

The conceptual basis of the SPPI for services

Two papers were provided, one by Alain Gallais and the other, a summary paper, by André Laranger (updated by Mary Beth Garneau). The first outlined the user-value-resource-cost debate on what should be the conceptual basis of quality adjustments for SPPIs, and the stance taken by the PPI Manual. The characterizations of the alternative conceptual bases and of the theoretical fixed-input output price index (FIOPI) in the paper was helpful, but not always clear. The second outlined three general questions and three case studies, and provided supporting analysis. It may help, though this account is somewhat long-winded, to revisit the *PPI Manual*'s position in section A, its application to quality adjustment in section B, and then look at the problems raised for the SPPI in C.

A. The *PPI Manual* and SNA 2008 background

The conceptual basis of the PPI is the FIOPI. The primary application of this framework is to gain insights into formulas choice and substitution bias. Loosely, a price-taking revenue-maximizing establishment has a production possibility function (technology) with fixed (intermediate and primary) inputs. The technology describes the combination of outputs that can be produced given the fixed inputs available. The revenue-maximizing establishment, as a price-taker, chooses the combination of outputs to produce given the current prices that will maximize revenue.

What we want is an index between two periods, say between 0 and t , that shows only pure price change. A Laspeyres formulation would ask in the numerator what the hypothetical revenue (for this revenue maximizer) would be in period t at period t prices if we held the technology and inputs constant in period 0; it would then compare this with the (maximizing) revenue in the denominator at period 0 prices, technology, and inputs. Any change in the ratio is due to price changes, not inputs or technology. It is a theoretical index, a thought experiment, asking a useful counterfactual question, much as a constant utility COLI index does. It is not a requirement that in practice either utility or production technologies/inputs are in practice constant, though this is referred to in both papers as such.

The main benefit of FIOPI is that Paasche and superlative concepts can be similarly defined holding technology and input fixed respectively in period t and some average of the two periods. Insights into substitution bias, bounds on theoretical indexes, and superlative approximations to theoretical indexes arise from this framework. All of this is taken from Chapter 17 of the PPI Manual, more formally written up by Erwin. There is no obvious reason for services to not be under this useful conceptual framework.

The valuation for this output SPPI is not at purchasers' prices, but basic prices, as is the case with its nominal counterpart.

B. How does quality adjustment fit into the FIOPI?

The PPI Manual in Chapter 21 addresses the conceptual basis of the quality adjustment issue. The issues are outlined in sections B.1 to B.5. However, importantly, Erwin has a section B.6 that applies the same FIOPI framework to output phrased in terms of characteristics space. Simply, under the FIOPI we are comparing prices in two periods, period t in the numerator and period 0 in the denominator, with technology and inputs held constant. These prices can each be formulated in terms of hedonic functions. The FIOPI framework is thus extended into characteristics space and a constant (period 0) quantity of characteristics can be valued at period t in the numerator and period 0 in the denominator for a Laspeyres hedonic price index and a constant (period t) quantity of characteristics can be valued at period t in the numerator and period 0 in the denominator for a Paasche hedonic price index. Section B.6, and subsequent sections, provide a basis for discussing quality changes within the FIOPI framework as well as being well-suited to being operationalized by hedonic price indexes.

The formulation in B.6 is well-suited as a practical standard, but it is not a unique solution to the problem. The B.6 approach uses observed market (basic) prices and thus may be phrased as a market user valuation at basic prices, but this arises from the assumption of a firm as a price taker. The market price may well be an equilibrium price arising from the interplay of demand and supply considerations or one arising from monopolistic behavior. The PPI Manual in extensive sections (17.36 and 17.37, 21.18-21.32, and 21.49-21.51) considers these issues. Sections C3-C5 focus on practical hedonic regression formulations to operationalize the B.6 theoretical concepts. Just as Laspeyres and Paasche theoretical indexes are outlined in chapter 17, so too in characteristic space are operational Laspeyres and Paasche hedonic imputation indexes in chapter 21.

Chapter 7 is the practical chapter on quality adjustment. It outlines a range of methods available, one of which is hedonic regressions. Phrasing prices in terms of their characteristics and the associated valuations of these characteristics is useful for outlining FIOPI in terms of quality characteristic changes and hedonic formulations are a natural expression of this. But this does not mean that only hedonics is suitable. A quantity (service flow) quality adjustment is akin to a hedonic one with some dimension of the service flow as the explanatory variable and the marginal (basic price) valuation as the coefficient. Option costs can be similarly phrased, as can imputed valuations from similar products/brands with and without the additional service flow. The overlap method makes assumptions about differences in original and replacement market prices reflecting differences in quality. The only real cause for concern is the use of production costs when margins vary.

There is a final point worth noting on reconciling quality adjustment based on different valuations (chapter 7 B.2.5). The valuations are at basic prices for the supply (output and import price indexes) and at purchasers' price for use (intermediate input, final consumption,

capital formation) at the detailed level in supply and use tables (SUT). The PPI Manual advises, for consistency in valuation and reconciliation of the SUT, the use of basic prices throughout the SUT.¹ It is also recognized that in practice there will be second-best methods based on resource costs that require careful use.

C. On SPPI quality-adjustment questions

There is neither an apparent reason nor is it strongly argued in the papers, that there is something about the nature of service industries that would lead to abandoning the PPI Manual (2004) principles for a SPPI.

Detailed-level nominal service output changes at basic prices should be deflated by appropriate output SPPI sub-indices at basic prices. FIOPI as a useful theoretical framework. is adapted in the *PPI Manual* B.6 to include quality change by phrasing the output in terms of their characteristics, that is in terms of revenue (at basic prices) maximizing behavior choosing between a set of quality characteristics (models) to produce using fixed inputs. The bilateral change in unit revenues for different price regimes using the same fixed technology/

¹ On consistency in valuation (*SNA 2008* paragraphs 14.138-141) as a general volume SUT principle (as opposed to just quality adjustment), these paragraphs are introduced with a preamble: “What follows, therefore, anticipates that general discussion but is provided here to complete the discussion on supply and use tables. The section illustrates the problems that need to be addressed in expressing a supply and use table in volume terms rather than giving detailed compilation advice.” It is a bit confusing, but nonetheless is worthy of note.

14.138 The first decision to be made in compiling supply and use tables in volume terms is whether to work with tables in basic prices or in purchasers’ prices. There are arguments for and against each choice.

14.139 When working with a basic price table, all the elements relating to trade and transport margins and to taxes less subsidies on products will have been separated from the value of goods and services at basic prices. Confusingly, the prices known as producer price indices (PPIs) correspond not to the concept of producer prices in the SNA but to basic prices. They exclude both trade and transport margins and the effect of taxes less subsidies on products. PPIs therefore seem well suited to deflating the rows of a basic price supply and use table on the grounds that the entries along a row of the use table are more homogeneous than in the case of a purchasers’ price table. However, the claim that the resulting entries are sufficiently homogeneous to justify using a single price index for each of them must be qualified. In addition, the elements referring to margins and taxes must be deflated separately and this raises conceptual and practical issues also.

14.140 When working with purchasers’ prices, greater use is made of CPIs and fewer problems arise about the treatment of margins and taxes. However, although CPIs are generally held to be robust, their underlying assumptions might not always be entirely compatible with those in the supply and use tables.

14.141 Whether a purchasers’ price table or a basic price table is being deflated, there are likely to be problems in deflating exports and imports.

inputs defines an output price index and changes in the output characteristic mix as a result of differential relative prices, allows for substitution effects.

The period 1 and period 0 prices in the respective numerator and denominator of the revenue ratio are replaced by hedonic functions that characterize the technologically feasible set of model characteristics while technology and input levels are held constant. A Laspeyres, for example, hedonic price index would hold technology, inputs and the vector of characteristics in the hedonic function, constant in the period t numerator and period 0 denominator, but the hedonic function that values the characteristics would change from period 0 to t —a constant quality price index. *PPI Manual* (2004, 21.33-21.48; Diewert).

As explained in the *PPI Manual* (2004, 21.48) and due to Erwin, the quality adjustments in this framework make use of the **user's valuation of each model's characteristics**. This is assumed in the Manual to arise from hedonic estimates (21.34). **Producers' costs or production functions enter into the quality adjustment only to determine which combination of characteristics, i.e. models, establishments will produce given their different technologies, primary inputs and, possibly, input prices.** This framework is remains one that looks at a revenue maximizing establishment valued at basic cost.²

1. *Traditionally statistical offices have used a production function approach to quality adjust Service Producer Price Indexes (SPPI). Are there service industries for which a consumer utility approach would be a better conceptual basis for quality adjustment?*

The term “production function approach” is not clear. I assume a resource cost approach is implied as opposed to one based on consumer utility. As explained above, the PPI Manual takes FIOPI as its conceptual basis in which ratios of unit revenues define pure price changes, technology and inputs held constant. Quality is incorporated into this framework by expanding prices into hedonic characteristic set formulations. Establishments are price takers and the valuations to the characteristics may be considered as coming at basic price, to be consistent with its SNA 2008 output counterpart. As noted above, and in the Manual, producers' costs or production functions enter into the quality adjustment only to determine which combination of characteristics, i.e. models, establishments will produce given their different technologies, primary inputs and, possibly, input prices.

One view, the “production-cost” view, supported by most Voorburg members, was that quality change should be considered only to the extent that these changes affect the production function of the service provider. In this view, changes that don't affect the

² Data on prices and characteristics may only be available at purchasers' prices. There may be cases where the transport and trade margins and taxes less subsidies are negligible and valuations at purchasers' prices works. Alternatively it may be argued that if we identify both of these wedges as margins and compare predicted values of a constant (say period 0) characteristic set using period 1 and period 0 hedonic regressions $f^1(z^0)/f^0(z^0)$ fixed percentage margins may be taken to cancel and yield a reasonable estimate of quality adjustment at basic prices.

production process would be excluded.

Consider a **stylized example** of ketchup sold by a producer to wholesalers. Assume a costless quality improvement of turning the label upside down so the bottle stands on its top and the flow of ketchup is improved from a user perspective. Assume further, that both the original and current bottles are sold at the same time, but the new ones have a 1 percent price premium, prices and volumes otherwise remaining constant over time. The hedonic quality-adjustment would pick up the 1 percent contribution to price on the “up-turned label” characteristic and overall price change would be constant. The nominal revenue at basic prices would increase, but this would be due to a volume (quality) change. Productivity has increased.

2. If National Statistics Offices follow a production-function approach to quality adjustment of SPPIs, where in the System of National Accounts would we account for the conceptual source of the discrepancy between CPI-based deflators of final demand and PPI-based deflators of service industry outputs?

SNA 2008 argues for a consistent basis for valuations in SUTs across accounts, see footnote 1.

3. Is the underlying good part of the distributive trade service? Should the changes in the quality of the good sold be included when quality adjusting the distributive trade service?

On distributive trade: margins should not reflect changes in the quality-mix of what is sold, unless there is a convincing case that the service flow required to trade a good of given quality differs significantly from that needed to trade a better/worse quality of the good. As a general methodology, service performance characteristic ratios, say in retail trade of number of checkouts to store traffic, or hedonic regressions might be more appropriate. In the latter case margins for (stratified sets of) representative unique item(s) of constant quality or representative group of relatively homogeneous items may be used to maintain a constant quality mix (see *PPI Manual* 10.16-10.181).

On advertising services: it is worth considering what variables would enter the hedonic price function to help determine price variation. In the first example it is *intended audience* and in the second it is *achieved audience*. An advertising agency may choose, for example, to price in terms of intended audience because its technology and inputs are such that this is most effective for them. A purchaser chooses the characteristic of *intended audience* because it is an important characteristic to them, and this will emerge as such in a hedonic regression. Both the examples in Tables 1 and 2 are correct, reflecting price-determining characteristics and quality adjustments for these extreme hedonic cases where, in turn, *intended* and *achieved audiences* are sufficiently important to enter the hedonic price function to the extent that they shift from the right-hand-side of the function to a denominator on the left, to become part of the pricing mechanism itself. In Table 1, a Laspeyres hedonic price index

values the Q1 expected audience at both Q1 and Q2 prices and divides the latter by the former. A Paasche index takes period Q2 audience and values it in period Q1 and Q2 and again divides the latter by the former. The results are the same as in Table 1. A similar approach for Table 2 yields the same results as the table.

Air transport services: again the focus is on the hedonic function for which (to stylize it) a data set exists in periods 0 and t of different-sized leg-rooms and their prices and there is a meaningful and strong relationship estimated by a hedonic regression. The size distribution in period 0 can be priced by both a period 0 and period t regression and the predicted price change estimated as a Laspeyres hedonic price index. There is a similar such exercise for Paasche hedonic price indices.