

A family of price indices: the different traditions, the strategic approaches & the work to be done

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Abstract

The definition, coverage and construction of a price index should depend on its use but in practice a price index often has multiple uses.

The original purpose of the index usually determines which particular agents the index covers, which range of goods and services are covered and the way in which prices are measured and the index constructed. As different index construction can lead to different numerical results, the inappropriate use of an index can undermine the deployment of the index.

A good example of this is a consumer price index that is used as an inflation target, a measure of price stability, a compensation index and a deflator. The problem extends beyond the direct measurement of inflation. Key economic concepts such as productivity and welfare are residuals derived by subtracting a series from a first deflated number. Inappropriate use of price indices will render such measures meaningless.

The consequences can be significant for economic analysis and the management of the economy as well as for the well being of the citizen.

This paper reviews the systems of price indices and the supporting frameworks which facilitate the process of identifying and defining in statistical terms user needs.

Different price indices are linked in the sense that they all relate to one economy and many analysts have therefore attempted to improve measures and/or forecasts of prices by comparing them in some overarching framework. There are two traditions.

- National Accountants have brought together deflators and compiled constant price supply and use balances.
- Price statisticians and economists have developed “stage of processing” analyses to explain consumer price changes as a function of supply prices.

This paper advocates a systematic approach to the strategic development and production of price indices through the extension of the framework of current and constant supply and use balances into social accounting matrices specifically designed to facilitate direct comparison of price indices. The paper also reviews the systems of price indices and existing supporting frameworks; shows how they might be subsumed within a SAM framework, and describes how such a framework would facilitate the coordination of the price statistician’s existing tasks rather than just generating extra work

Although the focus of the paper is the measurement of inflation, it takes the opportunity to argue amongst other things that only by taking the above approach, will the current issues relating to the inappropriate use of price indices as deflators be resolved.

Finally it considers the need for broader measures of inflation that extend beyond retail prices.

Keywords: International Standards; Conceptual Frameworks; Practical constraints; Consumer Price Indices; Laspeyres; Cost-of Living Indices; Social Accounting Matrices; Stage of Processing Framework; Stage of Production Framework; deflators; final expenditure price index

1. Introduction

The challenge of statistical offices is fourfold: to identify user needs; to conceptualise user needs in terms of economic theory; to translate the underlying concept into statistical measurement terms following the fundamental principles of price index measurement; to construct the indices so defined and evaluate them against purpose.

The compiler is faced with resolving the issues which arise, including the conflicts in meeting different demands and in being forced to make practical compromises.

It should be noted that meeting the challenges in a systematic way is a complex multi-dimensional process involving a sequence of inter-related activities. The approach described here differentiates between.

- Underlying conceptual frameworks used to define different methods of index compilation, in follow up to the identification of different user needs.
- Higher-level frameworks designed to identify gaps in the provision of price indices which can then be compared with user needs.

Both assist in the understanding of the relationships between different indices and also help to facilitate coherence and statistical integration. They complement one another and together provide a systematic approach to the delivery of a coherent family of price indices and in consequence improved national accounts via better and more relevant deflators

Price indices and deflators are different entities within a wider family of statistics relating to prices. It is pertinent to note against this background that the most recent and widely available guidance on deflators, the Eurostat Handbook on Price and Volume Measures in National Accounts¹, and SNA93, pre-date the UN Manuals on Consumer Price Indices and Producer Price Indices².

¹ Handbook on Price and Volume measures in the National Accounts. Luxembourg: Office for Official Publications of the European Communities, 2001.

² ILO/IMF/OECD/UNECE/Eurostat/The World Bank: Consumer price index manual: Theory and practice Geneva, International Labour Office, 2004 and ILO/IMF/OECD/UNECE/Eurostat/The World Bank: Producer price index manual Washington, International Monetary Fund, 2004.

The significance of this fact is that the two manuals, which were developed in parallel, take advantage of the latest research into index number theory and practice and are essentially based on the same underlying economic and statistical theory. They represent a significant step forward in the theory and construction of price indices which is not fully reflected in the official literature on national accounts. The two manuals provide a comprehensive and coherent overview of the latest thinking on the conceptual and theoretical issues associated with consumer and producer price indices and translate these into the available options for practical measurement³. The Manual on Consumer Price Indices also acted as a catalyst for the new ILO Resolution on Consumer Prices Indices, which was passed in 2003⁴.

This paper attempts to stimulate a broader-based debate on index and deflator construction which to a large extent has so far been relatively limited⁵.

2. Existing High level Frameworks for Price Indices

Price statisticians have developed “stage of processing” and other similar frameworks to provide a strategic overview.

Stage of Processing and Production frameworks - the price statistician’s and economist’s approaches

Many analysts have sought to “explain” consumer prices as the result of a chain or ‘pipeline’ conveying goods and services towards the consumer. While such analyses have undoubtedly proved useful it is actually quite difficult to anchor them in economic theory. In particular many of the analyses include lags and seem to envisage sellers setting prices as a mark-up on their actual costs⁶. However rational sellers would set their prices using expected replacement costs. It makes no sense to sell an item that costs twenty pound to replace for ten pounds even if you originally bought it at two and hoped to sell it for three. And expectations cannot be captured in a simple statistical framework

Stage of Processing Framework

US statistician Joel Popkin argues that the BLS’ “Stage of Processing” framework has a useful role to play in informing policy formation as it can provide the basis for systematically analysing the build-up of inflationary pressures in the economy and for

³ Practical measurement is constrained in large part by the lack of up-to-date and relevant data

⁴ Resolution concerning consumer price indices, adopted by the Seventeenth International Conference of Labour Statisticians, 2003.

⁵ The imbalance is not new. Samuelson and Swamy, “Invariant Index Numbers” American Economic Review 1974 say “Although most attention in the literature is devoted to price indexes...Once somehow estimated, price indexes are in fact used, if at all, primarily to deflate nominal or monetary totals in order to arrive at estimates of underlying “real” magnitudes.

⁶ For retailers, the price of an item will have to cover the cost of buying the goods from the producer, paying staff their wages and paying for other services required such as delivery, rents and electricity. A similar breakdown applies to producers. This will include the cost of materials and components that they purchase from other firms.” – Source Bank of England Website

tracking relationships between price developments in particular sectors⁷. From a compiler's point of view it also provides a useful tool for identifying gaps in available price index series and a focal point for investigating coherence in index construction.

The framework divides the entire economic process into distinct stages.

- **Rest of the world**
- **Production:** split into broad categories such as agriculture and manufacturing (and further sub-divided into primary, intermediate and final production)
- **Final demand:** separated into private final consumption, government consumption, capital purchases and exports.

The main series of price indices are then grouped according to coverage. For the UK this is as follows.

- **Consumers expenditure** (the Retail Prices Index [RPI], Consumer Prices Index [CPI] (Harmonised Index of Consumer Prices [HICP]) and the Index of Consumer Prices [ICP] component of the previously published Final Expenditure Prices Index [FEPI]⁸)
- **Other elements of Final Demand** (the Index of Government Prices [IGP] and Index of Investment Prices [IIP], components of the FEPI)
- **Inputs into and outputs from the manufacturing sector** (the Producer Prices Index [PPI])
- **Trade price indices**

The results are shown at Annex 1.

The PPIs and the trade price indices each cover a particular segment of economic activity. The PPIs are stand-alone, industry-based net sector indices⁹ relating to materials used in production and articles produced, while the trade price indices relate to imported and exported goods. PPIs are also published on a gross basis. The net sector basis means that transactions between establishments classified to the same industry sector are out-of-scope¹⁰.

In theory for all significant transfers of goods and services from one part of the economy to another, there should be a representative price index (based on directly-

⁷ It has been argued that there is a tension between Stage of Processing, which is essentially driven by economists' needs, and National accountant's Supply and Use frameworks, which are essentially driven by measurement needs. This can be resolved by the flexibility and generic approach provided by Social Accounting Matrices (SAMs). See also footnote 13.

⁸ Published in the UK as an experimental index but subsequently discontinued due to difficulties in obtaining adequate estimates of the prices of Government services.

⁹ The principal advantage of the BLS net sector approach is that it avoids the distorting effects that result from multiple counting of transaction prices as commodities flow through different production processes, as would occur under a "gross sector" approach. However, while conceptually valid these net sector measures are incomplete in terms of coverage of the targeted sectors of the economy because they exclude many intra-sector transactions. Note that BLS net sector indices are conceptually different from ONS Net indices which cover manufacturing as a whole.

¹⁰ For example, sales of sugar to the soft drinks industry are not included in the manufacturing net sector index for the output of the Food, Beverages and Tobacco Manufacturing Subdivision because establishments producing sugar are classified to the same industry as those producing soft drink.

measured prices) that reflects the changing level of prices for all such goods (or services)¹¹. The source of the goods/services is shown down the left side of the table; the destination is shown along the top of the table.

For instance, the prices charged by the manufacturing sector for consumer goods sold to the retail/wholesale sector are reflected in the PPIs (Producer Price Indices). The prices charged by the retail sector for consumer goods sold to private consumers are reflected in the RPI (and also by the ICP and the HICP).

Across the top of the table are the buyers, classified into two broad groups: intermediate demand and final demand. Most sectors of production are involved in both buying inputs and selling output - so they appear in the table both as buyers and as sellers.

The shaded cells represent significant transactions in the economy for which there are no relevant price indices. For instance, in the bottom right-hand corner the grey cell denotes the fact that services sold to rest of the world are significant - but that there is no published price index. Where published indices do exist, the name (or acronym) of the index is given. For instance, the sale of finished goods by retailers to private final consumption is measured by three different price indices - the RPI, the ICP (a component of the previously published FEPI¹²) and the HICP.

The treatment of other sectors is as follows.

- **Retail/Wholesale.** Retail and wholesale distribution is shown as a distinct component of the production process and each is shown separately under intermediate demand¹³.
- **Services.** This is presented as a single category but warrants a further breakdown in view of its increasing weight- for instance into financial services, healthcare, transportation, telecommunications, computer network services.

¹¹ In practice, in some cells transactions from seller to buyer will be insignificant and these are denoted by a dash. For instance, there are unlikely to be any imported consumer goods feeding into the construction sector as intermediate demand.

¹² The Final Expenditure Price Index (FEPI) was a wider measure of inflation which was published by ONS on an experimental series. It consisted of three components: consumers' expenditure; capital expenditure (investment); government expenditure. It was withdrawn because of problems with input data relating to Government and public sector productivity. These problems later lead to the setting up of the Centre for the Measurement of Government Activity.

¹³ The function of the retail sector is to buy from manufacturers and sell to private consumers. Although that part of the wholesale sector that supplies small retailers is in decline, the sector also covers import/export agents - hence the shaded cell from retail/wholesale (consumer goods and capital goods) to retail. Other transactions within this block of the table reflect recurrent purchases by industry from the retail/wholesale sector - e.g. stationary supplies. As noted above, the wholesale sector is perhaps not as significant now as it once was, because of the increasing dominance of major supermarket chains and high-street stores who buy direct from the manufacturer. Nevertheless the sector still accounts for about £50bn per annum, so a Wholesale Price Index would be a significant element in an analysis of inflation.

- **Rest of the World (RoW).** This appears as a supplier of goods but it does not appear within the intermediate stage activities as a consumer as it plays no part in economic activity within the UK. It does, however, appear under “Final Demand”, reflecting exports from the UK.
- **Other indices.** This consists of Agricultural Price Indices (published by DEFRA) and the Building Costs Indices and Construction Input and Output Price Indices (published by ODPM).

The practical advantages of such an approach can clearly be illustrated:

- The associated table of inflation rates can be used for analytical purposes and help inform economic policy.
- Aggregate price indices (and inflation rates) for each row and for each column may be computed to produce inflation rates for different sectors¹⁴.
- Possible enhancements to currently published indices can be identified¹⁵.
- Potentially more major gaps can be identified¹⁶.
- Issues relating to statistical integration and coherence can be identified. For example, issues relating to coherence in concepts and practical measurement arise when combining rows and columns.

The current value of the transfers for each cell would help identify the relative importance of the "gaps". An attempt was made in the UK to do this by referring to the supply-use balances at current prices. However, this had only limited success due to fundamental differences between the Stage of Processing framework and the aggregated combined use I/O matrix (see later section).¹⁷

¹⁴ For instance, an average for the first row (imports of raw materials and fuels) might be determined by combining together the different component price indices (i.e. the indices reflecting imports of raw materials into agriculture, manufacturing the wholesale trade and re-export). For imports, such indices would be constructed using gross weights because an import can only enter the economy once. Similarly, the row total for the production of consumer goods by the manufacturing sector would be determined by combining the price indices for those cells in the row which have significant inputs from this part of the production process. The cell covering output to the retail sector is likely to have the greatest contribution to the row total. Net weights might be more appropriate for determining the row average. Using the same approach, input price indices for each sector of the economy can be computed by calculating average price indices for each column.

¹⁵ For instance, in the UK an overall input price index for the agricultural sector already exists - though, as the table shows, it could be further enhanced by including the additional costs of business services and labour costs.

¹⁶ In the UK the most obvious gaps (not in order of importance) are: imports of services; imports of capital goods; imports of finished intermediate goods; imports of consumer goods; wholesale prices; exports of services; export prices charged by wholesalers (i.e. export agents); re-exports.

¹⁷ Fundamental differences between the Stage of Processing framework and the aggregated combined use I/O matrix are shown below. The second and third points can limit the usefulness and relevance of the I/O matrix for the analysis of inflation but may be considered particularly relevant for issues relating to the construction of deflators:

- The Stage of Processing framework assumes a breakdown of output from each sector of the economy into raw materials, semi-manufactured goods, finished intermediate goods, consumer goods and capital goods. The I/O table refers to the total value of products flowing from one sector of the economy to another as intermediate demand. In the UK it is currently

Furthermore, even if data were available to populate the framework a number of other issues, which could seriously limit the practical usefulness of such an approach, would need to be confronted, most particularly, the limitations of forecasting. The most compelling requirement of analysts is an early forecast of consumer price inflation. It is the final stage in the process - 'retailing' - that can have the most significant effect on the level of final inflation. But one of the biggest determining factors impacting on the latter is retailers' margins, which are determined by a number of imponderables (chiefly consumer demand and the "feel good factor").

Finally, and perhaps most problematic from an analytical viewpoint, the Stage of Processing Framework at Annex 1 is restricted to flow prices and ignores altogether asset prices and issues related to pricing a large stock of assets from transactions involving a few flows. These omissions can significantly undermine the value of the framework in solving conceptual and practical issues relating to understanding the analytical and economic relationship between asset prices and flows.

In summary within the limitations of the available data (which can be significant) such a framework can be used not just for analysis but also for assessing priorities for further work on price index development including filling gaps, strengthening existing indices or improving coherence and statistical integration. The case for further developing a framework is a strong one but a view needs to be taken on whether to develop an alternative framework based on Supply-Use tables (despite its limitations for this purpose – see later section) or to develop data sources which meet the requirements of a Stage of Processing framework. Also a number of other issues would need to be addressed in developing such a framework including the need for a facility to resolve the relationship between asset prices and flows.

Stage of Production Framework

The Australian Bureau of Statistics (ABS) have taken the above approach one stage further to a lower level of detail by applying a Stage of Production Framework to Producer Price Index development, in a strategic move to supersede industry-based indices, and as an aid to the analysis of inflation. The indices generated cover both

not possible to split these figures into raw materials, semi-manufactured goods and finished intermediate goods. To do so would require a significant increase in the range of data collected and a rise in compliance costs.

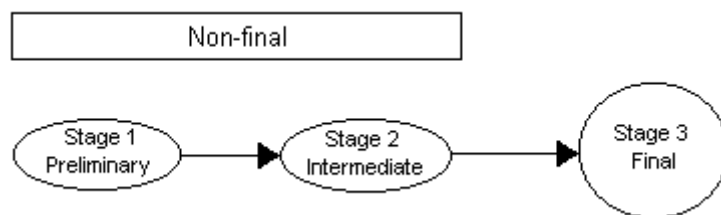
- The I/O matrix does not identify imports as a separate phase of economic activity. The I/O table simply identifies the total flow of products (inclusive of imports) to intermediate demand whilst in contrast the Stage of Processing framework lists the supply of goods and services from the Rest of the World to (a) Intermediate Demand and (b) Final Demand.
- The category "wholesale and retail trade" in the I/O table does not include retail and wholesale distribution margins - which are implicitly included within the figures (but are available separately if required). For example the SOP framework looks at the flow of products from manufacturing to retail as one stage in the economic cycle. Transfers from retail to private final consumption are then presented as a second stage. In the I/O table both stages are subsumed within the flow from "Manufacturing" to "Consumers Expenditure", reflecting the total value paid by consumers for manufactured products and therefore comprises (a) the manufacturing output value (including the value of imported consumer goods) (b) wholesale and retail distribution margins and (c) final taxes.

domestically produced and imported commodities, individually and in aggregate, and provide an alternative breakdown of existing ABS producer price indices. Basic prices form the basis of the price indices¹⁸.

Under the stage of production concept commodity flows are categorised sequentially according to their destination along the production chain following an input-output approach, the primary classification being between final and non-final commodities where:

- **Final commodities** are those destined for final consumption, capital formation or export.
- **Non-final commodities** are those that flow into inter-mediate consumption before further processing.

In practice and in order to assist analysis, as non-final commodities can flow into the production of both final and other non-final commodities, the non-final commodity flows can be further divided between preliminary commodities and intermediate commodities making three stages of production as illustrated below. Separate indices at each stage represent domestic production and imports and a further analysis of the final stage into capital goods, consumer goods and exports is possible. The three stages are not additive.



Under this model, “first stage intermediate goods” are used in the production of “second stage intermediate goods”. In turn “second stage intermediate goods” flow into the production of “final goods”. For each of the three stages, separate indices will be presented for domestic production and imports. The “final goods” will be further split into capital goods, consumer goods and exports.

The difference between this and the more traditional approach is illustrated below for Bauxite production.

In the first row below, bauxite production is classified as Stage 1 production because it is then used as input into the (Stage 2) production of alumina, which is then used as an input into the (Stage 3) production of aluminium. This is the final stage of production because the aluminium is then exported i.e. it passes to Final Demand.

¹⁸ The valuation basis of the “stage of production” price indices produced by ABS is at basic prices. The indices mainly based on a reclassification of prices collected under traditional producer and international trade price index collections from producers, importers and exporters.

In the second row the production of the bauxite is categorised as Stage 2 production because it then feeds into the Stage 3 production of alumina which itself is exported. In the third row the bauxite itself is exported, so this bauxite production is classified as Stage 3 production.

Further stages could be introduced. For instance, the aluminium in the example above could then have been used in the production of window frames - which in turn could then have been used in house construction- making five production stages. A judgement needs to be made about the point at which further stages add very little analytical value because of the relatively small production involved.

<u>Preliminary</u> <u>Stage 1</u>	<u>Intermediate</u> <u>Stage 2</u>	<u>Final</u> <u>Stage 3</u>	<u>Final</u> <u>Demand</u>
Bauxite	Alumina	Aluminium.	Export
	Bauxite	Alumina	Consumption
		Bauxite	Capital Formation

As with the Stage of Processing Framework, the Stage of Production Framework provides both a powerful analytical tool and a method of identifying data gaps and issues relating to statistical coherence and integration, but it is even more challenging because of the potential data requirements, which are due in large part to the more detailed level at which the analysis is undertaken. Such a detailed analysis also raises additional challenges, in particular.

- In the bauxite example, the classification of stages of production may seem rather arbitrary. For instance, the production of bauxite will be exactly the same whether the bauxite is eventually classified as Stage 1 or Stage 2 or Stage 3. Indeed, at the point of production the identity of the buyer (and therefore the destination of the bauxite) may well be unknown.
- Imports could also feed into Stages 1,2 or 3 (or straight to final demand)- once again depending on how many subsequent stages of production will follow before the product eventually passes to final demand. Also although imports can be a source of inflationary pressure it is unclear whether they should be included conceptually and certainly their inclusion potentially raises issues of coherence in inter-country comparisons. The same applies to exports. A further discussion takes place below in an international context.
- The inclusion of services, which should be covered but where data is often limited or of questionable quality. Similarly for construction prices¹⁹.
- The classification of flows is not unique. For example, whilst the ABS has adopted a transaction flow approach that assigns a commodity to a stage based on the proximity of its use in final demand there are alternatives. For instance some other countries with less open economies than Australia use **degree of fabrication** or **principal destination** approaches where commodities are allocated to only one stage. But this would be problematic in an Australian

¹⁹ ABS index coverage is currently limited to the output of the following ANZSIC classes: 4111 House construction; 4112 Residential building construction (not specified else-where); 4113 Non-residential building construction; 4121 Road and bridge construction. For reasons of data availability the House construction indexes are lagged one quarter.

context where, for instance, commodities such as wheat, wool, and iron ore are exported in large volumes as well as being further processed locally. The allocation of such commodities to a single stage would necessarily be arbitrary.

- The issue of timing. The bauxite involved in producing aluminium in time t is not the same as the bauxite being mined and imported at time t and may have a different price. A framework which shows current prices may be useful for analysing expectation but will not show the current values. Instinctively this is resolvable via the careful treatment of stocks and holding gains but this is left out of Popkin's framework.

Some of the practical limitations are shared in varying degrees with other price indices, including consumer price indices where practical solutions to the measurement of some services continue to evolve.

The relative analytical advantages of this further de-layering compared with the Stage of Processing Framework relates to the ability to split the value of commodity transactions across stages, and including imports and domestic production, thereby providing a stronger PPI-CPI linkage compared with the situation where the total value of a commodity is restricted to a single stage and where coverage is confined to domestic production only. The drawback associated with the latter was apparent when the UK Office for National Statistics attempted unsuccessfully to model the relationship between producer prices and retail prices based on an analysis of those sectors where the evidence indicated that domestic production dominated²⁰.

National Accounts deflators and Supply and Use Balances - the National Accountant's approach

Whilst the compilers of price indices have focused their work on stage of processing and stage of production frameworks, the National Accountants have focused work on constant price supply-use balances.

Both the SNA and the Eurostat handbook on National Accounts recommend the compilation of volume measures within a framework of supply and use balances for each product such as the one shown in Figure 1. Whilst some of elements of the framework can be filled by using projections from the base period, the vast majority are produced by deflating current values using price indices.

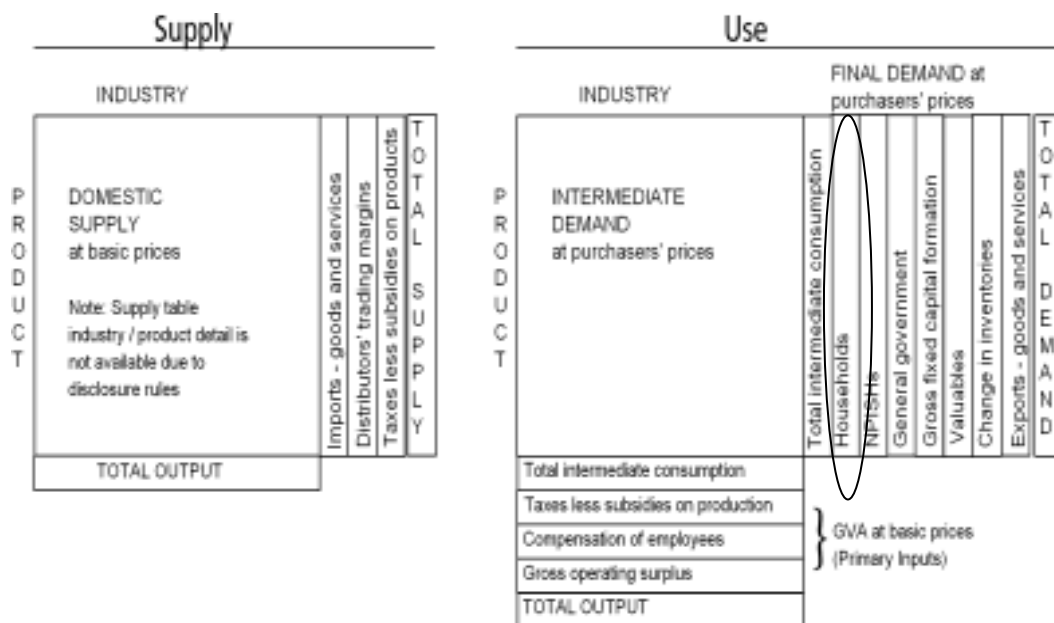
Clearly the deflator for any one element, household consumption, say, must be identically equal to the combined deflator for the other elements in the balance. As is well known however the deflators for the different elements in a row can differ due to 'mix' effects, and there is no identity between the base weighted price indices.

²⁰ This relates to unpublished work where the ONS attempted to model the relationship between producer and retail inflation in an effort to pick up early warning of future trends in retail prices. Other issues which confounded such an analysis included lack of detailed information on distribution costs and profit margins.

Despite the mix effects, Supply and Use balances contain identities at a deeper level. Like all national accounts they are double entry systems in which each transaction appears twice- once from the point of view of the seller and once from the buyer. Each item a household buys from a retailer will show up as a package of output or imports and retail services on the supply side and, equally, as household consumption on the Use Side. The price change for these transactions must be identical even if it is obscured by the lumping together of purchases from all different sources.

Populating a Supply and Use table can be difficult and the challenge that national accountants face in articulating their needs within this framework is accentuated by the fact that the literature on National Accounts deflation is relatively much less developed than that on consumer price indices.

Fig 1 Supply and Use Balances



The lack of progress in developing a methodology for deflators is illustrated by the limited attention given to constant price estimation in the System of National Accounts. Similarly, Eurostat's Handbook on Price and Volume Measures in National Accounts, whilst providing useful guidance on an industry by industry basis, goes no further in offering advice on a conceptual framework for deflators than recommending in general terms a Supply-Use approach. There is little generic guidance about when and where it is safe to use price indices to deflate a series they were not designed for.

The lack of guidance would not be a major concern if it wasn't for the fact that alternative approaches to constructing a price index can have a significant impact on the individual indices used for deflation and hence on GDP growth rates²¹. Thus the

²¹ For instance, in the UK national accounts the components of the Retail Prices Index (RPI) at a detailed level are used extensively in compiling constant price GDP, mainly to deflate much of household consumption expenditure, but also in the production approach to GDP, for instance to deflate those services which are mainly consumer services. In addition the all-items index is used where no suitable deflator is available, for instance in the deflation of value added by the UK Lottery.

recommendations of the System of National Accounts 1993 (SNA93) in respect of the measurement of volumes, insofar as they are prescriptive, have practical as well as theoretical implications for the use of CPIs as a family of deflators in the National Accounts. This extends beyond the provision of deflators for household expenditure. This is because the construction of price indices for deflators should allow for consistency and coherence across both production and expenditure approaches to GDP since the approaches are brought together to provide a single estimate of GDP volume. Thus the construction of price indices as deflators should allow for consistency and coherence across both approaches²². Producer Price Indices (PPIs) and Consumer Price Indices (CPIs) which are used as deflators need to be coherent and consistent in their construction with the system of national accounts.

Perhaps the most pertinent question relates to the choice between arithmetic and geometric means which is not academic. For instance, in the UK this can account for an average difference of 0.5 percentage points in the annual inflation rate between the main domestic measure of inflation, the RPI (which uses arithmetic means) and the CPI used for the inflation target for the Bank of England Monetary policy Committee (which uses a geometric mean).

Finally it can be noted that the SNA seems to make the assumption that *all* price observations are aggregated using *weights*.

“16.116 When there is price variation for the same quality of good or service, the price relatives used for index number calculation should be defined as the ratio of the weighted average price of that good or service in the two periods, the weights being the relative quantities sold at each price”.

This is the procedure adopted in the UK in constructing PPIs. However, in the construction of the UK CPI, as in common with other countries, there is a lower level of aggregation in which un-weighted price observations for a single item in a stratum are combined into elementary aggregates using some form of simple arithmetic or geometric mean. The index construction procedure- the type of average used- leads to an implicit assumption about weighting and substitution, namely arithmetic means represent an elasticity of substitution of zero and a geometric mean an elasticity of substitution of one. Thus, there is a conceptual issue to be resolved which has a numerical impact on the deflation of GDP.

This is just one example- the choice between an arithmetic mean and a geometric mean is not the only conceptual issue of relevance to the construction of deflators and the use of price indices. Other conceptual issues arise in connection with outlet substitution, quality change and discounts, and the treatment of housing.

²² SNA approach to deflation is:

- GDP is primarily a measure of value added.
- Changes in volume are not the same as changes in welfare
- As input-output provides the most complete framework for constant price calculations, it follows that deflation of other approaches to GDP should be consistent with the approach to deflating value-added.

3. Social Accounting Matrices for Prices

Social Accounting Matrices or SAMs are square sets of economic accounts in which each pair of rows and columns represents a single account. The entries in each cell show the payments made by the account at the top of the column to the account in the row. As the accounts are balanced the sum of entries for each row equals the sum for each corresponding column²³. SAMs have been built in many forms but are all essentially a matrix presentation of SNA accounts. They have been the subject of a long-established literature amongst both economists and statisticians but their use to date has been somewhat constrained. Certainly have not been used to their full potential in the examination of deflators- an area which the author feels is worthy of further investigation.

SAMs can be regarded as one of the main tools for developing and extending the core system of the National Accounts to meet specialised needs whilst maintaining:

- Consistency of approach, both in concepts and practical measurement.
- Coherence in terms of the definition, classification and measurement of flows and stocks of goods and services.

The power of SAMs is in the fact that their design and construction is not standardised but can be adapted to be most suitable for the purpose, for example the process of production or use of products. Similarly, they can be constructed according to classification by purpose for satellite accounts and facilitate the identification of the appropriate deflators for different sectors such as health. SAMs also provide a generic structured approach to the identification of data gaps and coherence issues relating to economic data including families of price indices.

Perhaps the most important feature from the viewpoint of national accountants is that SAMs allow for multiple sectoring to accommodate any classification. That is to say the same flow can be represented in two different classifications together with a mapping matrix showing the links.

Annex B is an attempt to show the accounts relevant for the price indices concerned with retail transactions.

Account 1 shows the balance of supply and use for retailers in each SIC category. Each row shows the sales and closing stocks and these are equal to the purchases from domestic sources, purchases from overseas sources, opening stocks, and trade margin in each column.

Account 2 shows the disaggregation of the SIC categories used for measuring retail sales into the COICOP categories used for deflating them and the further disaggregation of COICOP categories into CPI elementary Items

²³ more details on SAMs can be found in the 1993 SNA or Pyat and Round, 1980, Social Accounting Matrices for Development Planning.

Account 3 shows the payments for the sales classified by elementary item flowing from a composite institutional account that includes households as well as all other institutional sectors in the economy.

Accounts 4 and 5 show retailers' purchases of domestic and imported products classified by PPI items and IPI items respectively. The return from the sales is paid to the composite institutional account.

Accounts 6 and 7 show retailers opening and closing stocks valued at replacement cost classified by PPI items [Note there is an implicit assumption that all stocks consist of domestically produced items. The inclusion of separate stocks for imported goods is simple]. In each account opening stocks at replacement costs classified by SIC and the PPI classification are balanced against the opening stocks at historic cost classified by the PPI and ONS' stocks classification and a revaluation term.

Account 8 shows the opening stocks at historic cost balanced against the closing stocks and stock changes all classified using the ONS stocks classification.

Account 9, the composite institutional account shows all payments to and from the institutions making transactions. Because all institutions are consolidated it contains only one row and will balance automatically of the other accounts are all balanced.

Volume estimates for accounts 3 to 7 which are classified using elementary price index classifications are made by deflating directly using the relevant indices. All other volume measures are derived indirectly. By definition we have no lower level weights for elementary indices and so the consideration of the appropriate aggregation formula for the deflators, whether to use the geometric mean or the ratio of averages for example, is analogous to that in chapter 20 of the CPI manual.

Deflation of accounts 3 to 7 fixes the volume measure of all the elements of the supply and use balance for retailers (account 1) except the Sales by SIC and COICOP in cell 1,2 and the trade margin.

Assume for the moment that the volume of the Trade Margin is a fixed proportion of the sales in each SIC category²⁴. If we know the volume of all the elements of cell 2,3 this gives us the column totals for the volume of cell 1,2. If we are prepared to assume that all sales with a given COICOP group share the same price movements this gives us all the elements of the cell.

In practise we are unlikely to have timely information for the body, as opposed to the border, of any cell and have to rely on proportions extrapolated from some base period. This extrapolation is likely to be done by separate teams within the statistics office. In the UK for example the team compiling the Retail Sales index has a set of assumptions about the current price proportion of sales by COICOP for each sic

²⁴ In fact the margin for is likely to vary from shop to shop even for identical items within the same SIC category. It is however stable for given shops so a breakdown into high and low margins within the same SIC would be useful.

category of retailer in cell 1,2 while the Consumer price index compilers have assumptions about the constant price mapping of item indices to COICOP categories in 2,3. Their reconciliation will give a unified estimate of the change in the cost of living that takes account of all the information available in the statistics office and, still leaving aside the question of the margin provide.

- A clean comparison of the sampling and aggregation strategies of the different price indices
- The “Stage of Processing” analysis desired by Popkin et al (assuming rational expectations so that expected replacement prices and proportions equal actual.²⁵)

The balancing techniques for solving such problems are familiar to National Accountants if not to price statisticians and, given the price statisticians’ regular need to derive weights for their indices, should not add unduly to the work of the office as a whole.

4. Implications and possible ways forward for producers of price indices and users of deflators

Against this background it is legitimate to ask about the scope for a more systematic approach to the production of price indices by national statistical offices, facilitated by a greater debate amongst the international statistical community of price statisticians and more communication with users - including national accountants about the construction of deflators.

The common thread linking the issues raised in this paper is the system of national accounts and it is not surprising that the common chapter of the UN technical manuals on consumer price indices and producer price indices, entitled “The system of Price Statistics”, takes SNA 1993 as its starting point. This and associated chapters are addressed both to compilers and to users and in the view of the author of this paper, are core to the successful and systematic development of coherent and fit-for-purpose price indices and deflators. But their usefulness is constrained by the limited advice and guidelines on deflators in SNA 1993²⁶ and the lack of discussion and analysis of the practical implications of the resulting choices national accountants, in particular, currently have to make when using price indices for purposes for which they have not been designed. Neither is a great deal advice offered on how to minimise the problems which arise when such choices need to be made. Just as importantly it is possible that some of the difficult choices confronting national accountants may be avoidable if they were better able to articulate their needs to price statisticians.

5. Recent developments

The most significant recent development has been the increased interest in house price indices.

²⁵ Note that the actual stage of processing framework used in the BLS would require us to incorporate Make and Absorption Matrices in the SAM

²⁶ More so with the current revision where the issue of deflators is more heavily reliant on references to the international manuals on the CPI and PPI and the SNA is less self-contained.

House Price Indices

There are many areas of society where changes in house prices either directly or indirectly influence practical decision making or inform the formulation and conduct of economic policy. These different uses can have a significant impact on the desirable methodology and coverage of the index.

From an individual household's perspective, real estate represents the single largest investment. It also accounts for the largest share of wealth in a nation's balance sheet. Changes in house prices can have far-reaching effects for individuals, e.g. in equity and debt levels and this can permeate through to the overall economy. In fact, consumer spending is often affected by changes in house prices as a result of its effect on consumer confidence, as was experienced in the financial crisis of a few years ago and the impact of negative equity and the sub-prime mortgage market. House prices also have a key role to play in the measurement of the affordability of home ownership. House price changes also influences the decision to build new houses (supply) as well as the decision to either trade up or down or to decide to become a homeowner (demand). Investors turn to house price indexes to measure wealth and to help in assessing current and potential future rates of return

From a broader perspective, analysts, policymakers, and financial institutions follow trends in house prices to expand their understanding of real estate and credit market conditions as well as their impact on economic activity, and financial stability and soundness. For instance, mortgage lenders will use this information to gauge default risk, and central banks often look to movements in house price indices to track households borrowing capacity and aggregate consumption.

Against this background, statistics on residential property prices have a number of important uses.

- As a macro-economic indicator of inflation.
- For monetary policy targeting.
- As a measurement of wealth.
- As a financial stability indicator to measure risk exposure.
- As a deflator for national accounts.
- As an input into an individual citizen's decision making on whether to invest a residential property.
- As an input into other price indices, most particularly the Consumer Price Index for use, amongst other things for wage bargaining or indexation.

Until fairly recently, the compilation of House Price Indices had not always been a priority for statistical offices and where indices have been compiled the methodological approaches adopted have been mainly a function of the house price data sets generated by the legal and other processes associated with buying a house, due to the high cost of undertaking purpose-designed surveys. Data constraints still in large part determine the methodologies used but the position is changing in terms of the general availability of house price indices as more countries develop their house price indices and review the indices currently published.

Eurostat organized and financed the preparation of a *Handbook on Residential Property Price Indices*. The handbook provides best practices for compiling house price indices and aims to improve international comparability of Residential Property Price Indices. It will facilitate the development of house price indices where these are not produced and will improve existing indices. The Handbook is available from Eurostat's website and the plan is to publish a hard copy version in due course. This fills an important gap in facilitating the development of a family of indices and in the understanding of inflation.

6. A family of indices – gaps

Some possible gaps to fill include.

Commercial Property Price Indices

Regarding data gaps and the financial crisis it has been recognised that there is an increasing need and demand for Commercial Property Price Indices and for guidance on their construction – a demand that the international statistical organisations need to respond to. Eurostat has indicated its willingness to take the leadership in this field and to sponsor a CPPI Handbook.

Broader measures of inflation – the Final Expenditure Prices Index/Domestic Final Purchases Index

The idea behind such an index is that it should reflect final purchases not only of households but of businesses and government. It therefore provides a direct measure of inflation in the economy as a whole.

It has three components.

- the Index of Consumer Prices
- the Index of Investment Prices (plant and machinery, vehicles, new buildings & works)
- the Index of Government Prices

As mentioned earlier the strength of a national accounts approach lies in the fact that the System of National Accounts represents the only comprehensive and detailed framework for a systematic and integrated recording of the stocks and flows of an entire economy. Since most users of economic statistics are familiar with the underlying principles and the major aggregates of the national accounts, they can more easily envisage the concept of a price index structured in line with a “national accounts” aggregate.

The price index could be constructed to reflect the prices of *all* domestic purchases - not just final purchases. However, this would involve multiple counting because prices at various intermediate stages of production would be included together with final transaction prices. By recording final purchases only, the influences of the price pressures experienced at earlier stages in the production process are implicitly captured in the final prices.

Although the national accounts provides a suitable framework for defining wider inflation measures, it is important to bear in mind that they are designed specifically to measure the total value of economic activity within a country's borders. They are not designed as a basis for constructing an inflation measure which, conventionally, measures prices relating to market transactions only. Consequently several components of total domestic expenditure will be omitted when constructing the FEPI structure, including changes in inventories and imputed rents for owner occupiers.

The usefulness of the FEPI is that it can be used extensively both in macro-economic analysis and in developing a greater understanding of the inflation process. It could also be used in public expenditure planning; and in the business sector it could be used as a "deflator" to convert *nominal* profits to *real* profits; and in the index-linking of contract payments.

The development of such an index also has a number of other potential benefits, including.

- Providing useful inputs into national accounts balancing and improved deflators for national accounts.
- Assisting in statistical coherence e.g. in the reconciliation of the methodologies for imputing import prices.
- The consequential development of other indices & data sources e.g. the import prices of capital goods; public sector productivity measures.

The most challenging aspect of compiling such an index is the measurement of the Index of Government Prices – a reason, perhaps, why statistical offices in general have not taken forward work on broader inflation measures and an explanation that, where they have, such as in the UK some years ago, the development has been thwarted by a lack of reliable inputs into its construction.

7. Conclusions

The above discussion leads to the following conclusions.

- A co-ordinated approach to the systematic application of frameworks for the development of price indices is long overdue and this lack of progress amongst the international community of price statisticians, economists and national accountants is reflected in:
 - A limited articulation of the needs of users, particularly national accountants.
 - A current lack of availability of relevant price indices, including deflators.
 - Limited international comparability both between the different indices produced by different countries and in deflation practices.
- The systematic application of strategic frameworks within a country, particularly Social Accounting Matrices, provides a powerful tool for moving to a more relevant family of indices, for filling gaps and addressing issues relating to lack of coherence between different indices within the family. Such frameworks also provide a powerful tool for evaluating the performance of statistical offices.

- Common methodologies where appropriate between different indices, including between CPIs and PPIs, would add to coherence and would be an added bonus. This may apply to quality adjustment techniques, for instance, which can have a significant impact on some price indices and deflators such as in the IT sector.

At the level of a national statistical office this lack of user relevance and coherence can be facilitated by a much more structured approach to index construction which would be part of the compilation of a longer-term development plan for price indices. The Stage of Processing Framework could form the underlying framework for identifying gaps in the family of price indices which would then be the subject of a consultation exercise with users as part of a prioritisation exercise for future work. Other lower-level frameworks such as the Stage of Production Framework, together with the continuum between a COGI and a COLI (the macro versus micro-economic framework for CPIs), the need for sub-indices for more detailed analysis and the needs of national accountants for deflators would further inform prioritisation at a lower level. This process would in effect provide a decision tree for the optimisation of statistical outputs in terms of which indices are produced and coherence in their construction.

A more effective exploitation of specialised Social Accounting Matrices to provide all engrossing frameworks for the delivery of customised and integrated systems for economic analysis and for the clarification of conceptual issues and the identification of data linkages and gaps would also help.

References

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[2] United Nations, System of National Accounts 1993, United Nations, 1993.

[3] Schultze and Mackie, Panel on Conceptual, Measurement, and Other Statistical Issues in Developing Cost-of-Living Indexes, Committee on National Statistics, National Research Council, 2001.

[4] Boskin et al, Final Report of the Commission to Study the Consumer Price Index, US Senate, Committee on Finance, 1996.

Annex A: Initial design for an analytical (Stage of Processing) framework for the UK

From:		To: Intermediate Demand						To: Final Demand						
		Agricult.	Manufg Mining + Quarry'g	Constr'n	Retail	Wholesale	Services	Final Consumption		Investment Expend.	Exports			
Category of good/service								Private	Govt	Equip't & Vehicles	Constr'n	PPS Divn	Trade Stats	
Rest of World	Raw materials+fuels	API	IPI	?	-	IPI	-	-	-	-	-	-	EPI2	
	Semi-manuf. goods /a	-			-		-	-	-	-	-	-		re-exports
	Finished intermed. goods	API	6		-	6	-	-	-	-	-	3		
	Consumer goods	-	-		7	7	-	/c	-					
	Capital goods	-	-		/f 2	/f 2	-	/c	/c	IIP /g 2		/h		
	Services	-	1	BCI	1	1	1	/c	/c	/h	/h			
Domestic Production	Agriculture		API	API	-			/c	/c				EPI1	EPI2
	Manufact'g, Mining & Quarrying	Raw materials+fuels	API	PPI	BCI	API	API	-	-	-	-	-	/d	Prices charged by producers
		Semi-manuf. goods /a	-			-	-	-	-	-	-	-		
		Finished intermed. goods	API		BCI	-		PPI	/c	IGP				
		Consumer goods				PPI	PPI	PPI	/c	IGP /l	IIP			
		Capital goods /f	-	-	-				HPI	COPI /i		COPI		
	Construction Buildings etc													
	Retail,	Raw materials+fuels	API											Prices charged by agents
	Wholesale,	Semi-manufactured goods		/a 4	BCI									
	Distribution	Finished intermediate goods												
	Consumer goods	API			/j 4			ICP + RPI	IGP			8		
	Capital goods							+ HICP	IGP	/b 4	/h	5		
Services		Corporate Services Price Indices												
Labour supplied by the household sector		Average Earnings Indices /e												

- /a from wholesalers/dealers/import agents
- /b capital eqpt purchased through wholesalers/agents are not covered by the IIP - which reflects changing levels of output prices (ie manufacturers list or order prices)
- /c there may be direct purchases, but such transactions are not reflected in any published indices
- /d The only export prices collected by PPS are from the producers (EPI1s). The EPI2s published by Trade Stats cover all exported goods; but only the EPIs determined by PPS are based on direct price collection
- /e this block is equivalent to the sale of labour by private households to the productive sectors of the economy
- /f most capital goods will, by definition, feed into intermediate demand - but capital goods purchased for re-sale by dealers (eg cars) will be classified as intermediate demand
- /g not yet based on directly-collected prices - but an estimate of imported capital goods prices is made for the FEPI (and for the PINCCA)
- /h expenditure on services incurred as an integral part of the acquisition of capital goods is classified as part of investment expenditure
- /i output from the construction sector feeds into Govt final consumption (why?)
- /j from wholesale to retail
- /k eg domestic help
- /l capital goods that feed into Govt Final consumption (eg PCs costing < £1000)

Key to the gaps:

1. Imports of services
2. Imports of capital goods
3. Re-exports
4. Wholesale prices
5. Exports of services
6. Imports of intermediate goods
7. Imports of consumer goods
8. Exports of prices charged by wholesalers/agents

Construction Output Price Indices	COPI
Building Costs Indices	BCI
House Price Index	HPI
Import Price Indices	IPI
Export Price Indices (PPS Div)	EPI1
Export Price Indices (Trade)	EPI2

Producer Prices Index	PPI
Components of the FEPI (ICP + IIP + IGP)	FEPI
Harmonised Index of Consumer Prices	HICP
Retail Prices Index	RPI
Agricultural Purchaser and Producer Price Indices	API
No price indices published for these transactions	

PPI
FEPI
HICP
RPI
API

Annex B: A Social Accounting Matrix Structure for the Retail Sector

Accounts Paying

**A
c
c
o
u
n
t
s

R
e
c
e
i
v
i
n
g**

	1)	2)	3)	4)	5)	6)	7)	8)	9)	Deflators
1) Retailers by SIC		Sales by coicop					Closing stocks replacement cost			
2) Sales by Coicop			Sales by Coicop*CPI							
3) Sales by CPI Item									Financing of Sales	
4) Purchases by PPI Item	Goods bought-domestic									ppi
5) Imports by IPI item	Goods Imported									ipi
6) Opening Inventories by PPI item	Opening stocks at replacement cost									ppi
7) Closing Inventories by PPI Item								Closing stocks at historic cost	Reval of Closing Stocks	ppi lagged to close
8) Inventories at historic cost by Stocks Classification						Opening stocks at historic cost				
9) Institutions (single account)	Margin			Return to Producers	Return To Importers	Revaluation of opening stocks		Stock change at historic cost		
Deflators			cpi			ppi lagged to opening		ppi		