Experimental Constant Price Input-Output Supply-Use Balances: An approach to improving the quality of the national accounts

Nadim Ahmad
Office for National Statistics
e-mail: gdp@ons.gov.uk
National Statistics customer enquiry line: +44 (0)845 601 3034

Introduction

Constant Price Input-Output Supply and Use tables are increasingly receiving international recognition as the best way in which to balance the constant price national accounts and produce constant price GDP. A number of countries, including the Netherlands, Canada and Denmark, already balance their accounts in this way.

Since late 1996 the ONS has been investigating the feasibility of producing constant price input-output supply and use tables for the UK. This article begins by giving some background to the development of constant price supply-use tables in the UK, together with their benefits. Some conceptual issues on deflation are explained, followed by a description of the Office’s plans for integrating constant price supply-use tables into the National Accounts’ annual balancing process.

The article ends by describing how experimental constant price supply-use tables, produced earlier this year, for 1996 in 1995 prices, have quantified inconsistencies in the national accounts, between the Index of Production for manufacturing and current price input-output tables, together with our plans for resolving them.

Background

Input-Output balances at current prices are now a central part of the United Kingdom’s National Accounts. Since 1992 the input-output framework has been fully integrated within the National Accounts’ production process. Annual current price input-output supply-use tables are now the mechanism used to ensure consistency between the production, income and expenditure components of GDP. The result has been estimates of GDP, at current prices, that not only have greater internal coherence but also a higher quality.

Currently a different approach is used to derive estimates of constant price GDP. This compares the expenditure based estimate of GDP - derived by deflating the current price final demand and import aggregates that are implied by the current price supply-use tables - and the production based estimates that are produced as part of the quarterly national accounts production process. Balanced estimates of constant price GDP are the outcome of this balancing process.

We plan to improve the quarterly production based estimates of constant price value-added by developing an improved Index of Services. This development should also help to improve the quality of the annual services output data used in the current price input-output tables.

Our present process for balancing input-output years - that is those years that are balanced using the input-output framework - at constant prices, is not as conceptually rigorous as that used to balance current price GDP. Although our approach ensures consistency in estimates of constant price GDP measured by the expenditure and output approaches it does not, on its own, ensure that constant price estimates of lower level national accounts aggregates, and their associated deflators, implied or otherwise, are consistent. Equally, on its own, the present balancing system cannot ensure that constant price estimates of output say used in the Index of Production are consistent with the current price estimates used in the current price supply-use tables.

However, in practice, quarterly constant price estimates are used to inform the current price balances, and there are several relationships between deflators which have been built into the accounts over the years. For example we ensure that the deflators applied to imported industrial goods are the same at the time of import as when they go into capital formation or inventories. Similarly since 1993 we have ensured that goods produced for export are deflated in the same way as the export figures used in the trade statistics. These relationships ensure reasonable consistency of the building blocks but there is no overall comprehensive framework.
Benefits of Constant Price Input-Output Supply-Use Tables

Altogether, the benefits of compiling the national accounts using constant price supply-use tables include:

- A comprehensive framework within which constant price GDP is balanced.
- Coherent supply and demand estimates at the disaggregate level in constant prices.
- Coherent estimates of constant price and current price industry output.
- Coherent deflation of GDP and its components.
- A mechanism to feed back improvements into the current price supply-use balancing process via simultaneous balancing at current and constant prices.

In addition, constant price supply-use tables provide:

- Double deflated estimates (see section 'Double deflation') of value added by industry, with inputs being separately deflated from outputs.
- A framework to analyse industry production and cost functions, allowing the extension of productivity analysis beyond the more conventional assessment of labour productivity.
- A full description of how Supply-Demand economic relationships have evolved by measuring the real flow of goods and services between producers and consumers, showing the real contribution of each towards gross domestic product at constant prices.
- A framework which will facilitate the eventual production of chain-linked measures of GDP (as required by the 1995 European System of Accounts, ESA 95) and enable other constant price series (such as the Index of Production) to be annually benchmarked.

It must be recognised however that there are a number of difficulties in producing constant price supply-use tables, such as:

- Availability of data; and
- Potentially large variance in the double-deflated estimates of industries with small value-added to gross output ratios.

But development of price indices by ONS in recent years means that many of these difficulties are being overcome. ONS has recognised the benefits by developing a framework for the National Accounts within which constant price GDP is balanced using a supply-use framework.

The view that considerable benefits can be gained via the production of constant price supply-use tables is also recognised within the European System of Accounts 1995 which recommends them as the basis for estimating constant price aggregates and requires the UK to produce annual balances, for all but the most recent years, from 2002 onwards.

Double Deflation

Very simply, double-deflation is a method for calculating constant price value-added by industry that takes separate account of the differing price and volume movements of inputs and outputs in an industry's production process.

In current prices, total gross value added at basic prices by industry is defined as the sum of incomes accruing to land, labour and capital: the primary factors of production. In input-output terms, it is the sum of wages and salaries, gross trading profits and surpluses, rental income, consumption of fixed capital, and taxes, less subsidies, on production. Alternatively, industry value added can be calculated as the difference between industry total output and total intermediate consumption; where intermediate consumption is defined as expenditure on inputs used in the production process.

Because it is difficult, and for profits literally impossible, to sensibly deflate the income components of value added using price indices, the approach used is to take the difference between deflated industry output and deflated intermediate consumption. This is analogous to the current price method described above and is known as double deflation.

Of course the Index of Production, which as its name suggests covers the production side of the economy only, is already used to provide estimates of constant price output by industry, and is currently the nearest measure we have to constant price value-added by industry for the production sector but these estimates of value-added are based on the assumption that net-to-gross ratios do not change; in other words that constant price value-added grows at the same rate as constant price (gross) output. Any actual divergence from these ratios, between re-basing periods, will result in estimates of value-added, at the industry level, which will not be consistent with corresponding estimates derived via current price supply-use balances. Double deflated estimates of value-added can overcome this.
**The Accounting Framework**

The balancing and structure of the United Kingdom's current price input-output tables are described in detail in *Input-Output Tables: a Methodological Guide*. The contents of this section are confined to briefly describing the basic methods by which the balanced current price system together with price information are transformed into a constant price system.

The process of producing input-output supply-use tables at constant prices can be split into four main stages: (1) production of current price input-output supply-use balances; (2) deflation; (3) balancing; and (4) feedback to current price input-output.

The deflation and balancing processes can be thought of as the application of models involving consistency and logic. The consistency, related to the deflation process, is that price indices must refer to the same value concept as the figures that they are to deflate. The logic, used in the balancing process, is that total supply must equal total demand and that total inputs equal total outputs.

The important aspect of the constant price input-output framework is that, wherever possible, independent estimates of supply and demand are derived. This is important because creating balanced constant price tables could be a trivial and uninformative task. For example, final demand aggregates and industry output figures at constant prices are already produced in the UK. Getting from there to constant price supply-use balances could be easily achieved if intermediate consumption were to be used as a balancing item - (as is the practice in some countries). But whether this would be meaningful is another question. Allowing intermediate consumption, or indeed any other aggregate, to be pre-determined as a balancing item does not allow the balancing process to improve the quality of the supply, intermediate consumption, or final demand figures.

However it is not always possible to use separate deflators for supply and demand, so, for some products and industries, accounting identities that determine either constant price supply or demand as being equal to either constant price demand or supply are needed. For example the gross outputs of the electricity and gas industries are better-determined using demand-side estimates. This is done because, although estimates of volume for both of these industries are available - say total kilowatts produced by the electricity industry - these estimates do not reflect the fact that different customers pay different prices for, ostensibly, the same product. This does not however mean that, in the balancing process, these products are not subject to as much scrutiny as other products. Any implied deflator that arises from enforced balancing still needs to be thoroughly investigated.

**Balancing**

**Background to the Present Balancing Process**

It is instructive first to review how constant and current price tables are presently compiled in the UK's National Accounts for input-output years, and the primary purposes of constant price supply-use tables and the IOP:

- Current price supply-use tables use data on production, income, and expenditure to arrive at the best level of current price GDP, and estimates of gross value added by industry consistent with this level.

- Short-term quarterly estimates of GDP also use estimates of income, output and expenditure. However, the respective quality of the data sources at this stage means that more weight is generally given to output than either expenditure or income in arriving at a balanced estimate of GDP growth. The most recent input-output balances are generally produced eighteen months after the data period to which they refer, and so the quality of income and expenditure data is more robust than at the quarterly stage and consequently carries greater weight in the balancing process. How much weight depends largely on the quality of the three distinct data sources of GDP in any particular year. Some years the three measures may be given nearly equal weight but in others GDP levels might be determined by giving greatest weight to, say, expenditure data, with estimates of gross value-added by industry adjusted to agree with this GDP estimate.

- Once a current price balance has been set, constant price GDP levels are set by deflating the final demand and import categories that come out of the current price balancing process, and total constant price gross value-added is calculated by deducting taxes and subsidies on production and products.

- Estimates of constant price gross value-added for the Production industries are largely unaffected by the current price balancing process. However, the residual of constant price value-added - based on the final demand levels set above - and the constant price value-added of the production sector, based on the IOP. In practice this balancing rarely leads to significant change to the non-production estimates.

- The IOP's main purpose is to provide the best estimates of constant price value-added growth by industry grouping - using information largely from the Monthly Production Inquiry.
Balancing with Constant Price Input-Output

Reasons for Imbalances

The overall deflation process in a supply-use framework is unlikely to result in balanced constant price supply-use tables in the first instance, since most of the deflators used in constant price input-output tables are derived independently of each other. The aim of the balancing process is to ensure that total supply equals total demand and that total gross outputs are equal to total gross inputs. With the process focussing on quality considerations and industry-product historic relationships.

The quality considerations can be numerous, but in the main they boil down to two: the quality of the current price data and the quality and relevance of the deflators. Because of some of the assumptions needed in order to deflate, and because the current price data is usually subject to a greater degree of scrutiny, the emphasis on quality assessment is usually placed on the appropriateness of price indices.

How are Imbalances Resolved?

One of the main properties of input-output supply-use balances is that they depict the industry-product relationships between goods and services, and the industries and consumers that produce or use them. It is these relationships that can be used to identify possible explanations for imbalances in the accounts.

The main focus of analysis is carried out by looking at the behaviour of input-output ratios and by comparing double deflated estimates of value added with single indicator methods - that is by deflating current price value added directly, albeit using rather less specific deflators for profits. For example in the manufacturing sector one would expect to see a fair degree of stability in the goods to gross output ratios of individual industries. Where there appears to be higher than expected movements in these, or other diagnostic ratios, the data for the industry, inputs and outputs, both in current and constant prices, can be re-examined. The outcome may be that changes in ratios have occurred for genuine reasons. For example, the electricity generating industry switching from coal to gas as a generating fuel; as has increasingly been the case in the UK since the early 1990s. On the other hand the outcome may be that a balance can only be achieved if current price data or deflators are adjusted.

Further checks on the output figures can be made by comparing the constant price supply-use output figures against those produced as part of the Quarterly National Accounts process.

Other checks are related to the appropriateness of the price indices used for deflation. Corrective action may involve an expansion of the product classification used in the current price supply-use tables allowing for the use of more specific price indices.

It is important to recognise that because industries and final demand are inter-related, any adjustment made on account of one industry, could result in changes to other industries or final demand. Indeed final demand aggregates, imports, taxes and margins, should be subject to as much scrutiny as estimates of industry activity. These figures can be checked for plausibility using broad rules-of-thumb. For example one might expect the growth in expenditure by consumers on any specific product to be related to its price change relative to the headline RPI. Or put more simply, if the price of say potatoes rose relative to the price of rice, one might expect consumption of rice to rise relative to that of potatoes.

Particular care needs to be taken with those industries that have small value-added to gross output ratios. This is because small errors in total intermediate consumption and gross output can have disproportionate effects on the value-added estimates of these industries. In other words the smaller the net-to-gross ratio the higher the relative variance on value-added induced by double deflation. For example, if errors of about one per cent were made in calculating the intermediate consumption and gross output of a hypothetical industry, with respective values for both of 99 and 100, double deflated estimates of value added could give anything between 3 and -1, when of course it should be 1. In these circumstances it may be necessary to fix the value added of the industry in question using single indicator methods or base year value added to gross output ratios.

Integration Plans for Constant Price Input-Output

The aim is to compile constant price supply-use tables at the same time as current price tables. This will allow the overall balancing process to exploit the feedback synergies between the current, constant, annual and quarterly data sources with a consistent approach to deflation across the accounts.

The next step in our plans to meet this aim is to publish a further Economic Trends article, with more detail on the data sources that underpin constant price balances together with a set of illustrative constant price supply-use balances for 1997 in 1995 prices, towards the end of this year. Coming after Blue Book 1999 these balances will of course reflect the current price balances in Blue Book 1999, but they will not have had a significant influence on them.
For Blue Book 2000 our plans are that constant price input-output tables will be able to inform the annual balancing process. We describe this process as balancing in a ‘quasi-simultaneous’ environment; which largely reflects the fact that constant price tables will be new to the Blue Book process and will need some proving before they are allowed to have their full impact on the annual balancing process.

We aim to have completed this proving exercise by the time Blue Book 2001 arrives, at which stage current and constant price balances will be produced concurrently and will have a major role to play in the balancing process.

For the longer term we are considering benchmarking the IOP, and the indices of non-production gross value added, such as the planned Index of Services, to the latest set of constant price supply-use balances: alleviating some of the short-comings of net-to-gross ratio drift, and differences in estimates of gross output.

What have experimental balances told us?

As can be inferred from the above, the difficulty with our present balancing process is that, although constant and current price estimates of GDP and final demand have an in-built consistency, estimates of current and constant price value-added and output by industry do not.

In the absence of constant price input-output our approach has been to recognise the existence of inconsistencies whilst at the same time recognising, because of their focus, that current price input-output tables provide the best estimates of the distribution of value-added by industry and the IOP provides the best estimates of constant price growth.

Constant price input-output tables allow these inconsistencies to be quantified and corrected: which is one of the many reasons that we began to develop them. Importantly they introduce a mechanism that allows the monthly production inquiries and the quarterly turnover inquiries, used to produce estimates of quarterly constant price output and value-added by industry, to inform the annual balancing process. This mechanism will be strengthened further by the data improvements resulting from the planned Index of Services.

Earlier this year, experimental constant price supply-use tables for 1996 in 1995 prices were produced. These balances confirmed, and quantified, the existence of inconsistencies between the Office’s estimates of current and constant price value-added and output by industry. These inconsistencies are larger in the Blue Book 1998 data set than they have been in previous Blue Books.

Where is the inconsistency?

The inconsistency is between estimates of growth rates for output by industry, implied by the IOP for manufacturing, and the equivalent growth rates implied by deflating current price input-output balances. This feeds through into estimates of value-added by industry, but because of movements in net-to-gross ratios the size of the inconsistency is smaller in 1996.

The cause of the discrepancy largely reflects differences in estimates of current price industry output given in the Annual Business Inquiry (ABI – previously ACOP) – for current price input output – and the Monthly Production Inquiry (MPI) – for the IOP. Other things being equal, because of the way in which GDP is balanced, estimates of value-added for non-production industries are affected by an equal and opposite amount.

Although no estimates of current price output used in the Index of Production are produced, users can infer the consequential inconsistencies on value-added by comparing Tables 2.3 and 2.4 in last year’s Blue Book. Although deductions are difficult to make because, as explained earlier, value-added by industry can only sensibly be deflated via double deflation.

How big is the inconsistency?

Because of the way constant price GDP is calculated, all estimates of value-added for all industries are affected, but the inconsistency is driven by differences between estimates of manufacturing output used in the IOP and the equivalent estimates used in current price input-output. Because of the input-output balancing process, which uses estimates of expenditure and income, estimates of constant and current price GDP totals are more robust than the estimates of value-added by industry.

It is difficult to be too precise about the effect on GDP because the impact depends on the extent that estimates of industry value-added and output have been used to inform the current price balancing process. What we do know is that the overall impact is not likely to be significant, as total GDP is largely determined by final demand and trade aggregates, and because manufacturing makes up just over 20 per cent of total value-added.

The table and chart below compare the growth rates of the current price data that underpin the IOP for manufacturing (IOP(M)) and current price input-output (CPIO) in Blue Book 1998.
Comparison of Current Price Total (Gross) Output

<table>
<thead>
<tr>
<th>Differences</th>
<th>IOP (M) (CP)</th>
<th>CPI O BB98</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990</td>
<td>4.9</td>
<td>4.1</td>
</tr>
<tr>
<td>1991</td>
<td>-2.2</td>
<td>-2.2</td>
</tr>
<tr>
<td>1992</td>
<td>2.6</td>
<td>2.5</td>
</tr>
<tr>
<td>1993</td>
<td>5.8</td>
<td>6.2</td>
</tr>
<tr>
<td>1994</td>
<td>8.5</td>
<td>9.3</td>
</tr>
<tr>
<td>1995</td>
<td>5.9</td>
<td>7.6</td>
</tr>
<tr>
<td>1996</td>
<td>3.1</td>
<td>4.9</td>
</tr>
</tbody>
</table>

For the IOP, discontinuities are overcome by linking forward best estimates of growth rates. For the ABI the best estimate of level is produced each year. This may lead to discontinuities between concurrent ABIs but the current price input-output balancing process can correct these.

What is the cause of the inconsistency?

At this stage our investigations are not yet complete. We have investigated a number of areas that could have led to the discrepancy and these are briefly described below. Our investigations are continuing. This work is being presented now because the action we have taken to address the discrepancy impacts on this year’s Blue Book.

The fact that the discrepancy was most noticeable in the data for 1994-95 onwards suggested that, amongst other areas, the introduction of surveys based on the Inter-Departmental Business Register results, which were the basis of the data set used in Blue Book 1998 for the first time, needed to be investigated.

The IDBR was introduced in 1995 to replace the separate registers used for the output and employment inquiries. These had been generating for many years different levels of employment for manufacturing industries (where comparisons could be made). The differences between these sources, both in industrial classification and employment, were largely resolved by 1996. The move to the IDBR, however, required reconciliation of the different estimates and this process resulted in an increased variability during the period of transition. As a consequence the ABI estimates of industry output for manufacturing - grossed using IDBR employment estimates - currently published for 1994-96 are subject to a wider margin of error than is usual. The IOP and the ABI for services have not been similarly affected because of the use of alternative estimation procedures.

We have also investigated a number of other methodological areas that could be potential causes of discrepancy, including treatment of discontinuities, ratio estimation, sampling errors and grossing, but these investigations have not yet uncovered any systematic bias.

Another area of investigation has been company returns, where we have discovered some appreciable differences between the MPI and ABI. We are still investigating whether this has contributed to a bias in either of the inquiries.

Equally we have also compared both sets of data with a number of other data sources, including: CBI output data; productivity data; and total turnover from the VAT and Business register.

The above show that inconsistencies between the two measures have existed over time but that these were appreciably larger in 1995, 1996 and to a lesser extent 1994. Indeed inconsistencies at the SIC 2 and 4 digit industry level of detail over time are generally larger. This largely reflects the fact that the purpose of the IOP is to produce best estimates of short-term growth, whereas input-output provides best estimates of annual levels; consequently different approaches are used for say the treatment of discontinuities in the series.

Not shown in the above is a comparison for 1997, as input-output tables for 1997 were not available at the time of last year’s Blue Book. However, we have been able to compare the annual and monthly inquiries for 1997 and these point to a continuation of the discrepancy into 1997.
What are the conclusions?

- The period 1994-1996 saw the development and the introduction of the IDBR involving the reconciliation of company data and classification from the separate PAYE and VAT databases. It is acknowledged that this at first led to greater variability in register quality and, as a consequence, the current price input-output numbers for this period are subject to wider margins of error than is usual.

- Some company returns for the MPI and ABI are appreciably different. We are still investigating what contribution this source of difference is likely to have made.

- Methodological differences between the ABI and the MPI do not appear to have made an appreciable difference to the discrepancy in manufacturing.

- The inconsistencies affect the distribution of value-added at the industry level. Correcting the discrepancy is not likely to result in revisions to GDP and total value-added that are greater than normal Blue Book revisions.

- There may be other factors and we are continuing to investigate the MPI and the ABI, and consequently the IOP and CPIO estimates of growth in manufacturing.

- As a result of the discrepancy we have decided to introduce footnotes, explaining the discrepancy and referring to this article, to the tables and figures in this year’s Blue Book directly affected by the discrepancy.

How do we plan to put the inconsistency right?

Our investigations are continuing and at this stage we are not in a position to provide a consistent estimate of manufacturing growth for the affected period. This means that we will not be making changes to the 1996 input-output tables this year and so the 1997 input-output tables will point to a continuation of the discrepancy. We have however managed to reconcile the 1997 annual and monthly enquiry growth rates, and this has led to an upward revision to IOP growth in 1997 of around 0.25 per cent, which will be reflected in next month’s Blue Book. This should be regarded as our best estimate of manufacturing growth, consistent with the annual and monthly inquiries.

Most of the change needed to close the 1997 discrepancy has been identified in the annual inquiry data, and so, in the input-output balances. Early indications are that this will also be the case for earlier years. Next year’s input-output tables will be revised to reflect the position set out by consistent annual and monthly enquiries; and as a consequence be consistent with the IOP.

Equally, although annual inquiry data are not yet available for 1998, we have taken this opportunity to review our estimates of the IOP in 1998, in the light of the changes made in 1997 and this has also led to an upward revision to IOP growth of around 0.25 per cent in 1998. We do not expect any further changes to the 1997 IOP as a result of reconciling the annual and monthly inquiries. However conceptually driven (double-deflated) changes, reflecting eventual constant price input-output benchmarking, may be made in the longer-term; although these are not expected to be significant.

We will continue our investigations and aim to publish an improved data set as soon as possible. A further Economic Trends article with more detailed timetable plans is planned for the Autumn. Our plans for next year’s Blue Book are to fully correct the discrepancy, at the same time as taking on board other substantive changes; as set out in the accompanying Economic Trends article. These changes will reflect a different distribution of value-added by industry, but they are not likely to lead to significant revisions to GDP.

We will not be publishing the annual current price input-output supply-use publication for earlier years, but copies of the 1997 balances will be available.

For a description of other Blue Book issues, users are referred to the accompanying Economic Trends article ‘ONS plans for the 1999 and 2000 Blue and Pink Books’ (pages 25-28).

Final Conclusion

It is clear that constant price input-output supply-use balancing has an important role to play in improving the quality and coherence of the National Accounts. The introductory work on experimental balances has already demonstrated this. The next step for the ONS is to continue with its long-term system of improvements - that includes developments such as chain-linking and the Index of Services - and with its strategy for the full integration of constant price input-output into the National Accounts compilation process.

Notes

1 With the exception of the electricity industry, the net to gross ratio for any industry is equivalent to the ratio of value-added to total output for that industry.

The goods-to-gross output ratio is similar in concept to the more familiar net-to-gross ratio although it is not as well defined. Goods-to-gross output ratios are loosely defined as the ratio of the sum of core inputs to gross output for any particular industry. For example the goods to gross output ratio for the sugar industry (input-output group 15) can be defined as the ratio of the sum of intermediate expenditure on agricultural products (input-output group 1) and sugar products (input-output group 15) to the gross output of the sugar industry; although some caution is needed in the ratio's interpretation. For example the goods-to-gross output ratio as defined above may differ from previous years if intra-industry sales of sugar change. The same caution is also needed when interpreting net-to-gross ratios.