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Revisited paper - Adjusting for Quality Change:

ISIC 51

Air transport

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1 - Introduction

In the course of the 24th Voorburg Group (the Group) meeting in Oslo (2009), Statistics Austria contributed a revisited sector paper on producer price indices for air passenger and air freight transport services. The paper included a general description of the characteristics of the service branch as well as Services Producer Price Indices (SPPI) methods and characteristics.

According to an OECD inquiry, as a result of comprehensive development work in recent years, 28 countries have been developing and/or producing SPPIs for air transport activities.

As previous investigations (the Group 2003/2004[1]) show this service branch (in most countries) is dominated by a few large airlines which produce the majority of turnover for passenger and freight air transportation. Smaller airlines are prevailing in other branches like air taxis and air sightseeing.

Depending on the 'subject' of the transport, the following main distinctions of service activities can be drawn in ISIC as well as in NACE

- transport of passengers by air (over regular routes; charter; sightseeing; renting of aircrafts with operator)
- Freight air transport (on regular schedules; non-scheduled)
- Space transport (launching of satellites and space vehicles; space transport of freight and passengers)

Contrary to the above product classification the NAICS uses diversification of scheduled and non-scheduled air transport as the main criteria for their classification purposes.

In the respective product classifications (CPC, CPA) the division of freight and passenger air transportation is the main distinctive criterion also. Subsequent to these main classifications, further distinctions can be drawn according to scheduled, non-scheduled, domestic and international transportation.

In the development of SPPIs, the following pricing methodologies could be applied to the air transport service branch:

- Prices of repeated services
- Unit Values
- Model Pricing
- Component pricing

[1] See http://www.voorburggroup.org/english/voorburg/

A description as well as the pros and cons of each above methodology can be found in the revisited sector paper[2]. According to a survey which has been undertaken in order to gather information on the latest development in this service branch, the vast majority of countries reported that they use the method of 'prices of repeated services' for at least part of their price indices.

A major problem in developing an index for this service branch is to ensure prices are collected for service products which are solely delivered to businesses. Due to the fact that compared to other business service branches which are more tailored to business customers (like public relations or accounting activities), passenger air transport products are also delivered in large quantities to private households.

An advantage the air transport industry has over other service price indices being developed is the fact that instead of starting an expensive survey, data may be available through the International Air Transport Association (IATA) where the respective data can be purchased and used to calculate a price index.

The purpose of this paper is to give a brief overview of various quality adjustment methods, discuss conceptually the reasoning behind quality adjustments in the air transport industry and the implementation and daily practice of quality adjustment in this industry by member countries of the Group.

2 - Quality adjustment

One of the key principles in compiling price indices is to compare the prices of two 'products' that are identical over two periods in regard to their characteristics. By neglecting this principle, the resulting change in the price ratio may not reflect a 'pure' price change but may also be the result of quality differences of the two products.

A 'pure' change in the price of a product (without any changes in the characteristics) should be incorporated in price indices, but in cases where an unchanged service product could not be surveyed in the following period (either due to missing products, sampling issues or new products being introduced) a method of quality adjustment should be applied in order to avoid a biased price index.

A lot of information about quality adjustment can be found in chapter seven of the PPI Manual (Producer Price Index-Manual, Theory and Practice, ILO/IMF/OECD/UNECE/World Bank 2004[3]). Due to the fact that the manual devotes a full chapter to quality adjustment only an overview will be given of the national practice in other countries.

In general two groups of quality adjustment methods can be identified:

Implicit methods (the value of the change in quality is not taken into account)

- Overlap
- Overall mean /targeted mean imputation

[2] http://www.voorburggroup.org/english/voorburg/Documents/2009%20Oslo/Papers/2009%20-%2058.pdf
[3] See http://www.imf.org/external/pubs/cat/longres.cfm?sk=16966.0

- Class mean imputation
- Comparable replacement
- Linked to show no change
- Carry forward

Explicit methods (a valuation of the difference in quality is made)

- Expert judgement
- Quantity adjustment
- Differences in production/option costs
- Hedonic approach

Despite the fact that in theory all the adjustment methods mentioned in the PPI manual could also be applied to SPPIs, in practice only a few of them have been incorporated into the production of SPPIs by member countries of the Group. Moreover a quality adjustment method that works well in one country may not be feasible for another country due to differing circumstances – the history of the Group has numerous examples where both industry output and pricing mechanisms differ in different national economies.

The quality adjustment problem arises when price index practitioners are faced with quality change in sampled goods and services. For air transport services, quality changes arise when tickets are no longer available and the replaced tickets show a slight variability in their conditions attached to the flight, such as:

- Restrictions in baggage weight
- Meal served during the flight
- Possibility to rebook a flight (flexible ticket options) etc.

The two most popular methods of quality adjustment reported to last year's Voorburg survey on air transport and this year's survey specialising on quality adjustment were:

Overlap method (implicit method)

Provided that the old and new service product (e.g. ticket type) is available in the same period (t) this method can be used to replace outdated services. If product A has to be replaced by product B in period t+1, the price difference between product A and product B in the overlap period (t) will be treated as a complete quality change. The price index measuring price change between period t and t+1 will be affected only by price changes of product B between period t and period t+1. This method is applicable to service products of different price determining characteristics but which have the same intended use/purpose.

Table 1: Example of quality change using the overlap method

Example - Overlap method			
	May 2010	June 2010 (t)	July 2010 (t+1)
Price Product A	50	55	-
Price Product B	-	58	60
Price Index	100	110	114[=60/50*55/58*100]

Note that in application the overlap method is only applicable where the two products (A, the original, and B, the replacement) are on sale during the same period (t).

Comparable replacement (implicit method)

Using this method implies that the service product B which replaces product A is a service product of identical type and quality and does not differ in its price determining characteristics. Due to the identical product specifications no quality change occurs and the possible price difference will be represented/incorporated in the price index. To achieve this, the base period price of the incoming (replacement) item is determined as the base period price of the outgoing item.

Table 2: Example of quality change using the directly comparable method

Example - directly comparable			
	May 2010	June 2010	July 2010
Price Product A	50	55	-
Price Product B	-	-	60
Price Index	100	110	120 [=60/50*100]

In the case of temporarily missing service products, carrying forward the price information of the previous period and bridged overlap/class mean type imputation methods are often used to obtain the current price for the service. More often in practice, the quality adjustment determines the price that would have been observed for a replacement item had it been on sale in the base period.

Before discussing further what kind of quality adjustment is used by member countries of the Group in the air transport service branch, the next chapter should give a brief overview on how a change in service characteristics should be evaluated and what possible influence the decision will have on national account measures.

3 - Conceptually how should we treat quality change in the air transport industry?

As discussed above, the conceptual objective of a price index is to price to constant quality. Therefore, any change in price that results from an obvious change in quality should be adjusted so that only 'pure' price change is measured. However, frequently the price of an air transport service can change due to a change in the service being offered.

When such changes occur, an assessment should be made regarding the price-determining characteristics of the service to evaluate if quality adjustment should be applied. In these cases we need to consider if the change in characteristic represents a change in quality for those who are producing the service (in terms of inputs) remembering that the principal conceptual basis for an output PPI is the fixed-

input output price index (FIOPI)[4]. Constant output from a producer's point of view is defined as the service provided with a fixed production process, therefore, theoretically, any change which suggests a change to the production process should be considered as a quality change. Further consideration is then required regarding how this change should be reflected in the derivation of the volume measure of the national accounts.

It is useful to consider examples to illustrate this concept further. Note these examples are meant to highlight the above concept, not to provide a definitive set of rules for quality adjustment in the air transport industry:

Example 1: Baggage premium
First consider an example where a business traveller now pays an extra 10% for a ticket as the airline now includes a baggage premium in the ticket price. From the airline perspective (the producer) the inputs required to produce the service remain the same but the **pricing *mechanism*** used to charge is now different. In this example, a service comprising a bundle of characteristics (seat plus baggage) is repackaged as two jointly purchased services (seat service, and baggage service). The airline production function for this service remains unchanged. Therefore under such circumstances, this change in price should not be deemed as a change in quality and would therefore need to be reflected as a price change.

Example 2: Extra seats (smaller seat pitch)
Second we can consider the example where the price of a standard flight ticket to a destination has dropped by 10% due to the airline introducing a fleet of planes with smaller seat pitch. This now means the airline can increase the number of seats on a flight, so there has been a change in inputs required to provide the service (the aircraft has been re-configured with additional seats). The production function of the airline has changed and therefore, viewed from the perspective of the producer this change should be evaluated as a change in quality.

Quality change and volumes: the System of National Accounts (SNA)

Alongside the above consideration regarding changes to input and production function, further consideration is required to determine how the change should be reflected in the national accounts. This will depend on how a respective country measures (or derives) the volume output of air transport in their national accounts.

The System of National Accounts (SNA), in general, treats differences in quality as differences in volume. That is, a change in quality needs to be reflected in the national accounts as a change in volume. The direct measurement of volume for the air transport industry is acknowledged as difficult. In the national accounts, value can be used (such as deflated turnover) in place of direct volumes because the value measure is easier to define and collect. If we assume the output of the air transport industry is measured in the national accounts by deflated gross turnover then in the first example above, the change in characteristic is not deemed to be a change in quality (as the inputs required to deliver the service and the output of the industry have not changed). Therefore this should be reflected in the accounts as a change in price (i.e. no quality adjustment carried out) so that the volume measurement of the industry in the national accounts is unaffected.

[4] See page 148 of Producer Price Index Manual
http://www.imf.org/external/pubs/cat/longres.cfm?sk=16966.0

In this next section we will revisit example 1 (baggage) and example 2 (extra seats/smaller seat pitch) by considering the situation where the volume measurement in the national accounts is undertaken by deflation of current price turnover by a constant quality price index. Please note that the examples considered below have been kept relatively simple for illustrative purposes only. In reality there will be changes in price determining characteristics that are more complicated and difficult to assess. However, the key message here is that in each case, to ensure consistency, the changes should be assessed against the effect on inputs required to provide the service (i.e. have the airline inputs remained fixed) and how these changes should be reflected in the volume measure used in the national accounts.

Revisiting Example 1: (baggage premium)

As discussed, the regular price of a business ticket from an airline has increased by 10%. This increase is attributable to the ticket now including a baggage premium – all other characteristics remain constant.

For example, in 2009 the price of a trip between London and Luxembourg is £200 for a business traveller. Total turnover for this London-Luxembourg product in 2009 is £8,000,000.

In 2010, the observed price changes to £200, plus £20 for checked in baggage. The total turnover for the London-Luxembourg product is £8,800,000.

The current price turnover data has changed from £8,000,000 to £8,800,000, or by 10%, between 2009 and 2010.

As discussed earlier this change in price determining characteristic is evaluated as a change in pricing mechanism, and not a quality change (the producer inputs required to deliver this service remain the same as before the ticket price increase). Therefore, when priced to constant quality, p(2010)=£220.

Table 3 Price, volume and turnover data for the Example 1: Baggage

Example 1 : Baggage						
	Observed price (£)	Quality Adjusted Price (£)	Price index	Observed Turnover (£)	Derived (constant period 2009 price) volume	Change in volume
2009	200	200	*100*	8,000,000	*8,000,000*	-
2010	220	220	*110*	8,800,000	*8,000,000*	0.0%

The constant price turnover (volume) data has remained static at £8,000,000 for 2010, showing a zero volume change, despite the change in pricing mechanism accounting for a 10% change in actual turnover.

As the increase in price is not deemed to be a change in quality, the unadjusted price data is used to deflate the current price indicator and the price effect is removed from the volume measurement (that is, the output of the industry has not increased due to the change in pricing mechanism).

Revisiting Example 2: (extra seats/smaller seat pitch)

The second example discussed above suggested that the change in price determining characteristic (extra seats on the plane resulting in a smaller seat pitch) was evaluated as a change in quality (both the inputs required to deliver the service and the output of the industry have changed). This change in quality therefore should be reflected in the national accounts as a change in volume, so a method of quality adjustment will need to be applied to the price.

For example, in 2009, the price of a trip between Cardiff and Dublin is £140 for a business traveller. Total turnover for this Cardiff-Dublin product in 2009 is £5,000,000.

In 2010, the airline introduces a new airliner configuration, now capable of carrying more passengers (but offering a smaller seat pitch). The airline delivers the same number of passengers but uses less aircraft, substantially reducing the airlines operating and maintenance costs. The fixed inputs for this service have now changed as part of this reconfiguration. As part of the introduction of the new seating configuration, the observed price changes to £126. This price drop is confirmed as being solely attributable to the extra seats available on the service. Total turnover for this Cardiff-Dublin product in 2010 is £5,250,000.

Despite the 10% drop in ticket price, the total turnover for the Cardiff-Dublin product in 2010 moves to £5,250,000; and so the current price turnover data grows 5% between 2009 and 2010. In this example, we also know as part of the scenario that the volume of the industry has grown by 5% between 2009 and 2010 but in reality we wouldn't know this until after deflation.

The change to the airliner configuration is a change in the service provided (viewed as a change to the airline production function). This is therefore a quality change.

When priced to constant quality using an appropriate quality adjustment mechanism, the observed price of £126 is quality adjusted to a price of £140 – that is, the entire difference in observed price between 2009 and 2010 has been attributed to the quality change[5]. So p(2010)=£140.

Table 4 Price, volume and turnover data for the Example 2: Legroom

Example 2 : Legroom (consumer)						
	Observed price (£)	Quality Adjusted Price (£)	Price index	Observed Turnover (£)	Derived (constant period t price) volume	Change in volume
2009	140	140	*100*	5,000,000	*5,000,000*	-
2010	126	***140***	*100*	5,250,000	*5,250,000*	5.0%

If quality adjustment had not taken place, and the observed 2010 price of £126 were used in the deflation, the price index would show a price fall of 10%, with the resultant derived volume measurement increasing by 16.7%. This is contrary to the conditions stated in the scenario where we know that volume has grown by 5% and thus the volume increase would be overstated.

[5] This is an example of explicit quality adjustment. In this case we have confirmed that the entire difference in observed price is indeed due to a quality change.

Limitations on these examples and expanding the model:

The examples considered above are straightforward cases used for ease of illustration where the changes in price determining characteristics were easy to evaluate. It is acknowledged that in reality the examples don't necessarily reflect the complexities experienced in the pricing of air transport services. As detailed early in the paper, the price of an airline ticket can be a function of a number of different price determining characteristics such as:

- Flexible ticket options;
- The inclusion of in-flight meals/entertainment/refreshments
- Express check-in options
- The relative availability of seats (i.e. the time the ticket is booked before travel)
- Baggage options
- Class of seat
- Airline

As outlined in the above examples, each change in characteristic will need to be assessed against the effect on the production function of those producing the service (for the purpose of an output price index, the inputs to deliver the service should remain fixed) and ultimately how the change should be reflected in the national accounts. However, to make an assessment and potentially place a value on each change in price determining characteristic (where this is deemed necessary) can be a near impossible task for the price statistician to get correct. This raises the possibility of introducing hedonic regression for the collection of air transport prices. In hedonic regression, the influence of the specified characteristics on price is built into a regression equation which leads to a quality adjustment factor which can be applied to maintain constant prices.

However, the specification of such a model for the air transport industry will require detailed research into both the characteristics that might affect ticket price and how each characteristic is defined in terms of the airlines production function. Such a hedonic model would only be required to adjust for the price determining characteristics that impact on the production function (and ultimately ticket price).

A further limitation that needs to be considered (in the absence of a hedonic model) is the use of alternative explicit adjustment methods. In the second example above, the entire difference in observed price is determined to be caused by the change in quality. In all likelihood some discounting or other marketing activity will usually coincide with a change to a service. This could mean that the price change is attributed to both a change in quality and a 'pure' price change and therefore careful consideration of the value adjustment for quality is required not to miss-state the actual impact of the quality change.

In each of the above limitations, a thorough evaluation process will need to be followed. This includes evaluating if the change in price determining characteristic is a genuine change in quality (based on the impact on production function) and if so, should it be reflected in the output for the industry. Once these factors have been evaluated, the appropriate method of quality adjustment can be applied to the price (if required). The next section of the paper highlights the quality adjustment measures being used by other NSIs for the air transport industry.

4 - National Practices – quality adjustment in air transport:

A voluntary questionnaire was sent to a selection of member countries of the Group in May 2010 asking for information on quality adjustment methods used in their air transport price indices. In total, thirteen countries responded to the questionnaire with two of the countries stating they did not produce any air transport price indices.

Of the eleven countries that produce air transport price indices, four countries currently don't apply any method of quality adjustment to the price data so the information that follows is based on the experiences and methods of seven member countries of the Group.

As briefly discussed earlier, an explicit method of quality adjustment attempts to place a value on the change in quality with which the price can be adjusted. However, the use of such methods by member countries of the Group is not very popular, with only two countries reporting that such methods are used in their air transport price indices. An example of where an explicit quality adjustment method is used is in the US PPI for 'Non-scheduled air passenger chartering'. Explicit quality adjustment would be used, for example, when meals are excluded from the transaction when they were previously included. Since the meal is now optional the airliner is reducing the inputs required to produce the service and thus reducing the quality of service on offer to travellers. To apply an explicit adjustment method, the actual price of the meal component needs to be collected from the airline so that the value of the explicit adjustment can be calculated and applied to the price relative.

No other member countries of the Group reported that they use explicit methods of quality adjustment. In most cases, countries that carry out quality adjustment in air transport indices use implicit methods with the most popular being either the use of the overlap method or the comparable replacement method (as discussed above in section 2).

A final issue that can occur in the quality adjustment of air transport price data is where no supplementary evidence is available with which to quantify an exact quality adjustment. In such circumstances, the Australian Bureau of Statistics (ABS) reported that they consider two alternative approaches. Firstly, they will make contact with the respondent to ask them for an estimate of 'pure' price change between the two periods (for example, if the old product was still produced, would there be a price change). This estimate of 'pure' price change is then applied to the price relative. If this estimated data is also unavailable, then the movement in price for the old product is estimated from the price movements of similar products or services and applied to the price relative. It is interesting to note that no member country of the Voorburg Group use hedonic regression to quality adjust in the air transport industry.

5 - Conclusions and recommendations

The main purpose of this paper was to discuss the conceptual reasoning behind quality adjustment in the air transport industry and how this should be applied in practice. If we are aiming for consistent measurement of service sector GDP at constant prices then ultimately any decision will be driven by how the change in price determining characteristics impact those producing the service (in terms of inputs used) and how this change should be reflected in the output measurement used in the national accounts

Ultimately there is no universal rule for how a change in quality should be treated in the air transport industry. The examples detailed in section three above showed that two standard changes in price determining characteristics are treated differently (one is quality adjusted and the other is not) depending on how they are evaluated against the producer's production function and how this should feed through to the output measure used in the national accounts. If the ultimate objective is to produce consistent service sector GDP at constant prices then it is recommended any potential change in quality will need to be evaluated against two key criteria:

i. What effect does the change in price determining characteristic have on the service provider (in terms of production function/inputs)? Only those that impact on the production function should be considered as quality changes.

ii. How the volume output of the industry is ultimately measured in the accounts and how should the change in quality be reflected in this?

Once this evaluation has taken place and a decision is made on how the change in price determining characteristic should be treated, a further decision regarding the appropriate method of adjustment can be made. Again, careful consideration is required regarding the most suitable method of adjustment to apply. It is recommended that an explicit method of quality adjustment is used in the air transport industry; however, it is acknowledged that the use of explicit methods for services can be difficult due to the lack of accompanying information with which a change in quality can be quantified. Section three considered a case for the introduction of hedonic regression to quantify the price change attached to a change in quality, for those price determining characteristics that impact the production function only. However, the use of hedonic regression is far from easy as it can be both expensive and time consuming to implement correctly.

6 – References

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