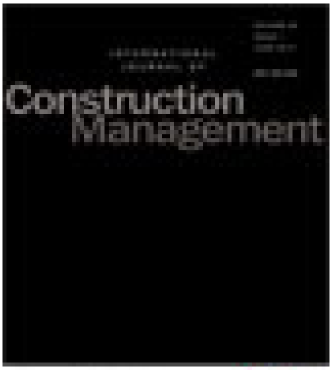

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A Comparative Study of Construction Industry Size and Structure between the UK and Australia and the Significance of Industry Fragmentation

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A COMPARATIVE STUDY OF CONSTRUCTION INDUSTRY SIZE AND STRUCTURE BETWEEN THE UK AND AUSTRALIA AND THE SIGNIFICANCE OF INDUSTRY FRAGMENTATION

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Abstract
While comparing both the size and structure between the UK and Australian construction industries, this study reveals that the UK construction industry is about two and a half times larger than the Australian construction industry, and both industries are dominated by the proportion of small firms. The issue of fragmentation is characteristic of the construction industries in these two countries, and beyond. This study then develops a self recruiting-subletting cost indifference point model to explain why fragmentation occurs. Although the high proportion of small firms in the construction industry has been criticised as it prevents the exploitation of economies of scale, the self recruiting-subletting cost indifference point model theoretically proposes that subletting is usually profitable for construction firms. Thus the size distribution of the construction industry has a propensity to skew towards small firms.

Key words
Construction, industry size, industry structure, international comparison, cost indifference point

INTRODUCTION

The construction industry makes a significant contribution to the economic and social welfare of a country. This is observed not only in the UK (CFR, 2003; Ive, 2004), but also in other countries (Ofori, 1990; Low and Chan, 1997; Shen, *et al*., 2002; Ding, 2005). While describing mainly UK construction, the *Pearce Report* (2003) brings together in one place the key facts and data for the industry. Nigel Griffiths, the Minister of Construction in the UK, comments that the *Pearce Report* (2003) provides an excellent basis for both a better understanding of the industry and opportunities for future collaboration between the construction industry and its UK clients (p.i). As such, to put the main focus of that report - namely the UK - in a wider context, international comparisons between the construction industries of other countries are warranted.

The UK construction industry has been the subject of a number of reviews in recent years, notably including Latham (1994) and Egan (1998; 2002). The Centre for Constructing Excellence is an attempt to improve construction productivity and practice in the UK and arose following the emerging industry reform agenda. Its objectives are to improve performance through increased productivity and competitiveness, improve industry image by taking action to create a step change in culture, in the development of people, and enhance engagement with the community and the industry's customers, and to more generally engage and take action with individuals, businesses, organisations and industry associations (http://www.

constructingexcellence.org.uk). The *Pearce Report* (Pearce, 2003) is the latest review of the UK construction industry, and in particular Chapter 3 focuses on definitions and measures used as the basis for the comparison in this paper.

Beginning with the report *Strategies for the Reduction of Claims and Disputes in the Construction Industry* (AFCC, 1988), the Australian building and construction industry was the subject of a number of significant studies such as the Industry Commission (1991) reports, and two Royal Commissions. Other reports by the then Department of Industry, Technology and Commerce revealed the state of the Australian building and construction industry's costs, efficiency, competitiveness and productivity. Problem factors in Australia, such as claims and disputes, were compared with similar problems overseas. Through productivity and performance studies a comprehensive snapshot emerged of the difficult situation the industry faced in the late 1980s. The findings revealed limitations within the industry that were self-imposed as well as problems that were a world-wide phenomenon of the time. The surveys clearly established not just the need but also the agenda for reform in the Australian building construction industry. The publication of *No Disputes* (NPWC, 1990) consolidated the reform agenda, and the subsequent process of reform, organisational and cultural change was led by the New South Wales and Commonwealth governments. In particular, The Royal Commission into the Building and Construction Industry (http://www.royalcombci.gov.au) amassed vast amounts of information on practices and performance of the Australian industry.

This paper aims to compare the UK and Australian construction industries by further examining the two definitions for the construction industry proposed in the *Pearce Report* (2003) and using the latest published data from both countries. It then develops a self recruiting-subletting cost indifference point model to explain the effect of fragmentation, as a significant characteristic arising from the comparison is that both countries are dominated by the proportion of small firms. The paper logically consists of five sections. Section 1 is the introduction. Section 2 brings out the implications of using either broad or narrow definitions of the construction industry - nationally and internationally. Section 3 analyses different indicators for measuring the size of the construction industry and how these might be interpreted. Section 4 looks at industry structure, and develops a self recruiting-subletting cost indifference point model to explain composition characteristics. Section 5 concludes the study.

THE IMPLICATIONS OF USING BROAD OR NARROW DEFINITIONS FOR CONSTRUCTION

This study is based on the similar podium created by Pearce (2003). He proposed two definitions for the construction industry, one narrow and one broad. The narrow sector is defined as "... those who construct, repair and maintain buildings or engineering works *in situ* ... including site preparation, construction of buildings and civil engineering works, building installation (e.g. electrical wiring, plumbing), building completion (e.g. painting, plastering) and renting of construction or demolition equipment supplied with an operator" (Pearce, 2003, p.9). The broad sector includes not only those who are already in the "narrow" sector, but also "those who quarry raw materials, plus those who manufacture and sell the materials, products and assemblies used by contractors, plus those who supply professional management, design, engineering and surveying services to the industry or its clients, plus construction and repair works undertaken by households and other non-contracting organizations" (Pearce, 2003, p.9). Pearce (2003) suggests that the broad sector that includes the supply chain for construction materials, products, assemblies and professional services, has the virtue of drawing attention to the economic activities that directly depend on the narrow sector of the construction industry. The fortunes of the activities in the broad sector are critically interdependent with the fortunes of the contractors (Pearce, 2003).

To compare the UK and Australian construction industries, a definition must be adopted. Meikle and Grilli (2005) point out that there is no international agreement on the definition of the construction industry and what is included or excluded varies from country to country. Unisearch (2002) and Ive *et al*. (2004) suggest that all international comparisons have to be treated with caution because of the reliability and comparability of data. Sawhney *et al*. (2004), also stress that the concept of comparability and representativity form the crux of international comparison. Hence, it seems that the key issue for adopting either the broad or the narrow definition is whether Pearce's definition is comparable with Australia's, and the availability and reliability of data.

Pearce's broad definition is sensible. Indeed, Pearce has drawn a reasonable boundary for his broad definition. However, based on the authors' knowledge, the Australian Bureau of Statistics (ABS) does not publish single-source data for Australian construction industry that is comparable with the broad sector proposed by Pearce. The *Pearce Report* also suggests that there is no single-source data for the broad sector of the UK construction industry either. Hence, it appears that it is impossible to find single-source data for the broad sector to compare the two industries.

Even though data for individual members of the broad sector can be assembled from various sources; still it is uncertain as to how accurate and reliable such aggregated data is. This is demonstrated by the data for the output of the UK broad sector. In the *Pearce Report*, the data for contractor's output were from the Department of Trade and Industry (DTI) Housing and Construction Statistics 2002 reported in DLC (2002). The data for construction materials and products, wholesale and retail trade were from Annual Business Inquiry (ABI) 2003 reported in ONS (2003). The data for construction professional services were from Construction Industry Council (CIC) Professional Service Survey 2002 reported in DLC (2002). The data for self-built activities were from Davis Langdon and Everest (2000). The data for direct labour were from both DTI Housing and Construction Statistics 2002 reported in DLC (2002) and CFR (2003). The data for the black economy were compiled from various sources. Because of the different sources and methods used for the various collections the resulting statistics are not always compatible with each other. Actually, the output of the informal construction for either the UK or other countries can be estimates only.

Even if data for each member of the broad sector, which is from various sources, is reasonably accurate and reliable, still the accuracy and reliability of the overall gross output of the broad sector, which is the aggregated data, is questionable. This is because there could be overlaps among members of the broad sector and the extent of the overlap has to be clearly stipulated. However, Pearce (2003) suggests that the output of self-built and informal construction is very difficult to estimate and that the extent of overlap between the members of the UK broad sector is unknown. Indeed, the overlap between informal construction and wholesale and retail can never be known either in the UK or Australia. Hence, comparisons between the UK and Australia construction industries cannot be based on the broad definition proposed by the *Pearce Report*.

The currently available data for the output of the construction industry in Australia published by ABS are for "residential buildings (house, flats, etc.), non-residential buildings (office, shops, hotels, etc.), and engineering constructions (roads, bridges, water and sewage, etc.)" (ABS, 2005, p.571). These three areas of activities fall *approximately* in the category of the narrow definition proposed by the *Pearce Report*. In addition, accurate and reliable data for the narrow sector is available in DTI statistics for the UK and in ABS publications for the Australia respectively. Therefore, based on the comparability of the concept, and the availability and reliability of data, it is the "narrow" rather than the "broad" definition that is adopted in this study. It may be argued that it may not be appropriate to exclude professional services in the UK when comparisons are being made with a country where "design and build" (DB) predominates. However, it should be noted that the DB procurement method is also widely adopted in the UK construction industry, rising from 35.7 per cent in 1993 to 42.7 per cent in 2001 by value of contract (RICS, 2001). In addition, there are no official statistics available relating to the percentage of this procurement method being used in Australian non-residential buildings and engineering constructions, although it is the main procurement method for Australian housing constructions (Georgiou, 2000). Indeed, the UK construction industry will be understated to some extent when the narrow definition is adopted, provided that the percentage of DB projects in Australia by value of contract is higher than that in the UK. This issue is further discussed later in this paper.

In short, a broad definition may be adopted for studies at a national level, such as a longitudinal study conducted to track the performance of the construction industry over time. But due to the reliability and comparability of available data, comparisons between the construction industry in the UK and Australia need to focus on the narrow sector. Indeed, the approach of the Ive *et al*. (2004) study, whose research objective was to compare the productivity in the UK, France, Germany and the USA, was also to use the narrow sector definition.

A COMPARISON OF CONSTRUCTION INDUSTRY SIZE

Due to problems of definition, measuring the size of the construction industry is not straightforward. Nevertheless, the size of the industry may still be measured using a number of potential indicators. Foremost among these indicators are 1) employment; 2) number of firms; 3) cement consumption; 4) housing completion in m^2 built area; 5) brick consumption; 6) gross output; and 7) value-added (Meikle and Hillebrandt, 1988; RCBCI, 2002a; 2005b; Pearce, 2003; Meikle and Grilli, 2005). While other indicators exist and have been used, the ones listed above appear to be the most common.

Employment and number of firms are indicators of the size of the labour force in a construction industry. Employment is chosen in this study simply because the ABS does not publish yearly data for the total number of Australian construction firms. There have been only four Construction Industry Surveys (CIS) conducted by the ABS, at intervals of approximately five years. Even the most recent survey was for 1996-97 (de Valence, 1999a; Croce, 1999; RCBCI, 2002a; ABS, 1991-2005). Furthermore, the size and distribution of the number of firms in the UK and Australian construction industries are not consistent (RCBCI, 2002a; Pearce, 2003). As such, a larger number of firms does not guarantee a bigger workforce. Hence, employment, rather than number of construction firms, is adopted in this study. At least this makes a comparison possible.

In the UK, there exist at least two distinct sets of statistics for measuring the size of the construction workforce. One is an employer-based survey undertaken by the Department of Trade and Industry (DTI). The other is an employee-based survey known as the Labour Force Survey (LFS) (Ive *et al*., 2004; Briscoe, 2004). Following the approach used in the *Pearce Report*, this study uses the DTI estimates to measure the workforce of the UK construction industry. The accuracy of the alternative LFS estimate is questionable as its sample size is only about 0.3 per cent of its population (Ive *et al*., 2004). Nevertheless, it should be borne in mind that the labour force of the UK construction industry is understated by using the DTI data, as "employment" in the UK means workers employed. This is not the same as the total workforce, since the incidence of self-employment in the UK is high (Briscoe, 2004).

Meikle and Grilli (2005) suggest that cement consumption, housing completion and brick consumption are physical measures, indirectly giving an indication of the volume of construction output. Among these physical measures, it seems that cement is the most reliable. Data on housing completions in m^2 built area cannot be considered a reliable indicator of the total amount of construction work, as it gives an indication of only one sector of construction - residential building - and is usually adjusted to value measures using dubious conversion factors. Brick consumption is not a reliable indictor either for two reasons. First, building technology across countries is substantially different. Second, brick consumption data is usually from brick production and import/export records. However, the ability to stockpile bricks is indeterminate (Meikle and Grilli, 2005). Cement has a short shelf life, usually about two months (Wu and Low, 2005a), and is usually manufactured on a large-scale with well-maintained production data (Meikle and Grilli, 2005). Data are also readily available in imports and exports (Low and Tan, 1993). Cement is also a basic building material (Wu and Low, 2005a; 2005b), and its annual consumption figures can be calculated with reasonable confidence. Therefore, it seems that cement consumption is a more reliable indicator than housing completion and brick consumption. Nevertheless, it may be argued that some countries (for example France) may use highly cement-intensive construction technologies (World Bank, 1992). However, it appears that this has not been recorded either in the UK or Australia.

The gross output and value-added can directly measure the value of construction output. Since gross domestic product (GDP) is the sum of all value-adding activities across all sectors in the economy, it seems that the value-added figure for construction is the more relevant measure as it indicates the contribution that the sector makes to GDP (Pearce, 2003).

The above brief analysis suggests that employment, cement consumption and value-added, in theory, should provide a more accurate estimate of construction industry size. Hence, the comparison of the construction industries in the UK and Australia is approached through the discussion of employment, cement consumption and value-added indicators.

Employment

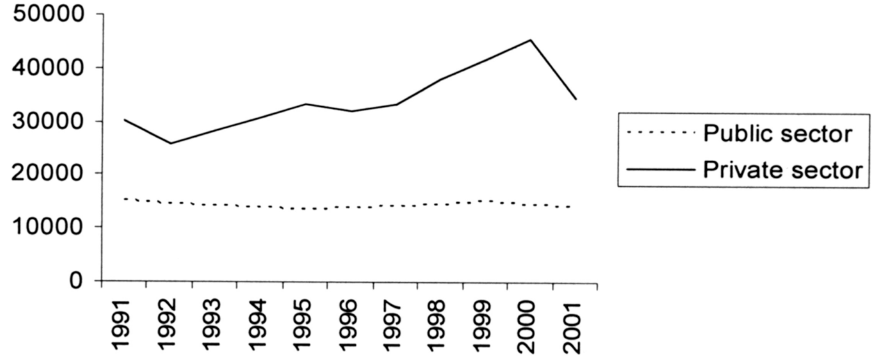
Table 1 shows employment trends for contractors in the UK and Australia respectively. The data for employment in the Australian construction industry are compiled from the Year Book of Australia (versions 1991 to 2002). The data are for May or June each year. The data for the employment in the UK construction industry are from DTI 2002 (reported in DLC, 2002) Housing and Construction Statistics, which are available in Pearce (2003). R_E in Table 1 is the ratio of labour force in the construction industry in the UK to that in Australia in the same year. μ_{RE} is the mean for R_E for the period from 1991 to 2001. δ_{RE} and ψ_{RE} are the standard deviation and co-efficient of variation for R_E in the same period respectively. The co-efficient of variation for R_E is the ratio of its standard deviation to its mean expressed as a percentage (i.e., =($\psi_{RE} = \delta_{RE} / R_E$) x 100%).

Table 1 Time series for labour force in the construction industry in the UK and Australia 1991-2001

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
UK(unit 1000)	1626	1478	1405	1381	1388	1385	1399	1426	1411	1485	1567
Australia(unit 1000)	518	536	563	590	600	586	597	648	739	668	706
R_E	3.14	2.76	2.50	2.34	2.31	2.36	2.34	2.20	1.91	2.22	2.22
μ_{RE}						2.39					
δ_{RE}						0.32					
ψ_{RE}						13.39%					

Source: DTI 2002 Housing and Construction Statistics reported in DLC (2002), and ABS Year Book of Australia (1991 to 2002)

Latham (1994) suggests that the UK construction industry experienced a recession in the early 1990s and that the recession hit its construction business hard. Table 1 shows that the industry in the UK lost 241,000 jobs between 1991 and 1996. However, since 1996, employment in the construction industry in the UK recovered steadily, rising to 1,567,000 in 2001, albeit still 3.6 per cent less than that in 1991. de Valence (1999b) suggests that Australia had experienced a major building boom in the late 1980s. Barda (1995) suggests that whilst a looming recession was approaching, the beginning of the devastation of the commercial property markets (non-residential building) in 1990 ironically provided an opportunity to reverse the slide. The statistics provided by ABS (1991-2005) suggests that since 1996, the sum of the volumes of activity in residential and engineering construction, driven by the private sector (see Figure 1), had grown steadily, probably by over 40 per cent (see Figure 2). It is largely for this reason that employment in Australia rose by about 13 per cent from 1991 to 1996, with an additional 20 per cent added from 1996 to 2001 (see Table 1).

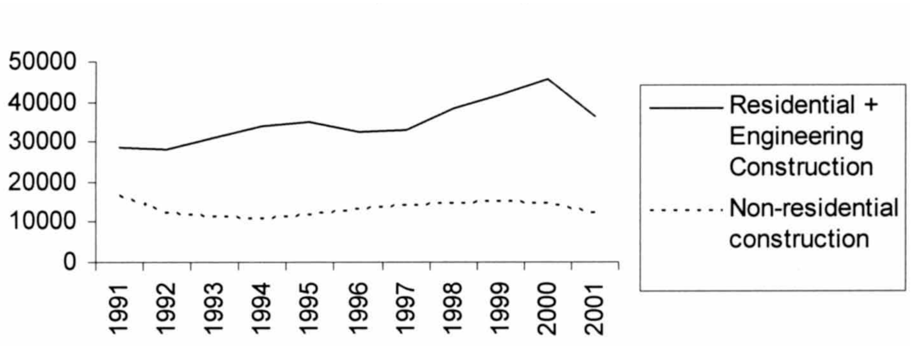


Source: ABS Official Year Book of Australia (2003)

Figure 1 Total construction activity in Australia, values of work done by type or sector

Figure 1 shows that construction activity for the public sector in Australia remained relatively constant at around A$15,000 million annually from 1991 to 2001. The value of annual construction activity is in chain volume terms and the reference year is 2000. Chain volume (constant dollars) measures show changes in value after the direct effects of price changes have been eliminated. Figure 1 also shows that the growth in the value of total construction output from 1992 to 2000 was driven by private sector activity. ABS (2003) suggests that the growth in Australian private construction activity resulted from government deregulation.

The *Pearce Report* suggests that the recovery of UK construction since 1994 is also mainly derived from the private construction sector. However, the growth of the private construction sector in the UK was the result of privatisation of public utilities and the classification of Private Finance Initiative and Private Public Partnership projects as private sector output (Pearce, 2003).



Source: ABS Official Year Book of Australia (2003)

Figure 2 Total construction activity in Australia, values of work done by type of activity(A$ million)

Figure 2 shows the value of work done by non-residential construction activities and the sum of work done by residential and engineering construction activities in the Australian construction industry respectively. The value of work done is in chain volume terms and the reference year is 2000. Figure 2 shows that the growth in value of Australian construction output is mainly attributable to residential and engineering construction activities, the sum of the volumes of which grew by over 40 per cent in the period 1991 to 2000. However, the *Pearce Report* suggests that the recovery of the UK construction industry was not because of its housing construction activities, as housing output remained constant for the same period in the UK.

In summary, Table 1 shows that while employment in the UK construction industry was cyclically recovering and reached 96.4 per cent of its 1991 record by 2001, employment in the Australian construction industry was expanding cyclically and experienced about a 36 per cent increase in the same period of time. The Construction Industry Training Board reported that 64,000 people were leaving the UK construction industry each year (CITB, 2000). Hence, more people had to be employed simply to replace those who left the industry. Despite the recent increase of jobs from 1999 to 2001 in the UK, its National Audit Office suggested that, probably because of its poor image, the UK construction industry had difficulty in recruiting, particularly talented people (NAO, 2001). The introduction of the new tax system in July 2000 in Australia was a significant factor behind employment in the construction industry of that year being substantially lower than in 1999, reversing the growth of the proceeding four years. Table 1 also shows that in terms of employment the construction industry in the UK was on average about 2.4 times larger than that in Australia.

Cement consumption

R_C is the ratio of the UK construction industry cement consumption over its Australian counterpart in each year from 1991 to 2001. μ_{RC}, δ_{RC} and ψ_{RC} are the mean, standard deviation and co-efficient of variation for R_C over the period respectively. Table 2 shows that in terms of cement consumption, the construction industry in the UK was about twice as large as that of Australia.

Table 2 Time series for cement consumption in the construction industry in the UK and Australia 1991-2001

	1991	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**
UK (unit million tonnes)	13.28	12.6	12.5	12.6	13.12	14.5	14.8	14.7	15.1	14.1	14.08
Australia (unit million tonnes)	5.7	6.3	6.68	6.72	6.7	6.75	6.8	7.1	7.4	8.0	7.4
R_C	2.33	2.00	1.87	1.88	1.96	2.19	2.18	2.07	2.04	1.76	1.90
μ_{RC}						2.02					
δ_{RC}						0.17					
ψ_{RC}						8.41%					

Source: International Cement Review (2005).

Value-added by construction industry

Langston and Best (2005) suggest that whenever different currencies are involved the cost impacts cannot be immediately understood without adjustment for time and location. As such, international comparisons of the value-added contributions of construction industries have to convert national currencies to a common base (Walsh *et al*., 2005). Monetary exchange rates and the purchasing power parity (PPP) exchange rates can be adopted to compare the construction costs internationally (Langston and de Valence, 1999; Walsh *et al*., 2005). PPP is the amount of currency in a given country required to purchase a basket of goods and services divided by the amount of currency in another country required to purchase the same basket (Walsh *et al*., 2005). PPP can therefore be understood as a means for inter-spatial comparison of prices and is generally regarded as superior to using monetary exchange rates (Langston and de Valence, 1999; Langston and Best, 2000; 2001; 2005; Sawhney *et al*., 2004).

The reliability of the monetary exchange rate approach is questionable, as exchange rates are based on short-term factors and are subject to substantial distortions from speculative movements and government interventions, even when exchange rates are averaged over a period of time. The problems associated with adopting exchange rates for international comparisons have been recognised for many years (e.g. Cassel, 1916).

The monetary exchange rate approach for the comparison of value-added contributions between the UK and Australian construction industries for the period 1993 to 2001 is shown in Table 3. Value-added data for the UK construction industry are taken from ONS (2002). Value-added data for the Australian construction industry was compiled from the ABS Year Book of Australia (issues 1993 to 2003). Data for the monetary exchange rates are compiled from the Penn World Table Version 6.1 (Heston *et al*., 2002) available at http://pwt.econ.upenn.edu/phpsite/pwt_index.php and additional data from http://hk.finance.yahoo.com. The years in Table 3 refer to calendar years. Value-added figures for the Australian construction industry are at 2003 prices. Note that the output of the Australian construction industry in Table 3 is in value-added terms, whilst the outputs shown earlier in Figures 1 and 2 are gross output. As expected, values in Table 3 are not the same as those in Figures 1 and 2. Value-added figures can be obtained from gross output by deducting materials costs. R_M is the ratio of the UK construction industry value-added (in Australian dollars) to the Australian construction industry value-added in a given year. μ_{RM} is the mean for R_M for the period 1993 to 2001. δ_{RM} and ψ_{RM} are the standard deviation and co-efficient of variation for R_M in the same period respectively. Table 3 shows that by means of a monetary exchange rate approach and in terms of value-added the UK construction industry was about three times larger than the Australian construction industry.

Table 3 The monetary exchange rate approach comparison

	1993	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**
Value-added in the UK (£ billion)	40.4	41.9	41.9	43.1	44.3	44.8	45.2	46.0	47.6
Exchange rate	0.454	0.478	0.470	0.502	0.453	0.379	0.399	0.383	0.370
Value-added in the UK (A$ billion)	89.0	87.7	89.1	85.9	97.8	118.2	113.3	120.1	128.6
Value-added in Australia (A$ billion)	35.3	36.7	32.8	34.1	35.4	33.3	39.0	37.1	31.6
R_M	2.52	2.39	2.72	2.52	2.76	3.55	2.91	3.24	4.07
μ_{RM}					2.96				
δ_{RM}					0.56				
ψ_{RM}					18.92%				

Source: Penn World Table Version 6.1, http://hk.finance.yahoo.com, ABS Year Book of Australia issues from 1993 to 2003, and ONS (2002).

Table 4 shows the same data using PPP adjustment. Exchange rates have been obtained from the Organization for Economic Co-operation and Development (OECD) at http://www.oecd.org/dataoecd/61/56/1876133.xls. R_O is the ratio of the UK construction industry value-added (in international dollars) to the Australian construction industry value-added (in international dollars) in a year. μ_{RO} is the mean for R_O for the period 1993 to 2001. δ_{RO} and ψ_{RO} are the standard deviation and co-efficient of variation for R_O in the same period respectively. Table 4 shows that by means of a PPP exchange rate approach and in terms of value-added the UK construction industry was 2.65 times larger than the Australian construction industry.

Table 4 The OECD PPP exchange rate approach comparison

	1993	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**
Value-added in the UK (£ billion)	40.4	41.9	41.9	43.1	44.3	44.8	45.2	46.0	47.6
PPP (UK)	0.622	0.618	0.622	0.626	0.623	0.634	0.644	0.632	0.624
Normalised value ($ billion)	65.0	67.8	67.4	68.8	71.1	70.7	70.2	72.8	76.3
Value-added in Australia (A$ billion)	35.3	36.7	32.8	34.1	35.4	33.3	39.0	37.1	31.6
PPP (Australia)	1.34	1.32	1.31	1.32	1.32	1.31	1.30	1.31	1.33
Normalised value ($ billion)	26.3	27.8	25.0	25.8	26.8	25.4	30.0	28.3	23.8
R_O	2.47	2.44	2.70	2.67	2.65	2.78	2.34	2.57	3.21
μ_{RO}					2.65				
δ_{RO}					0.25				
ψ_{RO}					9.43%				

Source: OECD (2005b)

The World Bank via the International Comparison Program (ICP) also publishes PPP exchange rates for the UK and Australia. A table similar to Table 4 can be created using ICP PPP exchange rates sourced from the Penn World Table Version 6.1 at http://pwt.econ.upenn.edu/php_site/pwt_index.php. The calculation (not shown here) suggests that in terms of value-added the UK construction industry was about 2.4 times larger than the Australian construction industry. The result from the OECD PPP exchange rate approach is very close to that from the ICP PPP exchange rate approach. This is expected. The OECD PPP is prepared from more detailed data than that for ICP PPP, yet the two PPPs share a similar methodology including lists of product specifications for the price survey covering consumer products and equipment goods (OECD, 2005a). OECD is arguably the most robust approach for countries included in its survey.

It has been argued that PPP approaches are more reliable than a monetary exchange rate approach (Sawhney *et al*., 2004; Walsh *et al*., 2005). Comparing the mean for the ratio of the UK construction industry value added to the Australian construction industry value-added derived by the OECD PPP approach (μ_{RO} in Table 4) and that derived by the monetary approach (μ_{RM} in Table 3), it can be shown that the UK construction industry is overstated by about 11.7 per cent (i.e. ((2.96-2.65)/2.65)x100%=11.7%) by the latter approach. If using an ICP PPP approach, this would be even more pronounced at 23.3 per cent (i.e. ((2.96-2.4)/2.4) x100%=23.3%). Hence, a monetary exchange rate approach is biased in favour of the UK, a more developed country.

A simple calculation of PPP-adjusted value-added per person employed in the industry shows an interesting result. For the period 1993 to 2001 in the UK, the average per capita output (labour productivity) was $49,050 with a 2.54% co-efficient of variation. In Australia for the same period, the value-added per person employed was $42,250 with a 9.87% co-efficient of variation. In each year except 1993, the UK outperformed Australia with an average increase over the period of 16.1%. Using monetary exchange rates instead of PPP, this would be even more pronounced. This result confirms earlier research by Langston and de Valence (1999) that ranks the UK ahead of Australia based on standard building projects priced in each country.

Discussion

The ratio of the UK construction industry size to its Australian counterpart, as shown in Tables 1 to 4, are not the same. This is to be expected, as although labour, cement consumption and value-added are widely adopted indicators for measuring the construction industry size, none of them are perfect. Briscoe (2004) suggests that a substantial number of construction workers undertake work on an informal basis and therefore their employment may not be recorded. Figures for exports and imports of cement may not be reliable. Value-added can be no more than an estimated figure (Meikle and Grilli, 2005). However, while bearing in mind the “errors” there could be, for example, in the data for output and employment and the accuracy of the PPPs, the ratios in Table 1 to 4 are actually remarkably similar. This suggests that the proposition made in this study to use the narrow definition for international comparisons is acceptable.

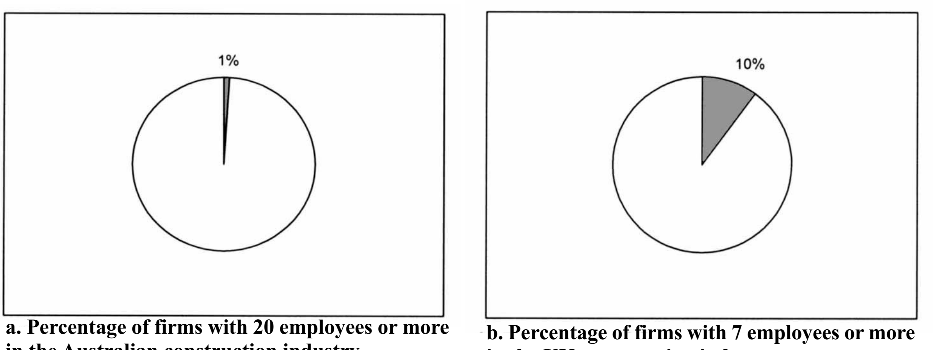
Nevertheless, it has been argued that the UK workforce is understated when measured by DTI data (Briscoe, 2004). The actual ratio of labour force in the UK construction industry to the Australian construction industry figure should be higher than the value for μ_{RE} calculated in Table 1. Since the average labour productivity in the UK construction industry also outperforms that in the Australia construction industry over the period 1991 to 2001, it can be concluded safely that the UK construction industry is at least 2.39 times larger than the Australian construction industry over the same period.

Assuming all the projects in Australia are “design and build” (DB) projects, professional services in Australia have already been included into the output of Australian contractors. This assumption is biased against Australia, as at least not all of its housing projects are DB projects (Georgiou, 2000). Under such an assumption, to be fair to the UK construction industry, professional services in the UK also need to be incorporated in the output of UK contractors. DLC (2002) suggests that professional services in the UK contribute about 17 per cent of the output of contractors. RICS (2001) suggests that the average value of DB projects in the UK is about 38 per cent by value of all contracts over the period 1993 to 2001. Hence, the mean for the OECD PPP approach ratio of the UK construction industry value-added to the Australian construction industry value-added in Table 4 needs to be revised to be 2.93 (i.e. 2.65 x (1 + 0.17 x (1 - 0.38))=2.93). Since the assumption that all the projects in Australia are DB projects is biased in favour of the UK; and OECD is arguably the most robust approach for countries included in its survey (OECD, 2005a), it can be concluded with confidence that the UK construction industry is at most 2.93 times larger than the Australia construction industry over the period 1993 to 2001.

In summary, the UK construction industry is somewhere between 2.39 and 2.93, and probably about two-and-a-half times larger than the Australian construction industry over the period 1993 to 2001. In terms of effectiveness, the UK construction industry has also outperformed Australia in real terms per capita.

A COMPARISON OF CONSTRUCTION INDUSTRY STRUCTURE

Ofori (1990) found that firms in the construction industry were usually smaller than those in the manufacturing industry. To understand the structure of the Australian construction industry, ABS conducted four nation-wide surveys. As stated above, the fourth and most recent survey was in 1996-97. All four surveys found that the Australian construction industry was overwhelmingly made up of small firms. Firms with more than 20 employees accounted for merely one per cent of the total number of enterprises (RCBCI, 2002a). This is dramatically illustrated in Figure 3(a), where the shaded area represents the percentage of firms employing 20 persons or more. CFR (2003) investigated the structure of the UK construction industry. Based on the CFR study, Pearce (2003) concluded that the vast majority of construction firms in the UK construction industry tended to be small, with only 10 per cent of all firms employing 7 persons or more (see Figure 3(b)). Nevertheless, small firms in the UK and Australia contributed most of the national construction output (RCBCI, 2002a; Pearce, 2003).



a. Percentage of firms with 20 employees or more in the Australian construction industry
Source: RCBCI, 2002a

b. Percentage of firms with 7 employees or more in the UK construction industry
Source: CFR (2003)

Figure 3 Construction industry size structure

Pearce (2003) feels that the basic structure of the construction industry, namely, the preponderance of small companies, precludes the exploitation of economies of scale and hence poses special problems for cost reductions and adding value. Fragmentation is certainly a key characteristic of the construction industries in both UK and Australia, and anecdotally elsewhere. Yet Pearce's conclusions are disputed, in the sense that the tendency for a large number of small firms driving construction industry output is not necessarily an undesirable condition that requires remedial treatment or interference. A unique approach to conceptualising the drivers that lead to construction industry fragmentation is discussed in the remainder of this paper, and the resulting model is used as a defence to the need for policy intervention.

The model developed here suggests that the size distribution of the construction industry must skew towards small firms. This section consists of two parts. First, a model is developed for a firm to decide whether it should sublet a workload to a sub-contractor. Second, the model and its implications are discussed.

A self recruiting-subletting cost indifference point model

The construction industry (whether UK or Australia) is dominated by small firms. This is mainly the result of subletting practices. In this section, a model is developed to help a firm to decide whether it should sublet workload to a sub-contractor.

A factory produces a manufacturing product, such as a desktop computer. A contractor builds a construction product, for example, a hotel. Both the manufacture of a desktop computer and the construction of a hotel involve many trades. A computer consists of a monitor, keyboard, hard disc, motherboard, floppy disk drive, DVD drive, speaker, case, power supply, etc. The manufacture of the power supply can be further broken down to wiring, welding, etc. The construction of a hotel involves substructure, superstructure, finishing, fittings, services, etc. The services can be further broken down to plant, pipe installation, electrical wiring, etc. To complete an approved task, for example, welding, a firm (which could be a manufacturer or a contractor) can purchase its own facilities and hire its own employees to complete the task, or alternatively, can sublet the work to a sub-contractor.

To recruit its own people, the firm needs to pay a recruiting fee, k (\$). The recruiting expenditure includes an advertisement fee and interview expenditure, or else pay a fee to an employment agency. The recruiting fee is assumed to be fixed for each round, no matter how many people are recruited. The number of people recruited in each round is Q . The annual salary is P_{self} (\$). The firm also needs to set up a workshop and purchase its own facilities, such as welding machines, fire extinguishers, etc. The facilities are usually in proportion to the number of people using the facility. To cut down its expenditure, when a task is completed, the firm releases its workforce again. The firm recruits new people when a new task arises. The sum of the workload of the tasks is D (man.year/annum). Although people may be released when a task is complete, the firm has to keep all the facilities for the next task. The annual cost of keeping the facilities and workshop per person is H (\$). Alternatively, the firm may sublet its work to a sub-contractor. In such a case, all the recruiting fees and facility fees are transferred to the sub-contractor, but charged back to the firm as a higher unit cost per annum P_{sublet} (\$) (i.e., P_{sublet} is greater than P_{self}). It is assumed that k, Q, P_{self}, D, H and P_{sublet} are constant and D is predictable.

Previous studies (Wu, 2004; Wu and Low, 2005a; 2005b) suggest that the crux of the decision as to whether a firm should hire its own employees or sublet the workload to a sub-contractor is to identify the cost indifference point between the self recruiting system and the subletting system. The self recruiting-subletting cost indifference point is the amount of workload at which the total annual optimum cost under a self recruiting system equals the total annual cost under a subletting system. Based on the conditions above, the total cost under the self recruiting system, TC_{self} is the sum of the recruiting costs, holding costs, and the salaries paid directly to employees, or:

$$TC_{self} = \frac{kD}{Q} + HQ + P_{self}\,D \tag{1}$$

The optimal number of people recruited in each round which can minimise the total cost under the self recruiting system, Q^* can be found by taking the first order derivative with respect to Q of Eq. 1 and setting it to equal to zero, and is:

$$Q^* = \sqrt{\frac{kD}{H}} \tag{2}$$

Eq. 2 results in a total annual optimal cost under the self recruiting system as:

$$TC_{self} = 2\sqrt{kDH} + P_{self}\,D \tag{3}$$

As suggested above, under the subletting system, the recruiting cost and holding cost are mainly transferred to the sub-contractor. The total annual cost under the subletting system, TC_{sublet} , thus is the product of P_{sublet} and D, given by:

$$TC_{sublet} = P_{sublet}\,D \tag{4}$$

P_{sublet} is greater than P_{self} to partially reflect the facility cost and recruiting costs that have been transferred to the sub-contractor.

The difference, , between the self recruiting total costs and the subletting total costs, from equations (3) and (4) is given by:

$$Z = 2\sqrt{kDH} + P_{self}\,D - P_{sublet}\,D \tag{5}$$

But cost indifference is when Z = 0.

Thus $0 = 2\sqrt{kDH} + P_{self}\,D - P_{sublet}\,D$ (6)

i.e. $2\sqrt{kDH} = D\,(P_{sublet} - P_{self})$ (7)

Thus $4kDH = D^2(P_{sublet} - P_{self})^2$ (8)

or $\dfrac{4kH}{(P_{sublet} - P_{self})^2} = D_{indr}$ (9)

Discussion

The self recruiting-subletting cost indifference point model is actually developed from the economic order quantity (EOQ) and just-in-time (JIT) material purchasing models developed by Harris (1915), Fazel (1997), Fazel *et al.* (1998), Schniederjans and Olsen (1999), Schniederjans and Cao (2000; 2001), Wu (2004), and Wu and Low (2005a; 2005b). The base assumptions behind the EOQ-JIT models are explained in these papers, and critiqued in Wu (2004) and Wu and Low (2005a; 2005b). Whilst the EOQ-JIT cost indifference models examines the material purchasing approaches, the self recruiting-subletting cost indifference point model focuses on personnel recruiting. The self recruiting-subletting cost indifference point is shown in Figure 4.

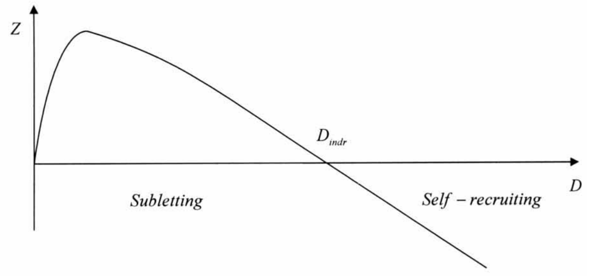


Figure 4 The self recruiting-subletting cost indifference point

Two rules can be summarised from Figure 4. Rule 1 is that when the self recruiting-subletting cost indifference point D_{indr} is a constant, a firm with a low workload may sublet its workload to a sub-contractor and a firm with a high workload probably should purchase its own facility and recruit its own people to finish a task. Rule 2 is that when workload is a constant, any shift in the self recruiting-subletting cost indifference point D_{indr} (see Eq. 9) to a higher value encourages subletting the workload to a sub-contractor.

Figure 4 seems to suggest that whilst a self-recruiting system should be encouraged in the manufacturing industry, subletting is probably a more economically viable alternative in the construction industry. The construction industry is project-oriented. The contractor has to shift to a new construction site for a new project. The frequent shifting incurs additional costs for maintaining facilities thus increasing H in the self recruiting-subletting cost indifference point model in Eq. 9, therefore shifting D_{indr} to a higher value, forcing construction firms to skew towards a subletting system, even when workload remains constant. This is Rule 2.

The workload for a specific kind of person (such as a welder) for a project is usually low. The reasons are two-fold. Firstly, "one-off" designs are normal in the construction industry, as the final product of construction is usually of unique composition and is site specific (Low and Chan, 1997). Hence, there is seldom a "standard" process in the construction industry. Secondly, the construction industry is highly fragmented with different transient project consultants, builders and suppliers. Since the workload for a specific kind of tradesperson for a construction project is low, based on Rule 1, subletting is again probably a more economic viable alternative for a contractor.

The workload for each kind of tradesperson in the manufacturing industry is usually high, as the situation in the manufacturing industry is conversely different from that in the construction industry. In the manufacturing industry, standard designs and repetitive processes are strictly adhered to. The standard designs and repetitive production runs are usually adopted for a specific period of time until the next change in design arises, usually a few years later to accommodate changes in marketing strategies (Low and Chan, 1997). According to Rule 1, and since it is possible for the workload for a specific kind of tradesperson in the manufacturing industry to be higher than the self recruiting-subletting cost indifference point, a self recruiting system should be encouraged in the manufacturing industry.

In summary, the self recruiting-subletting cost indifference point model suggests that the construction industry should encourage subletting and the industry should skew towards small firms. This is what the data shows. While it may be argued at a superficial level that the large number of small firms leads to a loss of potential economies of scale, when looked at more closely, the nature of the construction industry, whether it be the UK, Australia or elsewhere, suggests that the use of subletting work has economic advantage. Viewed in the context of specialisation, quality and compliance, the case for fragmentation is even more convincing.

CONCLUSIONS

This study compares the size and basic structure of the UK construction industry and the Australian construction industry. This study finds that in terms of employment, cement consumption, and the value-added contributions by the construction industry, the UK construction industry is about two-and-a-half times larger than that of the Australia construction industry over the period between 1993 and 2001. In terms of value-added per person employed, the UK industry is on average 16.1 per cent more effective than its Australian counterpart, at least assuming all other factors (e.g. time to complete, quality of construction, client satisfaction, etc.) are equal. It is found that both the UK and Australian construction industries are heavily skewed towards small firms. In this study a self recruiting-subletting cost indifference model has been developed to provide insight into the reasons behind construction industry fragmentation. Whilst the overwhelming number of small firms can be criticised for preventing the exploitation of economies of scale, the self recruiting-subletting cost indifference model suggests that subletting is probably the most profitable practice for construction firms. It is not surprising, therefore, that the structure of the construction industry is skewed toward a large number of very small firms.

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