$ be the vector of final demand for domestically produced products, then

$$\mathbf{q} = (\mathbf{I} - \mathbf{BD})^{-1}\mathbf{e}$$

2.3 A Complete Description of the Model

IOR is slightly more complicated than the standard industry by product input-output model. As mentioned above, final demand is divided into a matrix, **E**, rather than a vector **e**. A full description follows.

FINAL DEMAND

Final demand of products is divided into different demand components. A complete list can be found in the Appendix. Let the matrix of final demand, for *n* products (in the row dimension) divided up into *k* demand components (in the column dimension), valued at market prices/purchasers prices, be given by $\mathbf{E}_{\mathrm{MP}}$. The subscript MP stands for market prices.

SUPPLY SATISFYING FINAL DEMAND

Total demand in the economy can be divided into final demand and input demand. Final demand is consumption, exports, and so on. Input demand is demand from firms using products in their production process. Supply is divided into six different sources, where imports and domestic production are the most important. Furthermore, each source of supply is divided into the *k* demand components (in the column dimension) and the *n* products (in the row dimension), that is, the same dimensions as the final demand matrix. The six sources are:

1. Value added tax, other product taxes and product subsidies. In the model these are treated separately, for readability they are treated jointly here. The matrix of production taxes and subsidies which are a direct result of final demand is denoted $\mathbf{E}_{\text{TAX}}$.
2. Trade margins (MAR).
3. Domestic production by the business sector at basic prices, excluding trade margins and merchanting (PRO).
4. Imports (IMP).
5. Sales by the non-profit and public (government) sector (GOV).
6. Merchanting (TRE, short for *Trepartshandel*, third party trade).

These sources of supply satisfying *final* demand sum to final demand valued at market prices:

$$\mathbf{E}_{\text{TAX}} + \mathbf{E}_{\text{MAR}} + \mathbf{E}_{\text{PRO}} + \mathbf{E}_{\text{IMP}} + \mathbf{E}_{\text{GOV}} + \mathbf{E}_{\text{TRE}} = \mathbf{E}_{\text{MP}}$$

We index the sources of supply by s, and let the full set of sources of supply be denoted S_1, hence

$$S_1 = \{\text{TAX, MAR, PRO, IMP, GOV, TRE}\}$$

And we can rewrite the equation above as

$$\mathbf{E}_{\text{MP}} = \sum_{s \in S_1} \mathbf{E}_s \tag{1}$$

CALCULATING THE FINAL DEMAND MATRIX

Data for all of the E matrices is provided by Statistics Sweden for the base year, which is indicated by a superscript *b*, for instance $\mathbf{E}_{\text{MP}}^{b}$. Normally, the base year is the latest year with definitive national accounts. Forecasts of final demand are not generally divided into products however, and so for all years except the base year, we only have information on the sum of all products in each of the *k* demand categories. In other words, we only know the column sum of the $\mathbf{E}_{\text{MP}}^{t}$ matrix. The superscript *t* refers to any year not equal to the base year, both in the forecast period or in the past. We denote the vector of total final demand at market prices for *k* categories of demand in year *t* by $\boldsymbol{\kappa}_{\text{MP}}^{t}$. Final demand is allocated to products by use of fixed coefficients from the base year. Let the matrix containing the product share of final demand for each demand category *k*, be given by $\boldsymbol{\Psi}_{\text{MP}}$ and defined by

$$\boldsymbol{\Psi}_{\text{MP}} = \left(\hat{\boldsymbol{\kappa}}_{\text{MP}}^{b}\right)^{-1} \mathbf{E}_{\text{MP}}^{b}$$

For all years, except the base year, total final demand is allocated to products using the following formula[2]

$$\mathbf{E}^{t}_{\mathrm{MP}} = \mathbf{\Psi}_{\mathrm{MP}}\hat{\boldsymbol{\kappa}}^{t}_{\mathrm{MP}} \tag{2}$$

To conclude, equation (2) is part of the IOR model with $\mathbf{\Psi}_{\mathrm{MP}}$ as a matrix of constants and $\boldsymbol{\kappa}^{t}_{\mathrm{MP}}$ exogenously given, either from the forecast of final demand or from alternative scenarios in experimental set ups.

CALCULATING SUPPLY SATISFYING FINAL DEMAND

For all of the sources of supply, during the base year we calculate the share of final demand for each product, in each demand category, satisfied by that source of supply. Let $\mathbf{\Psi}_{\mathrm{E},s}$ be a product by demand matrix where each cell represents the share of final demand satisfied by supply $s \in S_1$.

$$\mathbf{\Psi}_{\mathrm{E},s} = \mathbf{E}^{b}_{s} \odot \mathbf{E}^{b\ \odot -1}_{\mathrm{MP}}$$

This simply means that each element of $\mathbf{E}^{b}_{s}$ is divided by each element of $\mathbf{E}^{b}_{\mathrm{MP}}$. Of course, this operation is undefined if any of the elements of $\mathbf{E}^{b}_{\mathrm{MP}}$ is zero. For all elements where this is the case, the corresponding element of $\mathbf{\Psi}_{\mathrm{E},s}$ is replaced by zero. An illustrative example: assume that fixed investments at market prices in the product machinery and equipment in the base year were 1000 SEK. Base year data indicates that 100 SEK were directly imported. Then the import share of investment demand for machinery and equipment is 10 percent. Imagine instead that the import was zero in the base year, the import share is set to zero in this case. This implies that the import value is zero for any alternative value of investment demand for machinery and equipment.[3]

For all years *t* we are then able to calculate

$$\mathbf{E}^{t}_{s} = \mathbf{\Psi}_{\mathrm{E},s} \odot \mathbf{E}^{t}_{\mathrm{MP}} \qquad \forall\ s \in S_1 \tag{3}$$

In reference to the previous example, if we forecast an increase of investment demand to 2000 SEK in the following year, we expect a direct increase in imports to 200 SEK as a result.

DOMESTIC PRODUCTION

The calculations described above yields the supply originating from domestic production, excluding trade margins, that is used directly in final demand ($\mathbf{E}^{t}_{\mathrm{PRO}}$ from equation (3)). To calculate the total amount of domestic production we have to add production used as intermediate products (input demand). Total domestic production is

[2] Inventory investments are treated somewhat differently, see more below.

[3] The model makes use of more disaggregated investment data, and the supply shares differ depending the investing sector. See the Appendix for a full list of final demand categories.

denoted $\mathbf{Q}^t_{\mathrm{EM}}$. This matrix has products in the row dimension and final demand components in the column dimension. The subscript EM is used to clarify that this is production excluding trade margins and merchanting trade ($\mathbf{Q}^t$, without a subscript, denotes output including trade margins and merchanting trade). Likewise, the market shares matrix $\mathbf{D}_{\mathrm{EM}}$ also has this subscript to distinguish it from the industries' market shares of the products' value including trade margins. In line with the basic model depicted above, $\mathbf{Q}^t_{\mathrm{EM}}$ is obtained by pre-multiplying $\mathbf{E}^t_{\mathrm{PRO}}$ with the Leontief inverse, that is,

$$\mathbf{Q}^t_{\mathrm{EM}} = (\mathbf{I} - \mathbf{B}\mathbf{D}_{\mathrm{EM}})^{-1}\mathbf{E}^t_{\mathrm{PRO}} \tag{4}$$

where **B** and **D** are calculated using base year data. Finally, the production of each product is divided to different industries according to the market share matrix. Thus, total domestic production by industries, $\mathbf{X}_{EM}$, is given by

$$\mathbf{X}^t_{\mathrm{EM}} = \mathbf{D}_{\mathrm{EM}}\mathbf{Q}^t_{\mathrm{EM}}$$

The *i*:th row of **X** shows the total production of industry *i*, divided into the different components of final demand (in the columns).

INPUT USE

Input use of domestically produced products, $\mathbf{\Gamma}_{\mathrm{PRO}}$, is given by

$$\begin{aligned}\mathbf{\Gamma}^t_{\mathrm{PRO}} &= \mathbf{B}\mathbf{X}^t_{\mathrm{EM}} \\ &= \mathbf{B}\mathbf{D}_{\mathrm{EM}}\mathbf{Q}^t_{\mathrm{EM}}\end{aligned} \tag{5}$$

Input use of other sources of supply except merchanting, for which there is no input use, is assumed to be proportional to domestic production (excluding trade margins) of industries. As a first step, we calculate fixed coefficients of supply towards input demand as a fraction of industry production using base year data,

$$\mathbf{\Psi}_{\Gamma,s} = \left(\hat{\mathbf{x}}^b\right)^{-1}\mathbf{\Gamma}^b_s$$

Then, for any year *t*,

$$\mathbf{\Gamma}^t_s = \mathbf{\Psi}_{\Gamma,s} \odot \mathbf{X}^t_{\mathrm{EM}} \tag{6}$$

for $s \in \{TAX, MAR, GOV, IMP\}$

Merchanting trade constitutes an exception and is not a source of supply satisfying input demand, hence

$$\mathbf{\Gamma}^t_{\mathrm{TRE}} = \mathbf{0} \tag{7}$$

Finally, total input use at market prices use is the sum over all sources of supply,

$$\mathbf{\Gamma}^t_{\mathrm{MP}} = \sum_{s \in S_1} \mathbf{\Gamma}^t_s \tag{8}$$

TOTAL SUPPLY

A matrix showing the total supply, for each source of supply, can be obtained by summing input use and final use for that particular source of supply. The total supply is here denoted $\mathbf{\Omega}$, and is given by

$$\mathbf{\Omega}^t_s = \mathbf{\Gamma}^t_s + \mathbf{E}^t_s \qquad \forall\, s \in S_1 \tag{9}$$

So for instance, total imports in any year *t*, ${\omega_{IMP}}^t$, that satisfies the predetermined final demand, is given by summing the elements of the import matrix, that is,

$${\omega_{IMP}}^t = \mathbf{i}'\mathbf{\Omega}^t_{\mathrm{IMP}}\mathbf{i} \tag{10}$$

In the forecasting process, this is one of the most important contributions of the IOR-model, the ability to calculate total imports for a given forecast of final demand.

INDUSTRY OUTPUT AND VALUE ADDED

From the previous sections, we know the industry by demand category matrix of production valued at basic prices, excluding trade margins and merchanting trade, in any time period, denoted $\mathbf{X}^t{}_{\mathrm{PRO}}$. In order to get the corresponding matrices for product and industry output, we must add the value of trade margins and merchanting trade to these matrices. All trade margins and merchanting trade is allocated to the trade product. Let

$$\boldsymbol{\eta}_{trade} = \begin{pmatrix} 0 \\ \vdots \\ 1 \\ \vdots \\ 0 \end{pmatrix} \tag{11}$$

be a vector of zeroes with a one in the row corresponding to the trade product. Then

$$\mathbf{Q}_{\mathbf{MAR}} = \boldsymbol{\eta}_{trade}\mathbf{i}'\mathbf{\Omega}_{\mathbf{MAR}} \tag{12}$$

is simply a matrix with the sum of all trade margins in the row corresponding to the trade product, and zeroes elsewhere. Merchanting trade is treated in exactly the same manner, and so total domestic output of products, including trade margins and merchanting trade is

$$\mathbf{Q} = \mathbf{Q}_{\mathbf{PRO}} + \mathbf{Q}_{\mathbf{MAR}} + \mathbf{Q}_{\mathbf{TRE}} \tag{13}$$

Not all trade margins are produced by the trade industry, and data allows us to construct market shares matrices for trade margins and merchanting respectively. Thus, the matrix of industry production by demand category is given by

$$\mathbf{X} = \mathbf{D_{PRO}Q_{PRO}} + \mathbf{D_{MAR}Q_{MAR}} + \mathbf{D_{TRE}Q_{TRE}} \tag{14}$$

The *vector* of total business sector industry output valued at basic prices is

$$\mathbf{x} = \mathbf{X'i} \tag{15}$$

A vector of value added shares by industry, in the business sector, $\mathbf{v}^b$ is used to calculate value added for each industry. This is a vector with values between one and zero in each element representing the value added of each industry as a share of that industry's output. The vector can be calculated using base year data using the input matrix $\mathbf{U}$ and the supply matrix $\mathbf{V'}$, including trade margins and merchanting, provided by Statistics Sweden, in the following manner:

$$\mathbf{x}^b = \mathbf{V}^b\mathbf{i} \tag{16}$$

Let the vector of total input use at market prices be dentoted by $\boldsymbol{\gamma}$.

$$\boldsymbol{\gamma} = \mathbf{U'i} \tag{17}$$

Then the vector of value added shares in the base year is given by

$$\mathbf{v}^b = \mathbf{i} - \boldsymbol{\gamma}^b (\mathbf{x}^b)^{\odot\text{-}1} \tag{18}$$

and the vector of value added at basic prices, by industry in the business sector, denoted by $\boldsymbol{\zeta}$, is for any year given by

$$\boldsymbol{\zeta}^t = \hat{\mathbf{v}}^b \odot \mathbf{x}^t \tag{19}$$

THE PUBLIC SECTOR

Value added of the public sector, ζ_{GOV}, is found by summing all elements of the supply of GOV

$$\zeta_{GOV} = \mathbf{i'\Omega_{GOV}i} \tag{20}$$

In other words, all government supply is assumed to be value added. This is consistent with the way the data structure is set up. This is only the case if sales by the government sector are measured as net sales, where the input use related to these sales has been deducted from the sale value. Or that all input use by the government sector should be attributed to activities related to its own final use, and that all sales made to other sectors is the result of activities that do not require input use.

ζ_{GOV} can be added to the vector of value added for the private sector to obtain a vector of value added for the whole economy.

2.4 Supply Shares for the Main Final Demand Categories

Besides generating forecasts of imports, product taxes and industry value added contingent on the forecast of final demand, the IOR model is used to calculate supply shares for the main demand categories:

Household consumtion, public consumtion, investments, and exports.

For example, the model can be used to answer questions such as: How large is the share of imports in the total supply satisfying export demand?

Aggregated demand categories and the supply satisfying this demand is easily calculated by aggregating the relevant matrices in the main model, from the original set of demand categories into a more aggregated one.

In order to do this properly, and adjustment must be made for consumption by foreign tourists in Sweden, that is included in household consumption the main model, but is actually exports of services.

The adjustment is done using the tourist satellite account data on what products are consumed by tourists in Sweden provided by Statistics Sweden. All of this tourist demand, and the supply require to satisfy it, is subtracted from household consumption and added to the export column. The products assumed to be consumed by tourists is shown in the table below.

Table 1 Products Purchased by Foreign Visitors

Share of total purchases at market prices, values for year 2012

		Share, percent
C excl. C19	Food, beverages and other goods	46.3
C19	Gasoline and diesel fuels	8.4
H	Transportation and storage	13.1
I	Accommodation and food service activities	22.0
L	Renting and other real estate activities	1.5
M, N	Professional, scientific and technical activities, etc.	1.2
R, S	Arts, entertainment and recreation, etc.	7.5

Sources: Statistics Sweden and NIER.

2.5 Inventory Investments

Base year data on the sources of supply towards inventory investment is not very informative about future supply, and unreasonable supply shares are not uncommon since inventory investment can be both positive and negative. Unrealistic base year supply coefficients are therefore adjusted. Adjustments are made to base year supply coefficients that are negative or greater than 1.

The allocation key for allocating total inventory investment to products is also not based on base year data. Rather, values are allocated depending on what type of inventory investment is made: growing forests, finished products, etc. The allocation key has been set using judgement rather than national account data. The reason is that data can vary significantly from year to year, and does not necessarily give any indication as to what can be expected in the future.

Supply shares towards inventory investment are not stable over time and can have values much lower than 0 and higher than 1 depending on what type of inventory investment was made in any given year. This is partly because forest growth, with zero import share, is a large component of inventory investment. Model generated aggregated supply shares for total inventory are not stable, and should therefore not be used in any type of analysis, as the stylized example below shows.

Table 2 Import Share of Inventory Investments

Stylized example, not actual values

	Value	import share, percent	Imports
Year 1			
Forest growth	8,000	0.0	0
Other inventories	−4,000	50.0	−2,000
Total	**4,000**	**−50.0**	**−2,000**
Year 2			
Forest growth	8,000	0.0	0
Other inventories	4,000	50.0	2,000
Total	**12,000**	**16.7**	**2,000**

Source: NIER.

3 Empirical Illustrations

3.1 Share Tables

The table below summarizes the supply shares for the main demand categories excluding inventory investments.

Table 3 Direct Supply Satisfying Final Demand as a Percent of Final Demand

Values for year 2012

	C	GOV	INV	EX
Business sector domestic production[1]	54.6	30.6	59.1	79.4
Trade margins	12.5	1.9	4.6	6.1
Public Sector Production[2]	4.9	56.7	5.0	0.2
Direct imports	15.4	5.4	23.5	9.9
Direct VAT	10.1	5.1	7.3	0.6

[1] Excluding trade margins and merchanting. [2] Includes non–profit organizations serving households.

Sources: Statistics Sweden and NIER.

Table 4 Supply as a Percent of Final Demand

Values for year 2012

	C	GOV	INV	EX
Business sector value added[1]	51.7	26.2	48.0	58.5
Public sector value added	5.7	57.2	5.9	1.2
Total value added, basic prices[2]	57.3	83.4	54.0	59.7
Imports	25.7	10.9	38.2	39.2
VAT	11.7	5.8	7.6	0.9

[1]Including trade margins and merchanting. [2] Includes non–profit organizations serving households.

Sources: Statistics Sweden and NIER.

Note that the public sector value added shares slightly exceed the public sector production share. This may seem odd, but is the result of public sector production being identical to public sector value added. In the first table, only the public sector value added directly satisfying final demand is included. The figures in the second table account for the fact public sector production also satisfies input demand from the business sector: Some the business sector production processes use public sector production as an input. This additional public sector value added is also included in the second table.

3.2 Forecasting Imports and Value Added

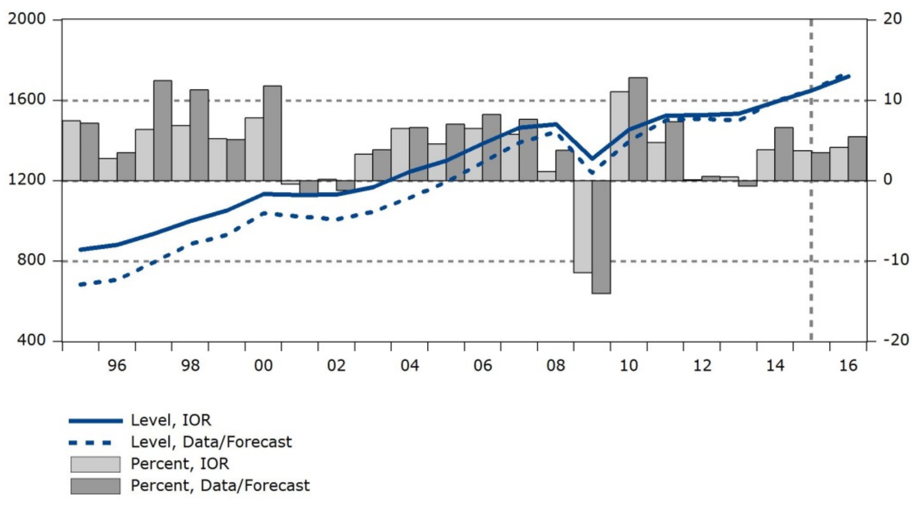
Figure 1 shows the calculated value of total imports in IOR, similar figures for imports divided into goods and services respectively are found in the Appendix. For each year, the value is calculated conditional on the actual or forecasted final demand that year. The base year 2012 share matrices were used. The figure shows that, as we would hope, IOR delivers a value for the 2012 level close to the actual value reported in the National Accounts. This is more or less a requirement and a positive check of the calibration of the model. However, differences can occur for two reasons: Firstly, the treatment of inventory investment deviates from base year data. Secondly, if the base year does not coincide with the reference year, volumes are not exactly additive because of the chained price indexation method.

The annual growth rate of IOR in 2012 is also close to the actual growth rate. This is not in general necessary the case, but of course a good sign of the usefulness of the model. The fit is also good for 2013. However, the model underestimates the import growth in 2014. The figure also reveals that the NIER's forecast of 2015 and 2016 were highly influenced by the model results.

The import level before the base year according to IOR is higher than the actual level which shows that the import shares of final demand in general have increased over time. In other words, the import share matrix of 2012 does not well represent the imports in 1995. As will be shown next, this implies a systematic (negative) error in the growth rate of imports in IOR. One reason for the discrepancy over time is that IOR works by summing over import volumes by product expressed in reference year prices. Because the national accounts uses the chained price index method, the evolution of the sum of the import volumes differs from the evolution of the total volume. Moreover, it is reasonable to expect the import shares in volume terms to rise over time since growth in international trade for a long time, on average, has been higher than GDP growth. This is the case in most industrialized countries.

Figure 1 Imports

Billion SEK constant prices, percentage change (right)



Note that the forecast is from August 2015.

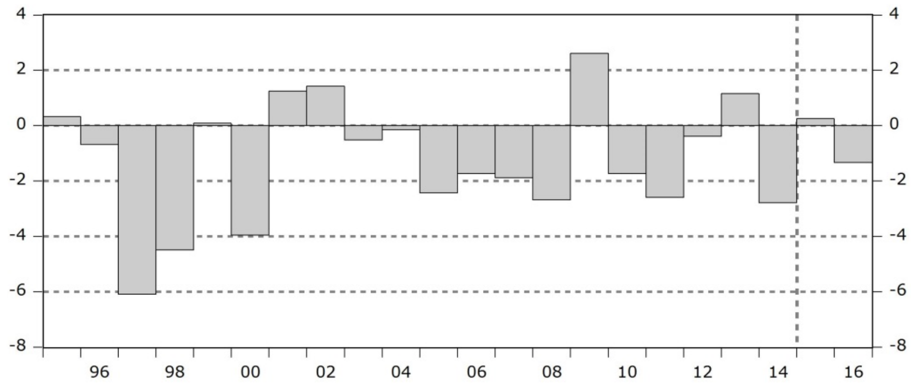
Sources: Statistics Sweden and NIER.

Figure 2 shows the historical errors of IOR's import growth rate, that is, the difference between the annual growth rate of imports according to IOR and the National Accounts. The typical error is negative which is consistent with an increasing import share in general, and because of the problems due to additivity mentioned earlier. The mean error for the whole historical period, 1995–2014, is –1.3 percentage points. However, the errors have declined over years, for example, the mean error for the more recent period 2001–2014 is –0.7. If one expects import shares in volume terms to increase over time, the forecasted imports from the model will be underestimated.

One should also note that the errors are highly volatile, see Figure 2. The standard deviation is around 2 percentage points. The results of IOR should therefore be interpreted with care. The final forecast has to take into account temporary effects, for example.

Figure 2 Import growth, deviation between IOR and outcome/forecast data

Percentage points



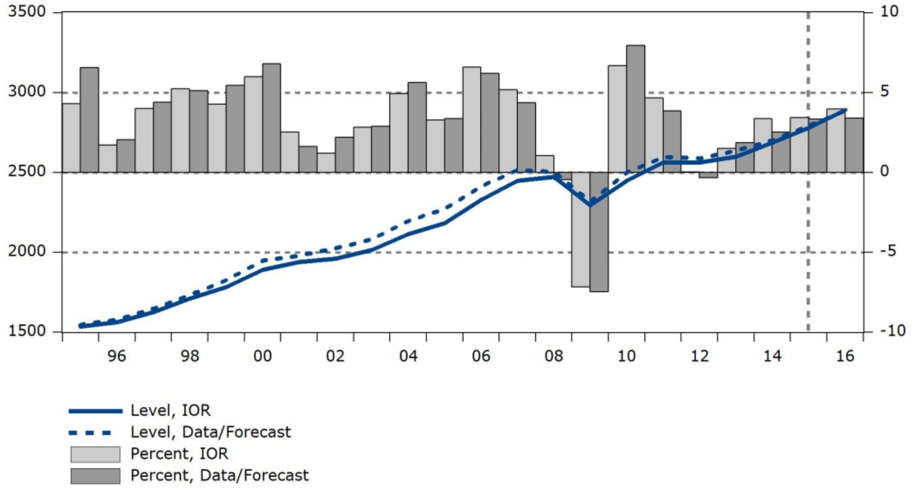
Note that the forecast is from August 2015.

Sources: Statistics Sweden and NIER.

As discussed above, it is also possible to calculate the value added of different sectors of the economy, given the final demand, in the model. Figure 3 shows value added in the aggregated business sector according to IOR, compared with the actual values in the National Accounts and the forecast of NIER (2015–2016). Similar figures for value added for the sub sectors manufacturing industry and service sector are found in the Appendix. The IOR value is relatively close to the actual values for the whole period. In this case, the share matrices used here seem not have the same trends as in the case with the import shares, which is to be expected. It is only possible for the business sector value added share and the import share to rise simultaneously if the tax share, or the public sector value added share is falling.

Figure 3 Value added, Business Sector

Billion SEK constant prices, percentage change (right)



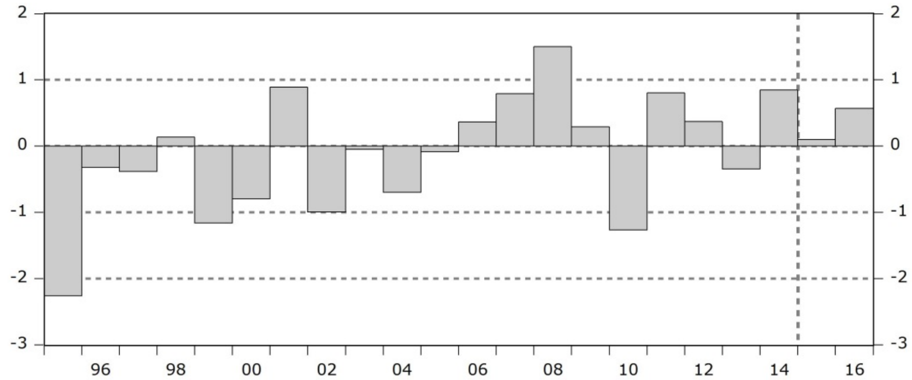
Note that the forecast is from August 2015.

Sources: Statistics Sweden and NIER.

Figure 4 shows the errors of IOR's annual growth rate of value added in the aggregated business sector. The mean error for the period 1995–2014 is –0.1 percentage points, and for 2001–2014 it is +0.2. The standard deviation is 0.9 and 0.8 for the respectively period.

Figure 4 Value added growth, Business Sector, deviation between IOR and outcome/forecast data

Percentage points, constant prices



Note that the forecast is from August 2015.

Sources: Statistics Sweden and NIER.

4 Concluding Remarks

The IOR model is a valued tool at the NIER and has a wide range of possible uses beyond those described in this document. It is of great use for both structural analysis and short term forecasting. The calculated supply shares are used at the NIER to analyze effects of structural changes in the economy on imports and productivity, for instance. In the short term forecasting process, the model plays a key role in the estimation of future import developments and production changes at an industry level.
We are thankful for all the data provided by Statistics Sweden. Without this data there would be no model.

References

Blair, D. and Miller, E., (2009) *Input–Output Analysis, Foundations and extensions,* second edition, Cambridge University Press.

Ensäter, L. and Rosenberg, I., (1989) "KOSMOS – en makroekonometrisk modell för Sverige", Chapter in *Konjunkturläget maj, 1989*), Konjunkturinstitutet.

Höglund, B. (1958) "Input–output och den strukturella interdepensen", Industrins Utredningsinstitut.

Lind, M., (1997) "Samband mellan efterfrågan, produktion och import i Svensk ekonomi 1991–1994 – En input–output studie", Unpublished presentation material at Konjunkturinstitutet.

Långtidsutredningen (1976) *Långtidsutredningens modellsystem*, Bilaga 8 till Långtidsutredningen 1975, SOU 1976:42, Finansdepartementet.

Jonsson, B. (1981) "2. Modellens ekvationssystem, 2.1 Prisutveckling inom produktionssystemet" Extract from unpublished documentation material, Ekonomidepartementet, Konjunkturenheten.

Appendix

Note that industries and products coincide with the following exceptions: ENMI, KOHUI are not industries. O is not a business sector industry.

Table 5 Industries (and Products) in IOR

#	IOR name	SNI 2007 (NACE Rev,2) code	Description
1	JOFI	A01, A03	Agriculture and fishing
2	SKBR	A02	Forestry
3	ENMI	B05–06	Extraction of energy minerals
4	GRUV	B, excl, B05–06	Mining and quarrying
5	C10_12	C10–12	Manufacture of food products, etc.
6	C13_15	C13–15	Manufacture of textiles, etc.
7	C16_18	C16–18	Manufacture of wood and paper products, etc.
8	C19	C19	Manufacture of refined petroleum products
9	C20_21	C20–21	Manufacture of chemicals and pharmaceutical products
10	C22	C22	Manufacture of rubber and plastic products
11	C23	C23	Manufacture of other non–metallic mineral products
12	C24	C24	Manufacture of basic metals
13	C25	C25	Manufacture of fabricated metal products
14	C26_27	C26–27	Manufacture of electronic products and electrical equipment, etc.
15	C28	C28	Manufacture of machinery and equipment n.e.c.
16	C29_30	C29–30	Manufacture of motor vehicles and other transport equipment
17	C31_33	C31–33	Manufacture, other; repair and installation
18	ELVA	D, E	Electricity; water supply; sewerage, waste management, etc.
19	BYGG	F	Construction
.20	HATJ	G	Wholesale and retail trade; repair of motor vehicles
21	FRKT	H	Transportation and storage
22	HOTR	I	Accommodation and food service activities
23	IKTJ	J	Information and communication
24	FITJ	K	Financial and insurance activities
25	FASH	L68201A, L68201B, L68A	Renting and operating of own or leased real estate
26	FATJ	L, excl, L68201A, L68201B, L68A	Real estate services
27	FOTJ	M, N	Professional, scientific and technical activities; support, etc.
28	O	O	Public administration and defence; compulsory social security
29	VUTB	P, Q	Education; human health and social work activities
30	FRTJ	R, S, T	Arts, entertainment and recreation; households own production, etc.
31	KOHUI	X9901	Household consumption abroad

Sources: Statistics Sweden and NIER,

Table 6 Final Demand Components in IOR

#	IOR name	Code (COICOP, SNI 2007)	Description
1	KOHDAG	01–02	Household consumption, frequent purchases; Food and beverages
2	KOHSAL	0311–0313, 0321, 0431, 0511–0512, 052, 0531–0532, 054–055, 0561, 061, 0712–0713, 0721, 0812, 0911–0914, 0921–0922, 0931–0934, 095, 1212–1213, 123	Household consumption, infrequent purchases; Clothes, footwear, materials, tools, furnishings, household equipment, medical products, cycles, spare parts, telephones, electronic equipment, other durable equipment, pets, papers, books, and other goods
3	KOHE	045	Household consumption of energy; Electricity and heating fuels
4	KOHVVBI	0711	Household consumption; Motor cars
5	KOHVO	0722	Household consumption of other goods; Fuels for personal transport equipment
6	KOHTBO	041–042, 0432	Household consumption of housing; Actual and imputed rentals for housing
7	KOHTO	0314, 0322, 0513, 0533, 0562, 062–063, 0723–0724, 073, 0811, 0813, 0915, 0923, 0935, 094, 096, 10–11, 1211, 122, 124–127	Household consumption of non-housing services; Repair, education, restaurants and hotels, and other services
8	KOHUI	15	Household consumption abroad; Direct purchases abroad by Swedes
9	KOY		Consumption by non–profit institutions serving households (NPISH)
10	FBDKZ		Intermediate consumption and social contributions in kind by central government
11	FBDKK		Intermediate consumption and social contributions in kind by local government
12	FIINDU	B, C	Fixed capital formation; Mining, quarrying and manufacturing industry
13	FIVAVEEI	A, D–F	Fixed capital formation; Other producers of goods
14	FITJVEEL	G–K, M–N, P–S	Fixed capital formation; Producers of services, excl, real estate activities
15	FIFASH	L68A	Fixed capital formation; One and two family houses, secondary homes
16	FIFATJ	L68B	Fixed capital formation; Management of real estate
17	FIHIO		Fixed capital formation; NPISH
18	FIZM		Fixed capital formation; Central government
19	FIKM		Fixed capital formation; Local government
20	LI*		Changes in inventories
21	EXJOFI	A01, A03	Exports; Agriculture products and fish
22	EXSKBR	A02	Exports; Forestry products
23	EXENMI	B05–06	Exports; Energy minerals
24	EXGRUV	B, excl, B05–06	Exports; Other minerals
25	EXC10_12	C10–12	Exports; Food products, etc.
26	EXC13_15	C13–15	Exports; Textiles, etc.
27	EXC16_18	C16–18	Exports; Wood and paper, etc.
28	EXC19	C19	Exports; Refined petroleum products

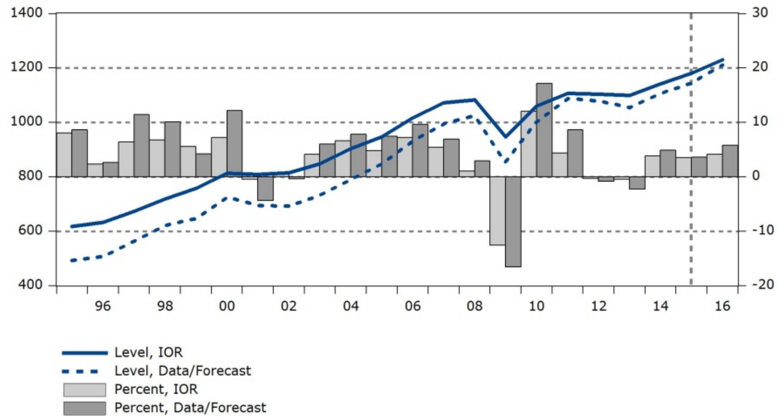
29	EXC20_21	C20–21	Exports; Chemicals and pharmaceutical products
30	EXC22	C22	Exports; Rubber and plastic products
31	EXC23	C23	Exports; Other non–metallic mineral products
32	EXC24	C24	Exports; Basic metals
33	EXC25	C25	Exports; Fabricated metal products
34	EXC26_27	C26–27	Exports; Electronic products and electrical equipment, etc.
35	EXC28	C28	Exports; Machinery and equipment n.e.c.
36	EXC29_30	C29–30	Exports; Motor vehicles and other transport equipment
37	EXC31_33	C31–33	Exports; Other goods
38	EXELVA	D, E	Exports; Electricity, etc.
39	EXTJAN	G, I–S	Exports; Services, excl. transports
40	EXFRKT	H	Exports; Transports
41	omKoep		General government consumption of own production (public sector consumtion of public sector value added)

*) Changes in inventories is further divided into subcomponents, see text.

Sources: Statistics Sweden and NIER.

Figure 5 Imports, Goods

Billion SEK constant prices, percentage change (right)

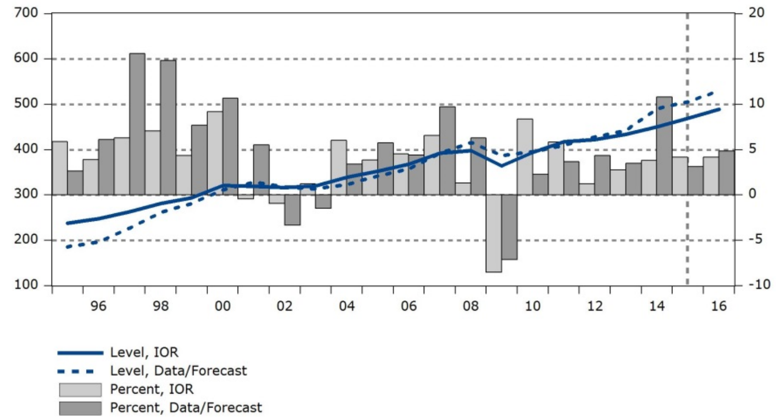


Note that the forecast is from August 2015.

Sources: Statistics Sweden and NIER.

Figure 6 Imports, Services

Billion SEK constant prices, percentage change (right)

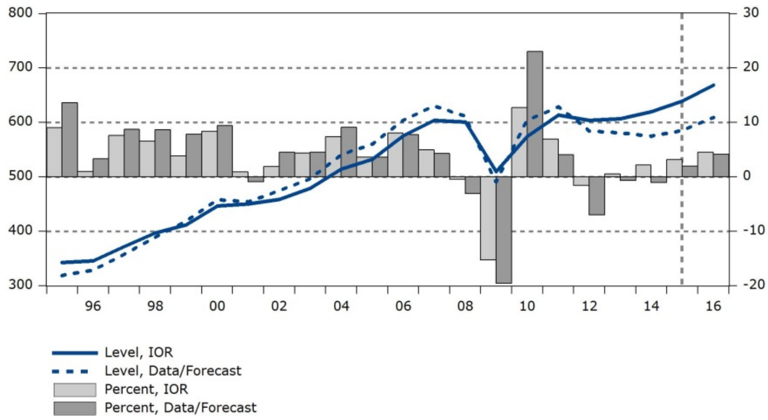


Note that the forecast is from August 2015.

Sources: Statistics Sweden and NIER.

Figure 7 Value added, Manufacturing Industry

Billion SEK constant prices, percentage change (right)

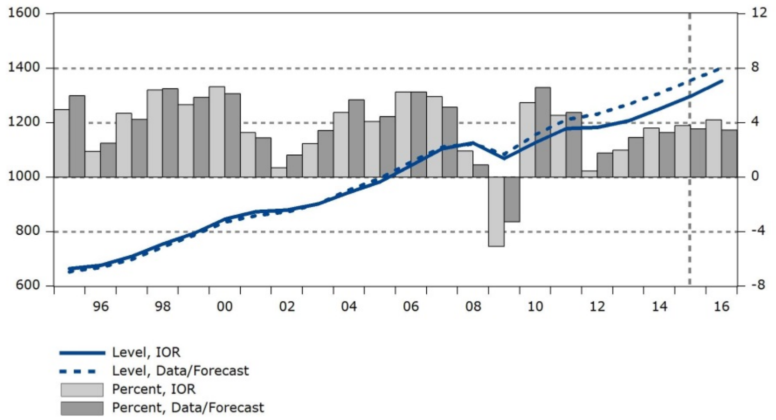


Note that the forecast is from August 2015.

Sources: Statistics Sweden and NIER.

Figure 8 Value added, Service Sector excl. Finance and Real Estate

Billion SEK constant prices, percentage change (right)



Note that the forecast is from August 2015.

Sources: Statistics Sweden and NIER.

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