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Cross cutting topic (5): Quality Change

A proxy approach to quality adjustment of a service industry

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Introduction

Deflators are an important input into the measurement of economic statistics as they allow for the effects of price changes to be removed from current price data series, enabling the resultant volume measures to be compared across time in real terms. Price indices are used to compile deflators, which are in turn used in the compilation of economic statistics. One of the most challenging processes in the production of index numbers and deflators is to account for quality change over time and the standard techniques for quality adjusting price indices are not always suitable or practical. Consequently, price indices of goods and services in areas impacted by rapid technological advancement often tend towards upward bias resulting from the challenges of adjusting for improvements in quality. Applied to U.K. data on Architecture and Engineering services, we combine insights from the characteristics of the services to develop a method for incorporating quality changes which leads to plausible estimated inflation rates for Architecture and Engineering services. This work aligns to a key aim of the ONS' Deflator Strategy (ONS, 2020a); to capture quality change more effectively in fast changing industries.

1. Productivity within the service sector

Currently the Office for National Statistics applies no explicit quality adjustment to Service Producer Price Indices (SPPIs). Instead, respondents are asked whether the nature of the service they provide has changed over time; respondents are not explicitly asked about quality change. The need for ONS to better adjust SPPIs in fast-changing industries was highlighted in the Bean Review (Bean, 2016).

As proven by application to other price indices, the choice of method used to deflate products with rapid quality change can have significant implications for volume estimates, which in turn distorts international comparisons of economic growth and productivity. Evidence points to low productivity growth in recent years for several service industries, including those which have experienced rapid technological change. We would expect rapid technology change to result in increased efficiency in these industries, which should lead to increased productivity. This may reflect an under-estimation of service productivity growth, due to difficulties measuring volume series of services by suitably adjusting for quality improvements over time.

Figure 1 displays the UK productivity index over the period 1994 to 2018. As to be expected, there was a downturn in productivity following the financial crisis of 2008. What was not expected was the flatlining of productivity following this period. While there are undoubtedly several different reasons for this, the under-estimation of productivity growth due to difficulties measuring quality change in a growing service sector (Figure 2) with increased digitalisation is likely to be a contributing factor to the “productivity puzzle” (ONS, 2020b).

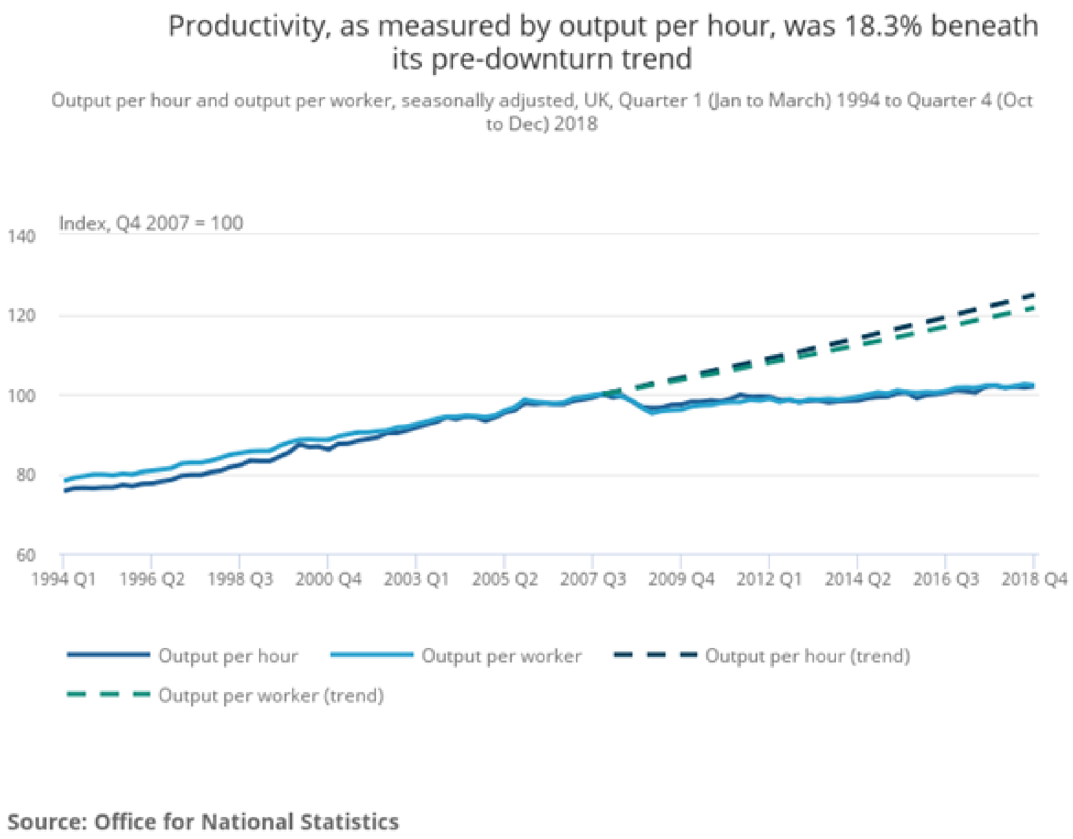


Figure 1: UK productivity index, 1994 to 2018 (ONS, 2019)

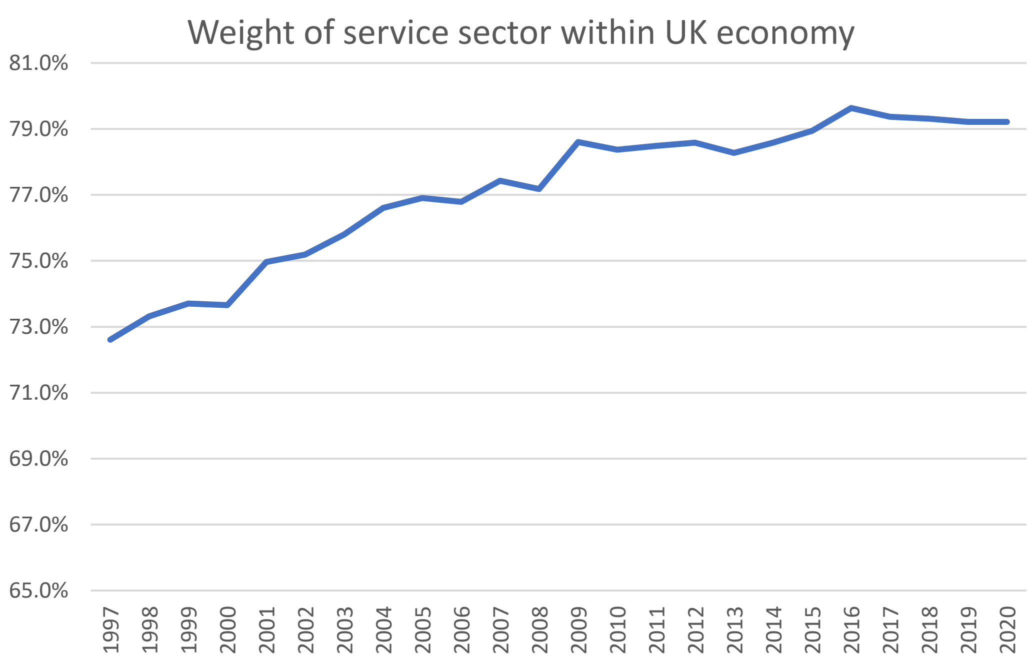


Figure 2: Plot illustrating increasing weight of services within UK economy from 1997 to 2020 (ONS, 2022)

2. Challenges in measuring quality change in the service sector

2.1. Quality adjustment methods

Standard methods used by the ONS to control for quality change in the price indices include (but are not limited to):

- **Direct volume measurement**. When the volumes of two products are directly observable, the price of the old product is pro-rated to make it comparable with the new product.
- **Option costing**. When the difference between two products consists of an extra option which can be directly valued at market prices, the price of the option is subtracted from the overall price difference.
- **Hedonic adjustment**. When characteristics cannot be directly valued at market prices, econometric methods are used to estimate the impact of observed changes in the characteristics of a product on its price.

Adjusting for quality change in the service sector is more challenging than for the manufacturing sector due to the often-heterogeneous nature of the products; most standard quality adjustment methods are therefore not practical for application. The quality of a service is a function of its intangible characteristics and can be subjective depending on the perspective of the individual. Intangible characteristics such as reliability, effectiveness, and customer satisfaction may vary over time resulting in changing quality.

Measuring changes in quality without clearly defined characteristics can prove more difficult when compared with physical products as they are more difficult to identify. Three key features of services are that they are intangible; perishable; and inconsistent. This diversity of activity within the service sector is a challenge and individual prices cannot always be easily defined, and are not common from service to service, or even within a specific service. Many services tend to be tailored to each client's needs, are unique, and change from period to period. Many businesses in the service sector can change rapidly, innovate and provide new products, resulting in key improvements in service quality which are difficult to capture. It is therefore difficult to track price changes over time and to separate pure price changes from changes in quality.

2.2. Pricing methods for measuring services

Ideally, there would be no need to apply additional quality adjustments to services if we were using a pricing method that inherently accounted for changes in quality or productivity.

The current pricing method used for a number of ONS' SPPIs is time-based – the survey asks how long workers of different grades/positions work over a given quarter and their standard charge-out rate. This method does not inherently account for any quality changes (for example any changes impacting productivity). Eurostat considers this a B method for pricing these services (Eurostat, 2016).

Model pricing may be a more suitable method for tracking price movements of unique products. In this case, the respondent will construct a model service that reflects its business or select a representative service that was recently transacted. The respondent is then asked to estimate the price of this service, had it been provided in each reporting period. This method should reflect any recent changes to labour costs which will reflect changes to productivity. This method however involves significant burden on the respondent, and it's necessary to update models to ensure they remain representative (Eurostat-OECD, 2014). Eurostat considers model pricing an A method for pricing these services.

There are other pricing methods which may be appropriate to use depending on the service – however we have focused on the time-based method as it's typically widely used, and model pricing as it is better at accounting for quality change in services.

3. Case Study: Application to Architecture & Engineering (71.1)

As a case study, we have investigated quality change in Classification of Product by Activity (CPA) 71.1 – Architecture and Engineering services. These services have made increasing use of emerging technologies over the last 10-20 years, and as such we would expect to see this reflected as quality change in our deflators. However, for the reasons outlined in section 2, we do not believe sufficient quality adjustment is currently occurring.

3.1. Architecture and Engineering sample

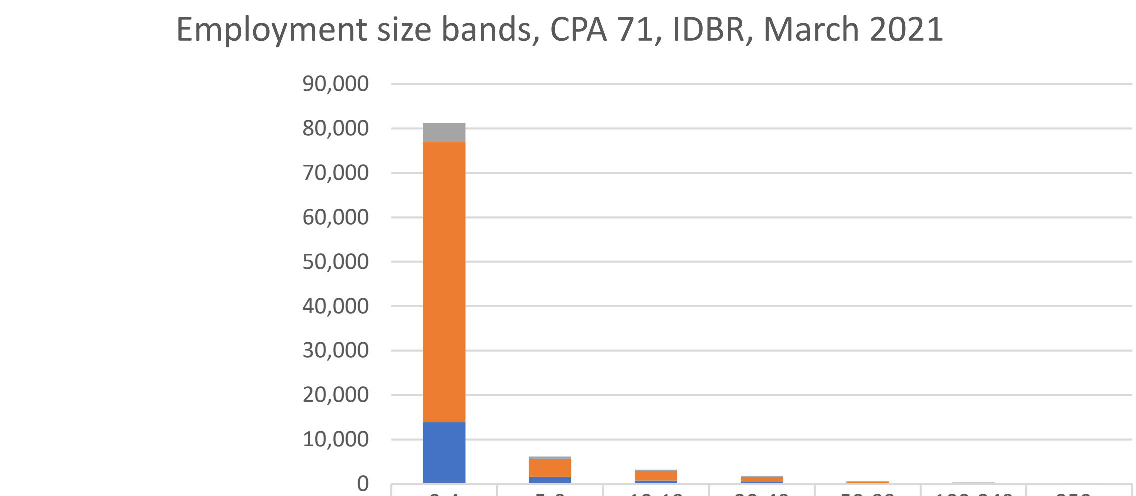
Table 1 details the sample composition of ONS' SPPIs for Architecture and Engineering services.

Table 1: Architecture and Engineering services

CPA 4dig	Sample Composition	Pricing and Price Collection Method	Coverage
Architectural Services (71.11)	39 Items 34 Suppliers	Time-based methods Survey – stratified random sample	Index is calculated using prices collected in the following CPA 6-dig categories: • Landscape architectural services • Building project architectural advisory services • Project site master planning services Categories not included in sample at present: • Rural land planning services • Urban planning services • Architectural services for non-residential building projects • Landscape architectural advisory services

			• Architectural services for residential building projects • Plans and drawings for architectural purposes • Historical restoration architectural services
Engineering Services and Related Technical Consulting Services (71.12)	72 Items 58 Suppliers	Time-based methods Survey – stratified random sample	Index is calculated using prices collected in the following CPA 6-dig categories: • Engineering services for industrial/manufacturing projects • Engineering advisory services • Project management services for construction projects • Geophysical services • Engineering services for building projects Categories not included in sample at present: • Map-making services • Geological and geophysical consulting services • Engineering services for water, sewerage and drainage projects • Engineering services for transportation projects • Engineering services for waste management projects • Engineering services for telecommunications and broadcast projects • Mineral exploration and evaluation services • Engineering services for other projects • Engineering services for power projects • Surface surveying services

ONS recognises that the sample coverage is low for the Architecture and Engineering SPPIs and is therefore aiming to implement sample improvements to these deflators in the future. CPA 71 also includes CPA 71.2 (Technical Testing and Analysis); this is a small component of CPA 71 in the UK and is not the focus of this work.



	0-4	5-9	10-19	20-49	50-99	100-249	250+
7120 : Technical testing and analysis	4,330	470	260	185	65	40	25
7112 : Engineering activities and related technical consultancy	63,020	4,030	2,180	1,270	415	190	120
7111 : Architectural activities	13,845	1,650	780	380	140	60	15

Figure 3: Employment size bands for Industry 71, based on the 2021 IDBR data (ONS, 2021)*. The IDBR (Inter-Departmental Business Register) is a list of UK businesses used by the government for statistical purposes and provides the main sampling frame for surveys of businesses by the ONS.*

As shown in Figure 3, CPA 71 is dominated by small businesses in the UK – more than 86% of businesses captured under CPA 71 have between 0 and 4 employees as of March 2021. As such, when surveying businesses we need to account for this in survey design by not placing unreasonable burden on the respondents.

3.2. Quality change in Architecture and Engineering

Increased digitalisation of architectural design and project management, and off-site manufactured construction are perceived to have led to a productivity revolution in this industry in recent years. However, our existing Architecture and Engineering deflators fail to recognise technological advancements in the sector.

Our research looks at implementing new quality adjustment to the Architecture and Engineering deflators to reflect the improvements made to these services. There have been several significant technological changes to these services over recent years, including the introduction of 3D Building Information Modelling (BIM). These technologies have enabled improvements such as better communication between parties working on a project and potential problems to be highlighted earlier in the work, which have positive implications for efficiency.

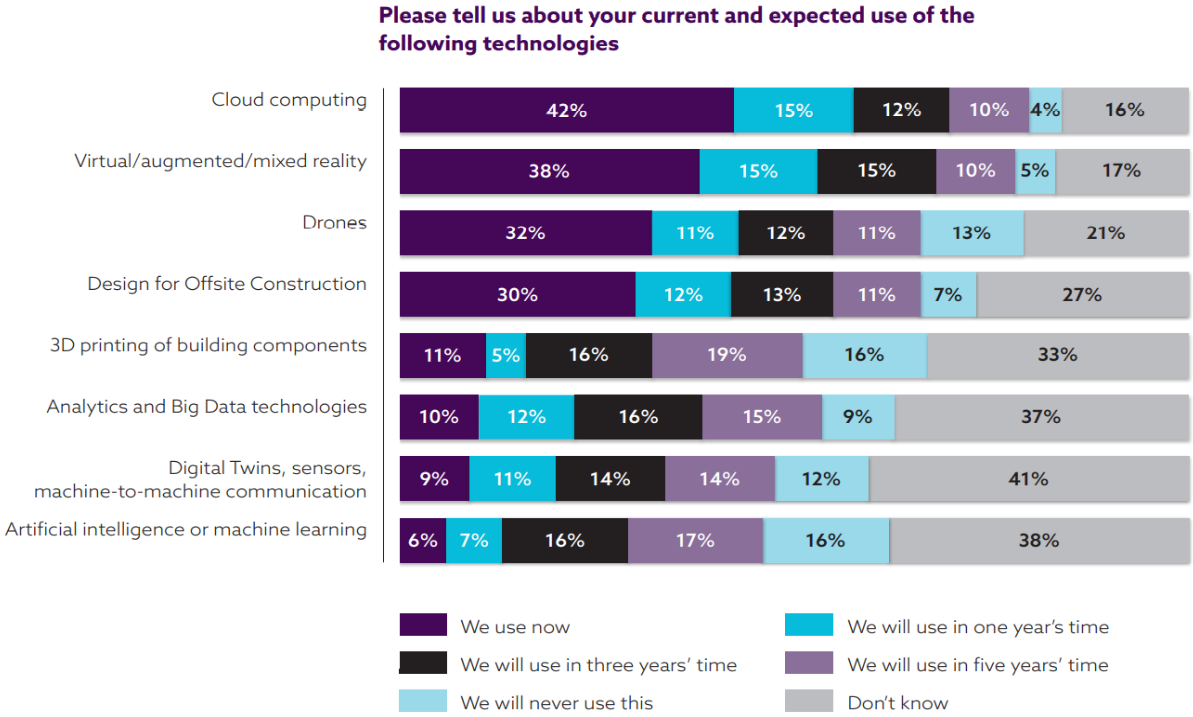


Figure 4: The current and expected use of a variety of technologies, according to a survey by the National Building Specification (NBS) of over 1,000 industry professionals (NBS, 2020)*. We do recognise that there may be some bias in this survey as a result of self-selection – those who use BIM and other technologies may have been more likely to respond*

Figure 4 shows the current and expected use of emerging technologies, according to a 2020 survey of more than 1,000 design and construction professions. This illustrates the widespread use of new technologies such as cloud computing, virtual reality, drones and design for offsite construction within the construction, architecture and engineering sector. In addition, it also highlights the potential changes likely to take place over the next five years, as further use is made of these technologies.

3.3. Case study: BIM

BIM is one such technology that has now entered mainstream use in the UK, as evidenced by Figure 5. In 2011, the UK government commenced a programme encouraging the use of BIM across public- and private-sector organisations involved in the construction of buildings and infrastructure (BIS, 2012). Since then, as is clear from Figure 5, there has been a rapid increase in awareness and use of BIM across those surveyed by NBS – 1061 individuals, with 27% of these architects. This timeline gives us some indication of the potential scale of quality change that has occurred since 2011 – which should be reflected in our deflators.

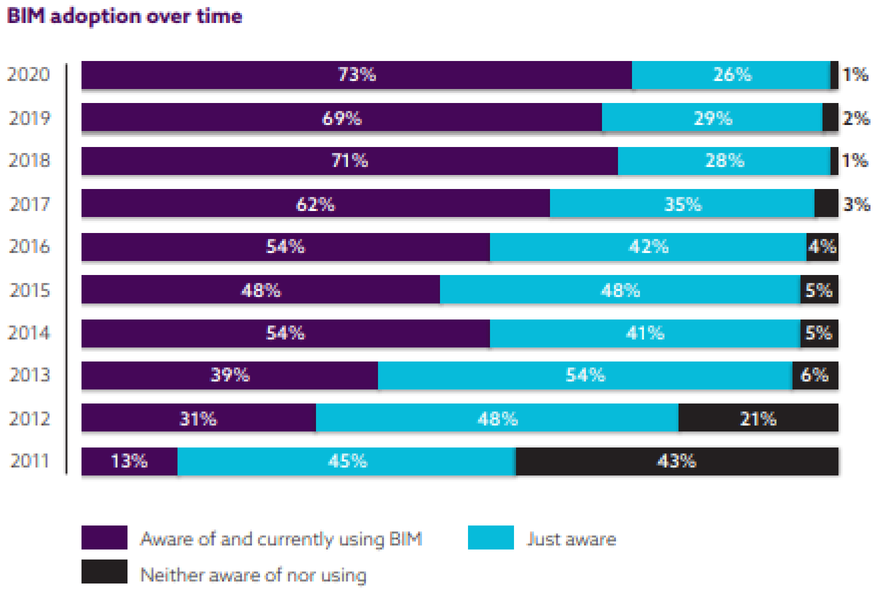


Figure 5: BIM adoption over time, according to NBS Annual BIM report (NBS, 2020)

Figure 6 illustrates some of the potential benefits of using BIM. The statement "Adopting BIM has made/would make us more productive" is especially interesting with regard to our understanding of how technologies such as BIM should impact productivity in these services. In general, the majority of these statements would all reflect increased quality in the service being provided.

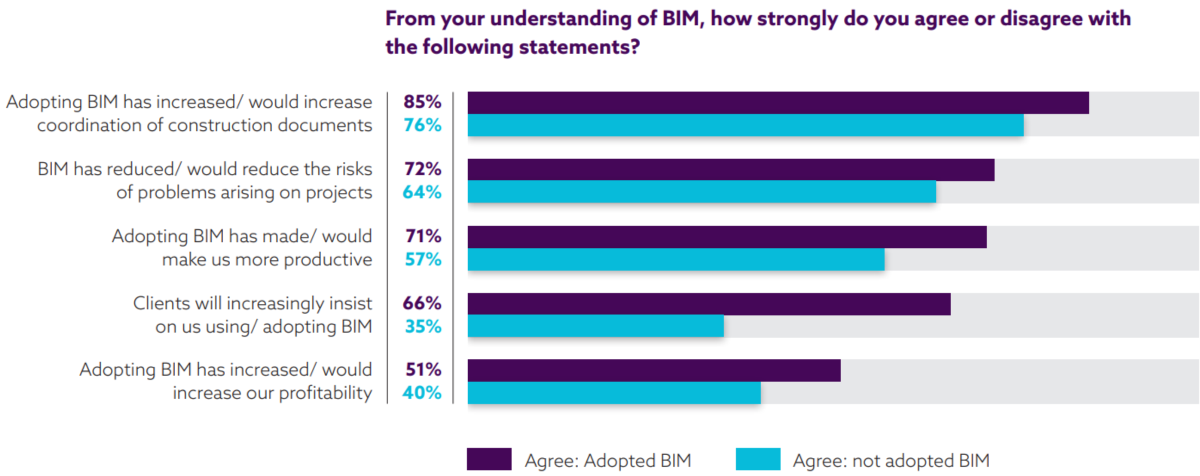


Figure 6: Opinions on a number of statements regarding BIM (NBS, 2020)

3.4. Proposed approaches for quality adjustment

Potential methods for adjusting for quality change in Architecture and Engineering services include:

1) Implementing a price adjustment using relevant proxies that could indicate quality change. For example, requests for information could be used as a proxy to indicate the number errors that arise in a project so these should reduce if technology changes increase the quality. Other proxies could include change orders (e.g. extra costs paid to contractors); non-conformance reports (detail work that fails to meet pre agreed quality standards); KPIs (e.g. client satisfaction, profitability, productivity); energy usage; accident rates; defects
2) As mentioned above, using a pricing method which allows for the inclusion of changes in quality or productivity – such as model pricing – would be preferable. However, whilst the introduction of this will be investigated it is unlikely to be practical to implement within a short time frame.

Approach (1) is the focus of this paper

3.5. Implementing a price adjustment using satisfaction as a proxy for quality

Proxy data on industry performance has been sourced from UK industry performance reports published by Glenigan (Glenigan, 2021). Glenigan is a market leader in the field of construction sales leads and marketing intelligence. The reports provide a snapshot of the construction sector over several years using Key Performance Indicators (KPIs). KPIs capture the sector's performance and provide a benchmark for comparison across the years, which allows firms within this sector to identify areas of improvement. There are various types of KPIs measuring different aspects of the sector: economic indicators, people indicators, and environmental indicators. While the KPIs in the Glenigan report cover the construction sector, we know that Architecture and Engineering have adopted many of the same new technologies (as evidenced in NBS survey discussed in section 3.3) and therefore assume that the trends also apply to Architecture and Engineering.

Economic indicators include measures such as client satisfaction, contractor satisfaction, profitability, and predictability (of different stages of the construction process such as project planning, design stage and the construction stage). People indicators include measures such as staff turnover, sickness absence, qualifications and skills, demographic of workers, and accident incident rate. Finally, the environmental indicators include measures such as on-site energy usage, median waste removed, mains water usage and commercial vehicle movements.

The KPIs from the Glenigan report provide a suitable metric to capture industry trends and we have utilised the KPIs to calculate a weighted index for quality adjustments. The client and contractor satisfaction measures which fall under the economic indicators have been used as we assume that change in satisfaction over time is a good indicator of quality change. Including just satisfaction KPIs will also ensure that there will be no collinearity within the measure. For example, client satisfaction and predictability of project time are likely to be strongly correlated so there is no value in including predictability in the measure.

Environmental indicators were not factored into the weighting index as these measures were more prone to being affected by other factors such as the types of projects for a given year. As a result, changes may not be a true indication of changes in trends of the environmental measures and therefore less representative of the quality or performance of the sector.

The client and contractor satisfaction measures can be further broken down into different categories:

- Client satisfaction
    - Product
    - Service
    - Value for money
- Contractor satisfaction
    - Performance (overall)
    - Provision of information (overall)
    - Payment (overall)

Figure 7: Percentage of responses that gave an 8 out of 10 score or above in relation to the client's satisfaction for product, service, and value for money

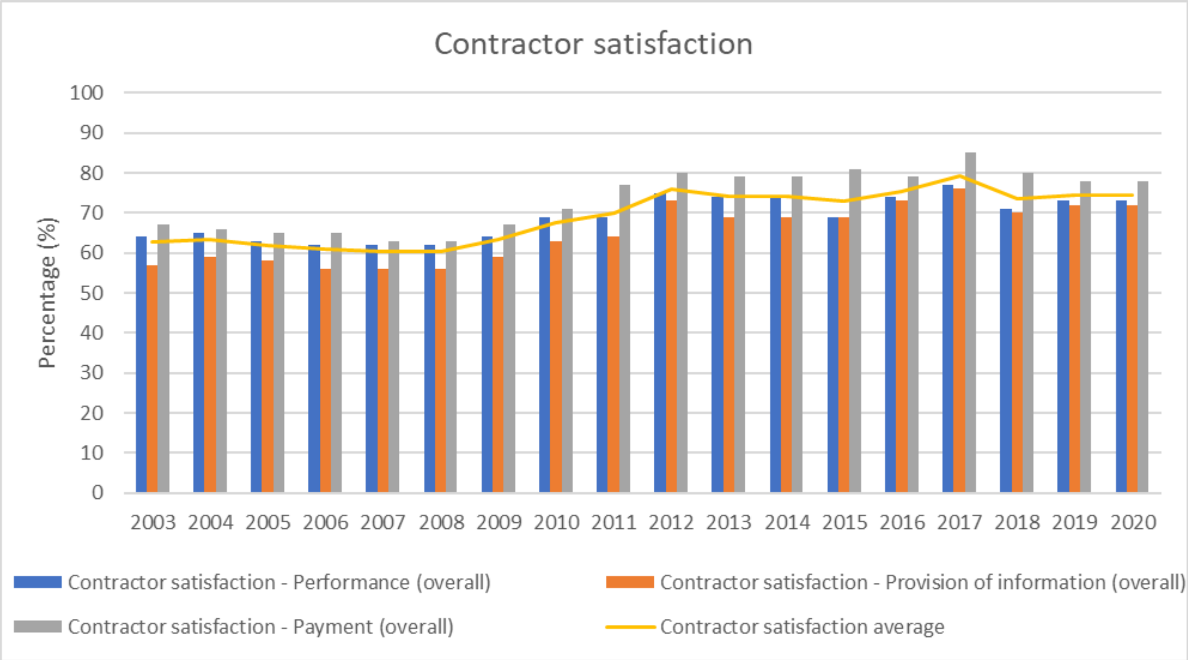


Figure 8: Percentage of responses that gave an 8 out of 10 score or above in relation to the contractor's satisfaction for the overall performance, provision of information and payment

Data for client and contractor satisfaction has been sourced back to 2003, and over that time both have exhibited a general upward trend, as illustrated by the averages shown in Figures 7 and 8.

The quality adjusted index was calculated as follows:

- Calculate a satisfaction measure, an arithmetic mean of the client and contractor satisfaction measures.

$$Satisfaction_t = \frac{Satisfaction_{client,t} + Satisfaction_{contractor,t}}{2}$$

- Calculate a quality index, a 3-year rolling average of the satisfaction measures to smooth out year-to-year volatility.

$$Quality\ index_t = \frac{\sum_{i=t-2}^{t} Satisfaction_i}{3}$$

- Re-reference the quality index and unadjusted index to 2010=100.

- Calculate a quality adjusted index, the ratio of the unadjusted index to the quality index multiplied by 100.

$$Quality\ adjusted\ index_t = \frac{Unadjusted\ index_t}{Quality\ index_t} * 100$$

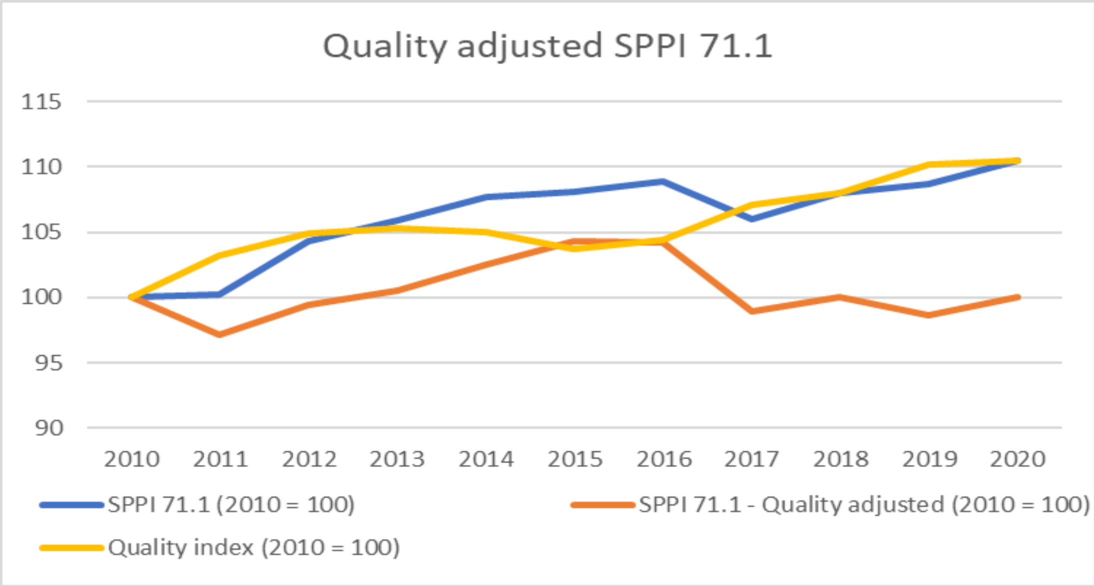


Figure 9: Quality adjusted SPPI for CPA 71.1.

As a result of applying the quality adjustment to the SPPI for CPA 71.1, the index exhibits a flatter trend when compared to the current SPPI, as shown in Figure 9. We propose that this illustrates that by taking quality change into account, the price index for CPA 71.1 has not exhibited overall growth between 2010 and 2020. While the current SPPI is increasing, suggesting increasing prices, by stripping out the quality change these price increases are offset. As a result of this, we would expect volumes calculated with the quality adjusted SPPI to show more growth than those calculated with the current SPPI. We would expect this to have therefore also led to higher productivity growth over this period.

4. Conclusions

The paper highlighted the difficulties in adjusting for quality change within the service sector. The heterogeneous nature of services often prevents applying quality adjustment using standard methods. The difficulties of measuring quality change in a growing service sector with increased digitalisation is likely to have contributed to an underestimation of productivity growth in recent years.

Applied to data on Architecture and Engineering services we used a proxy approach to quality adjustment using changes in scores for client and contractor satisfaction as proxies for quality change in the industry. The adjustment led to plausible estimated inflation rates for Architecture and Engineering services, which would result in higher productivity estimates in recent years. This is to be expected due to increased use of new technologies such as BIM, which have proven to have positive impacts on efficiencies of projects.

We recognise that there are some potential limitations to this research. The KPIs used are specific to the construction sector and we have assumed that Architecture and Engineering has experienced similar change. Furthermore, we have only currently included economic indicators within our proxy measure of quality change. We will continue to investigate additional data sources which may be more suitable for developing quality indices as well as considering the use of additional KPIs such as people and environmental indicators.

We hope that this method may provide a practical and pragmatic approach to quality adjustment using proxies, which may have implications for how we can approach quality adjustment for other fast-changing services – such as computer services. This could in turn have positive effects on measurement of productivity.

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