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The productivity puzzle: Is it just about the data?

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ABSTRACT

Measuring construction industry productivity at any level above that of site activities such as bricklaying or plastering remains a vexed question. A variety of methods have been developed and tested but results are often far from consistent with different methods that appear equally valid in theory producing quite different results. A recent study conducted in Australia demonstrated the application of different methods that produced some similar results but with some care required in the analysis of the outcomes. Another example showed large variations in results following the application of a similar method to different yet apparently equally valid datasets. Analysis of these studies shows that it seems likely that the differences are often a function of the quality of the data rather than the underpinning theory. The second example displayed methodological problems as well as data reliability issues.

Keywords: construction productivity, construction project data

INTRODUCTION

It is often suggested that while productivity in some industry sectors, notably manufacturing and agriculture, has increased steadily over recent decades, productivity in construction has at best been stagnant or has even decreased. This seems counter-intuitive as there have been many improvements in materials, equipment and processes such as building information modelling (BIM) and the introduction of mobile IT devices such as tablet computers and smart phones.

While there may be reasons for the perception of declining productivity such as the increasing complexity and improved quality of buildings (see, for example, Bernstein, 2003) there are those who question both the data and the methods used for measuring productivity in construction (e.g. Rojas and Aramvareekul, 2003).

Certainly there is no consensus in regard to exactly how productivity should be measured and obtaining reliable data is always a challenge, and it is a challenge that is magnified when international comparisons of productivity are attempted. In this paper two recent exercises are examined and some observations are made about the relationship between the quality of the data and the methods used to interpret that data.

A CONSTRUCTION PRODUCTIVITY COMPARISON - AUSTRALIA

The first study discussed here was completed in late 2012 (Best *et al*., 2013). The authors used three complementary methods to compare construction productivity between states in Australia; while it was originally intended that all states would be included problems with obtaining sufficient data from South Australia and Western Australia meant that viable comparison were only possible between the eastern states and for two of the methods the comparisons were really between capital cities.

The three methods used were:

- A performance index based on cost (*c*), time to construct (*t*) and floor area (*a*) (for details of method see Langston and Best, 2001)

- Comparisons of industry output, persons employed and hours worked using data published by the Australian Bureau of Statistics (ABS)

- A measure based on a fixed weight basket of inputs (labour and materials) called a BLOC (Best, 2010)

Each method required a different dataset. For the performance index figures for cost, time and area were found in the public domain for a total of 79 projects of 20 storeys or more completed in the previous ten years (2003-2012) in Melbourne, Sydney and Brisbane (including Gold Coast). Published ABS data for construction output, persons employed and hours worked for the various states was collected from the ABS website. Materials and labour costs for the BLOC were collected by direct survey, with quantity surveyors and contractors' estimators supplying input costs for a basket comprising 22 materials/components and four classes of labour.

Data issues

Collecting data for each part of the study presented its own challenges.

Project data for the Performance Index

The project–level data for the production of performance indices was initially sought by direct contact with quantity surveyors and major contractors, however, after considerable effort and expenditure data (often incomplete) was collected for only 20 projects with a number of major firms refusing to part with data that they claimed was confidential.

Subsequently data for many more projects was found to be freely available from internet sources and, in a later extension of the study, data for over 200 projects of similar scale and age in four US cities were obtained in this way. Direct contact with project participants (e.g. architects and builders) provided validation of roughly a quarter of the Australian dataset and that suggested that the data in the public domain was generally reliable. In some instances though common sense had to prevail as data emerged that seemed absurd, e.g. unvalidated cost and floor area data for one office building suggested a GFA rate in the order of $15,000/m^2 where the highest rates for similar buildings of similar age obtained from cost books such as Rawlinsons did not exceed $6000/m^2. The key would appear to be in gathering large datasets so that the effect of outliers is limited when mean values are computed. The real concern is that firms withhold information from researchers on the grounds of confidentiality when the information is not sensitive and may actually be publicly available. Validating data that is found in the public domain is time-consuming and difficult so it would be much preferred if robust data could be made available to researchers directly. Given that university research is monitored by sometimes over-zealous ethics committees and that data analysis routinely sees data aggregated and presented as anonymous averages or samples this reluctance by industry to support research is unfortunate.

Data for the macro-level comparison

The ABS data was freely available on a state by state basis but not on a city by city basis and there was no way available for the state data to be disaggregated. This meant that the results from this part of the study were not necessarily directly comparable to the results produced by the other methods. The ABS data is for ‘all construction’ which includes engineering construction; this contrasts with the data collected for the BLOC and the performance index which is generally based on city buildings. Differences in results such as the finding (Best *et al.,* 2013) that 20% more labour was required for construction work in Queensland than in Victoria were probably skewed due to the high levels of activity in engineering construction in that state and the remote location, complexity, uniqueness and scale of many of those construction projects. As this study was confined to Australian states there was no issue with differences of approach between the national statistics offices of different countries but this becomes a major problem when international comparisons are attempted.

Input costs for the basket of inputs

A number of issues with input costs for baskets of goods appear often in exercises of this type (Meikle, 2012). A common problem is the provision of “supply and fix” rates rather than basic input costs, e.g. where a basic supply price for a material such as plasterboard is asked for respondents simply insert all-in unit rates that include labour, wastage and sundries such as fixing and jointing materials (Best, 2008). At worst respondents give rates for whole assemblies rather than for the basic material; one example encountered by Best (2008) in an earlier study had a respondent entering a unit rate for plasterboard around ten times that supplied by other respondents from the same city. When queried the respondent checked and it was found that the rate quoted was for a complete stud wall including plasterboard, framing, insulation and the labour required to install and fix the materials.

If respondents do not indicate that they have priced in some way other than that specified researchers are left to decide whether to include or delete the suspect data or assume that the rate is incorrect and adjust it. Neither option is attractive as the first limits the coverage of the dataset while the second could be seen as making the data invalid but this step is often necessary if research is to proceed. As Stapel (2002: 8) puts it, "[t]he issue of the validation of the prices is an important but difficult one, because there is no 'right answer' ….. results can only be assessed on a qualitative basis, i.e. whether they 'look' or 'feel' right."

As the number of countries increases and expands to include countries in differing stages of development the data problems multiply. The World Bank's International Comparison Program (ICP) routinely collects comprehensive cost data across many economic sectors and many countries; in the current round of pricing the scope has expanded to cover nearly 200 countries (World Bank, 2013). To collect construction costs the ICP is using a basket of resources that includes input costs for a range of materials and components, several classes of labour and some items of plant and equipment. The greatest challenge in this exercise is in populating a basket with items that are reasonably typical of construction practices in all locations and are thus representative of construction work generally in each place and similar enough to be comparable. Assuming that such a basket can be assembled the challenge of collecting accurate prices for the items becomes apparent. Items need to be tightly specified to ensure comparability yet there needs to some scope for variations so that the items priced are reasonably representative of local practice. Finally there is the question of how many observations can be collected in each location; expert input is required and often the costs associated with price collection determine that only one set of prices is collected in each country. Extensive validation exercises are required to confirm the data; this is both time-consuming and expensive and may or may not actually produce better results as respondents often have little interest in the process and when questioned can simply try to provide the answers that they think the collectors wish to hear (Meikle, 2012).

Results

The results of both the project based (performance index) and input based (basket of inputs) methods showed Victoria not to be performing as well as New SoutH Wales or Queensland. The exercise based on ABS data suggested that industry performance, based on the ratio of total employment to output, was very similar in Victoria and New South Wales with Queensland not doing as well; when based on the ratio of hours worked to output Victoria trailed NSW but appeared to be doing better than Queensland. It is important to note that in the macro study (using ABS data) the data is state-based rather than city-based and the data is for 'all construction' and thus includes engineering construction. The difference is results for Queensland in this case may well be due to the high levels of activity in engineering construction in that state and the remote location, complexity, uniqueness and scale of many of those construction projects. These are all factors that are likely to affect a measure such as the ratio of hours worked to output and thus the apparent difference in results for Queensland were not considered to be critical.

AN INTERNATIONAL CONSTRUCTION COST COMPARISON

In June 2012 two Australian newspapers published articles referring to 'landmark' research into the relative cost of construction in Australia and the US (Hepworth, 2012; Forrestal and Dodson, 2012). The articles were based on a report published by the Business Council of Australia (BCA, 2012) which claimed not only that Australia was a much more expensive place to build but also that productivity was low. Best (2012) showed various flaws in the methodology used and produced quite different outcomes by using similar data from different sources. Best also noted the BCA's erroneous conclusion that apparent differences in the cost to build between the countries were indicative of productivity differences.

Data issues

There are two potential data issues here: one relates to the use of a single set of data and the second relates to the problems that arise when using data from different countries when there is little consistency in how data is collected and presented by firms and agencies in different countries.

In the BCA report freely available $/m2 rates for a number of building types were used to compare construction costs between the US and Australia. The report claimed that it is was considerably more expensive to build in Australia: airports, they said, were 90 per cent more costly and hospitals 62 per cent more expensive with other projects ranging from 26 to 43 per cent above. Best (2012) discussed a number of problems with the methodology used including the inappropriate conversion of costs to a common currency using money market exchange rates, however, the focus here is on the data used.

The report relied on building costs published by a major international construction consultancy (Turner&Townsend, 2012). Similar data is available from a number of credible sources including those published by other large consultancies (e.g. RLB, 2013). In most cases these costs are published as a publicity exercise and they carry clear caveats, e.g. Rawlinsons (2012: 868) say: “Costs given are average prices for typical buildings, they provide no more than a rough guide to the probable cost” [emphasis added].

Best showed that, regardless of how costs were converted to one currency, simply using data from a variety of sources produced very different results. For example, using building costs published by Davis Langdon (2012), another large international consultancy, Best showed that hospital were 45 per cent and schools 50 per cent *less* expensive in Australia compared to the BCA claim that they were 62 per cent and 26 per cent *more* costly in Australia even when the same method of calculation was used and thus the difference in outcomes was purely to do with the data used. Tables 1 and 2 provide a snapshot of the differences that appear when the same method is applied to different datasets.

Table 1 2011: Turner&Townsend data, annual average exchange rate (0.97AUD=1USD)

	US cost/m2 (USD)	**Aus cost/m2 (AUD)**	**Aus cost/m2 (USD)**	**Difference**
Shopping centre	1560	2172	2235	+43%
Hospital	3300	5185	5337	+62%
School	1570	1919	1975	+26%

(Source: Best *et al.* 2013)

Table 2 2011: Davis Langdon data, annual average exchange rate (0.97AUD=1USD)

	US cost/m2 (USD)	**Aus cost/m2 (AUD)**	**Aus cost/m2 (USD)**	**Difference**
Shopping centre	3033	2353	2424	-20%
Hospital	7033	3771	3864	-45%
School	3267	1600	1648	-50%

(Source: Best *et al.* 2013)

There are a number of potential causes for these apparent inconsistencies; it is not simply that one set of costs is wrong and another right. One explanation is that there is no agreed set of rules for how building area is measured nor for what costs are included in “total” cost.

The first is well illustrated in a paper published by the European Council of Construction Economists (CEEC, 2004); Table 3 shows the differences in gross floor area for an identical building as measured using local measurement conventions in a number of European countries.

Table 3 GFA for a typical building as measured in various European countries (UK base)

Country	GFA (m2)	Variance
UK	2585	-
Switzerland	2875	+11%
Holland	3007	+16%
France	3412	+32%
Finland	2758	+7%
Denmark/Spain	1800	-30%

(Source: CEEC, 2004)

The markedly lower GFA reported in Denmark and Spain is a result of basement floors being excluded from GFA in those countries. The remaining countries, however, show larger GFAs than the UK and while the CEEC does not provide any explanation for these variances it is likely that they relate to factors such as the inclusion or exclusion of areas such as voids at lift and stair wells, and floor area occupied by internal and external walls. Such measurement may be carried out reasonably consistently within a country but there is certainly no standard set of rules that is applied across national boundaries.

It could be argued that the data published by one company should be consistent as data are collected from offices that are part of the same company but in reality the co-ordinators of these exercises are reliant on the goodwill of respondents in their various offices and often struggle to obtain any data (Emmett, 2012). In that situation it is hardly surprising that the way building areas are measured may vary as regional offices would presumably use local methods and may not spend the considerable time necessary to adjust their historical data to match other conventions. The same applies to how costs are recorded: the range of possible inclusions and exclusions is extensive. For example, results will vary depending on whether cost factors such as design fees and value-added tax are recorded as part of building or project cost. The range of cost/m2 rates across a number of countries can become very large when differences in both area measurement and cost reporting are added together.

CONCLUSION

Assessing productivity in construction at any level above that of individual site activities is a tricky business for a variety of reasons. Apart from the lack of agreement on methodology there are fundamental problems associated with available data that have to be addressed. Equally any conclusions drawn based on that data must be tempered with due regard for the potential for variations in data that can substantially skew results. To paraphrase one of the World Bank’s ICP consultants, “We may be able to devise the best possible method but if we can't get good data to feed into it, it's virtually useless" (Meikle, 2012).

The best approach at this stage is seek out data from as many sources as possible and look for averages of samples that are sufficiently large that the impact of outliers and anomalies is minimised. Certainly some caution is warranted in assessing studies such as that published by the BCA and discussed above. Apart from the methodological problems that have been identified the data on which the conclusions about Australia being a high cost/low productivity environment for construction are based has been shown to be quite different to comparable data from other sources. The choice of base data had a significant effect on the conclusions reached and had different data been used the outcomes that made good headlines at the time of publication could have been quite different.

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