STUDY REPORT

SR 256 (2011)

Construction industry data to assist in productivity research Part One

I C Page

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Preface

This is the third of a series of reports on construction industry productivity. An earlier report was a general review of construction industry productivity and how to measure it (BRANZ Study Report 219). The second report was an examination of variations in productivity and profit margins in the construction sub-industries at the 4–digit level (BRANZ Study Report 254). This report collects together miscellaneous data related to the industry as a basis for making decisions about the future productivity research.

Acknowledgments

This work was funded by the Building Research Levy.

Note

This report is intended for researchers.

Construction industry data to assist in productivity research

BRANZ Study Report SR 256

I C Page

Abstract

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

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 is a variety of ad-hoc data related to the construction industry and does not cover all aspects of the required research programme. Instead it was provided to help identify useful areas of research that can be effective in improving industry performance.

2. SUMMARY

The main conclusions/ questions from the data analysis are:

- It is worth looking for simple correlations at the 3-digit industry level between firm productivity and profits, and firm operations behaviour as revealed in the Business Operations surveys.
- The boom-bust cycle has some correlation with industry productivity, and measures to reduce fluctuations need to be considered.
- Industry employment is overwhelmingly in small firms (less than 6 persons), so measures to improve performance need to be addressed to these small firms.
- There is a large variation in productivity and profit margins between construction firms in any 4-digit industry. More work is needed on why this is so. Profit margin data may encourage benchmarking.
- New house owners satisfaction levels are high (as revealed in pilot surveys) but call-backs occur in 60% of new houses. Does the customer have low expectations of the industry, and can we better measure satisfaction and quality?

3. MAIN RESULTS

A number of data sources were investigated in support of developing the research programme. These included:

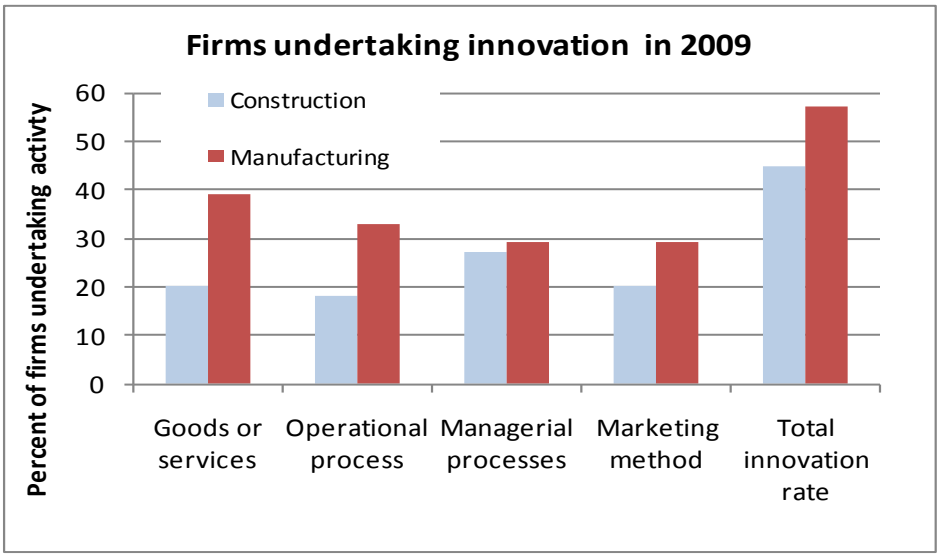
- Business operations survey (BOS).
- Boom-bust cycles
- Construction firm employment
- Firm productivity variations
- New house owners survey of satisfaction and all-backs.

3.1 Performance monitoring using the BOS

This business operations survey is carried out every year by Statistics NZ (SNZ). The first part of the survey is the same for each year, and the second part varies from year to year. Many questions are relevant to monitoring trends affecting productivity. For example, questions on innovation, benchmarking, worker occupations, project performance, and new processes and technology. Some survey results are shown in Figure 1 and Figure 2. There are more data not shown from the BOS and which may of use for monitoring the industry.

It may prove possible to investigate BOS responses for individual firms and compare these to their productivity and profit performance from tax data collect by SNZ. The aim would be to identify firm behaviours that have an effect on performance. Confidentiality issues arise in this type of analysis and SNZ would need to be satisfied these were addressed before allow access to individual firm data.

SNZ provided sample size data for their BOS, see Table 1, and the main problem is the firm numbers are low. If regression type analyses were done, the number of explanatory variables would be a large proportion of the sample size at the 3 digit level. Also, the BOS is for firms 6 persons and more only, so it is ignoring the majority of firms in the industry. Despite these reservations it may prove possible to identify some significant BOS variables affecting productivity in the 3 digit industries, though probably not to a 95% confidence level.



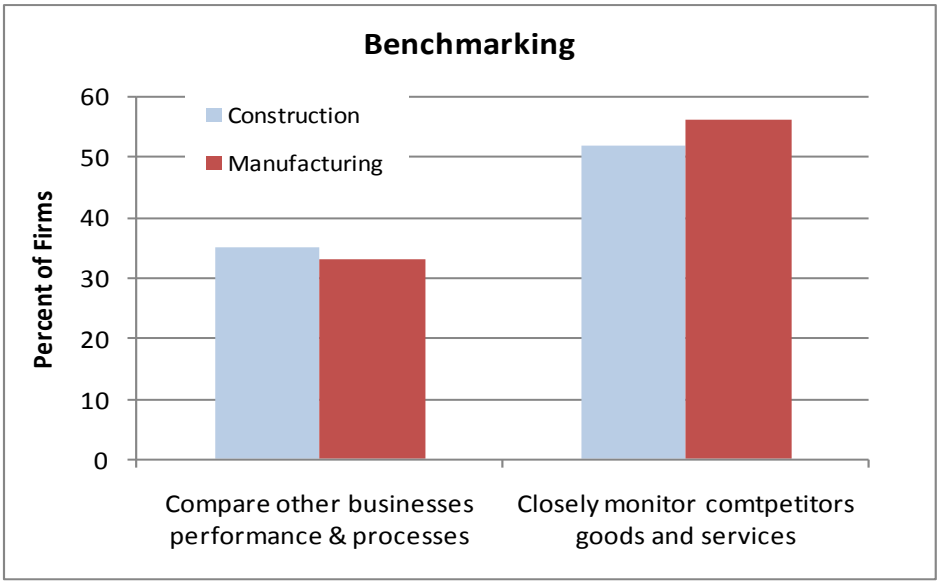
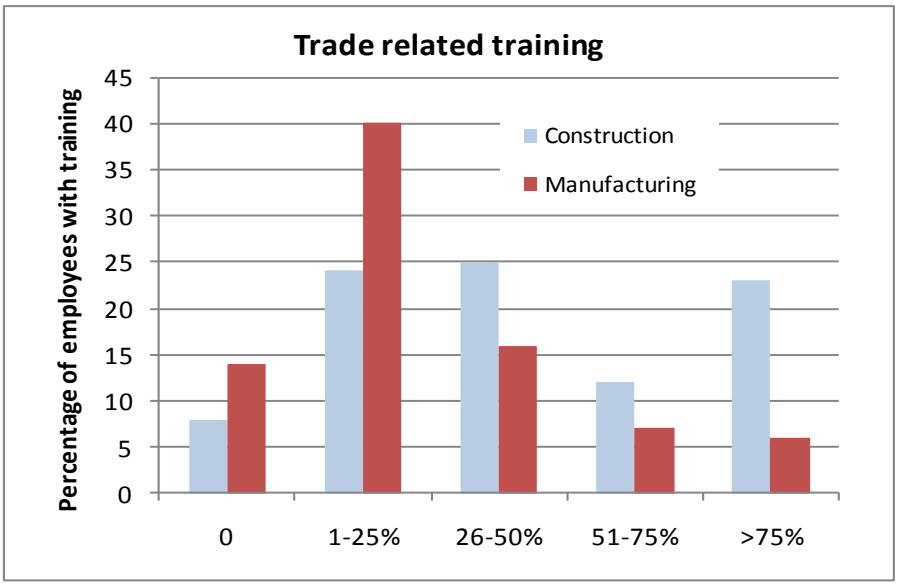


Figure 1 Innovation and benchmarking



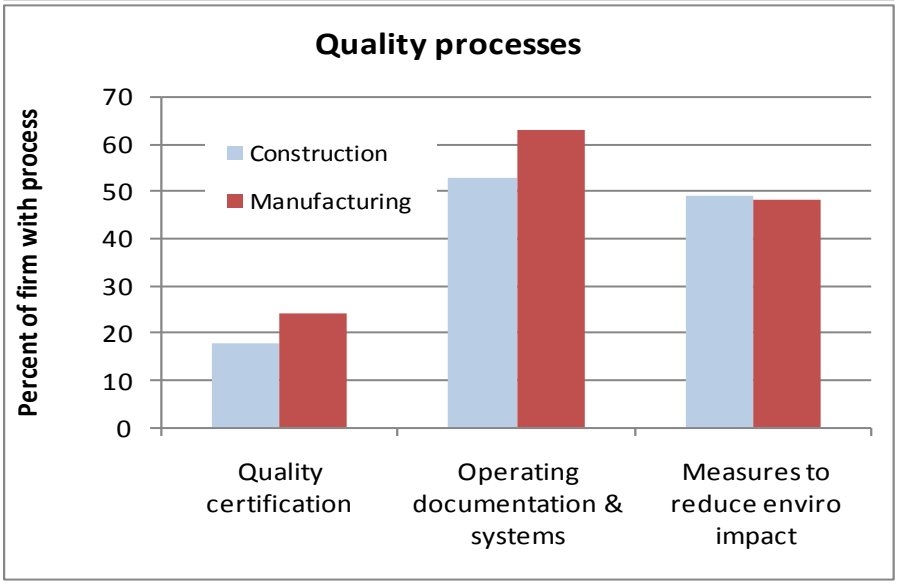


Figure 2 Training and quality processes

Table 1 BOS survey sample size at 3 digit level

Business counts for the Business Operations Survey

2005 & 2009[1]

Cross section				Panel	
ANZSIC06	**2009**			**ANZSIC06**	**2005 & 2009**
E301	27		Residential building construction	E301	9
E302	51		Non-residential building construction	E302	39
E310	48		Heavy and civil engineering	E310	27
E321	42		Land develop/ Site prep Services	E321	18
E322	15		Building Structural Services	E322	9
E323	81		Building Installation Services	E323	42
E324	24		Buiding Completion Services	E324	15
E329	33		Other Construction Services	E329	12

Cross section			
ANZSIC96	**2005**	**2009**	
E411	102	78	Building Construction
E412	66	48	Non-building Construction
E421	42	39	Site preparation Services
E422	21	15	Building Structural Services
E423	105	78	Installation Trade Services
E424	57	24	Building Completion Services
E425	30	30	Other Construction Services

1. For the year ending March

Note: Business counts have been randomly rounded to base 3 to protect confidentiality.

Source: Statistics New Zealand

3.2 Boom-bust cycles

Boom-bust cycles were identified as a factor influencing productivity in the construction industry productivity taskforce (DBH 2009). A BRANZ Study Report (Page 2010) found some correlation between changes in productivity and changes in industry workloads, see Figure 3.

A paper was prepared on boom-bust cycles, see the appendix, and the main findings were:

- New housing is the largest segment of the industry at most times and fluctuates significant. Non-residential is the next largest sector and is mainly in the private sector.
- Government controlled expenditure such as most civil construction (roads, rail, local infrastructure, power) and some non-residential buildings (education, health) are smaller segments than the private sector housing and non-residential building markets, but central and local Government work could be phased to mitigate the boom-busts in the private sector.

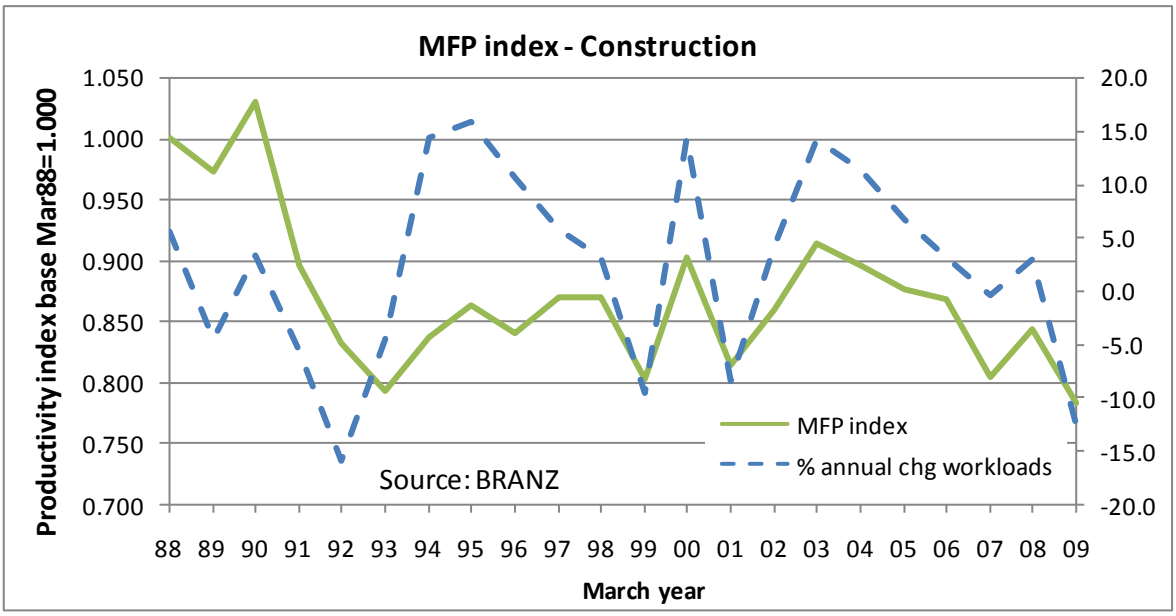


Figure 3 Multi-factor productivity and workloads

3.3 Construction industry firm sizes

A characteristic of the industry is that the firm size (persons per firm) is quite small; see Figure 4 and Table 2. Approximately 40% of all employment is in firms with less-than-6-workers, compared to all industry with about 11% in the less-than-6-worker firms.

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 it's average small firm size, see Figure 5. In part this is due to good exports price, but there are likely to be lessons from agriculture that could be applicable to construction firms.

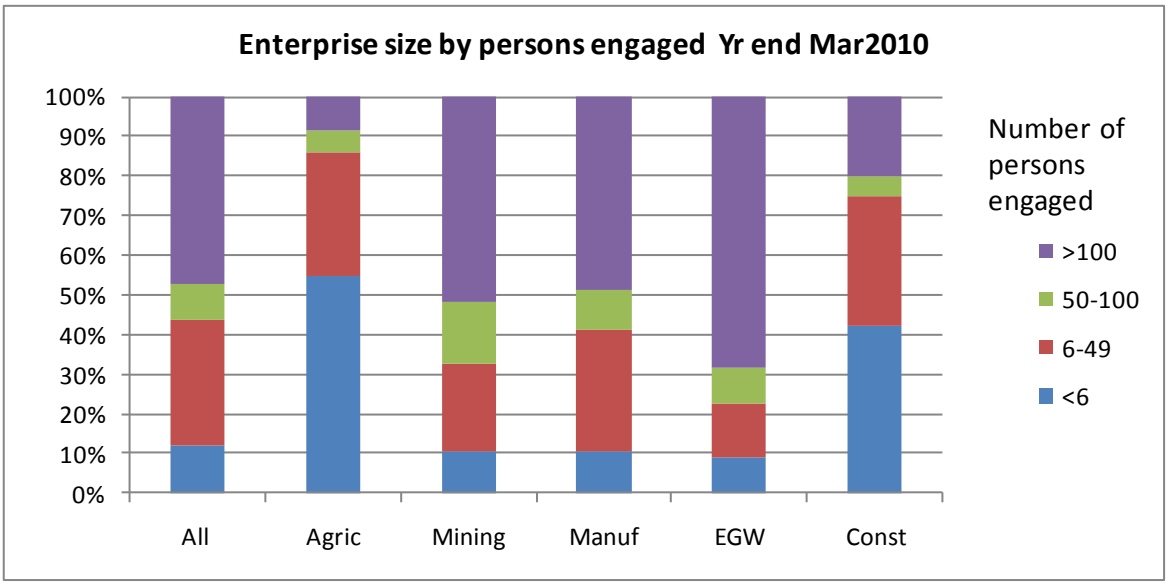


Figure 4 Construction firm sizes compared with other industries

Table 2 Average firm size by number of workers by construction sub-industry

Average firm size - Number of employees								
							Number of firms in 2010	
Year end March	2005	2006	2007	2008	2009	2010	All firms	Firms more than 5 employees
House Construction	1.1	1.1	1.1	1.2	1.0	1.0	14845	597
Other Residential Building	0.8	0.7	0.8	0.9	0.7	0.7	1292	26
Non-Residential Building	7.4	7.0	6.7	6.6	6.6	6.3	1492	283
Road and Bridge Construct	18.6	19.7	20.0	20.6	20.3	19.5	636	163
Other Heavy and Civil Eng	9.9	10.2	11.2	11.2	11.9	11.5	1210	311
Land Development and Subd	0.3	0.3	0.3	0.3	0.2	0.3	1560	134
Site Preparation Services	3.5	3.5	3.5	3.6	3.3	3.2	2226	191
Concreting Services	2.4	2.4	2.5	2.5	2.3	2.2	1002	98
Bricklaying Services	1.6	1.6	1.7	1.8	1.4	1.5	1001	98
Roofing Services	1.9	2.0	2.2	2.2	1.9	2.0	1022	100
Structural Steel Erection	2.0	2.2	2.3	2.1	1.9	1.6	253	25
Plumbing Services	1.9	2.0	2.1	2.1	2.0	2.0	3413	407
Electrical Services	2.4	2.4	2.5	2.5	2.4	2.3	5382	641
Air Conditioning and Heat	4.8	5.0	5.0	5.1	4.3	4.7	936	112
Fire and Security Alarm	3.9	4.3	4.7	4.9	5.4	5.5	566	67
Other Building Installation	2.6	2.6	2.9	3.1	3.3	4.2	361	43
Plastering and Ceiling	1.2	1.2	1.3	1.4	1.1	1.1	1767	93
Carpentry Services	0.8	0.9	0.9	0.9	0.8	0.9	1704	90
Tiling and Carpeting	0.8	0.8	0.9	0.9	0.8	0.8	2010	106
Painting and Decorating	1.6	1.6	1.6	1.6	1.5	1.5	3940	208
Glazing Services	2.4	2.5	3.3	2.6	2.5	2.3	545	29
Landscape Construction	2.0	1.9	1.9	1.9	1.8	1.8	2284	226
Hire of Construction Mach	4.5	4.4	4.7	4.2	4.0	3.5	241	24
Other Construction Services	3.4	3.4	3.2	3.3	2.9	3.0	1581	156
Source: Statistics NZ Business Demographic Survey							51269	4225

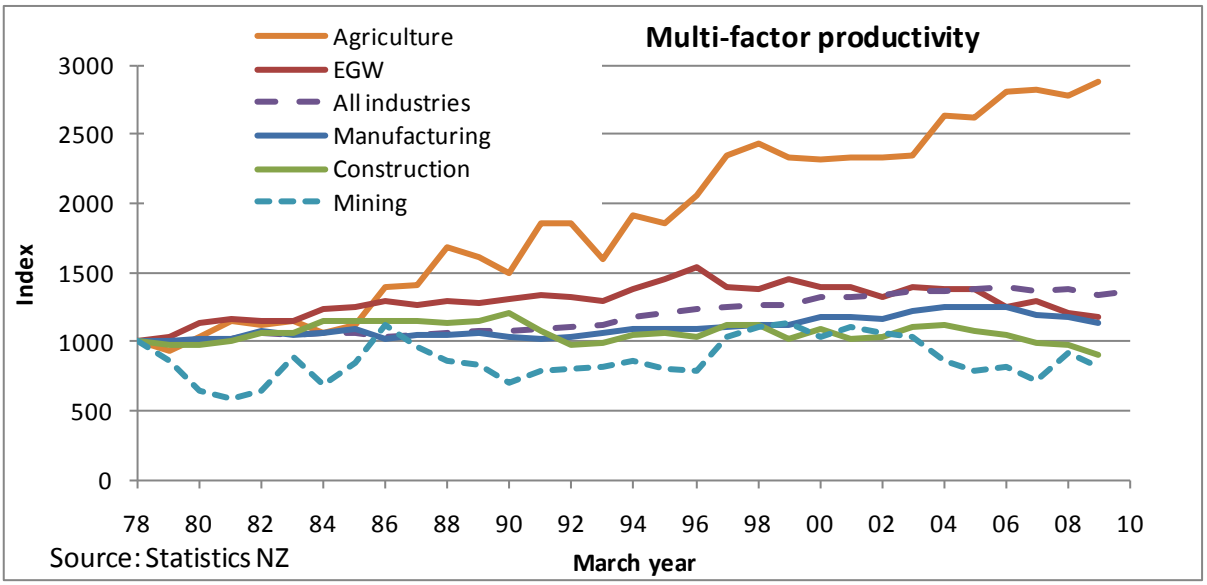


Figure 5 Productivity industry comparisons

3.4 Firm productivity variations

A Building Research Levy project was carried out at BRANZ on this topic and a study report published (Page, Curtisl 2011). The main findings were that productivity and profit margins varied significantly within sub-industries, and between sub-industries. Two examples follow, one for house construction sector (i.e. the main contractors), and the other for plumbers, see Figure 6 and Figure 7. It is not well understood why there is such a broad range in performance, which occurs across all sub-industries. Also, the significant proportion of firms at the high productivity and profit end of the distributions is believed to be mainly one or two person firms taking the operating surplus as profits rather than wages.

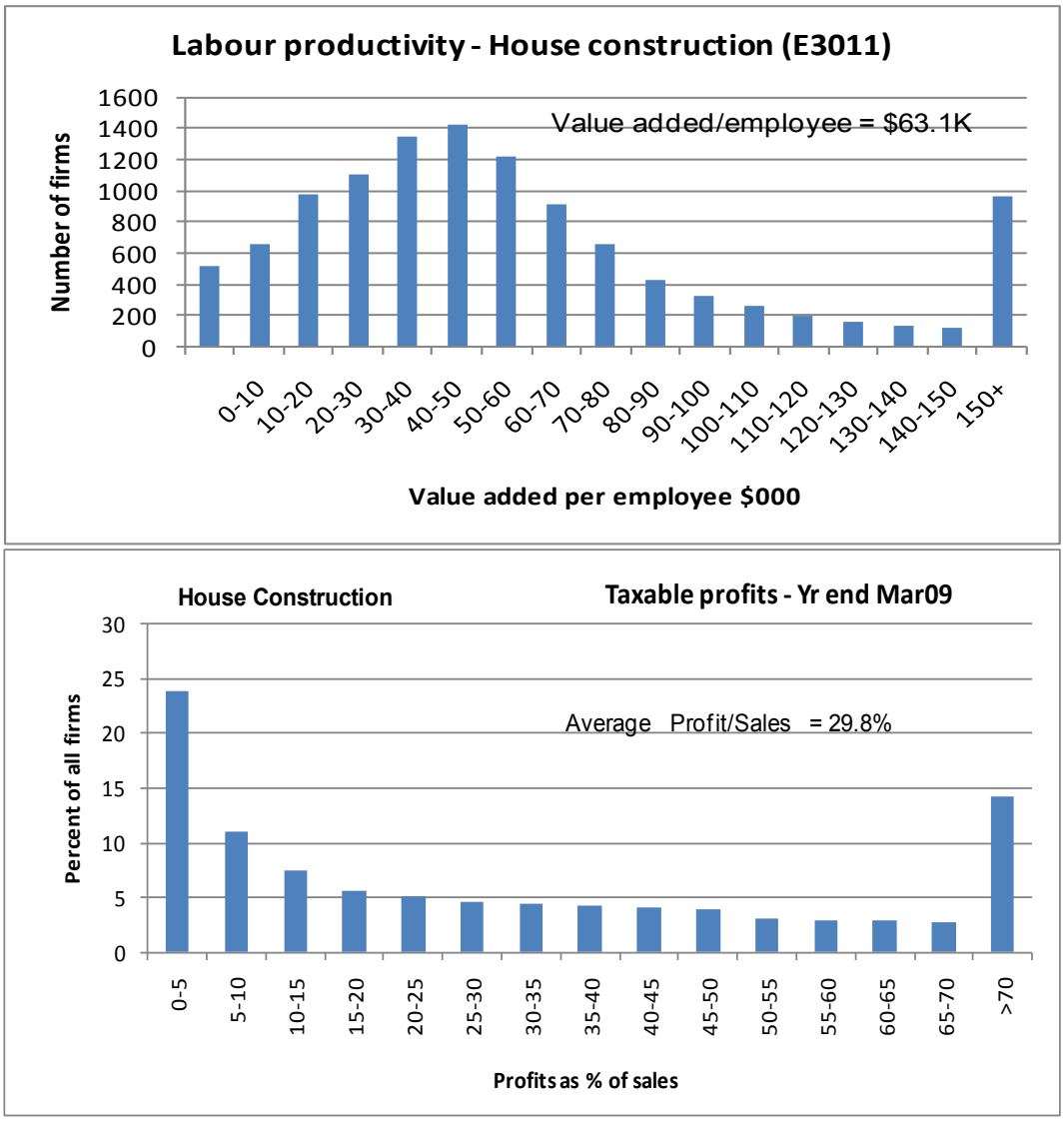


Figure 6 House construction firms productivity and profit distributions

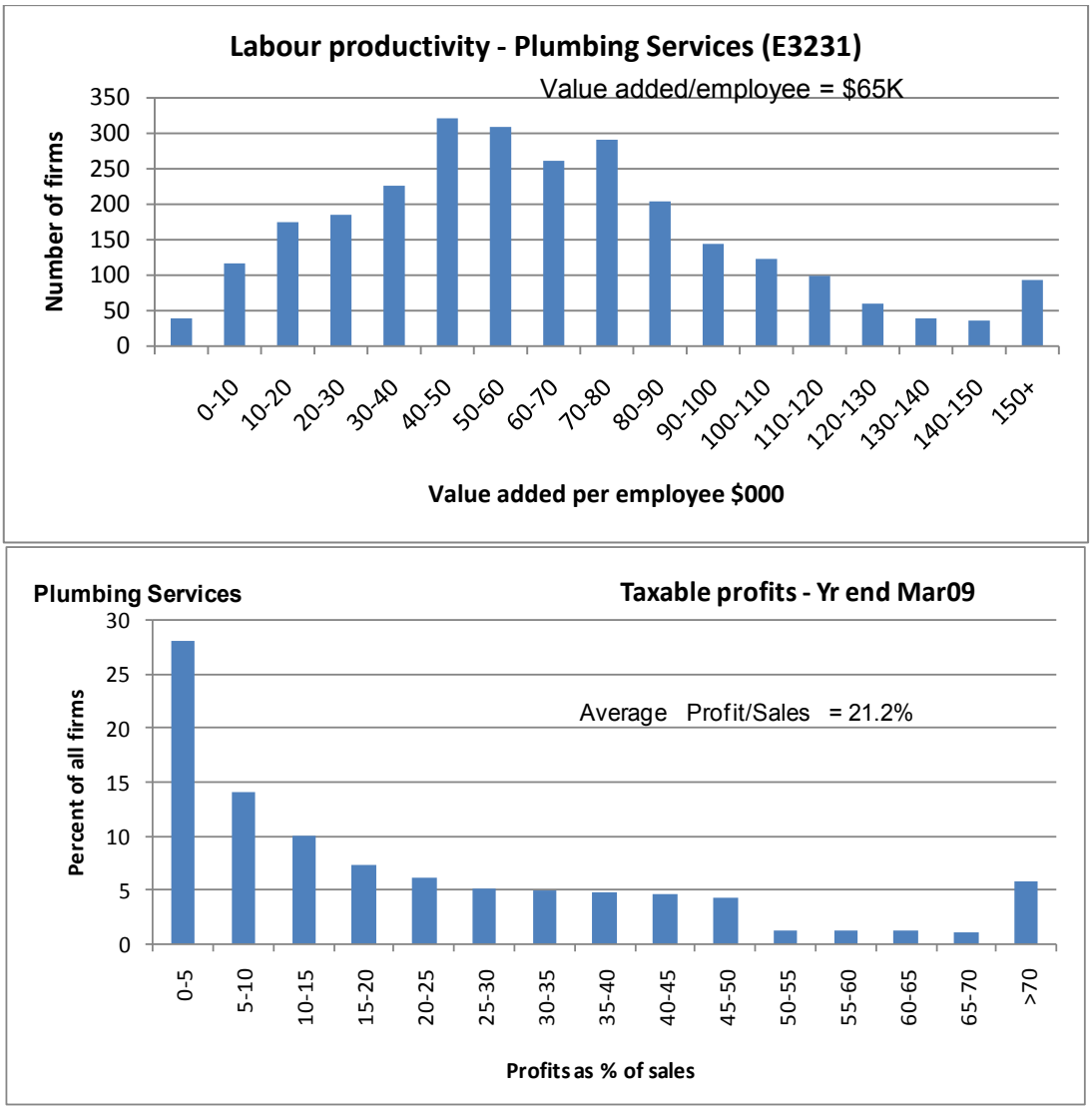


Figure 7 Plumbing service firms productivity and profit distributions

A possible use of these charts is for individual firms to benchmark themselves and thereby encourage improved performance.

3.5 Monitoring New House Owners Satisfaction

One of the concerns of the CPP is how to monitor the quality of output of the construction industry. BRANZ undertook a pilot survey of new house owners in an attempt to assess quality in the new housing sector. The aim was to monitor call backs, as an indicator of quality. As well, overall satisfaction, the importance of various house features, and the type of designer, was recorded. The survey form is attached in the appendix as Table 6. Some results are shown in Table 3 to Table 5.

Table 3 Call backs by new house owners

Builder Call Back		
	Responses	%
Yes	162	60.9%
No	104	39.1%
Total	266	100%

A quite high proportion of owners had call-backs, the most common being paint defects, and problems with the fittings (doors, plumbing and electrical). While these are not likely to create health or safety problems, they are annoying to the owner and suggest a lack of concern for achieving a quality product.

Table 4 Types of call-back by owners

Defects repaired after occupancy		
	Number in sample with defect	% new houses with defect repair
Surface finish (mainly paint defects)	61	23%
Doors defects	57	21%
Plumbing/ wastes	48	18%
Electrical	46	17%
Joinery/ fittings	45	17%
Alumimium windows/ doors	26	10%
Lining defects	25	9%
Floors/ coverings	18	7%
Other	92	35%
All houses	418	61%
Number of respondants answering this question =		266

Table 5 Satisfaction by type of designer

Satisfaction by House Design March 2011 Quarter												
	Satisfaction (1)										Total	Average score
	very happy	%	quite happy	%	OK	%	unhappy	%	very unhappy	%		
Select design from builder's standard plans with NO CHANGES	6	86%	1	14.3%	0	0.0%	0	0.0%	0	0.0%	7	1.14
Select design from builder's standard plans with SOME CHANGES BY OWNER	87	73.1%	28	23.5%	3	2.5%	0	0.0%	1	0.8%	119	1.32
One-off design by and architect/ architectural designer with owner input	108	76.1%	33	23.2%	1	0.7%	0	0.0%	0	0.0%	142	1.25
Total	201		62		4		0		1		268	1.28
Note: Satisfaction 1= very happy, ... 5= very unhappy.												

Overall the level of satisfaction was high with an average score of 1.3 on a 1 to 5 scale (1 = very happy, 5 = very unhappy). It was interesting to note the standard designs with no changes did not score significantly worse than the changed standard plans or one-off designs.

4. REFERENCES

Department of Building and Housing (2009) Report of the Building and Construction Sector Productivity Taskforce.

Page I, Curtis M (2011) Firm productivity variations. Study Report 254. Building Research Association of New Zealand, Wellington.

5. APPENDIX

This appendix contains:

- paper on boom-bust cycles
- Survey form of new house owners

5.1 Boom-bust cycles in construction

5.1.1 Introduction

This paper includes a review of factors that affect the cycles. The aim is to provide a basis for an action programme that industry might consider adopting.

5.1.2 Boom-bust impacts

Figure 8 shows workloads over the last 30 years and Figure 9 shows the volatility or percentage annual changes. The lessons from these two charts are:

- The largest volume changes are in housing, and as it is normally about 50% of the total market it is a “big ask” for the other two sectors to take-up all the slack.
- Peaks and troughs in the three sectors tend to be in phase. Private sector funded work such as housing and commercial buildings move approximately together, with the economic cycle. But it is surprising other construction also tends to move in cycle with the other sectors even though it is mainly government funded (roads, rail, water, sewage, power generation/ transmission, etc).
- The volatility or “spikiness” (Figure 9) is similar for the three sectors with all three having ±30% annual changes in the last 30 years.

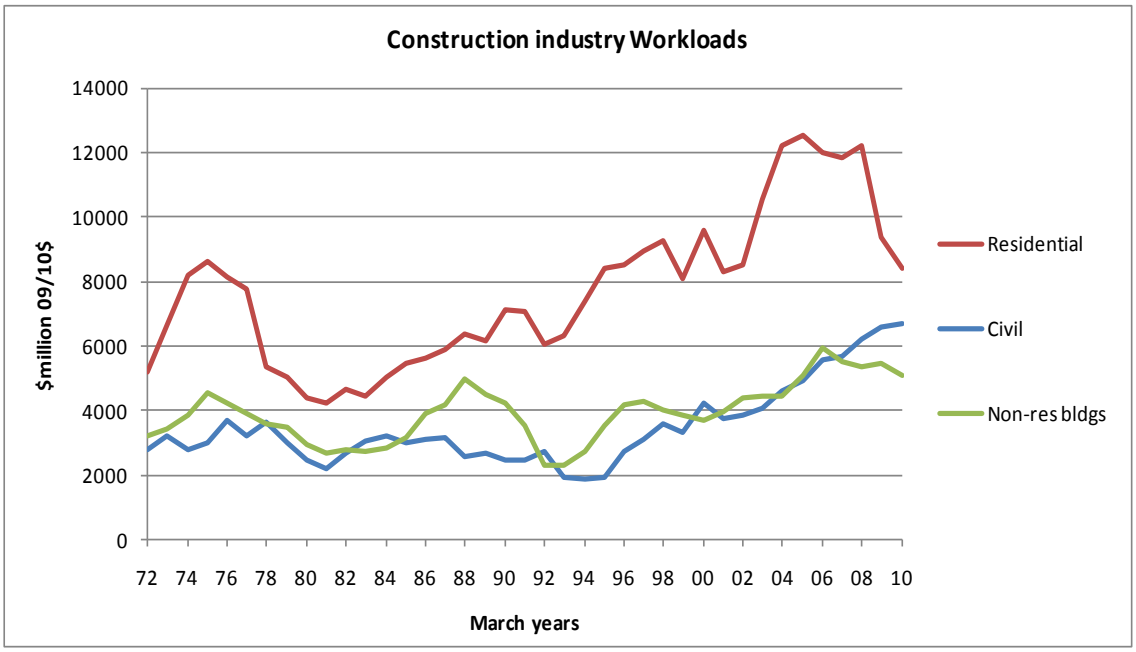


Figure 8 Industry workloads in constant dollars

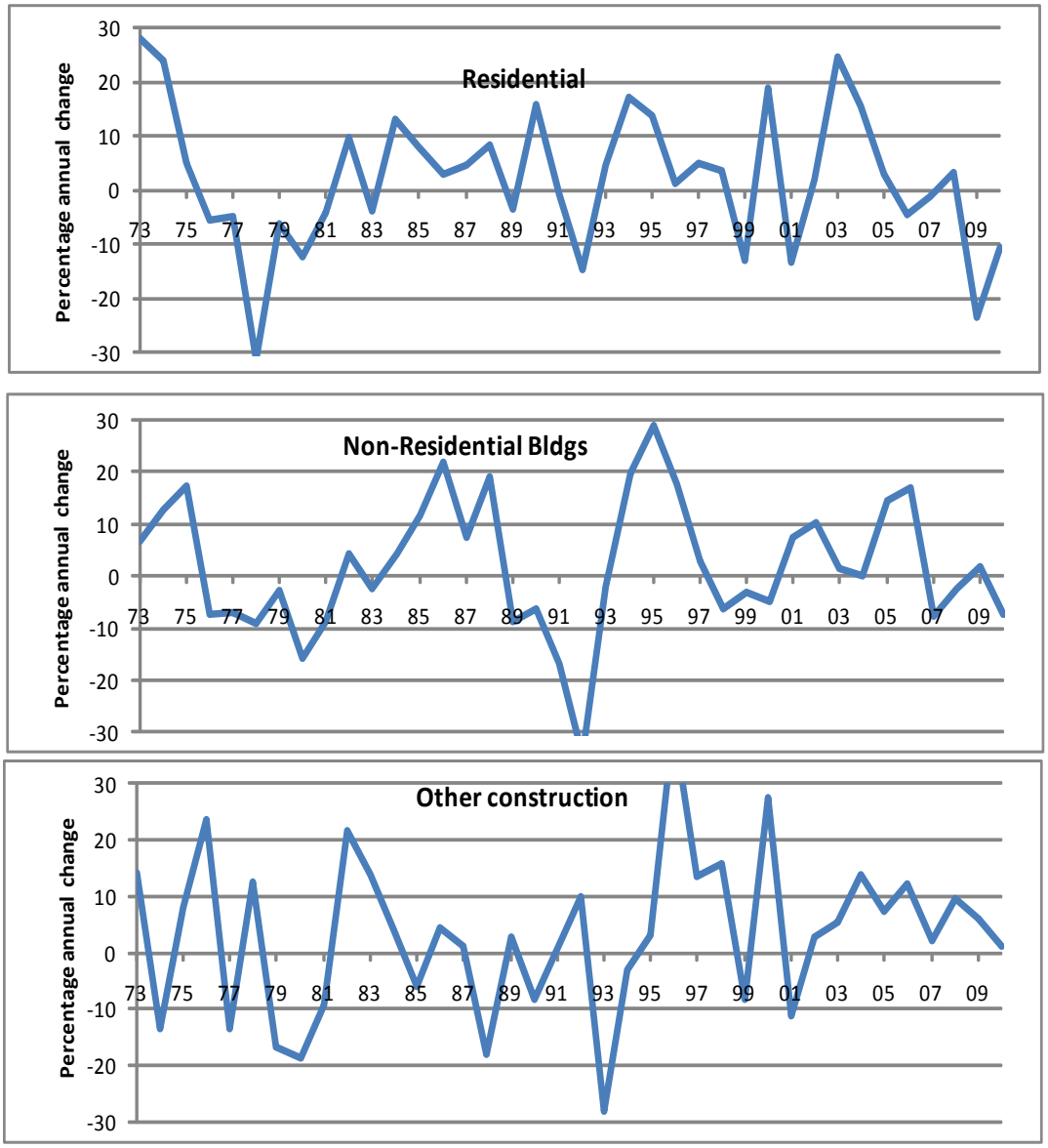


Figure 9 Percentage annual change in workloads

A more detailed breakdown on construction is in Figure 10. It shows:

- Private sector non-residential buildings and private sector other construction (mainly power projects and mining) are the next largest segments after residential.
- Central Govt other construction (roads, NZ Rail) have trebled in the last 10 years but is still quite small compared to the 3 main segments.
- Private sector other construction, including mining and power projects, (some are SOEs, not private sector), has tended to move in phase with private sector non-residential buildings.
- Central Government non-residential buildings (education, health, prisons, etc) have tended to move in phase with private sector non-residential buildings. But it is quite small in comparison to the 3 main segments.

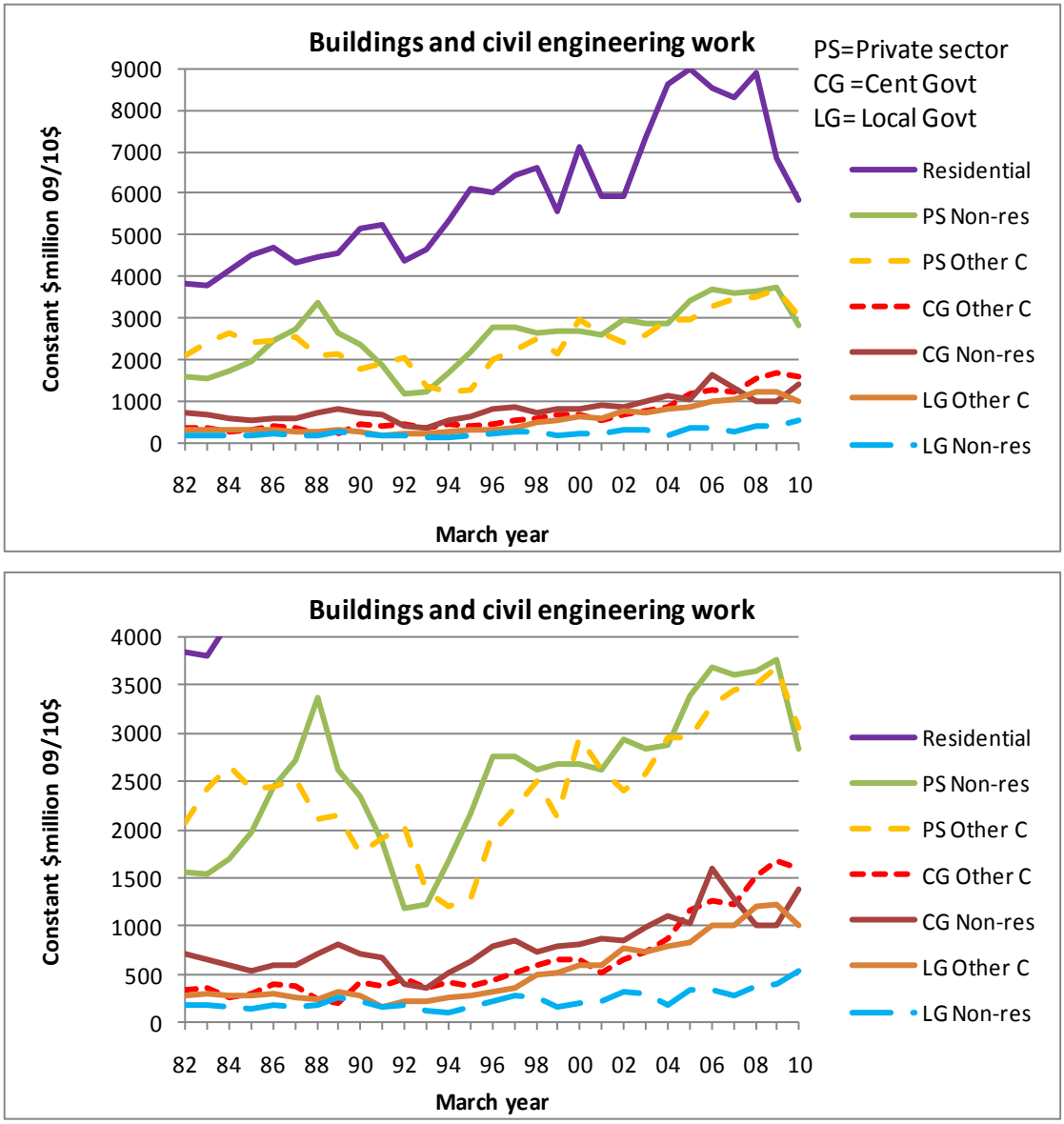


Figure 10 Detailed sector breakdown of work

Notes:
1) Other construction is in fixed capital formation (FCF) $, while buildings are from the work placed surveys, so the two main groups are not strictly comparable. The work-in-place series would be about 10% larger if converted into FCF terms but as detailed FCF breakdowns are not available they have been estimated by BRANZ.
2) Private sector other construction in figure 3 includes the SOE power companies so it is an over-estimate of private sector work.

5.1.3 Industry multiplier effect

The construction industry has a quite high multiplier effect with feedbacks and flow-ons into other sectors of the economy. For building work, every

additional $1 expenditure creates about $2.5 of activity through the economy, while civil engineering is a little lower at about $2.2 of activity. The average multiplier for all industries is about 1.9.

5.1.4 Potential solutions

Counter-cyclical investment by Government.

Large falls in housing are difficult to completely off-set by increased spending in other segments. However Government spending, such as is occurring at present, does help mitigate the impact. Similarly, in boom times, the Government could reduce spending on buildings and in the SOEs, if it wanted to moderate the cycle.

External economic factors

These factors which affect construction investment include employment, GDP growth, business confidence, the business cycle, interest rates, and world growth. They are largely outside Government's ability to alter in the short to medium term (1 to 3 years).

Migration directly affects housing demand but has quite a long lag time. So increasing migrant quotas, for example, has a delayed effect extending from 6 months to 3 years on new house demand. Conversely migration outflows can occur quite quickly and Government has no control over these in the short term.

The business or economic cycle is common in all economies and the causes are not well understood. The construction industry as a whole moves in phase with the economic cycle, see Figure 11, though housing tends to be early in the upturn and other construction later after the peak in the cycle.

The reason why construction fluctuates so much is that economic output goes into three main categories, namely consumption, fixed capital and net exports. Net exports (exports minus imports) are a small fraction of total output, while consumption is about 80% and fixed capital investment about 20%. Consumption (mainly the basics of food, clothing, housing, transport, energy, etc) does not vary greatly during the economic cycle so that any change in total output is mainly taken up in fixed capital investment (buildings, civil, plant, machinery, vehicles). So a 1% change in economic output is magnified by a factor of about 4 in the fixed capital formation sectors, including buildings and civil engineering.

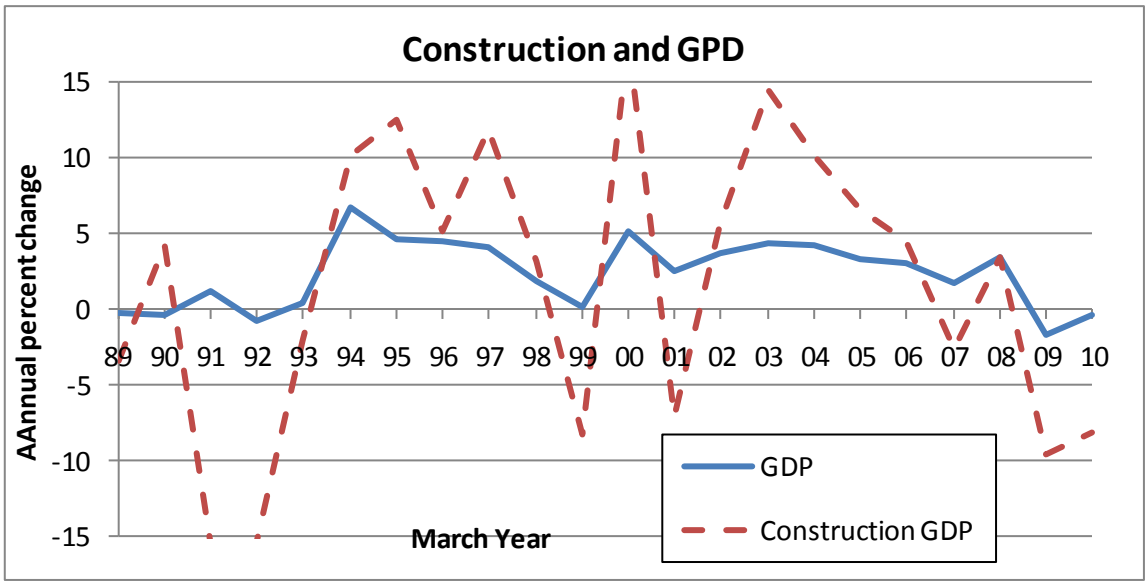


Figure 11 Construction and NZ GDP

Internal industry factors

The CAENZ commissioned (BRANZ funded) a report on the cyclical performance of the industry and finds that a significant part of industry volatility is due to internal factors, "..... much of the construction industry boom-bust effect in New Zealand is actually caused by the industry's own internal system structure and behaviour rather than external shocks[1]."

These factors are:

- Poor supply chain communications
- Lack of visibility of future work orders
- Lack of skill planning
- Approval delays
- Delays and mis-pricing caused by the procurement method
- Few barriers to the establishment of speculative development firms (apartments and commercial).

The main limitation of the system dynamic approach used in the CAENZ work is that the relative importance of the above factors, and also of external versus internal factors, is unquantified. Though the report stated internal factors are more important than external factors it was not possible to find the evidence for this from the report.

5.1.5 Possible action points for industry

- Encourage Government to continue the current high levels of expenditure on infrastructure, and health and education buildings, see Figure 12.
- The Treasury Infrastructure Unit to better provide details of planning and projects to the industry. Include government building programmes in their forecasts.

[1] Page 47 "A study into the cyclical performance of the NZ construction industry". CAENZ, November 2008.

- Health boards to be more transparent about their infrastructure programmes.
- Tertiary education sector to be more transparent about their works programmes.

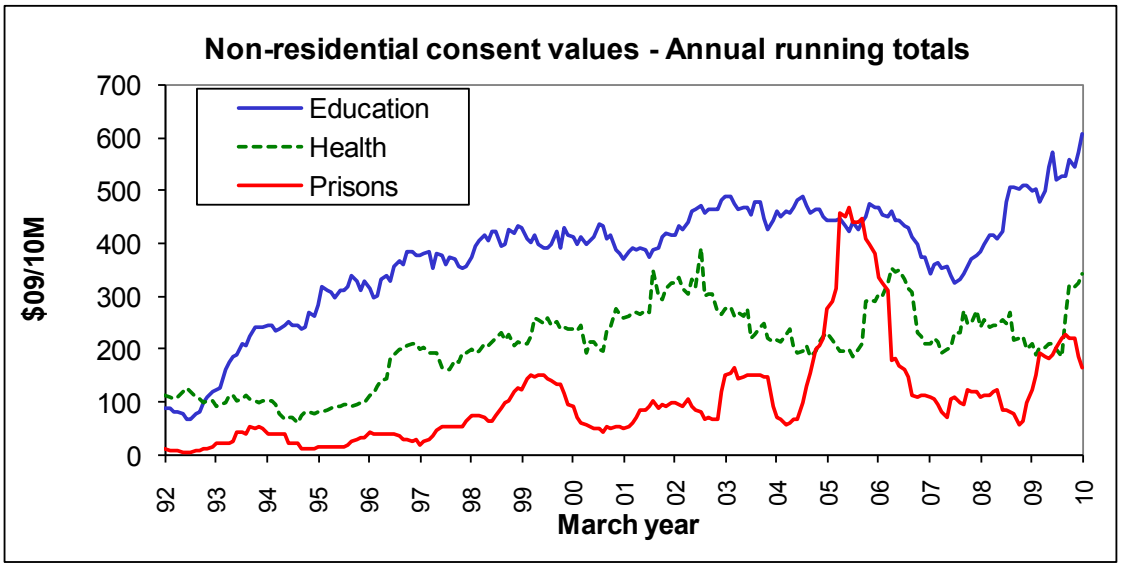


Figure 12 Central Government funded non-residential buildings

- Consider issues connected with speculative property development companies – their legal status, insurance requirements, and the provision of cautionary advice to contractors.
- Support reviews of the RMA and housing land costs, to facilitate easier development of housing, and in particular land available for housing.
- Consider research into whether a capital gains tax, and/or the Reserve Bank supervision role of financial institutions could mitigate the boom-bust cycles in housing and speculative commercial buildings.
- Commission further research to identify which external and internal boom-bust factors are important and amenable to change.
- Continue to promote the important role construction has in NZ's economic recovery (including higher multiplier factor, retention of skills in NZ, etc).

5.2 New house owners survey to ascertain quality

A pilot survey was undertaken by BRANZ of new house owners and 268 responses were obtained from late 2010. The owner's addresses were obtained from building consent lists published by the Whats-On group. An incentive was offered for the return of completed forms (a lotto ticket, book voucher). A response rate of about 25% was obtained. The survey form is shown in Table 6.

The survey had two purposes, first to obtain data on features required in new housing by their owners. This was used in projects on house price modelling, and standardised housing. The second purpose was to obtain data for productivity studies, including monitoring quality and defects.

Table 6 New house owners survey form

HOUSE FEATURES FOR NEW HOUSES SURVEY

All responses are added together and no individual is identified in reports produced by BRANZ.

1. What house features were important in selecting/designing your new home?

	Very Important	Quite Important	Minor Importance	No Importance	Not considered
Size of house	☐	☐	☐	☐	☐
Games room	☐	☐	☐	☐	☐
Study	☐	☐	☐	☐	☐
Double garage	☐	☐	☐	☐	☐
Number of bedrooms	☐	☐	☐	☐	☐
Heat pump	☐	☐	☐	☐	☐
Central heating	☐	☐	☐	☐	☐
Wood burner	☐	☐	☐	☐	☐
Quality of kitchen fittings/fixtures	☐	☐	☐	☐	☐
Quality of bathroom fittings/fixtures	☐	☐	☐	☐	☐
Low maintenance section	☐	☐	☐	☐	☐
Low maintenance walls/roof	☐	☐	☐	☐	☐
Two or more stories	☐	☐	☐	☐	☐
Character of home/architectural design	☐	☐	☐	☐	☐
Security/safety features	☐	☐	☐	☐	☐
Detached house with garden/lawn	☐	☐	☐	☐	☐
Storage space	☐	☐	☐	☐	☐

2. How satisfied are you with your new house?

Very happy	Quite happy	OK	Unhappy	Very unhappy
☐	☐	☐	☐	☐

3. What features of your house do you think could be improved? Please list as many as you can

_____

_____

_____

_____

4. Did you call back the builder to repair defects after first occupancy? Yes / No (Circle one)

If Yes what defects needed fixing?

_____

_____

_____

_____

_____

5. Did you have input into the house design before it was built? Yes ? No (Circle one)

If Yes what type of input from the options below (**tick one**)

Select design from the builder's standard plans with **NO CHANGES** ☐

Select design from the builder's standard plans with **SOME CHANGES BY OWNER** ☐

One-off design by an architect/ architectural designer with owner input ☐

Thank you. Please fold, and send back to BRANZ with the attached reply paid envelope. Feb-11