The empirical foundation of RIO and MRIO analyses

Some critical reflections

Contents

Introduction

It is one of the characteristics of input-output (IO) analysis that more emphasis is put on the empirical basis than in other fields of empirical economics.

Wassily LEONTIEF defined input-output analysis “as a general methodological approach designed to reduce the steadily widening gap between **factual observations** (emphasis added) and deductive theoretical reasoning” (LEONTIEF 1989).

“Input-output analysis is based exclusively on magnitudes that are **directly observable** (emphasis added) and that can be measured using the ordinary instruments for measurement in economics” (KURZ, SALVADORI 2006).

Introduction

Such a view neglects the fact that most IO analysis is based on input-output tables (IOT) fully integrated in national accounts.

In the long sequence of steps which lead from the basic observation via economic statistics to the IOT, observations are combined with data taken from the box labelled ‘model results’, as termed by Richard STONE (1986).

Even the best national IOT is not exclusively based on factual observations.

The model content of regional IOT (RIOT) and multiregional IOT (MRIOT) is considerably higher than the one of any national IOT.

Models to generate statistical data

Models of Type 1 Condensation of information

Classification and aggregation are inevitable stages in arriving at statistical results.

Each of these steps has a theoretical background and is value laden; none of them is neutral with respect to the final use of the aggregates.

If the processes are well documented, the implications of applying models of this type are quite clear to users.

It is not possible to discriminate between various conceptual alternatives on the basis of empirical tests.

Models to generate statistical data

Models of Type 2 Substitution of information – Generating data elements which are observable

Models of this type substitute observations by model results although the target variable could - at least in principle – be observed.

Models of this type are based on a functional relationship, in which both the dependent variable and the explanatory variables are observable.

Therefore it is - at least under certain circumstances - possible to test the underlying functional relationship empirically.

Models to generate statistical data

Models of Type 2 Substitution of information – Generating data elements which are observable

Typical examples are:

- Imputations.
- Sampling instead of collecting data from all units.
- All kinds of model estimates, so frequently used in the compilation of national accounts data, such as
  - o Use of information on purchases instead of information on inputs by products.
  - o Use of information of closely related variables.
- Balancing, reconciliation; starting from available but not consistent observations (or model results) with the aim to achieve a consistent solution.

Models to generate statistical data

Models of Type 3 **Generation of elements which are not observable**

In models of this type data elements which are not observable at all are substituted by observed variables.

Models of this type rely on functional relationships, in which the explanatory variables are observable but the dependent variable is not.

Therefore it is not possible to test the underlying functional relationship empirically.

The decision in favour of one of a number of alternatives has to be taken on the basis of a priori considerations.

Models to generate statistical data

Models of Type 3 **Generation of elements which are not observable**

Generating data outside the domain

Models of this type try to generate data outside the domain in which these variables are observable.

The treatment of rents in national accounts is an illustrative example. Rents paid are of course observable, but the imputed rents for owner occupied houses and apartments have no counterpart in the world of observable transactions.

Models to generate statistical data

Models of Type 3 **Generation of elements which are not observable**

Relabeling information

The definition of output of non-market producers as the sum of inputs is a well-known example for a model of this type.

Models to generate statistical data

Most aggregates in national accounts (and IOT) consist of layers of different nature. The size of these different layers is unknown to the user and - in most cases - even to the Statistical Office.

What is published is by no means homogeneous.

It is not aggregation over different layers of reliability. It is aggregation over elements which are of different cognitive character.

From a methodological perspective it is adding up elements that are not commensurate. Aggregation results in conglomeration.

The model content of national IOT

The SNA states that supply and use tables are data-oriented in nature whereas the (so-called) symmetric tables are always constructed from having made certain analytical assumptions.

In order to arrive at ‘statistical’ supply and use tables a number of modelling steps are unavoidable which alter the cognitive character of the results:

- Estimating data on the establishment level.
- Necessary steps from use tables at purchasers' prices to use tables at basic prices.
- Reconciliation procedures.

The model content of national IOT

Derivation of technology matrices

Supply and use tables at basic prices represent an intermediate stage between the basic statistics and the unknown, hidden pure industry- or product-specific input structures.

Almost all users are aware that the conversion to either industry by industry or product by product tables has to be based on technology assumptions.

Few users are aware that the assumptions are applied to data which results from a long chain of transformation processes. In many of these steps model assumptions have already gone into the data generating process.

The model content of regional IOT

A regional IOT (RIOT) based on extensive surveys has all the characteristics of a national IOT.

The model content will always be higher because of statistical units which are not homogenous with respect to the region. They have to be portioned, a process which always has to be based on hypotheses.

A RIOT faces also all the problems encountered in regional (national) accounts, the use of models of Type 3 becomes inevitable.

Although it is in principle possible to compile a RIOT in analogy to a national IOT, most RIOT are derived from national IOT by some regionalisation approach (non-survey method).

The model content of regional IOT

All non-survey methods are models of Type 2.

The key challenge is to determine which part of the use of a specific product in the region was produced within the same region and which part was imported.

The only hard facts given are lower and upper boundaries on the level of the totals of a product group:

> If a commodity-balance can be established the balance provides margins for the minimum of (regional) imports or exports.
>
> The maximum can be calculated by assuming that all regional production is exported and all regional use is dependent on regional imports.

The model content of regional IOT

The various approaches to estimate the regional imports such as the use of location coefficients, regional purchase coefficients, trading coefficients are based on rather strong assumptions.

If the basic data for calculating such coefficients are not readily available, the calculation has to rely on additional hypotheses such as assuming identical technologies and labour productivity on the regional and national level.

More refined approaches try to take cross-hauling into account, which requires to rely on assumptions such as that the product heterogeneity (one of the driving factors behind cross-hauling) is the same on the regional and the national level.

The model content of regional IOT

Other options to refine the approach are inter alia to take the size of the region into account.

What is usually neglected in the rich literature discussing the properties of the different non-survey approaches is that the outcome is extremely dependent on the level of disaggregation chosen.

The model content of subnational MRIOT

The model content of such tables is even higher than the one of RIOT. In almost all cases interregional trade data is lacking and has to be substituted by the results of models.

In addition to modelling the regional imports and exports the regional origin and the regional destination has to be estimated.

Most approaches rely on some versions of gravity models, with simple distances, road distances, transport costs etc. as explanatory variables.

The models may again be refined by taking cross-hauling into account.

The model content of global MRIOT

The model content of such inter-national tables is considerably lower than the one of subnational MRIOT.

Core building blocks are national IOT and bilateral trade data in remarkable product detail.

Nevertheless a number of complex model calculations are required for compiling a MRIOT, inter alia for

- harmonisation of different concepts of the national IOT,
- harmonisation of different aggregation levels,
- finding a common numeraire, conversion of different currencies,
- “imputations” for countries with no IOT,
- allocation of imports to users,
- balancing.

Consequences for analyses

The consequences of the characteristics of IO data for empirical economics are manifold.

A considerable part of the datasets is produced on the basis of assumed functional relationships, either on the basis of models of Type 2 or Type 3.

The datasets are conglomerates of elements of different cognitive nature.

IO analyses start from the assumption of perfect homogeneity of the underlying data. In the Leontief Inverse each element - to an unknown degree - is dependent on elements with a very different ‘model content’.

Consequences for analyses

Any available dataset is just one out of a big number of potential datasets.

As a consequence no result of an analysis on the basis of the available dataset should be interpreted as a point solution.

Any result of an analysis is just one out of a big (but unknown) number of competing results.

Consequences for analyses

Regional level

Most analyses on the basis of RIOT are devoted to assess the impact of special events, big investment projects etc. on the economy on the regional level.

Such exercises reflect to a considerable degree the assumptions which have gone into the estimation of the regional import shares.

They take the regional production structure into account; otherwise they add little empirical evidence.

The sensitivity of the results with respect to the underlying non-survey method is inter alia illustrated in studies like the one by FLEGG et al. (2016).

Consequences for analyses

Multiregional level

The aim of most analyses based on subnational MRIOT is to quantify the consequences (by industries and by regions) of events occurring in one of the regions.

If the off-diagonal elements in the subnational MRIOT are constructed by non-survey methods the patterns will mirror the assumptions used in the gravity models applied.

A number of different global MRIOT have been developed in the recent past. Although they are based on a similar stock of basic information they differ considerably.

Consequences for analyses

Multiregional level

As comparative studies such as the one by STEEN-OLSEN et al. (2016) indicate the differences in the results based on different global MRIOT are quite remarkable even on the macro-level.

As expected, they differ even more on the level of single countries and industries.

The study by WIEBE and LENZEN (2016) concentrated on a single model step, on the reconciliation of a given dataset.

Even the differences of key results due to different balancing methods are substantial.

Concluding remarks

National, regional and multiregional IO analysis is not based exclusively on magnitudes that are directly observable.

As a matter of fact, most regional and multiregional analyses have no strong roots in observable economic reality.

The studies are based to a considerable extent on **assumed** aspects of economic reality.

The key empirical input usually consists in regional data on output and employment by industry which is used to reweight non-regional information.

Concluding remarks

Non-survey methods are models of Type 2.

The assessment of the performance of non-survey methods on the basis of “official” tables is nevertheless tricky.

The benchmark tables will be based on more observations, but will also be constructed on the basis of many model assumptions, usually not known to the analyst.

Terms like *accuracy, error* and *bias* might be misleading in the context of assessing non-survey RIOT and MRIOT.

They get us to believe that we are dealing with measurement problems in observations.

Concluding remarks

More attention needs to be paid to the empirical basis

What is needed: A certain reorientation in the economic profession. In the academic world ‘data issues’ are not considered to be ‘fancy enough’.

“It is the preparation skill of the chef that catches the professional attention, not the quality of the raw material which was used to prepare the meal” (GRILICHES 1986).

"In too many instances sophisticated statistical analysis is performed on a data set whose exact meaning and validity are unknown to the author" (LEONTIEF 1971).

Concluding remarks

Close cooperation between the producers and users of data.

Producers have to offer detailed metadata making all the modelling assumptions which have gone into the data generating process transparent.

Users have to study the metadata carefully.

Otherwise they run into the danger of “modelling on the basis of modelling results” (HOLUB, TAPPEINER 1997).

A specific implication of ‘modelling on the basis of the results of models’ is that the model is unintentionally respecified.

Concluding remarks

In the case of regional analyses, we pretend that our research is based on information on the division of labour between regions by product groups and we interpret the results of our analyses in this way.

De facto we base our calculations on the relative shares of the various industries in the region and perhaps some additional information.

Economists should be aware that „the truth value of work based on inadequate data is not improved in some magic way by the fact that better data is not available“ (MAYER 1993).

Concluding remarks

Avoiding unrealistic expectations

Given all the limitations researches should not spread the illusion to policy maker that “everything goes”.

Any result of an analysis is just one out of a number of competing, but not available, results also because each of the underlying datasets is just one out of a number of datasets.

Sensitivity analyses – including the underlying datasets – can provide some insight into the size of the solutions space.

It is promising that a number of such sensitivity analyses for investigations based on global MRIOT were published recently.

Concluding remarks

Despite all limitations in the empirical foundation there is no tool that could replace analyses on the basis of RIOT and MRIOT to address questions of high political relevance.

If we want to offer decision makers more than numerical illustrations of possible impacts, dependencies and relationships, we have to take the empirical foundations of our analyses seriously.

Thank you for your attention

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