STUDY REPORT

SR 283 (2013)

Construction industry data to assist in productivity research Part Two

IC Page

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Preface

This is the eighth in a series of reports on construction industry productivity. The first report was a general review of construction industry productivity and how to measure it (BRANZ Study Report 219). The second (SR254) was an examination of variations in productivity and profit margins in the construction sub-industries at the four-digit level. The third (SR256) collated miscellaneous data relating to the industry as a basis for making decisions about future productivity research. The fourth (SR259) quantified the value of time saved through quicker construction of housing. The fifth (SR266) looked at industry segmentation and provided investigation, design, construction and occupancy costs for a range of sectors, to provide guidance on value stream investigations. The sixth (SR267) was a review of official and other data available for measuring industry performance. The seventh (SR270) reported the survey results in 2011/12 of 500 new home owners including satisfaction levels and call-backs, and was developed as one measure of industry performance. This report continues on from the third report, in that it contains a variety of information related to productivity research as requested by the productivity partnership.

Acknowledgments

This work was funded by the Building Research Levy.

Note

This report is intended for researchers and officials.

Construction industry data to assist in productivity research – Part Two

BRANZ Study Report SR 283

IC Page

Abstract

Various data related to construction industry productivity has been collected by BRANZ in the last 12 months. This data, based on official information and BRANZ surveys, is presented in this report as background information to assist in undertaking productivity research programmes.

Contents

Page

Figures

Page

Tables

Page

1. INTRODUCTION

This report provides details of data used to help the development of the research programme of the Construction Productivity Partnership (CPP). It contains a variety of ad-hoc data related to the construction industry and does not cover all aspects of the required research programme. Instead it is a record of data requests from various persons involved in research on improving industry performance.

2. MAIN RESULTS

The main data provided is on estimated workloads and the demand for labour in the industry. A number of miscellaneous requests are recorded, covering new house owners' requirements, firm size and builders' views on potential for productivity improvements.

The results include:

- Nationally, the forecast is for a 17% increase in building work by 2015/16, above the peak reached in the mid 2000s.
- An increase in labour numbers of at least 15% above current numbers is required to meet future workloads, a situation made worse by trade net migration still running in negative numbers.
- Recovery work in Christchurch is now well under way as recorded in building consents, with their value above the peak of the mid 2000s and rising.
- Modelling of labour demand using regression methods on capital formation data does not appear to be very reliable and other ad-hoc methods are needed. Part of the reason appears to be because repairs/maintenance work is a significant sector which is not included in capital formation.
- A survey of new house owners indicated the main priority was maximising floor area, i.e. as many bedrooms, garage space and storage area as is possible within their budget.
- Construction industry firm sizes are small compared to other industry, apart from agriculture. This adversely affects the industry's ability to achieve economies of scale.
- A survey of builders' productivity measures found better skills and project management, and better design details have a large effect on productivity in the building industry.

2.1 Projected workload volumes

The project industry workloads over the next few years are large because of a number of factors, including:

- Pent-up demand for buildings due to low construction levels in the last three years.
- Christchurch earthquake reconstruction.

- Leaky building repairs.
- Aging housing stock requiring refurbishing.
- Upgrading of non-residential buildings for earthquake loading resistance.

These high workloads, and in particular the urgency of the Christchurch earthquake repairs, offer the opportunity for the industry to trial new ways of working that are known to have an influence on sector productivity. These opportunities include methods of procurement, new technologies, pre-fabrication, standardisation, training, supervision and inspection.

The BRANZ national forecasts are shown below in Figure 1 and the data is in Table 1.

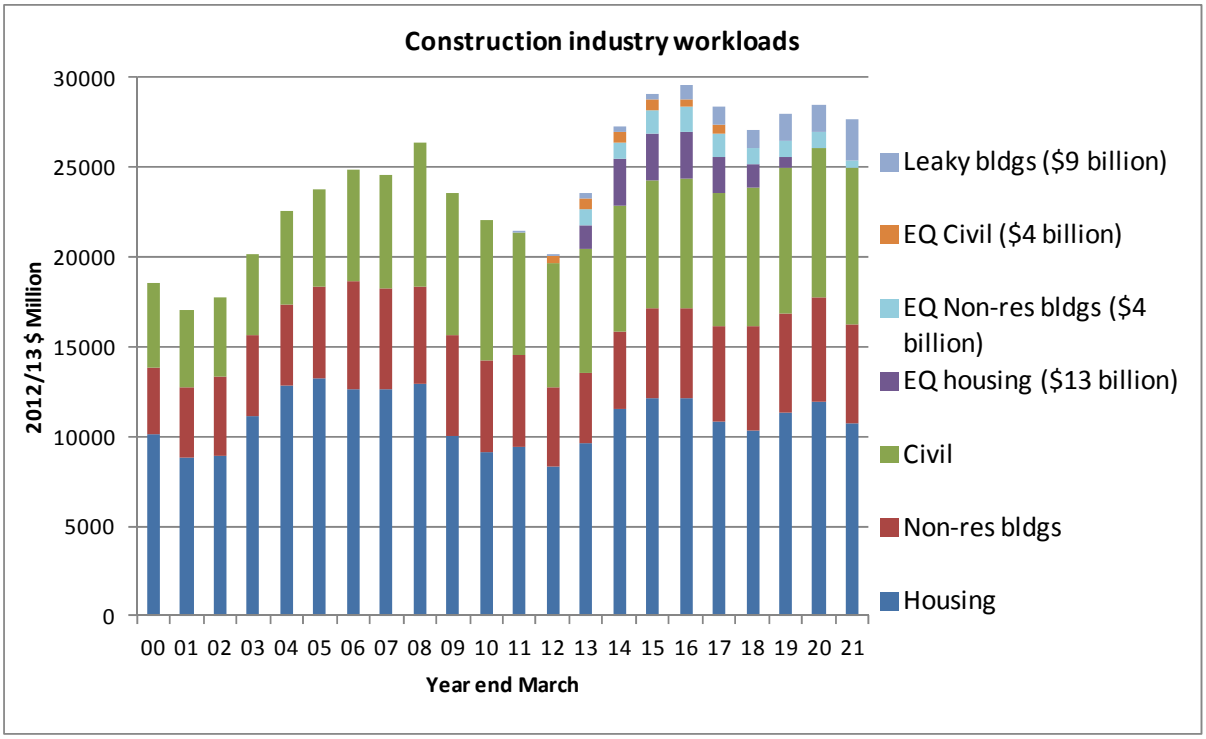

Figure 1 Construction industry workload projections

Table 1 Workload forecasts

Fixed capital formation $billion 12/13$																		
BRANZ forecasts at December 2012																		
	Mar yr	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	Total
Baseload	Housing	12.6	12.6	12.9	10.1	9.2	9.4	8.3	9.6	11.5	12.1	12.1	10.9	10.3	11.4	11.9	10.7	
	Non-res bldgs	6.0	5.6	5.4	5.6	5.1	5.2	4.4	4.0	4.4	5.0	5.0	5.3	5.8	5.5	5.8	5.5	
	Civil	6.2	6.4	8.1	7.9	7.8	6.7	6.9	6.9	7.0	7.2	7.3	7.4	7.7	8.0	8.4	8.7	
	Cant EQ Housing ($9 billion)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.3	2.6	2.6	2.6	2.0	1.3	0.7	0.0	0.0	13.0
	Cant EQ Non-res bldgs ($3 billion)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.9	1.4	1.4	1.4	0.9	0.9	0.9	0.5	9.0
	Cant EQ Civil ($ 3 billion)	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.6	0.6	0.6	0.5	0.5	0.0	0.0	0.0	0.0	3.1
	Leaky bldgs ($12 billion)	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.3	0.3	0.3	0.8	1.1	1.1	1.5	1.5	2.3	9.2
	Total $B	24.8	24.6	26.4	23.5	22.1	21.4	20.2	23.5	27.3	29.1	29.5	28.4	27.1	28.0	28.5	27.6	
	Buildings only $B	18.64	18.21	18.32	15.62	14.22	14.65	12.9	16.06	19.67	21.35	21.8	20.49	19.38	19.92	20.11	18.93	
	New dwellings number (000)	25.4	25.7	24.5	16.2	15.4	14.6	14.6	17.5	22.0	24.0	26.0	24.0	21.0	25.0	25.0	22.0	
New dwell numbers includes 10,000 Chch replacements over six years from now.																		
Note: FCF includes design, legal, admin costs & is typically 30% above consent values for housing. (It also includes existing building																		
sale transaction costs such as land agents and legal, etc.)																		
Upgrading/replacement of non-residential buildings outside Canterbury for earthquake (EQ) resistance are included in the Baseload work.																		

The Christchurch earthquake work totals about $25 billion as per the Treasury estimate of December 2012 and the leaky buildings total is about $12 billion ($11 billion housing from the PriceWaterhouseCoopers (PWC) report, plus $1 billion non-residential buildings as estimated by BRANZ).

The increase in buildings work (excluding civil) from the mid 2000s period to the future peak (2013/14 and 2014/15) is about 15%. This implies a need to find about 15% more building workers than we had during the last boom period.

The percentage increase from current work levels is much larger, at about 30%. However, at present the average hours worked per person is down on the mid 2000s level, and some labour hoarding will be occurring now in expectation of an upturn. So the actual increase on current numbers required will be well below 30%, probably nearer 15%, allowing for an increase in average hours per worker and efficiency improvements.

This will be a significant challenge. There are currently about 110,000 trade and other on-site workers in the building sector, so we will be looking for an extra 17,000 workers over the next two years. Likely sources include people coming out of other industries, returning from overseas, new trainees, and immigrants. But it seems unlikely we will find all the required numbers in the assumed time period.

The result is likely to be deferred work. We have allowed for a quite large new dwellings catch-up in 2014 and 2015 at 23,000 new dwellings per year, of which 2500 per year will be in Christchurch. It is possible that some new dwellings work outside Canterbury will be deferred, as well as leaky building repairs.

An estimate of the various building trades required is shown in Table 2. They are an upper limit because they assume an eight-year reconstruction period for both earthquake and leaky building repairs, whereas due to resource constrains the period

may be longer.

Table 2 Projected trade number estimates

Labour demand for EQ and leaky home repairs, and projected baseload demand. At Jan 2013						
EQ Housing			**$ billion**			
10,000 replaced @ $300,000 ea =			3.0	assumes 180 sqm existing house @ $1700/sqm.		
100,000 houses repaired @ $100,000 ea =			10.0			
			13			
EQ Non-residential buildings			9.0			
EQ Civil infrastructure			3.0			
Total repair EQ as per Treasury (1)			25			
Leaky buildings						
PWC report 42,000 homes			11			
Non-res bldgs (2)			1.1			
			12.1			
Total EQ bldgs + leaky bldgs			34.1	$billion ignoring civil work (3).		
"Normal" workloads next 8 years All bldgs			132.0	$billion,BRANZ forecast, incl housing & non-res bldgs.		
EQ+ leaky bldg + normal work			166.1	$billion next 8 years		
			20.8	$billion per year spread evenly over 8 years.		
		Current workload	16.1	$billion per year		
			Number of workers			
			per yr for $1 million		Numbers required	% increase
		Approx	of completed work (4),(5)		for all work	on current
Trades		**numbers 2012/13**	2012/13		persons per yr (6)	numbers
Carpenters/ builders		39,500	2.45		50,900	29
Builders labourers		8,100	0.50		10,400	28
Electricians		12,100	0.75		15,600	29
Plumbers/ drain layers		12,200	0.76		15,700	29
Painters		11,700	0.73		15,100	29
Tilers, floorer		4,200	0.26		5,400	29
Bricklayers/ masons		2,600	0.16		3,400	31
Solid plasterers		2,300	0.14		3,000	30
Roofers		3,600	0.22		4,600	28
Fibrous plasterers		4,300	0.27		5,500	28
Concretors		3,700	0.23		4,800	30
Glaziers		2,000	0.12		2,600	30
Scaffolders		800	0.05		1,000	25
Insulation		1,200	0.07		1,500	25
		108,300			139,500	29
(1) Treasury Economic Outlook HYEFU 2012						
(2) BRANZ estimate for non-res leaky buildings						
(3) Have ignored civil EQ repairs as they are assumed to use different trade groups to building work (not totally correct.)						
(4) In the year end Mar2013 the amount of housing & non-res building work was about $16.1 billion which is used to obtain the ratios.						
(5) The mix of trades for repairs is different from new work. Probably the demand for builders will be lower and the demand for roofers, plumbers, plasterers, painters, floorers, & glaziers will be higher in the future, as shown.						
(6) $20.8 Billion x number of workers per $1million ratio.						

2.2 Recovery work in Canterbury

The post-earthquake rebuild in Christchurch was slow to start and early forecasts of the timeframe have turned out to be gross under-estimates. There are a number of reasons for this including the scale of the work, the need to assess damage, land re-instatement investigations and, not least, the after-shocks which made insurance companies reluctant to undertake repairs while there was the possibility of further damage. Figure 2 shows building consents issued in Canterbury. Points of note include:

- Non-residential building work increased sooner than housing work.
- There has been a large increase in new housing outside Christchurch, in the Waimakariri and Selwyn districts.
- The housing upturn started quite soon after the last major shock of December 2011 which is somewhat surprising given the uncertainty at the time whether the major after-shocks had finished.

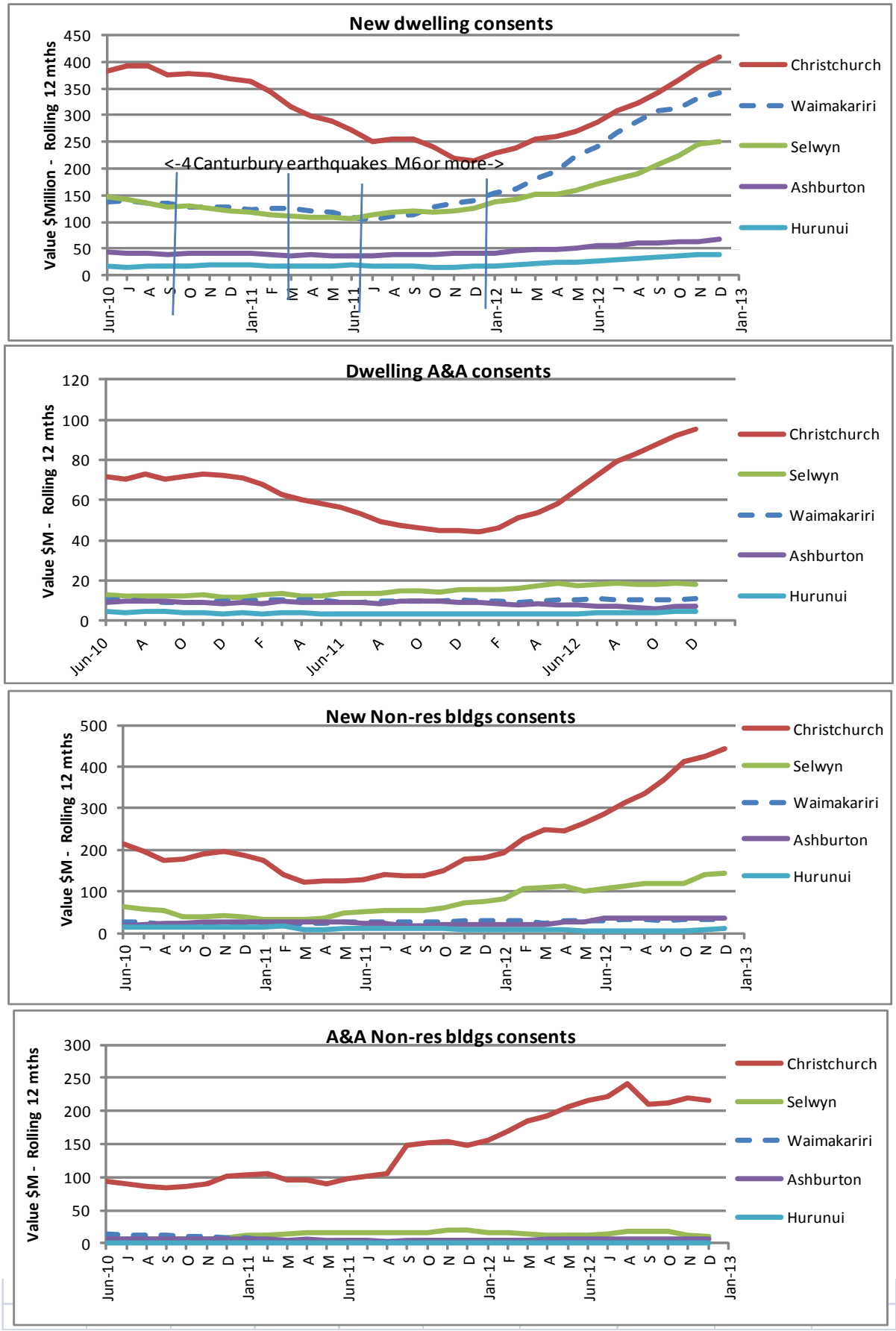

Figure 2 Canterbury building consent details

2.3 Migration of building occupations

As discussed above, one of the concerns for the Canterbury rebuild is the availability of labour. At present there is a net outflow of most trade groups based on data collected by Statistics New Zealand (SNZ). The exceptions are architects and engineers for which there are small net inflows, see Figure 3.

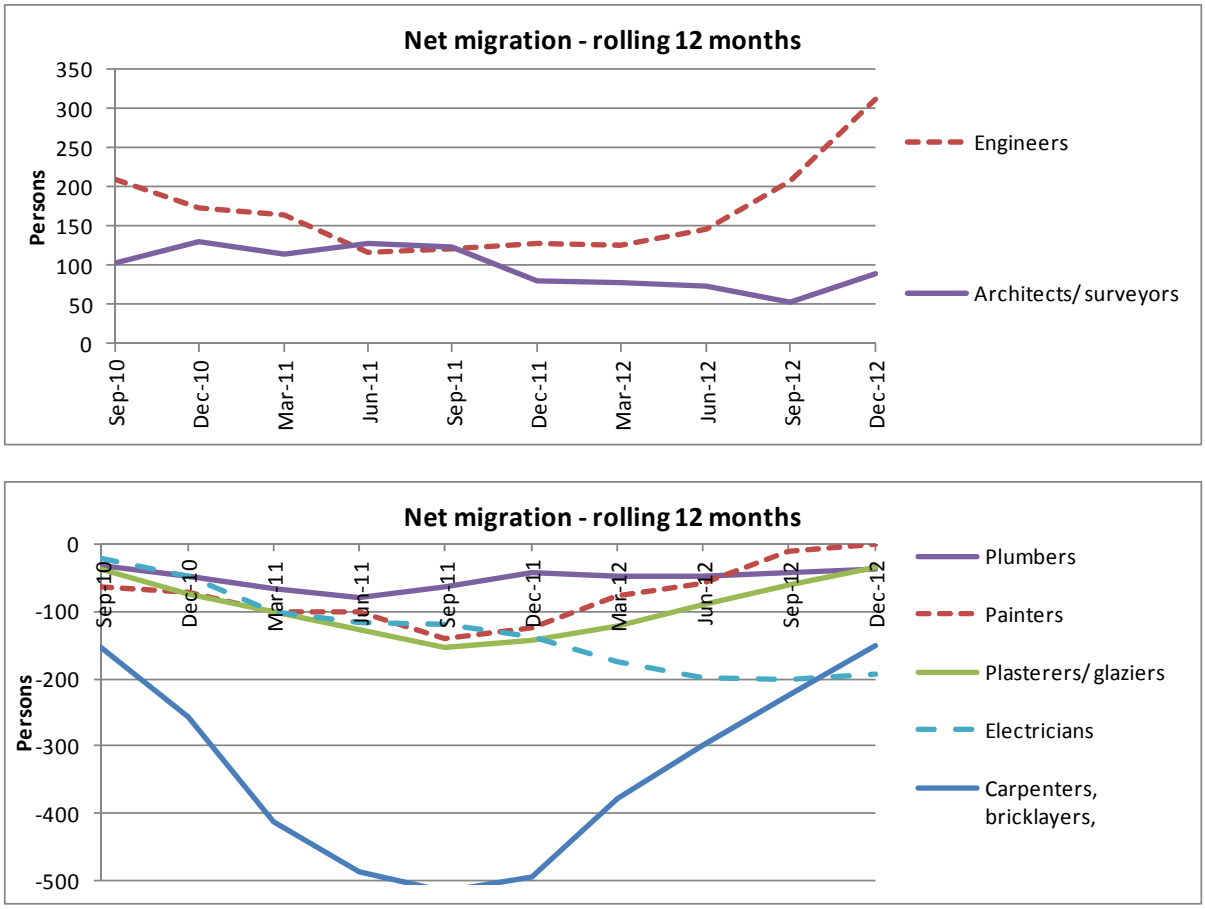

Figure 3 Net migration by occupational group

2.4 Workloads and employment

Table 2 assumed a constant ratio between value of building work and the number of trades persons required. This approach can be applied to estimate ratios separately for housing, non-residential building and civil engineering. A linear regression model was developed to explain total industry employment in terms of the amount of work done in each of housing, non-residential buildings and "other construction" (i.e. civil engineering). SNZ records numbers in all construction employment and these are shown as the solid line in Figure 4.

The regression model in Table 3 indicates the number of construction workers required per year per $1 million of work placed. The table shows that housing requires approximately five workers per $1 million of work per year, non-residential building needs eight workers per $1 million of work and civil engineering requires about 16

workers per $1 million of work per year. This result is quite surprising because it implies two-thirds of all industry employment is in civil engineering, given that approximately 50% of workloads are in civil engineering. The modelling used data up to March 2010 and then forecasted employment thereafter using the coefficients from the regression. The forecasts are not particularly accurate, see the chart, suggesting the model is not very reliable even though it has an R squared of 94%. The main problem with the method is that repairs, maintenance and minor alterations work is not included in the regression and it is known from surveys (Page, Curtis 2013) that this work is about 35% of total workloads for builders. Also the dependant variable, the number employed, is an approximation of labour volume since it does not allow for average hours worked per person employed.

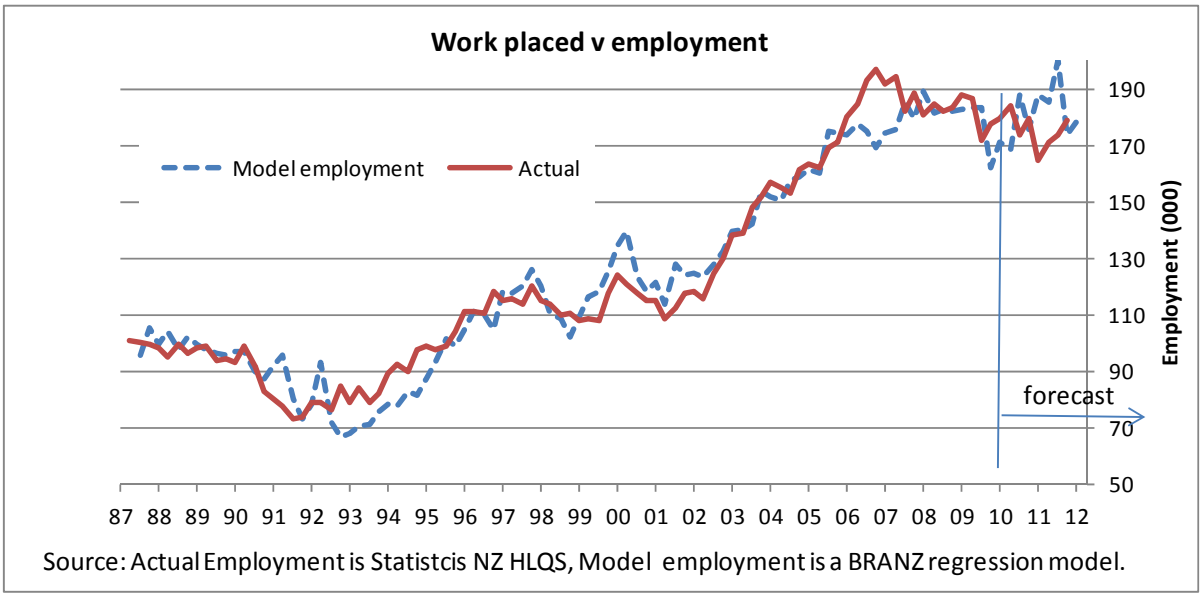

Figure 4 Work done versus employment in construction

An alternative method for modelling employment by segment is to use the business demographic survey from SNZ. It has data on employment by sub-industry namely housing, non-residential buildings, civil engineering and the various sub-contracting groups (structural services, installation services and completion services). However, it does not show how the sub-contractors are allocated between building work and civil engineering. Instead, BRANZ has made assumptions on how sub-industry labour is distributed between the three segments, see Table 4. The net result is that only 26% of employment is in the “other construction” segment of the industry. This contrasts with Table 3 with 68% in the segment. Of the two methods, the second in Table 4, is believed to be more reliable as to where labour is utilised in the industry.

Table 3 Regression modelling of employment

	Employment = c1 +c2RB + c3NR + c4OC				RB= $ Residential work		
	SUMMARY OUTPUT				NR=Non-residential buildings		
					OC= Other construction (i.e.		
	Regression Statistics					civil engineering).	
	Multiple R	0.971					
	R Square	0.942					
	Adjusted R Square	0.940					
	Standard Error	9.012					
	Observations	92					
				Coefficients	*Std Error*	*t Stat*	
	Intercept		c1 =	-0.1506	4.88	-0.03	
RB	X Variable 1		c2=	0.0198	0.00	5.38	
NR	X Variable 2		c3=	0.0308	0.01	5.01	
OC	X Variable 3		c4=	0.0622	0.00	18.39	
		Annual employmt			Workloads	Implied	
		persons per $M			for 2012	employment	
	per qtr	for 2012			$M		
RB	19.8 persons/$M	5.0			5,172	25602	14%
NR	30.8 persons/$M	7.7			4,357	33552	18%
OC	62.2 persons/$M	15.6			8,269	128582	68%
						187737	100%

Table 4 Demographic survey modelling of employment

Employment by 3 main segments 2012										
Industry sub-sector (1)	Number	Persons	Percentage (3)				Employment numbers (4)			
	of firms (2)	engaged (2)	RB	NR	OC	Total	RB	NR	OC	Total
E301100 House Const	13995	28255	100			100	28255	0	0	28255
E301900 Other Residential Building Const	1631	2601	100			100	2601	0	0	2601
E302000 Non-Residential Building Const	1363	11183		100		100	0	11183	0	11183
E310100 Road and Bridge Const	434	14114			100	100	0	0	14114	14114
E310900 Other Heavy& Civil Eng Const	993	16123			100	100	0	0	16123	16123
E321100 Land Development & Subdivision	1326	1646			100	100	0	0	1646	1646
E321200 Site Preparation	2085	9645	30	50	20	100	2894	4823	1929	9645
E322100 Concreting	931	3141	35	35	30	100	1099	1099	942	3141
E322200 Bricklaying	956	2196	65	35		100	1427	769	0	2196
E322300 Roofing	1007	3077	70	30		100	2154	923	0	3077
E322400 Structural Steel Erection	227	667	20	50	30	100	133	334	200	667
E323100 Plumbing	3357	10417	50	40	10	100	5209	4167	1042	10417
E323200 Electrical	5389	17229	30	40	30	100	5169	6892	5169	17229
E323300 Air Conditioning and Heating	891	5371	20	80		100	1074	4297	0	5371
E323400 Fire & Security Alarm Installation	519	3649	20	80		100	730	2919	0	3649
E323900 Other Building Installation	426	1756	50	50		100	878	878	0	1756
E324100 Plastering and Ceiling	1654	3674	40	60		100	1470	2204	0	3674
E324200 Carpentry	1532	2792	65	35		100	1815	977	0	2792
E324300 Tiling and Carpeting	1967	3557	50	50		100	1779	1779	0	3557
E324400 Painting and Decorating	3950	10040	60	40		100	6024	4016	0	10040
E324500 Glazing	543	1683	30	70		100	505	1178	0	1683
E329100 Landscape Const	2202	6002	60	40		100	3601	2401	0	6002
E329200 Hire of Const Machinery with Opera	201	1191	20	50	30	100	238	596	357	1191
E329900 Other Const Services n.e.c.	1520	6880	35	35	30	100	2408	2408	2064	6880
		166889					69462	53841	43586	166889
							42%	32%	26%	100%
(1) Statistics New Zealand categories			RB= Residential buildings							
(2) From the SNZ Business Demographic Survey 2012				NR = Non-residential buildings						
(3) BRANZ estimate of what percentage of workforce goes into the 3 segments.					OC = Other construction					
(4) Column 2 x Column 3.										

2.5 Boom-busts in the existing housing sector

The Real Estate Institute data was examined for the sales price index of detached housing from 1989 and before that their series was linked to Quotable Value data back to 1962. The combined sales price index was used to produce Figure 5 which indicates a peak-to-peak time of approximately eight years. New house price changes tend to move concurrently with the existing house market, though the size of the price change is less in new housing than in existing houses.

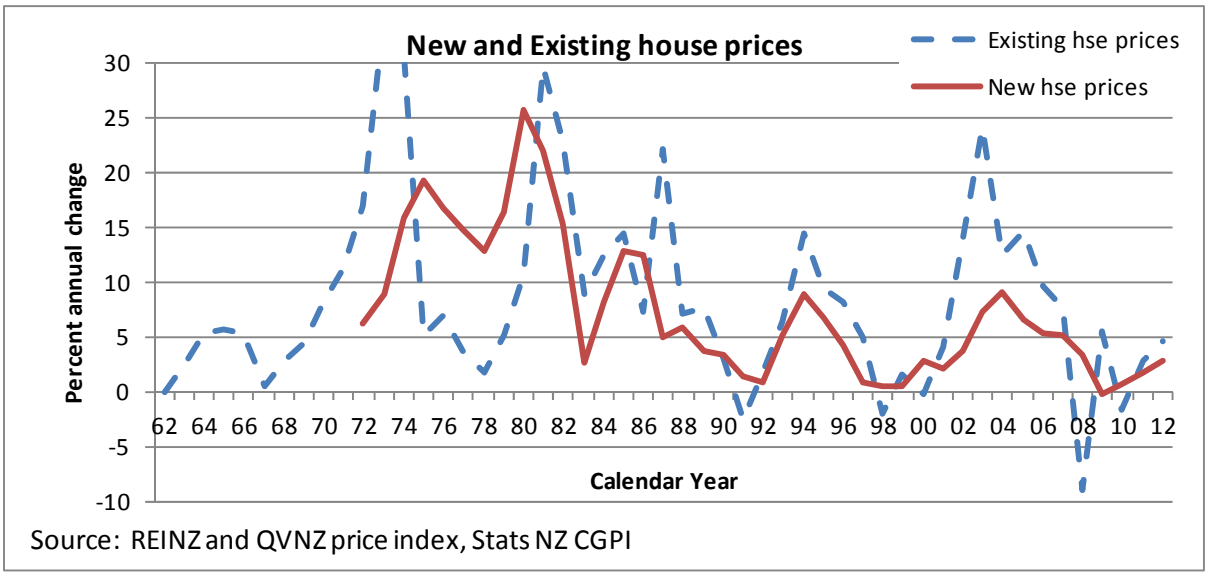

Figure 5 Average annual price changes in new and existing houses

In fact the existing market slightly leads the new housing demand and the percentage change in numbers is similar for both series, i.e. the percentage change in existing house sales is followed within about six months by a similar change in new housing starts, see Figure 6.

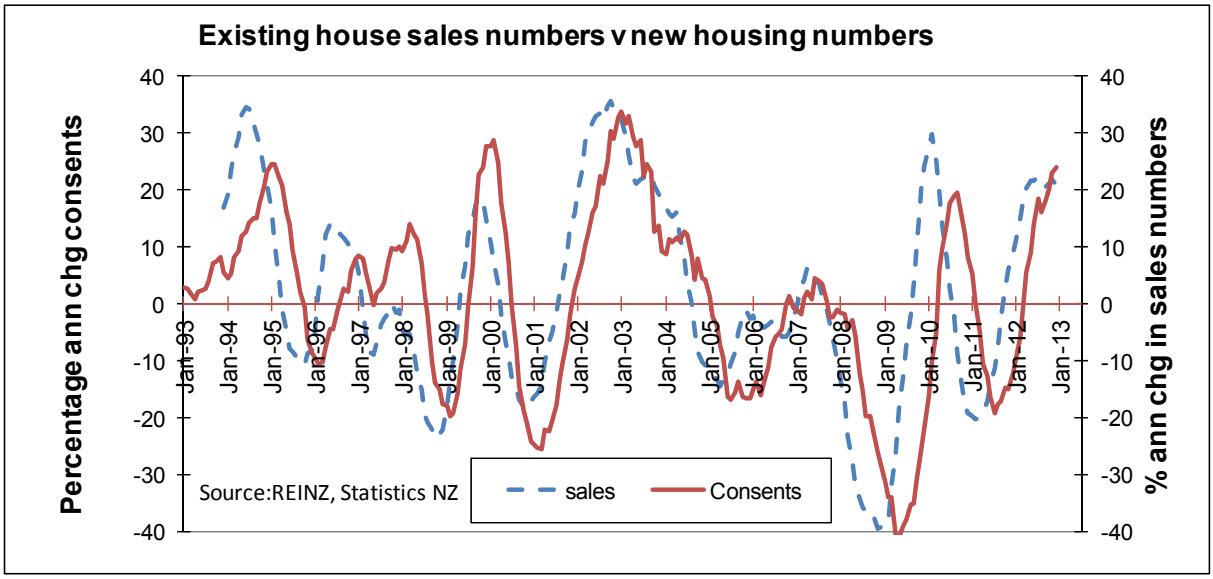

Figure 6 Existing sales numbers versus new house numbers

The existing sales percentage change line historically shows two alternative paths, either a steep decline after the peak or a decline extending over several quarters before it cross the zero line. The BRANZ forecast is that the existing sales will continue as a positive percentage change for several quarters. This means new consents will continue to grow in number for several quarters but the rate of growth will begin to slow by mid to late 2013. The forecasts are for 21,000 new dwelling consents by March 2014, up from about 17,000 in late 2012.

2.6 Work not done by a consent

The building consent series published by SNZ is a very useful source of data on building activity but we know that a significant amount of building work that is done does not require a consent. How large is this market? The SNZ economic survey of households indicates the average household (HH) spent approximately $57 per week on maintenance, alterations, additions and improvements. Adding in the value of own labour, the value of work is about $67 per week. This average includes renters whom do not spend on maintenance or additions and hence for owner-occupiers the average expenditure is about 30% higher.

Table 5 Spending on consented and non-consented work on housing

Household Economic Survey 2010						
		average weekly $ per household				
			own labour		**Comment**	
Home ownership	A&A Materials	2.2	2.2		Assume owner's labour is equal to material cost.	
	A&A Services	18.5	0		Uses contractors.	
Property maintenance	Maintenance Materials	7.3	7.3		Assume owner's labour is equal to material cost.	
	Maintenance Services	29.5	0		Uses contractors.	
		57.5	9.5	67.0	= total value of work done on property $/wk/HH	
A&A = alterations, additions and improvements.						
Ave expenditure $/ yr/ HH =	3497	spent on maintenance, additions & improvements.				
Number of households	1.61	million	includes rentals.			
Total expenditure =	7320	$ million	allow a 1.3 factor for renters whom spend zero on maintenance.			
A&A consents =	1290	$ million	for year end June 2010			
Hence non-consented work =	6030	$ million	for year end June 2011			

In Table 5 landlords are assumed to spend similar amounts as owner-occupiers on maintenance and additions, giving a total expenditure of $7.3 billion per year. Consented A&A work is only about $1.3 billion per year, so the non-consented work is almost five times the consented work. Note that the former includes a wide range of work such as decorating, new joinery, insulation and outside work such as patios, paths, fences and landscaping.

2.7 Owners' requirements for new housing

Previous work (Curtis 2012) has indicated satisfaction levels with new housing do not vary greatly with the method of obtaining a new house. Satisfaction is roughly the same for owners on one-offs and owners of the so called "standardised houses". As part of the satisfaction survey, owners were asked what features are important in their new house. The results are in Figure 7 and indicate number of bedrooms, double garages and size of house have top priority. The survey was on owners of new detached housing only, so it is perhaps unsurprising that space requirements are important. Multi-unit owners may have different priorities but these were not surveyed. Also, the responses had an average floor area of 220 sqm compared to all detached housing of 216 sqm in the same period (late 2010 to early 2011), so the sample is slightly biased toward larger houses.

It was interesting to note that the presence of a games room or study did not score particularly high. Respondents appear to want large houses with plenty of bedrooms. Why this is so given declining household sizes is uncertain, but may reflect owners' perceptions of re-sale value. Double garages are high in the list of needs as are kitchen finishes. It is pleasing to see low maintenance appearing as a high priority.

The implications for affordability are several. Firstly, as house size, bedroom numbers, a detached house with garden and double garaging rank high, it will be a struggle to get owners to accept smaller housing. Conversely, low maintenance of the section and house, and security features also rank quite high and these can be more readily achieved in compact multi-unit housing than in large detached houses.

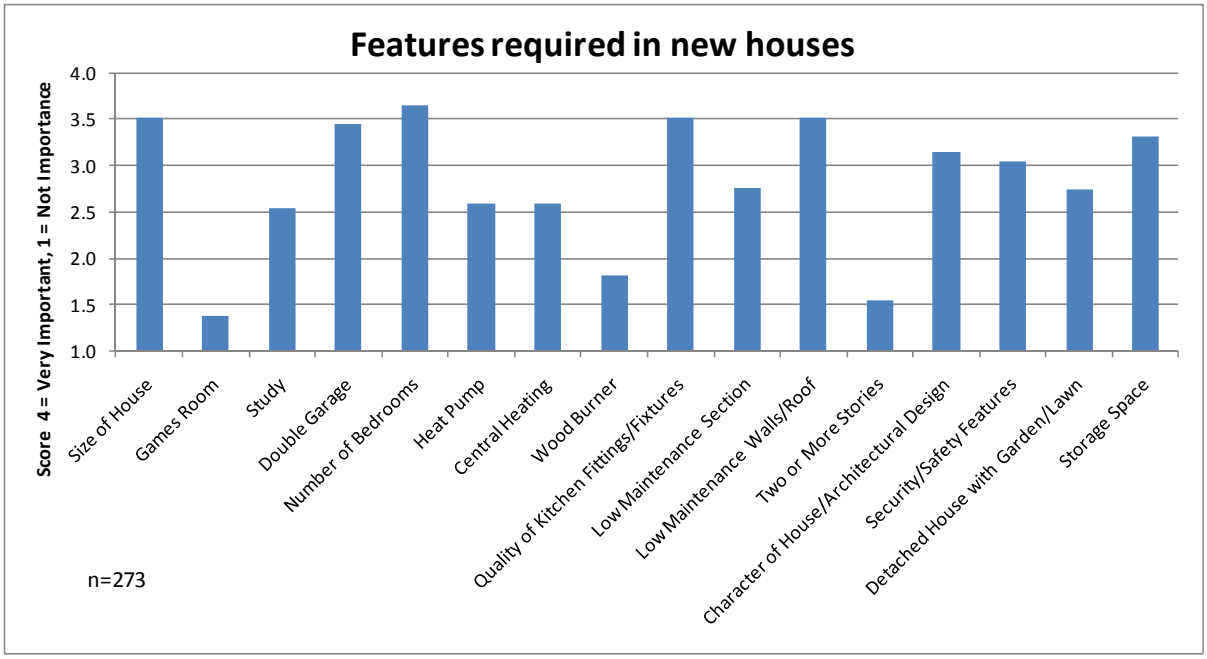

Figure 7 Features required in new housing

2.8 Construction industry firm sizes

A characteristic of the industry is that the firm size (persons per firm) is quite small, see Figure 8, Figure 9 and Table 6. Approximately 44% of all employment is in firms with less than six workers, compared to all industry with about 27% in the less-than-six-worker firms. About 92% of all housing and sub-contractor firms have five employees or less.

Only the farming sector rivals the construction industry in this small firm concentration. The small size of the industry makes it difficult to introduce innovation due to lack of economies of scale. However, the farming industry performs quite well in productivity trends, despite its average small firm size, see Figure 10. In part this is due to good export prices, but there are likely to be lessons from agriculture that could be applicable to construction firms.

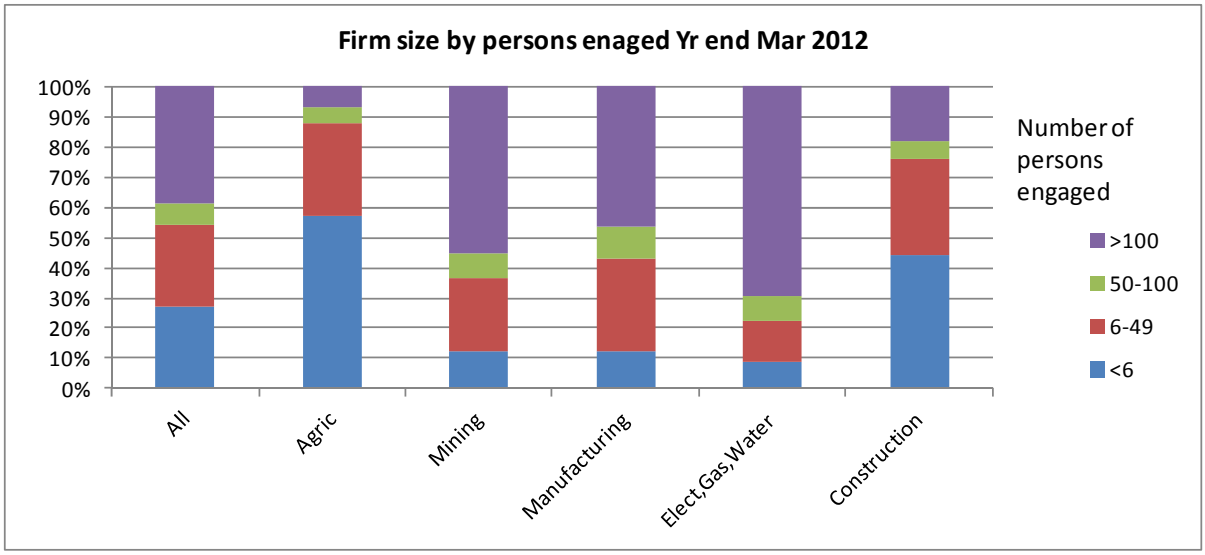

Figure 8 Construction firm sizes compared with other industries

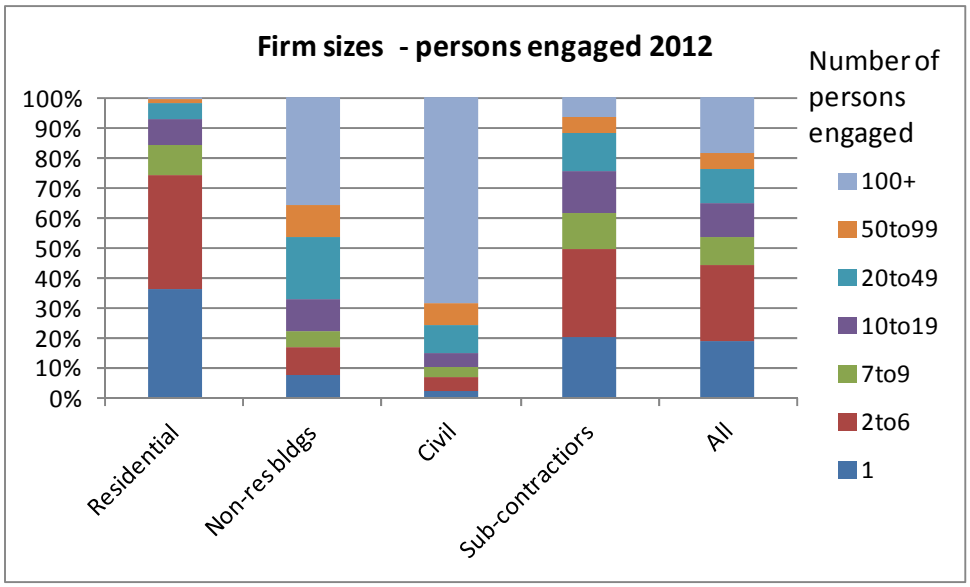

Figure 9 Construction industry firm distributions

Table 6 Average firm size by number of workers by construction sub-industry

Average firm size - Persons engaged Year end March 2012			
	Number of firms	Persons engaged	Average persons/ firm
House Construction	13995	28255	2.0
Other Residential Building	1631	2601	1.6
Non-Residential Building	1363	11183	8.2
Road and Bridge Construct	434	14114	32.5
Other Heavy and Civil Eng	993	16123	16.2
Land Development and Subd	1326	1646	1.2
Site Preparation Services	2085	9645	4.6
Concreting Services	931	3141	3.4
Bricklaying Services	956	2196	2.3
Roofing Services	1007	3077	3.1
Structural Steel Erection	227	667	2.9
Plumbing Services	3357	10417	3.1
Electrical Services	5389	17229	3.2
Air Conditioning and Heat	891	5371	6.0
Fire and Security Alarm	519	3649	7.0
Other Building Installation	426	1756	4.1
Plastering and Ceiling	1654	3674	2.2
Carpentry Services	1532	2792	1.8
Tiling and Carpeting	1967	3557	1.8
Painting and Decorating	3950	10040	2.5
Glazing Services	543	1683	3.1
Landscape Construction	2202	6002	2.7
Hire of Construction Machinery	201	1191	5.9
Other Construction Services	1520	6880	4.5
	49099	166889	
Source: Statistics NZ Business Demographic Survey			
Include working proprietors.			

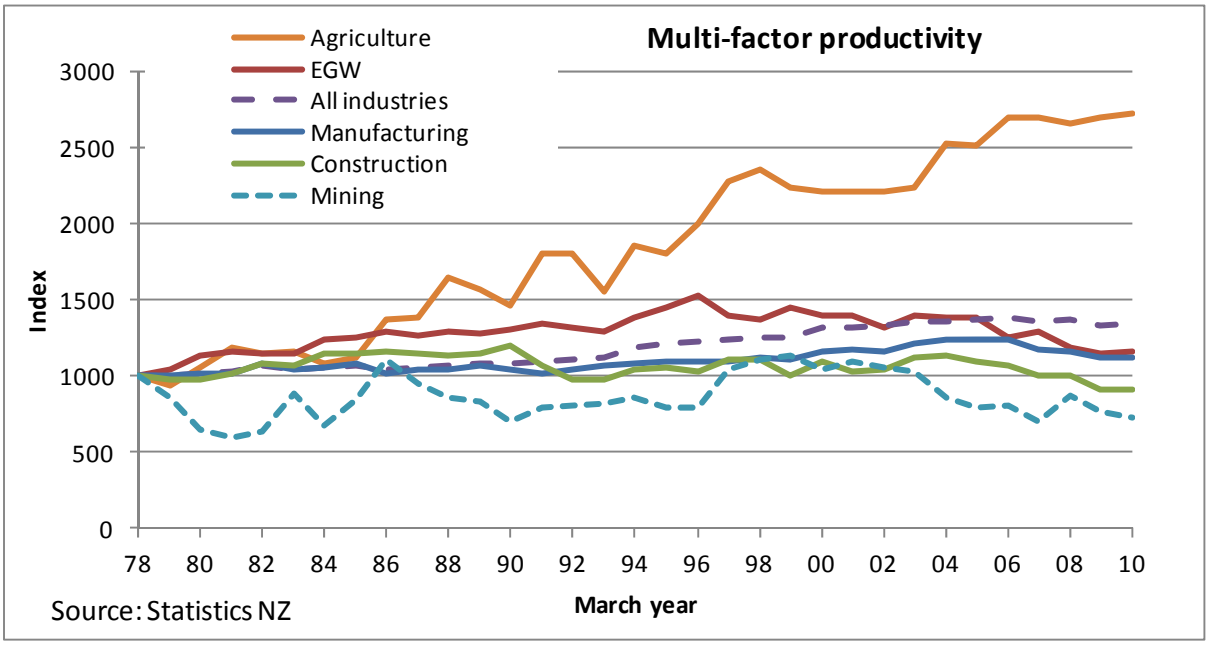

Figure 10 Productivity industry comparisons

2.9 Builders' views on productivity factors

In 2009, a small pilot survey was carried out with builders on the factors affecting productivity. The results are in Figure 11 and Figure 12. The number of responses was 189 and 81 respectively for new housing and non-residential building contractors.

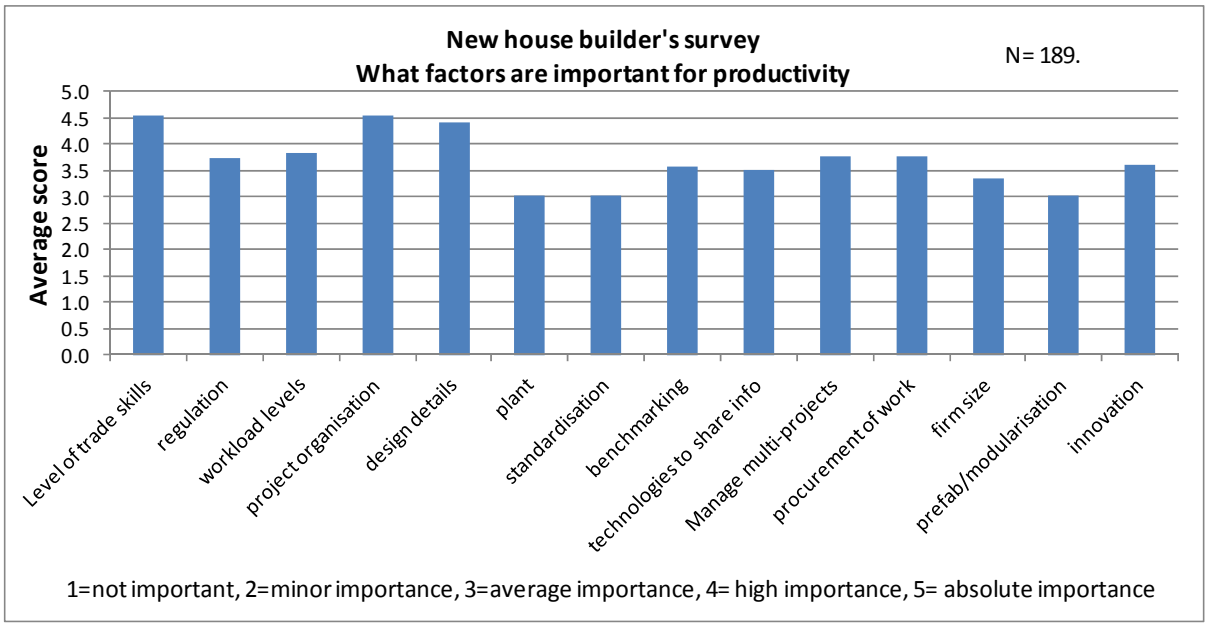

Figure 11 New house builders' productivity factors

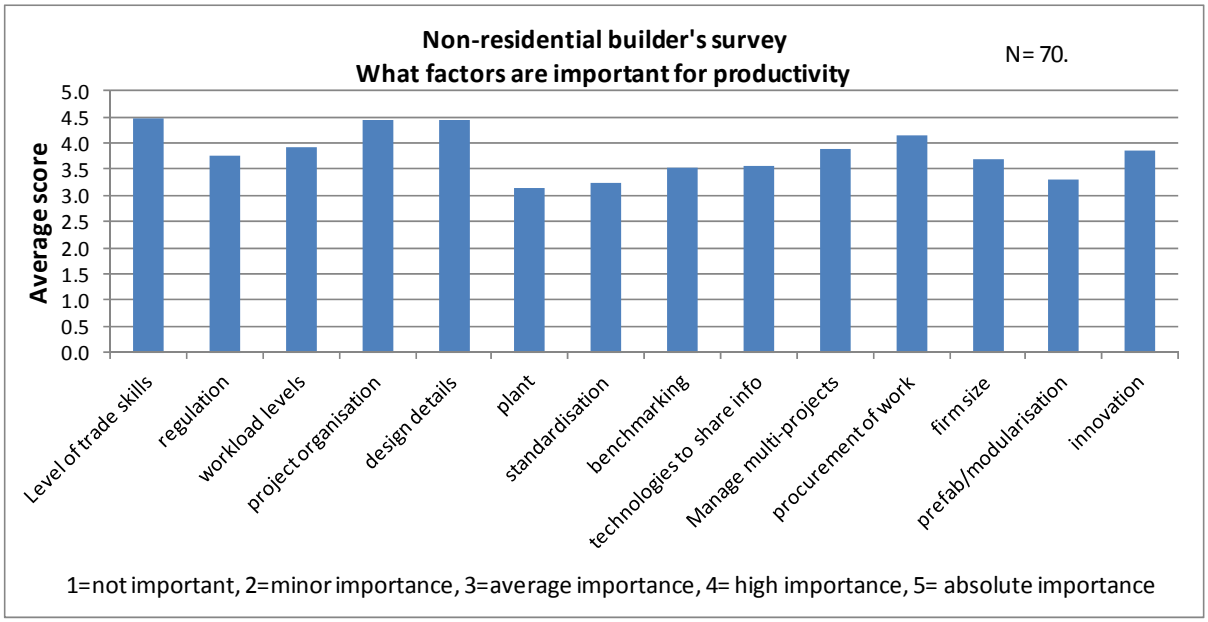

Figure 12 Non-residential building contractors' productivity factors

Both sectors of the industry had similar views in that skills, project management and design details had the greatest effect on productivity. The overall level of work and the

ability to procure new work, were also important factors in productivity. Benchmarking rated about average among all factors and is probably an indication that most firms do not do it, nor are aware of, its effect in improving performance. It was interesting to note the contractors said that standardisation and prefabrication were relatively unimportant. Why this is so is not known, but it could be the respondents had little experience of these factors or that they thought prefabrication had gone as far as is possible, given the current methods for assembling houses on-site and the current structure of the building sector. The literature identifies these as important measures to improve productivity throughout construction (CIB 1996).

A new Study Report (Page, Curtis 2013) reports on a more extensive survey on opportunities for productivity improvement in new housing. Good design details and project management also feature with high importance in that survey. Client briefing to minimise changes were other important factors to improve productivity.

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