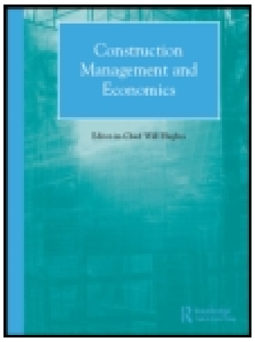

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Trends of productivity growth in the construction industry across Europe, US and Japan

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Productivity is a key driver for economic growth and prosperity in any country. The pursuit of productivity growth requires an understanding of the factors affecting productivity. The trend of productivity growth, along with the possible factors underlying such growth across Europe, the US and Japan, is thus examined. In particular, there is a focus on comparing the productivity performance of the construction sector to that of other industries. Using the recently released EU KLEMS[1] database,[2] a growth accounting framework was adopted to assess the contribution of the following factors to productivity growth (during 1971–2005): capital, labour quality and total factor productivity (TFP). It was found that there is a general slowdown in labour productivity growth in total industries including construction across major OECD countries, with the exception of the UK. The differences in labour productivity growth between construction and total industries can be largely explained by construction's poor TFP performance. With the exception of the UK, TFP negatively contributed to labour productivity growth in the period 1990–2005, suggesting that the industry has become less efficient in combining the factors of production. That phenomenon seems to be consistent across all selected countries and warrants further investigation. Indeed a better understanding of the factors underlying productivity growth in OECD countries is a prerequisite for effective intervention of policy makers to support sustained productivity growth.

Keywords: Productivity, growth accounting, skills, capital.

Introduction

The wealth of nations is determined by nations' productivity performance (Smith, 1776). Higher productivity translates into higher wages, profits and tax revenue, and cheaper and better products and services for customers, thus benefiting society as a whole. Given its overriding importance for society's prosperity, raising productivity is and has always been a top policy priority, as exemplified by the EU's Lisbon Agenda. Economic policy in OECD countries policy has thus called for 'productivity-enhancing' reforms with a particular emphasis on measures for enhancing human capital (OECD, 2009).

An economy's productivity performance can only be as good as the performance of its constituent parts. The construction industry is a significant contributor to the economy in most countries. According to Arditi and Mochtar (2000), the construction industry accounts for 6–8% of an economy's GDP. An improvement in construction productivity performance not only would raise profits and earnings in the sector, but could provide substantial cost savings. For example, an increase of 10% in the UK construction labour productivity is equivalent to a saving of £1.5bn to the industry's clients, sufficient to procure perhaps an additional 30 hospitals or 30 000 houses per year (Horner and Duff, 2001). As such, these cost savings could be used to pursue other projects and thus support further economic growth.

An understanding of the factors underlying productivity growth across the economy, including the construction industry, is essential for helping policy makers and practitioners to take effective action that would support such growth. A plausible way for understanding the drivers for productivity growth is to draw

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up cross-country productivity comparisons for the construction sector, though it is often plagued by difficulties in obtaining adequate and consistent data (Pilat, 2001; Crawford and Vogl, 2006). Thus, the release of the new EU KLEMS database presents a fresh opportunity for drawing up an adequate cross-country comparison given that it 'provides a consistent structure in which data on output and inputs can be collected, both across industries and between variables, and as such it is a powerful organising principle' (O'Mahony and Timmer, 2009, p. 391).

A key objective of the EU KLEMS database is to look beneath the aggregate economy level and examine the productivity performance of individual industries and their contribution to aggregate growth. Previous studies have shown that there is enormous heterogeneity in output and productivity growth across industries, so analysts should focus on the industry-level detail to understand the origins of the economic growth process. Substantial efforts were undertaken to ensure harmonization of the basic data, and to generate data in a consistent and uniform way across countries and time (Van Ark and Woltjer, 2008). Thus, this research aims to use this new dataset to explore the factors underlying productivity growth in major OECD countries with a focus on comparing the construction industry with other industries.

Inter-country productivity assessment

There are three approaches for inter-country measurement of productivity, namely: macroeconomic, case and pricing studies (Edkins and Winch, 1999). The major differences between these approaches are: the source of data, their level of aggregation, the boundary/definition of the production process and the completeness with which it is described (Chau and Walker, 1988).[3]

While there are plenty of examples of the aforementioned approaches in the literature (see for example Edkins and Winch, 1999), existing work is typically weak on providing empirical evidence on the underlying causes of differences in productivity across countries. In the construction industry, site-based productivity comparisons (case studies) are preferable because they help construction companies to identify areas for improvement that relate to their business activity. Such an approach, however, would require a sufficiently large, consistent and representative cross-country projects database, containing both qualitative and quantitative information on construction outputs and inputs.

Given that such data are not readily available and are resource intensive to collect, previous productivity studies that use a construction site approach typically focus on a few projects and particular type of construction work, such as house building (Clarke and Wall, 1996) or high rise concrete construction (Proverbs *et al.*, 1999). That makes it difficult to generalize and provide an overall assessment of the state of productivity in the construction industry. There is also evidence in the literature which suggests that there is a divergence between productivity measured at the macro and micro levels which points to a discrepancy between aggregate and activity measurements. It was found in the US (during the period 1976–98) that an improvement in productivity performance at the activity level in the construction industry was not captured in the industry's overall productivity performance (Goodrum *et al.*, 2002).

It comes as no surprise that the UK Department for Business, Innovation and Skills (BIS), formerly the Department of Trade and Industry (DTI), and the EU Commission have in recent years expended considerable efforts in creating datasets (for all sectors of the economy including the construction industry) with the aim of informing policy for productivity and economic growth (Mason *et al.*, 2008). The application of this 'macroeconomic approach' to the construction industry is common and can be found in the Royal Commission into the Building and Construction Industry (2002), Blake *et al.* (2004), and Ive *et al.* (2004).

Summing up the experience of these studies, any ranking of countries at sector level is highly problematic, as these estimates do not compare like for like, definitions and capture of resource inputs may differ substantially across countries and exchange rates used to convert output into a common currency are subject to substantial criticism and are often arbitrary.

Comparisons of international differences in growth rates, however, should be more robust, as these are not affected by exchange rates and are less affected by international differences in data definitions and capture, provided these differences are fairly constant over time.

The EU KLEMS database provides a sound basis for drawing up cross-country comparisons of output and productivity growth particularly given that it is rooted in neo-classical production theory (see O'Mahony and Timmer, 2009). The findings below are therefore based on comparisons of productivity growth rates rather than productivity levels. Data were obtained from the EU KLEMS database for five major OECD countries, namely: the USA, the UK, Germany, France and Japan. The definitions and measures adopted for productivity and its growth, in addition to the factors underlying growth, namely: capital inputs; labour quality (skills); and total factor productivity (TFP), are subsequently discussed.

Definitions and measures

Productivity and growth measures

Productivity describes the output potential of a production process conditional upon its inputs. Most papers on construction productivity measure productivity as average labour productivity (ALP). The calculation of average labour productivity involves dividing some measure of output (gross value added, and sometimes gross output) by labour input (number of workers, or hours). Economists tend to prefer estimating multi-factor production functions for more in-depth productivity analysis where there is a need to separately identify the contribution of all determinants to productivity growth.

Researchers can choose from a variety of estimation methodologies: index number based growth accounting methods, data envelope analysis (DEA), and econometric methods. All these methods have their strengths and weaknesses.[4] This paper presents an application of a growth accounting framework which provides a useful starting point for the identification of the contributions of the proximate sources of productivity growth (O'Mahony and Timmer, 2009). Under a growth accounting framework, labour productivity growth measured as real value added per hour worked is expressed as follows[5]:

$$A\dot{L}P = \dot{y} - \dot{e} = (\alpha_e - 1)\dot{e} + a_e\dot{q} + a_k\dot{k} + a_{k-ICT}\dot{k}_{ICT} + T\dot{F}P \quad (1)$$

Output, y, is defined as the growth rate of real value added; e is the growth in hours worked; q is the rate of labour quality improvement; k is the growth in non-ICT capital services; k_{ICT} is the growth in ICT capital services; a represents factor shares and TFP is the growth in total factor productivity.

TFP represents technological progress in the production of outputs for a given set of inputs. These may include quality of management, knowledge and techniques, and best practice in various construction activities or regulation.[6] Equation 1 thus suggests that labour productivity growth is determined by growth in hours worked, labour quality improvements, capital services growth and TFP growth.

Labour quality

Labour quality is commonly measured by the change in qualification levels in each country. Steedman (1999) argued that qualification levels are a respectable proxy for skills within the context of developed economies. Previous research has tended to divide the labour force into three or four categories of formal qualifications and then attempt to match those categories across countries (see e.g. O'Mahony and de Boer, 2002).

This method is sensitive to the allocation of qualifications to the various categories, which is fraught with difficulty due to the differences in education and training institutions and formal qualifications systems in each country. It has also to be noted that the definition of skills could also refer to a wide range of things, such as: reading, writing reliability, communication, reasoning, problem solving and motivation to assertiveness, judgement, leadership, team working, customer orientation, self-management and continuous learning (Payne, 2000).

While there is an increased interest in how skills in Britain have changed over time, how they are distributed, and how these trends and patterns compare with competing nations, there is surprisingly little agreement on what 'skills' actually refer to (Felstead *et al.*, 2002). For a further discussion of the definition of skills see Abdel-Wahab *et al.* (2005). For the purpose of this paper, we follow the EU KLEMS database which provides a breakdown of different skills levels (measured by qualifications) and uses that information to compile a labour quality index.

Capital inputs

A measure of the capital stock should represent the total amount of capital services available for producing output, i.e. adjusted for efficiency losses due to physical deterioration and technical obsolescence. The perpetual inventory method (PIM) is the standard approach used by national statistical offices. This involves cumulating investment flows and adjusting for depreciation, where possible, differentiating by type of asset.[7] In the following analysis a distinction will be made between ICT capital and non-ICT capital.[8]

Total factor productivity (TFP)

In a perfect world, estimates of production functions, from which TFP is derived, take full account of the contribution of all inputs to output. Such 'pure' TFP measures show how efficiently the various inputs to the production process are combined. Essentially, TFP measures the increase in output that is not attributable to an increase in measurable inputs, namely: labour and capital inputs.

These efficiency gains could be brought about by a range of intangible measures, such as improved technology, better management, organization and regulation. TFP could be interpreted as an aggregated proxy measure for these influences on productivity, and is often used as a measure for the impact of innovation on economic activity. As countries develop, innovation gradually becomes the most important source of economic growth since the growth potential of other sources, such as capital accumulation and technological imitation, becomes exhausted.

However, TFP has its own problems, the main one being that it is only as good as the measures of outputs and factor inputs it is derived from. Besides measurement problems and noise in the data, TFP could also pick up business cycles, economies of scale, changes in the output mix and quality and various other difficult or impossible to measure determinants of construction output.

Findings and discussion

Productivity growth

The following section shows productivity trends, where productivity is measured as value added per hour worked, and drivers of productivity growth in selected countries. The national construction industries are benchmarked internationally but also against the total of all industries in the respective national economies. Figure 1 shows that there was—with the exception of the UK—a general slowdown in labour productivity growth across major OECD countries. Furthermore, productivity growth in construction has been below total industries in all countries over both sub-periods and has further decelerated in the second period, where Germany and Japan experienced the largest deceleration. In fact, labour productivity in construction declined between 1990 and 2005 in Germany and Japan.

Clearly, the productivity growth of the construction industry lags behind total industries and the productivity performance of the UK construction industry does not appear to be worse off compared to other OECD countries—though this does not imply a better productivity level in the UK—as the data are based on growth rates as opposed to actual values. Previous studies suggest that the US is about 25–35% ahead of the UK and Germany in terms of ALP in construction (Ive *et al.*, 2004).

A decline of productivity, in particular for the construction industry, has negative repercussions on the economy. Brackfield and Martins (2009) showed that labour productivity growth declined significantly in the years prior to the current financial crisis, particularly in the US construction sector. They argued that financial markets may have failed in that they did not detect the deterioration of structural productivity trends in the early 2000s. Thus, the aforementioned finding is interesting to note as it points to the progression of the downward spiral in productivity pre-2007. It also highlights the significance of the construction sector as a key barometer for the economy.

Factors affecting productivity growth

The EU KELMS data can also provide insights into the underlying causes of the above trends in average

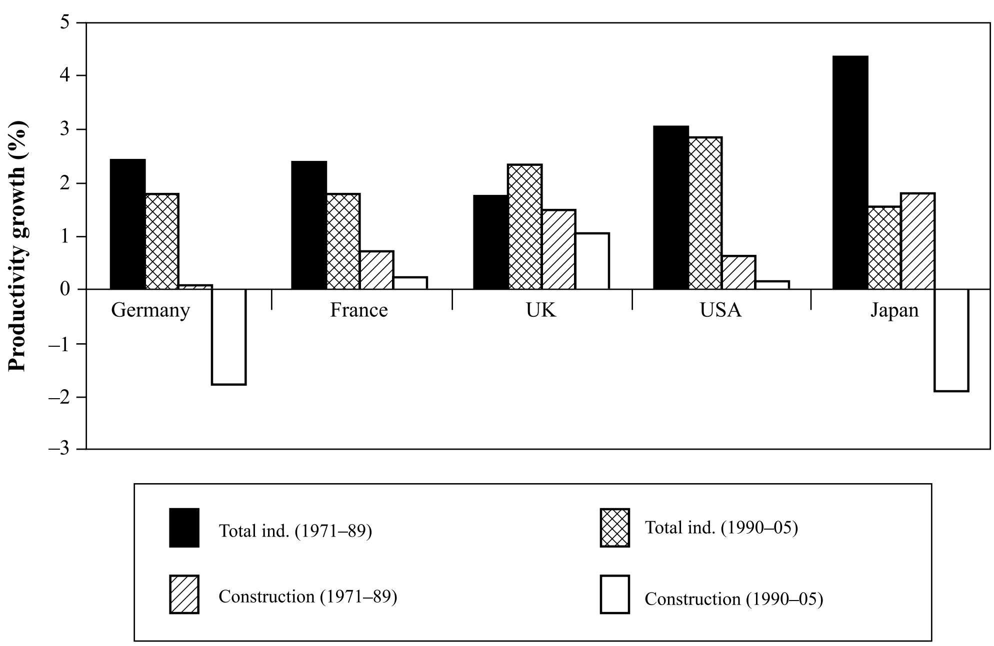

Figure 1 Average annual labour productivity growth across major OECD countries (1971–2005)

Table 1 Average annual labour productivity (ALP) growth (%)

	Construction		Total industries	
	1971–1990	1990–2005	1971–1989	1990–2005
Germany	0.05	−1.77	2.40	1.80
France*	0.73	0.25	2.37	1.84
UK	1.49	1.06	1.73	2.35
USA	0.63	0.17	3.01	2.84
Japan**	1.83	−1.91	4.35	1.55

Notes: *Growth accounting data for France pre-1981 are not available. **Growth accounting data for Japan from 1970 to 1973 are not available.

annual labour productivity growth. The contributions of: working hours, labour quantity and quality, capital (ICT and non-ICT) and TFP to the average annual labour productivity growth are shown below. The findings presented are based on the premise that the accumulation of physical and human capital can provide an explanation for productivity growth over the long term (Sharpe, 2001).

Working hours

It has to be noted that the percentage contribution from growth in hours was minimum—which indicates that there was not a significant change in the number of hours worked over the entire time period. The effect of cyclical fluctuations in employment and working hours seems to cancel out over the long run.

Labour quality

Table 2 suggests that—with the exception of Japan—the contribution of labour quality (skills) improvements to productivity growth in construction had been rather weak in the period 1971–89, and had been below the contribution of skills improvements to total industries productivity growth. In Germany, the contribution of labour quality to productivity growth was roughly the same in both sub-periods.

However, in the UK, France and the USA there was a significant increase in the contribution of labour quality to productivity growth during 1990–2005. This finding is consistent with Scarpetta *et al.*'s (2000) findings that during the 1990s, the quality of labour directly contributed to labour productivity growth across all OECD countries. Indeed the demand for more and better skills has risen in response to more and better technology (Pilat, 2001). Nonetheless, the gap between construction and total industries figures declined during the second sub-period in France, the UK and the USA—which indicates an improvement in labour quality in those countries.

ICT capital

The most significant contribution of ICT capital to construction productivity growth was in the USA and the UK. In Germany, France and Japan the effect of ICT capital on productivity growth remained roughly the same. These findings are consistent with the European Commission (2006) report which found that the largest contributions of ICT capital to GDP growth were found in the USA, UK, whereas there were low contributions in Germany and France.

Moreover, Gust and Marquez (2004) found that ICT use was a key driver of productivity growth in the US during the 1990s, as opposed to other industrialized countries which lagged behind in terms of their adoption of ICT. There has been an increase in the contribution of ICT capital to construction productivity growth in the USA and the UK.

In Germany, France and Japan the effect of ICT capital on productivity growth remained roughly the same over both sub-periods. However, the contribution of ICT capital to improvements in construction productivity seems to be rather limited and is significantly lower than in total industries, to some extent reflecting the more limited scope for the use of ICT equipment in construction. This finding is particularly echoed in the UK construction industry where businesses are reluctant to invest in IT due to the

Table 2 Contribution of labour quality to ALP growth

	1971–1989		1990–2005	
	Total industries	Construction	Total industries	Construction
Germany	0.23	0.10	0.00	0.11
France*	0.58	0.10	0.45	0.32
UK	0.17	0.09	0.47	0.39
USA	0.15	0.09	0.20	0.22
Japan**	0.53	0.55	0.39	0.44

Notes: *Data for France pre-1981 are not available. ** Data for Japan from 1970 to 1973 are not available.

Table 3 Contribution of ICT capital to ALP growth

	1971–1989		1990–2005	
	Total industries	Construction	Total industries	Construction
Germany	0.25	0.09	0.35	0.08
France*	0.20	0.14	0.25	0.15
UK	0.45	0.05	0.64	0.12
USA	0.33	0.01	0.54	0.19
Japan**	0.30	0.09	0.34	0.09

Notes: *Data for France pre-1981 are not available. ** Data for Japan from 1970 to 1973 are not available.

low level of perceived benefits from IT investments by managers (Andresen *et al.*, 2000) and the lack of a clear business case for IT investments, in addition to absence of good practice demonstrating its successful use by others (Anumba, 1998).

Non-ICT capital

Capital deepening, i.e. net investments in plant, tools and machinery should enhance productivity performance. The estimates in Table 4 show the extent to which this type of capital contributed to productivity growth in construction. In Germany, the contribution was even negative over the period 1971–89, which results from a declining capital stock in the industry. In other words: construction work had become less capital intensive over that period.

In other countries, capital deepening made a significant contribution to construction productivity growth. While in France and Japan the contributions remained almost unchanged over the two sub-periods, the UK and the USA showed a sizable increase in the contribution of capital deepening to productivity growth in the second sub-period. However, in all countries construction productivity growth benefited less from capital deepening than total industries productivity growth, where the difference is most striking in Germany and Japan. This finding is not surprising as the construction industry is largely regarded as labour intensive, except in Germany and Japan where there are higher levels of capital investments and efficiencies particularly in Japan with the adoption of the lean principles and construction automation.

Table 4 Contribution of non-ICT capital to ALP growth

	1971–1989		1990–2005	
	Total industries	Construction	Total industries	Construction
Germany	0.74	–0.17	0.89	0.11
France*	0.46	0.32	0.56	0.32
UK	0.90	0.29	0.59	0.46
USA	0.97	0.16	0.69	0.42
Japan**	1.86	0.29	1.19	0.32

Notes: *Data for France pre-1981 are not available. **Data for Japan from 1970 to 1973 are not available.

Table 5 Contribution of TFP to construction ALP growth

	1971–1989		1990–2005	
	Total industries	Construction	Total industries	Construction
Germany	1.18	0.03	0.56	–2.07
France*	1.12	0.16	0.58	–0.54
UK	0.21	1.06	0.65	0.09
USA	1.58	0.37	1.41	–0.65
Japan**	1.69	0.91	–0.38	–2.75

Notes: *Data for France pre-1981 are not available. **Data for Japan from 1970 to 1973 are not available.

TFP

With the exception of Germany, TFP constituted the largest contribution to productivity growth in total industries. The growth lead in total industries of the USA in the second sub-period is essentially attributable to its stronger TFP performance. Something odd seems to be going on in construction. The figures suggest that the differences in labour productivity growth between construction and total industries can be largely explained by construction's poor TFP performance. In fact, with the exception of the UK, TFP negatively contributed to labour productivity growth in the second sub-period, suggesting that the industry has become less efficient in combining factors of production. That phenomenon seems to be consistent across all selected countries and requires further investigation.

The focus of attention should therefore be placed on a better understanding of these TFP trends which are counterintuitive. As mentioned above, TFP is associated with technological progress and improvements in management and organization. Has there been technological regress in construction? The puzzle of negative productivity and TFP growth is well documented in the literature and has been largely debated in the context of declining labour productivity in the North American construction industry (see for example Stokes, 1981; Allen, 1985; and Harper *et al.*, 2010).

In Germany and Japan, the negative TPF growth rates might be to some extent explained by the prolonged periods of suppressed construction activity. At the aggregate economy level, there is also evidence that overinvestment in Japan during the 1990s led to a decline in capital productivity, which may also contribute to a decline in TFP growth (Scarpetta *et al.*, 2000). Similar problems may be at work in Germany, where the capital allocation was distorted by fiscal incentives which aimed at promoting investments in Eastern Germany.

These investments typically yielded lower returns than comparable investments in the western part of the country (Bundesministerium der Finanzen, 2002). However, given the only modest increase in the capital stock of the construction industries, overinvestment or distortions in the allocation of capital are unlikely explanations of the phenomena.

Given that the phenomena of declining labour productivity growth and negative TFP growth can, although to a lesser extent, be also observed in the other countries, there are likely some other common causes. The composition of construction output may have changed across countries, e.g. towards more repair and maintenance as the age of the built environment increases or from large-scale projects to housing (Allen, 1985). By aggregating data to an industry level, valuable information on the heterogeneous nature of construction outputs is being lost. If the composition of output shifts to sectors or activities with lower than average productivity levels, then aggregate labour productivity will rise more slowly or could even become negative. Jorgenson and Griliches (1967) call this an error of aggregation. Moreover, a shift in the composition of output or changes in working practices, e.g. more subcontracting, can potentially lead to diseconomies of scale and thus might affect the estimates of productivity growth. This problem could be addressed by undertaking an international comparison by type of construction work or firm activity. Unfortunately, robust and comparable breakdowns of input and output measures in construction are not available at lower levels of aggregation.[9]

TFP estimates may also pick up the impact of regulation on productivity. Construction activities are subject to a wide range of regulation, e.g. labour market regulation, health and safety, environment, and product regulation. Changes in existing or new regulation can potentially enhance productivity but could equally well hamper productivity growth. There are two possible ways through which regulation might have an impact on productivity: (1) regulation may cause firms to uses resources for compliance rather than for production; and (2) regulation may force companies to adopt different technologies or working practices and these may be less efficient. Unfortunately, there is little robust information on the effect of changes to the regulatory environment on construction productivity over time. Nonetheless, the effect of regulation could be captured in the TFP measure.

Conclusion

International productivity comparisons are fraught with challenges, such as the heterogeneity of outputs and inputs. Nonetheless, the data presented in this paper shed some light on the trends of productivity growth, and factors underlying that growth, in major OECD countries. Overall, it was found that productivity growth in construction fell short of productivity growth elsewhere in the economy and that the relative underperformance worsened in the second sub-period.

Germany and Japan even showed negative productivity growth rates in construction. In Germany and Japan, the contribution of skills, ICT capital and other capital to labour productivity growth did not increase over time and both countries witnessed a sizable negative contribution from TFP. In France, the UK and the USA skills improvement in construction accelerated and so did the contributions of labour quality to productivity growth. In the UK and the

USA, acceleration in capital deepening led to a higher contribution of capital to labour productivity growth. The effect of ICT use on labour productivity seems to be rather limited in construction. Most importantly, the poor TFP estimates in all countries explain the overall deceleration in average labour productivity growth and the widening gap between construction and other industries. The results in this paper thus suggest that productivity growth is not primarily explained by the traditional suspects, labour quality and capital—except for the UK, but rather by TFP which warrants further investigation. Indeed identification of the key drivers of productivity enables policy makers to prioritize (focus) their efforts on issues where the impact is largest.

Furthermore, it appears clear that there is a need for the construction industry to enhance its productivity performance in OECD countries. A practical measure is to create a construction productivity fund. Such fund would provide grants to construction companies and/or projects seeking to enhance their productivity performance. A prerequisite to issuing grants would be for companies to demonstrate how the money will be spent alongside highlighting the tentative productivity gains that could be potentially realized.

It is recognized that such fund will need to be contextualized within the institutional framework for each OECD country. This will also require reviewing different models by which the fund can be implemented, such as the Construction Productivity and Capability Fund (CPCF) introduced by the Singaporean governments in an effort to help the construction industry improve productivity and strengthen its capability.[10]

Research limitations and recommendation for future work

There are no data without limitations. It is thus important to continue the quest for timely and reliable information about productivity. Better and timelier statistics may not prevent crises, but they could help agents build more consistent expectations about the future (Brackfield and Martins, 2009), in addition to helping us to learn lessons from the past.

While the growth accounting framework is useful as a descriptive tool for explaining cross-country differences in productivity growth, it is merely accounting-based and says nothing about causality; nonetheless it provides a useful starting point for the identification of the contributions of the proximate sources of growth (O'Mahony and Timmer, 2009). The productivity estimates are, however, constrained by assumptions such as constant returns to scale, perfect competition and a Cobb-Douglas specification of the production process (Jorgenson *et al.*, 1987). These may not fairly describe the underlying production process and economic realities.[11]

There is still a lack of an adequate and robust measure at the industry's macro level that would make it possible to establish the relative importance of the factors affecting productivity, such as management and organization (e.g. lean management), design, buildability, and innovation and technology (e.g. use of prefabricated materials), to name but a few. These factors are captured by TFP growth, but cannot be separately identified. Data for bought-in materials and services are available at the macro level and these data could potentially be used for estimating the impact of prefabricated materials on productivity.

Past research has merely focused on ranking the relative importance of the factors affecting productivity through eliciting the views of the industry's practitioners (see for example Arditi and Mochtar, 2000). A plausible way forward for cross-country comparisons of productivity is to focus on micro level data at either the project or firm level. Currently, there are data available at the firm level for companies' financial accounts through the FAME (Financial Analysis Made Easy) database albeit there are no project-level data available for government agencies and policy makers in the public domain.

While financial accounts data could allow controlling for the heterogeneity (e.g. type of work) of the construction industry up to a four-digit SIC code, there is a need for project-level data that would suit the project-based nature of the construction industry. Unlike the manufacturing sector, in the construction sector projects take place in a temporary setting in an open environment where a project evolves over time. In the manufacturing sector, however, the production process takes place in a closed and confined environment which allows for more control over the factors of production, thus providing a better basis for coming up with robust measures for productivity and the determinants thereof (see for example Bloom *et al.*, 2005).

Finally, it is recommended, before gathering any micro-level data, to conduct an in-depth review of the current assumptions and limitations of the existing productivity data (that are used for cross-country comparisons) in order to inform any future exercise for data gathering that is aimed at cross-country productivity comparisons. There are construction sector specific problems which require further attention. For example, construction deflators are limited in scope and coverage (Ive *et al.*, 2004). Aggregate construction output deflators are often a mix of output prices and input cost indices. The use of input costs, however, may overstate the rise in construction output prices and hence understate real construction output and productivity. Further, quality improvements can only be imperfectly captured by input costs. It is important thus to see how any detailed proposals for constructing cross-country productivity data attempt to address the shortcomings of existing data particularly in relation to the heterogeneous nature of the construction industry.

Notes

1. KLEMS refers to the first letters of inputs to the production process, i.e. Capital (K), Labour (L), Energy (E), Material (M) and business Services (S).
2. The database is publicly available at www.euklems.net. The basic data files for selected OECD countries were downloaded from the EU KLEMS database.
3. See also Crawford and Vogl (2006) for a discussion of these methodologies.
4. See van Biesebroeck (2004) for a discussion of these methodologies.
5. See Jorgenson and Griliches (1967).
6. If measures can be developed for these 'intangible' inputs, they would join the set of measurable inputs.
7. See Martin (2003) for an exposition of the perpetual inventory method.
8. The former includes computing and communication equipment, the latter residential and non-residential investments, transport equipment, and other machinery and equipment.
9. The definition of the construction industry is based on NACE, which forms a common international format for analysing industrial data for most countries in our study. This NACE numbering system defines construction output as: site preparation; building of complete structures or parts thereof; civil engineering; building installation; building completion; renting of construction or demolition equipment with operator.
10. Further information is available at www.bca.gov.sg/CPCF/cpcf.html.
11. Econometric methods are more flexible in this regard. This flexibility may be at the cost of restrictions across time and space.

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