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Impacts of the NZ Insulation Fund on Industry & Employment

Prepared for

Ministry of Economic Development

economics | research | forecasting | public policy

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We are very grateful to the Ministry of Economic Development and the Energy Efficiency and Conservation Authority for comments on drafts of this report.

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Executive Summary

Background

This report provides an input to an evaluation of the New Zealand Insulation Fund (NZIF) that is coordinated and delivered by the Energy Efficiency and Conservation Authority (EECA). The report is part of a wider study on the costs and benefits. It examines the expected impacts of the programme on production and installation of insulation and clean heating; the impacts on producer surplus; and the impacts on additional employment.

The NZIF started in July 2009 replacing a number of existing programmes. Marketed as the Warm Up New Zealand: Heat Smart Programme, it provides co-funding to encourage the retrofitting of insulation and clean heating to houses built prior to 2000.

The programme provides partial funding for the purchase and installation of eligible products by approved providers. The underlying objectives are:

- Helping New Zealanders to have warm, dry, more comfortable homes;
- Improving the health of New Zealanders;
- Saving energy;
- Improving New Zealand's housing infrastructure through the uptake of cost effective energy efficiency measures; and
- Stimulating employment and developing capability in the insulation and construction industries.

Under the programme, the government aims to retrofit more than 188,500 New Zealand homes over a period of four years; it was originally expected that there would be 38,750 installations (27,500 insulation and 11,250 clean heating) by the close of the 2009/10 year, but applications were considerably more than this; in total, 64,291 (57,908 insulation and 12,658 clean heating) houses received installations.[1]

This report has a narrow scope for analysis; it examines the impacts on the industry supplying insulation and clean heating. It assesses:

- the producer surplus associated with production and installation of insulation and clean heating;
- additional employment in production and installation; and the
- wider effects on employment elsewhere in the economy.

Installation under the Programme

Data are collected by EECA on quantities, including area insulated and numbers of heaters installed. Summary data are shown in Table ES1 for the period July 2009 to May 2010.

[1] EECA (2010) Annual Report 2009/10; EECA personal communication

Table ES1 Quantities of Products Installed (July 2009 – May 2010)

Item	Number	Unit	Cost ($)	Average Unit Cost ($)
Underfloor insulation	2,940,214	m^2	53,376,264	18
Ceiling insulation	3,508,655	m^2	53,664,666	15
Underfloor moisture barrier	893,714	m^2	4,853,204	5
Hot water - pipe lagging & cylinder wrap	6,500	Houses	408,397	76
Draught-proofing doors	10,184	Doors	534,571	52
Clean heating	9,975	Heaters	29,691,472	2,977
Remedial work	4,814	Hours	162,605	34
Other	12	Houses		
Total			**142,690,180**	

Source: Data supplied by EECA; Covec analysis

Previous Programmes

The Warm Up New Zealand: Heat Smart programme replaced a number of existing programmes. The number of houses that were included in previous programmes is summarised in Table ES2 and those for the new programme in Table ES3.

Table ES2 Number of houses treated under previous insulation & clean heat programmes

	07/08	08/09
ENERGYWISE grants (insulation)	11,000	14,100
ENEGYWISE loans (insulation & clean heating)	47	6,500[1]
Clean heat	571	845
Total	11,618	21,445

[1] 3,868 insulation and 3,325 clean heating (some are combined)

Source: EECA Annual Reports for 07/08 and 08/09

Table ES3 Activity to 30 June 2010 under Warm Up NZ: Heat Smart programme (No. of houses)

	Targeted quantity	Revised target	Achieved
Insulation retrofits for low-income households	15,000	27,000	29,249
Insulation retrofits for other households	12,500	22,000	22,414
Clean heat installations	11,750	16,000	12,658
Total	33,500	55,000	57,908

[1]Estimated from total of 57,908 (EECA Annual Report 2009/2010) less numbers insulated

Source: EECA Annual Report 2009/2010; EECA Statement of Intent 2010-2013; EECA

Analysis of Effects

We have tried a number of different regression analyses to explain the increase in the level of consumption of insulation in response to the programme. We selected an approach that predicts insulation consumption on the basis of building consents data and the number of houses subsidised. The analysis finds that the insulation subsidy is a statistically significant factor in predicting insulation consumption. The regression analysis suggests that, for every subsidised home, there is additional insulation consumption of 127 m^2 and that 85% of the quantity of insulation installed in subsidised houses is additional to that which would have been installed under business as usual, ie. without the subsidy. However, there is a reasonably large uncertainty range, from 41% to 129% at the 95% confidence level.[2]

[2] This may underestimate the uncertainty because of the uncertainty in the input values on insulation consumption.

An estimate of additionality in the sales and installation of clean heating has not been possible because we have not identified any other independent variables to explain the changes in heat pump sales over time, as we did with building consents for insulation. We have therefore adopted the same estimate of additionality as used for insulation.

Using these calculated effects on additional insulation and clean heating, we have then estimated the additional employment and national producer surplus resulting from the programme. Employment impacts have been estimated from employment requirements for production and installation, as obtained from companies surveyed. Multipliers have been used to estimate the impacts on employment elsewhere in the economy (indirect and induced effects). The proportion of this total that is additional at the national level has been calculated as a range on the basis of company estimates of the proportion of new staff that were previously unemployed (at the top end) and from literature on the impacts of wage subsidies (at the bottom end). Producer surpluses have been estimated as the total revenue obtained from using a resource minus all opportunity costs of production. The calculation includes: (1) the wages paid to additional workers (assumed to be a transfer payment at the national level) and (2) estimates of marginal surpluses in production and installation.

The overall results are given in Table ES4 as impacts on additional consumption and employment, and in Table ES5 as the increase in producer surplus, which represents part of the national benefit arising from the subsidy programme. It does not include any benefits attributable to health benefits or energy savings; these benefits are being evaluated separately.

Table ES4 Additional Annual Consumption and Employment from the Programme (2009-10)[1]

	Insulation (underfloor & ceiling)		Clean Heat	
Scenarios	**Additional consumption (million m^2)**	**Additional FTE jobs[2]**	**Additional Consumption ('000 units)**	**Additional FTE jobs**
Low	3.2	29 – 198	5.1	4 – 26
Central	6.6	56 – 376	10.7	8 – 55
High	10.0	82 – 555	16.3	12 – 84

[1] Analysis is for 51,600 houses for insulation and 12,658 for clean heating; [2] FTE = Full-time Equivalents; employment impacts include direct and indirect effects.

Table ES5 Total Additional Producer Surplus in 2009-10 ($ million)

Scenario Estimate	All Insulation	Clean Heating	Total
Low	16 - 23	5	21 – 28
Central	35 - 53	10	44 – 62
High	52 - 80	16	66 – 94

1 Introduction

1.1 Background

This report provides an input to an evaluation of the New Zealand Insulation Fund (NZIF) that is coordinated and delivered by the Energy Efficiency and Conservation Authority (EECA). The report is part of a wider study on the costs and benefits. It examines the expected impacts of the programme on production and installation of insulation and clean heating; the impacts on producer surplus; and the impacts on additional employment.

The NZIF started in July 2009 replacing a number of existing programmes. Marketed as the Warm Up New Zealand: Heat Smart programme, it provides co-funding to encourage the retrofitting of insulation and clean heating to houses built prior to 2000.

Funding is allocated under contract to service providers that undertake to assess, advise, provide finance or access to finance, and install insulation and clean heating devices. Depending on their existing insulation and heating, and the characteristics of the house, applications to the Fund may be for funding for insulation and clean heat, insulation only, or clean heat only. The programme provides partial funding for the purchase and installation of eligible products by approved providers; the elements of the programme are set out in Table 1.

Table 1 Eligible Recipients of Programme Funding

Recipients	Insulation	Clean heating
All eligible houses built before 2000	33% of the total cost up to $1300 (incl GST)	$500 (incl GST)
Homeowners who hold Community Services Cards	60% of the total cost, or more[1]	$1200 (incl GST)
Landlords with tenants who hold Community Services Cards	60% of the total cost	$500 (incl GST)

[1] May be higher, if installation qualifies for a special project where third party funding from charities, lines companies or councils is provided
Source: www.energywise.govt.nz/funding-available/insulation-and-clean-heating

The underlying objectives of the programme are:

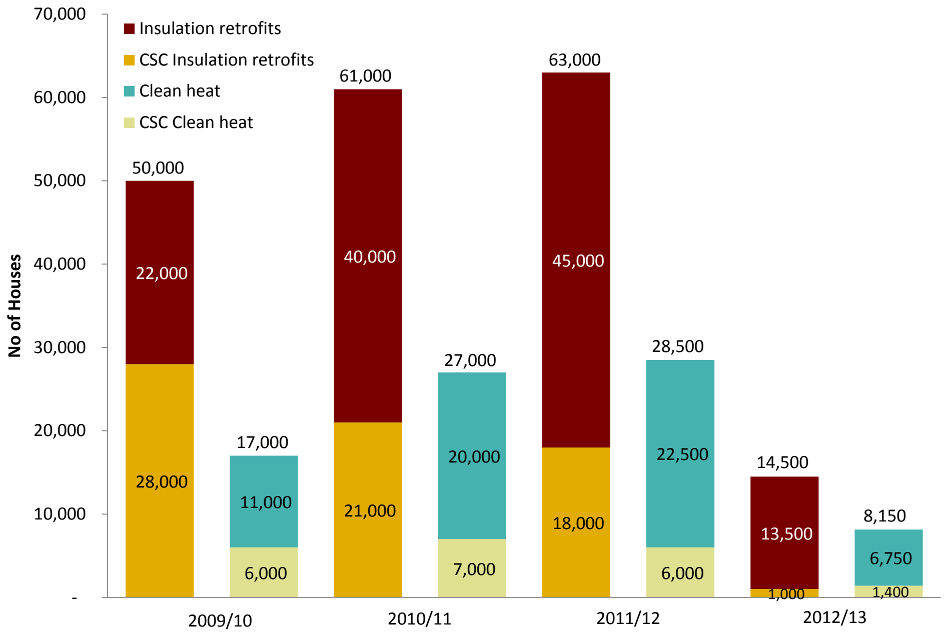
- Helping New Zealanders to have warm, dry, more comfortable homes;
- Improving the health of New Zealanders;
- Saving energy;
- Improving New Zealand's housing infrastructure through the uptake of cost effective energy efficiency measures; and
- Stimulating employment and developing capability in the insulation and construction industries.

The programme is expected to stimulate the labour market during the recession. At its commencement EECA estimated that it would lead to the creation of approximately 1,200 full-time jobs in the insulation retrofitting industry and up to 2,000 full-time jobs in the wider economy.[3]

[3] EECA (2010) Statement of Intent 2010-2013

Under the programme, the government aims to retrofit more than 188,500 New Zealand homes over a period of four years; it was originally expected that there would be 38,750 installations (27,500 insulation and 11,250 clean heating) by the close of the 2009/10 year, but applications were considerably more than this; in total, 64,291 (57,908 insulation and 12,658 clean heating) houses received installations.[4] Current (revised) target levels are shown in Figure 1.

Figure 1 Targeted Levels of Intervention under the Programme



CSC = Community Services Card
Source: EECA

The cost of the programme is estimated to be $347 million over its four year lifetime, and the government wishes to ensure that it is obtaining value for money from that expenditure. This report provides an input to that evaluation and is part of a wider study examining the costs and benefits of the programme, including an assessment of the health benefits and impacts on energy consumption. This report has a narrow scope; it examines the impacts on the industry supplying insulation and clean heating. It assesses:

- the producer surplus associated with production and installation of insulation and clean heating;
- additional employment in production and installation; and the
- wider effects on employment elsewhere in the economy.

1.2 The Economic Analysis Task

The methodology being adopted to evaluate the programme is cost benefit analysis (CBA). It is a technique for analysing the total impacts of a policy or project and can be used to estimate whether a policy is desirable or not (the benefits exceed the costs) or to rank policies/projects (in the order of net benefits). CBAs are always undertaken from a particular perspective that defines which effects are taken into account. For government

[4] EECA (2010) Annual Report 2009/10; EECA personal communication

policy, the appropriate perspective is (usually) the nation, ie what the total impact is on New Zealand.

The reason for intervention in the form of a subsidy for insulation and clean heating is because of a perceived market failure that means that the quantity of insulation (and clean heating) that is consumed is too low. The question of market failures in energy efficiency is widely addressed elsewhere and is not the subject of this analysis. It is assumed that this was addressed in the development of the programme as a policy intervention. This analysis is focussed on the costs and benefits.

A subsidy to address this market failure is expected to result in an increase in production and consumption of insulation and clean heating. In this report we are examining the increase in producer surplus as a result, ie the difference between the costs of supplying this additional insulation and heating and the price at which it is sold. The consumer surplus benefits are examined in other reports.

1.3 Wider Economic Impacts

The terms of reference for the analysis include consideration of the wider economic impacts of the programme, particularly on employment. In this section we discuss these effects and how they might be taken into account within a cost benefit analysis.

Typically cost benefit analysis limits its assessment of effects to certain markets only. It is a partial equilibrium (PE) analysis that does not take account of the impacts across all markets as would be done in a General Equilibrium (GE) analysis. PE analysis is appropriate if it is assumed that all costs of producing and installing insulation or clean heating are opportunity costs, ie they represent what is lost by those resources not being used in the production of some other goods or services. For example, the costs of labour reflect what workers could be paid in other employment, and the price paid for labour (eg the hourly wage) reflects the marginal value of a worker's contribution in that other employment.

If there are significant changes in resource allocation, there may be wider effects in the economy. For example, if there is a significant change in demand for labour as a result of the programme it could result in an increase in marginal wage rates; and similar price effects may occur in other input markets. However, such effects appear unlikely; levels of employment are not significant in comparison with total employment in the economy and this suggests that the PE approach is appropriate.

If there is an increase in total employment in the economy (ie, there is current unemployment that is reduced as a result of the programme), the opportunity cost of labour across some inputs may be zero, and the results of payment to workers to produce or install insulation or clean heating results in additional consumption that offsets the costs. The impacts on total employment are of interest in the analysis both from an economic perspective (because of the impacts on the costs of labour) and because of the employment objectives of the programme. Where there is an increase in total employment as a result of the programme, it is reasonable to assume that there will be some additional employment generated elsewhere in the economy from those supplying the insulation & heating industry (indirect effects) and as a result of the increased household expenditure of those newly employed (induced effects). We examine these using standard multipliers. However, in estimating impacts on additional employment, we note that any effects are short run and will last for the duration of the subsidy.

In the analysis we have assumed that wage rates reflect the opportunity cost of labour and that market wage rates do not change as a result of the programme; the impact is too small in comparison to total employment. However, labour employed in production and installation that was previously unemployed is assumed to have a zero opportunity cost of employment.

1.4 Supply-Side Analysis

This report addresses one component of the overall analysis. It is concerned with the effects on producers only, ie the change in producer surplus as a result of the NZIF and the change in employment. This requires consideration of the impacts on total quantity, costs of production, labour requirements, sales prices and profits. Other elements of the analysis are included in separate reports on the health and energy impacts, and in a summary cost benefit analysis. Previous studies in New Zealand[5] have focussed on these other benefits (energy and health) rather than considering producer surplus benefits.

The research for this study is based on data collected from phone interviews and email correspondence with a number of firms that produce and install insulation, in addition to an analysis of data provided by EECA.

[5] For example, Chapman R, Howden-Chapman P and O'Dea D (2004) A cost-benefit analysis of housing insulation: results from the New Zealand 'Housing, Insulation and Health' study; Phillips M (2007) Sustainability Options for Retrofitting New Zealand Houses – theoretical cost benefit analysis. A report prepared for Beacon Pathway Ltd.

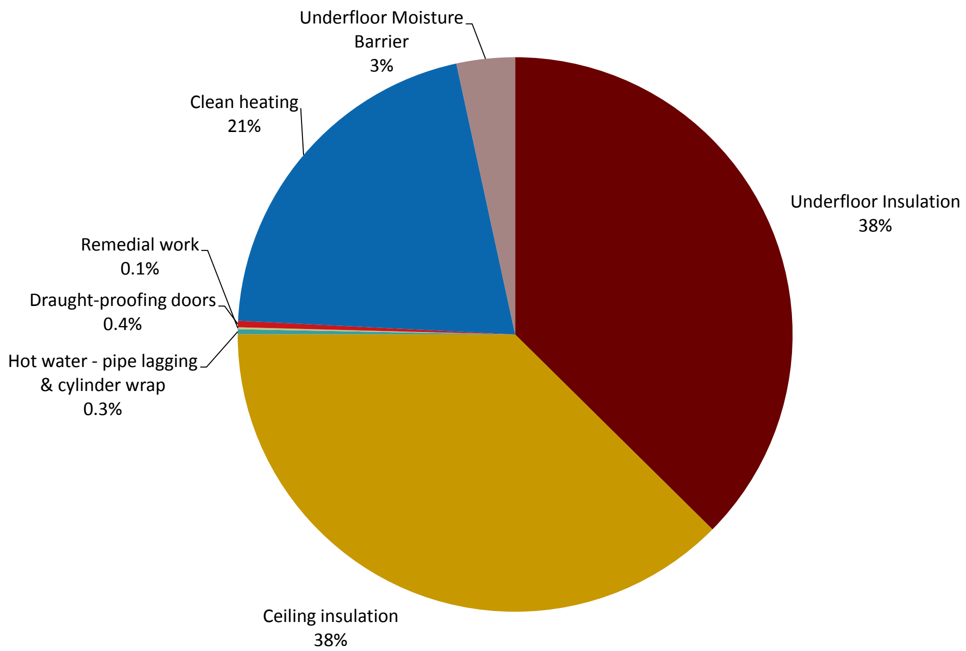
2 Programme Inputs

2.1 Components of the Programme

Initially we examine the components of the programme to identify priorities for analysis and to compile additional data.

EECA collects data from installers on their activities. The distribution of funding across the different activities is shown in Figure 2; over 75% of funding is applied to insulation and 20% to clean heating. We have limited our analysis to the effects on ceiling and underfloor insulation and on clean heating.

Figure 2 Proportion of Funded Projects (By Value) – July 2009 – May 2010



Source: Data supplied by EECA; Covec analysis

Data are also collected on quantities, including area insulated and numbers of heaters installed. Summary data are shown in Table 2 for the period July 2009 to May 2010.

Table 2 Quantities of Products Installed (July 2009 – May 2010)

Item	Number	Unit	Cost ($)	Average Unit Cost ($)
Underfloor insulation	2,940,214	m^2	53,376,264	18
Ceiling insulation	3,508,655	m^2	53,664,666	15
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Other	12	Houses		
Total			**142,690,180**	

Source: Data supplied by EECA; Covec analysis

The number of houses that are given different types of "treatment" are summarised in Table 3. Of the total, 92% of houses have some combination of underfloor and ceiling insulation, while 22% have clean heating installed.

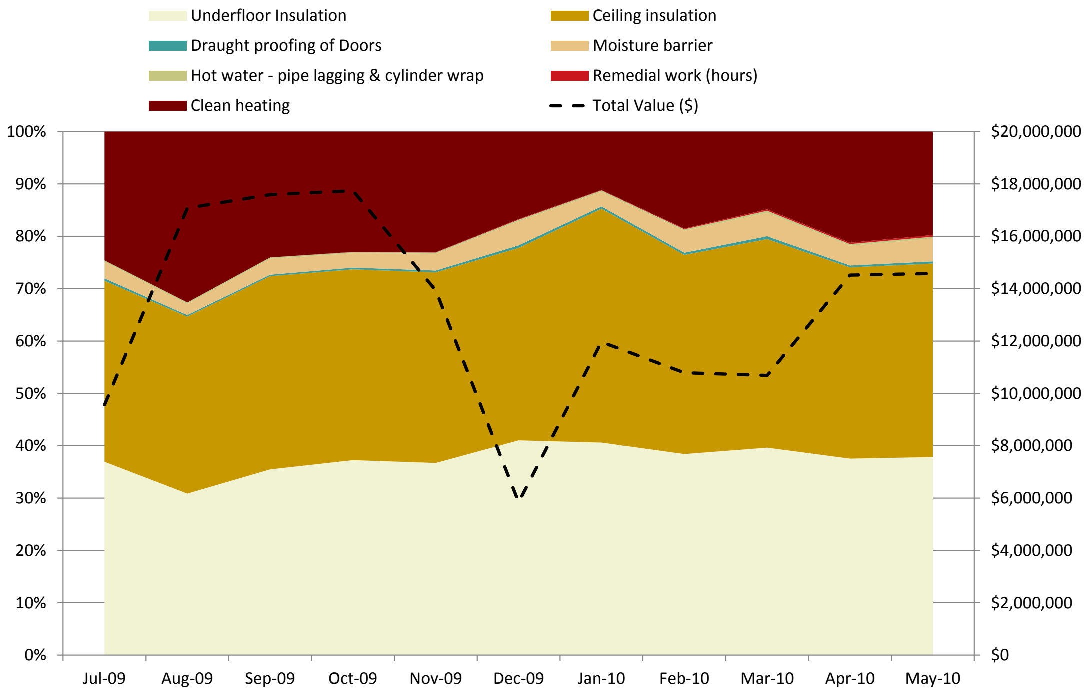
Table 3 Installation Activity Under the Programme (July 2009 – May 2010)

Activity	No of houses[1]	%
Underfloor insulation (no ceiling insulation)	6,266	13%
Ceiling insulation (no underfloor insulation)	12,558	27%
Underfloor and Ceiling insulation	24,026	52%
Other insulation (pipe lagging, cylinder wrap, door draught proof)	11,066	24%
Moisture barrier	9,178	20%
Clean heating & insulation	6,326	14%
Clean heating only	3,649	8%
Remedial	1,383	3%
Total	46,651	100%

[1] There are overlaps between categories so the number in the individual categories add to more than the total, eg most houses having "other insulation" will have underfloor or ceiling insulation also .

The relative (dollar) contribution of the different components has been fairly constant over time, apart from an increasing amount spent on remedial work (Figure 3).

Figure 3 Relative Contributions to the Programme ($) and Total Cost over time



3 Approach & Background Data

3.1 Defining a Counter-factual

The key analytical requirement is to estimate the impacts of the programme on insulation producers and installers in terms of:

- Levels of production and installation;
- Revenues and profit (the producer surplus);[6]
- Employment.

To isolate the effects of the programme requires data on current (or with-programme) levels of market activity and the estimation of a without-programme counter-factual, ie an assessment of what would happen in the absence of the programme. The difference between factual and counter-factual is used in turn to estimate the impacts on economic surplus (consumer and producer) and employment.

In the absence of the programme, consumption of insulation and clean heating will reflect the underlying demand, affected in turn by factors that include building activity, temperature and income effects. Estimating the counter-factual consumption is further complicated by:

- The existence of previous programmes to encourage the use of insulation;
- The effects of the recession on building activity.

Below we examine the effects and their implications for analysis.

3.2 Previous Programmes

Previous programmes run by EECA have included:[7]

- ENERGYWISE grants which were targeted at low income households and provided funding for improvements to insulation and energy efficiency measures. Households were eligible for a grant if their home was built prior to 1978 (later extended to pre-2000 houses), they had a community services card or significant health problems (such as asthma).

- ENERGYWISE interest subsidies or grants for insulation, clean heating and other energy efficiency measures. It was targeted at middle-income families who met income eligibility criteria and had a house built prior to 1978 (later extended to pre-2000 houses).

Clean heat grants fund clean heating retrofits for pre-2000 houses (originally targeted at pre-1978 houses) occupied by low income households in areas of low air quality. Clean heating includes efficient wood burners, wood pellet stoves, flued gas heating and heat pumps. These grants are funded by the Ministry for the Environment (MfE).

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[6] The producer surplus includes private surplus plus tax payments, including GST on additional sales;
[7] EECA Statement of Intent 2008-2011

The performance of these programmes, including expenditure and numbers of houses that benefited, is set out in Table 4. This compares with the targeted and actual level of activity under the Warm Up New Zealand: Heat Smart programme (Table 5).[8] Although initially the programme was not intended to yield a very significant increase in numbers of houses insulated (eg only a 6% increase in numbers of low-income households insulated), the outturn numbers have shown a far more significant change: over a 100% increase in grants for low-income households, a 245% increase in the number of other households receiving financial support for insulation and a very significant increase in numbers receiving support for clean heating. Nevertheless, the pre-existing programme somewhat complicates the identification of a counter-factual.

Table 4 Performance of previous insulation & clean heat programmes

Programme	07/08	08/09
ENERGYWISE grants (insulation)	11,000	14,100
ENEGYWISE loans (insulation & clean heating)	47	6,500[1]
Clean heat	571	845
Total	11,618	21,445

[1] 3,868 insulation and 3,325 clean heating (some are combined)

Source: EECA Annual Reports for 07/08 and 08/09

Table 5 Activity to 30 June 2010 under Warm Up NZ: Heat Smart programme (No. of houses)

Activity	Targeted quantity	Revised target	Achieved
Insulation retrofits for low-income households	15,000	27,000	29,249
Insulation retrofits for other households	12,500	22,000	22,414
Clean heat installations	11,750	16,000	12,658
Total	33,500	55,000	57,908

Source: EECA Annual Report 2009/2010; EECA Statement of Intent 2010-2013; EECA

3.3 The Effects of the Recession

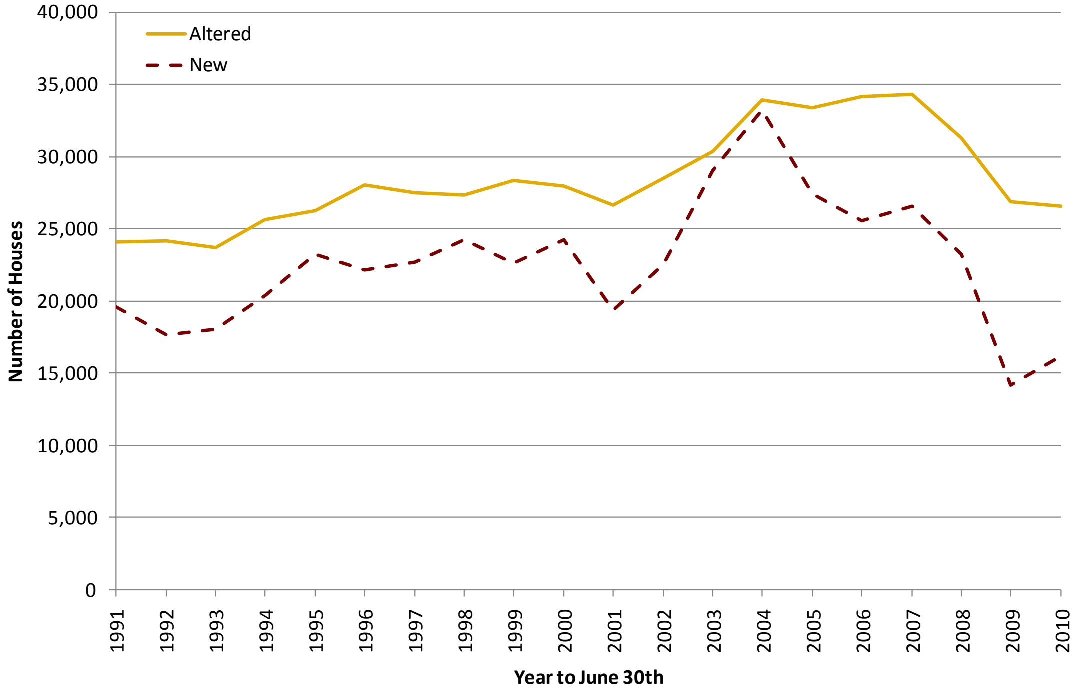
The recession has affected levels of building activity in New Zealand and this will have an impact on quantities of insulation produced (or imported) and numbers of heaters installed. Although the programme is targeted at retrofitting houses, some of those installations will happen at the same time as other building work, and some underlying level of demand for insulation (and clean heating) relates to the number of new houses built and to major renovations.

Figure 4 shows historical data on building consents, including those for new and altered houses. The recession could be said to start at the beginning of 2008.[9] This shows up on the consents data as a sharp reduction in new building consents and a fall in consents for building alterations. These underlying trends will affect the historical data collected and our ability to identify a counter-factual.

[8] In addition, there were 601 retrofits in 2009/10 under MfE's Clean Heat programme

[9] The first quarter of 2008, and the succeeding four quarters, showed reductions in real GDP relative to the previous quarter - data from Stats NZ, available from RBNZ (www.rbnz.govt.nz/statistics/econind/a5/download.html)

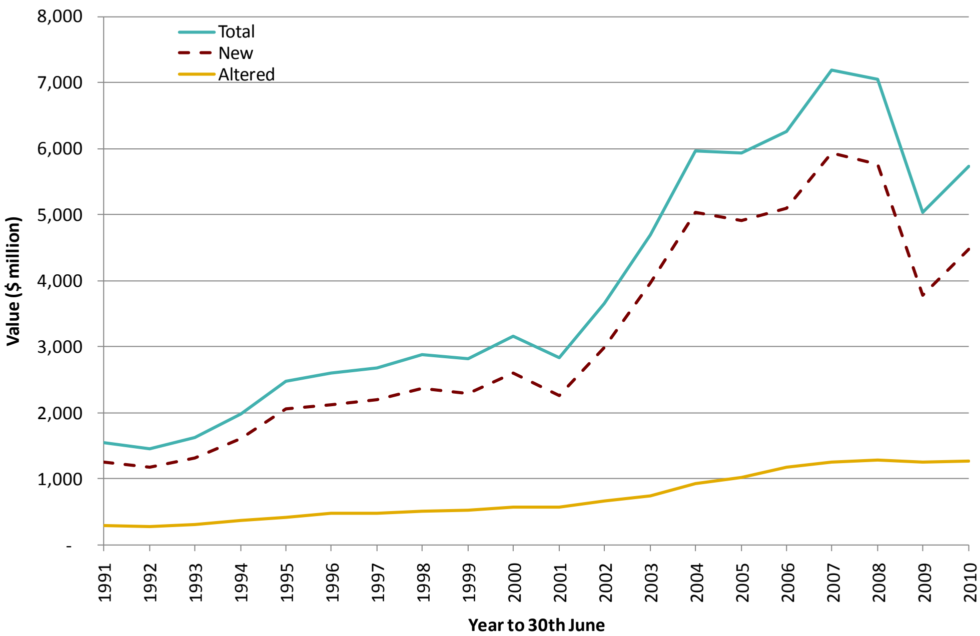
Figure 4 Historical Building Consents - Number of Houses



Source: Statistics New Zealand

Figure 5 uses the same data source to show changes in the value of building consents over time (in real terms). Again, the fall is more significant for new rather than existing (altered) houses.

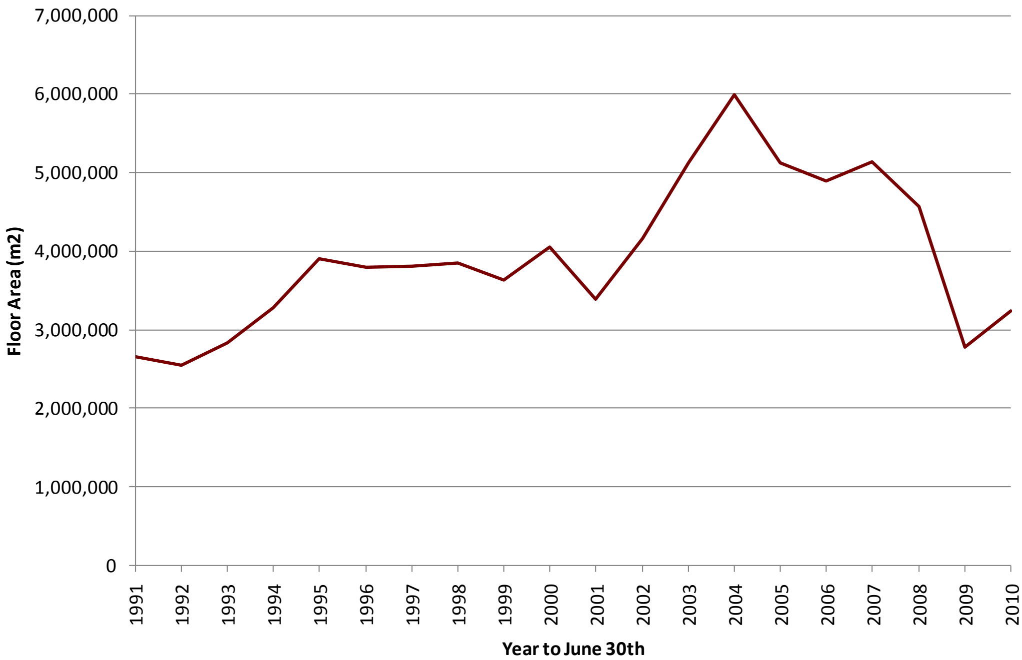
Figure 5 Value of Building Consents (in 2010 $ values)



Source: Consents data from Statistics New Zealand; converted to 2010 values using CPI Index (Stats NZ)

Data on floor area are only available for new build; they are shown in Figure 6.

Figure 6 Floor area of consented new buildings



Source: Consents data from Statistics New Zealand

These underlying trends set the scene within which the insulation and clean heat data need to be interpreted. The increased subsidy programme has occurred at the same time as levels of underlying demand for insulation as a result of building work appears likely to have fallen.

4 Insulation Analysis

4.1 Data Collection

Levels of activity have been assessed using data collected from industry participants and using independent data, where available. For the methodology to be successful, it is important that the data are comprehensive. The analysis is examining the extent to which total consumption (production and import) and installation levels have increased. There will be some shifts in the market, eg from unapproved towards approved suppliers, and these shifts would not be identified if the survey was not comprehensive. Rather, it might appear that consumption levels had increased more than they actually had, or it might even appear that they had decreased. Two broad approaches were considered.

- A survey of installers including those who were approved for participation in the programme and those who were not;

- A survey of producers of insulation accompanied by discussions with installers to obtain data on typical (or average) levels of employment, revenues etc per unit of insulation/clean heating installed.

EECA recommended that the first approach would be unlikely to be successful because of the quantity of data that it already required for collection from approved firms. EECA expected that these firms would be reluctant to provide additional data on a voluntary basis and that unapproved firms would be unlikely to participate because they had even less motivation to contribute data. Given this advice, and confirmation via some initial approaches to companies, the second approach was adopted, ie collection of data from producers, supported by import data. A number of firms were approached for data, including

Alsynite NZ Ltd	Autex Industries Ltd	CSR Bradford
Ellis Fibres	Energy Options	Expol
Imperial Trade Company	Insulpro Manufacturing Ltd	Koolfoam Industries
Lanwood plastics	Latitude	Paul Industries
Poly Palace	Premier Insulation Ltd	Styrobeck Ltd
Tasman Insulation NZ Ltd	Terra Lana Products Ltd	

Data requested included:

- Historical production data;
- Revenue and price data;
- Employment; and
- Profit data.

Not all companies provided data. Some refused to provide any on the basis that they had no incentive to and/or that they were concerned about its confidentiality and the risk of release.[10] However, on the basis of estimates of market share obtained from a

[10] This was despite the offer to sign confidentiality agreements

number of sources,[11] it is estimated that the data collected represent approximately 90% or more of total insulation on the market. The data collected have been "grossed up" to estimate total quantities of insulation used in New Zealand, including domestically produced and imported insulation.

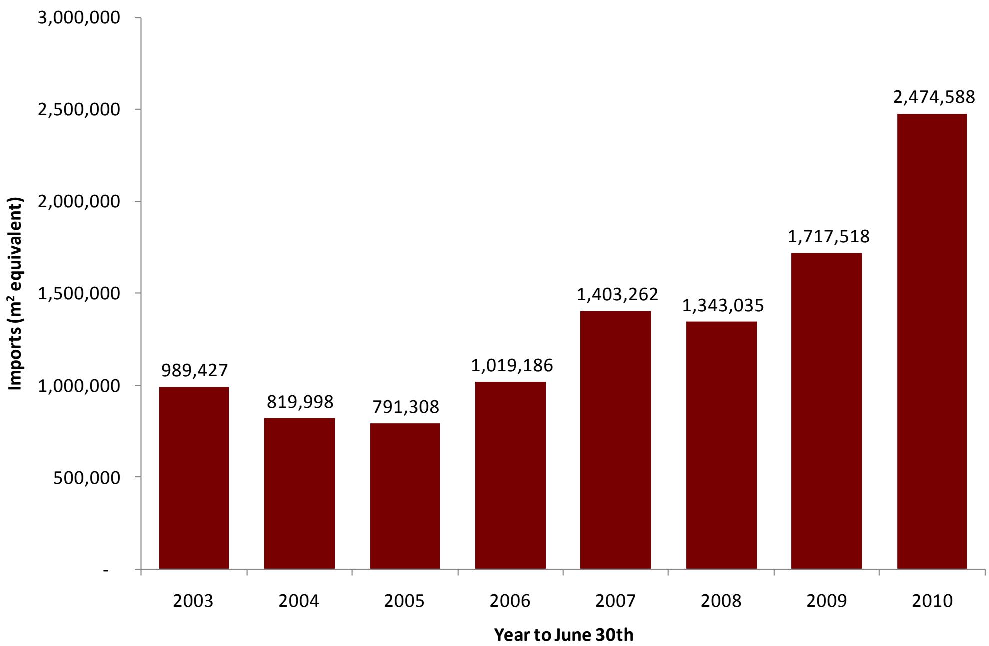
There are significant uncertainties in this approach. The total quantities depend crucially on market share estimates based on the perceptions of market participants. We have no independent means for checking whether these are over or under-estimates, but we know that we have obtained information from the major market participants and that we have obtained reasonably consistent estimates of market share.

4.2 Insulation – Historical Data

4.2.1 Production and Imports

Historical data were obtained from manufacturers on production of insulation in New Zealand and from Statistics NZ on glass fibre insulation imports.[12] Increasing amounts of glass fibre insulation have been imported to New Zealand, largely from Australia and Taiwan,[13] however data are recorded only on a value basis. We used estimates of the value of output from New Zealand producers to estimate import quantities as shown in Figure 7.

Figure 7 Imports of Glass Fibre Insulation



Source: Statistics NZ Infoshare

[11] These are based on comments by producers and distributors of insulation and were along the lines of: "our market share is approximately [x]% of the total market" and "data from [a number of identified companies would cover approximately [y]% of the market"

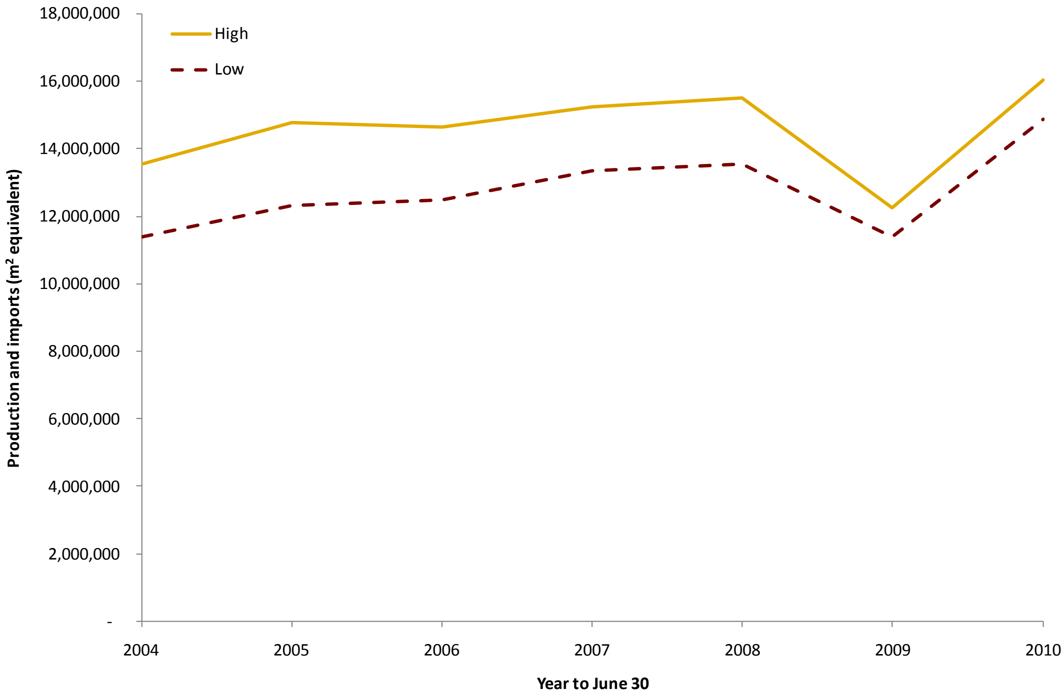
[12] Data on imports of other types of insulation were not available

[13] Australia accounts for 73% of imports over the last 5 years and Taiwan 20%

Imports have been increasing over the last three years and in the year to 30th June 2010 are estimated to be approximately 15% of total insulation on the market.

As noted above, not all companies provided data, so market share assumptions have been used to gross-up the data provided to estimate the total sales. This also meant that import numbers were not required to estimate totals, and the data do not differentiate between residential and commercial. Market share estimates for the major producers were obtained from individual companies and these estimates have been combined with data supplied to produce a range of estimates from different approaches to grossing-up, as shown in Figure 8.

Figure 8 Estimates of Consumption of Insulation



In addition to production and import data, information was also collected on costs and employment, both in production and installation.

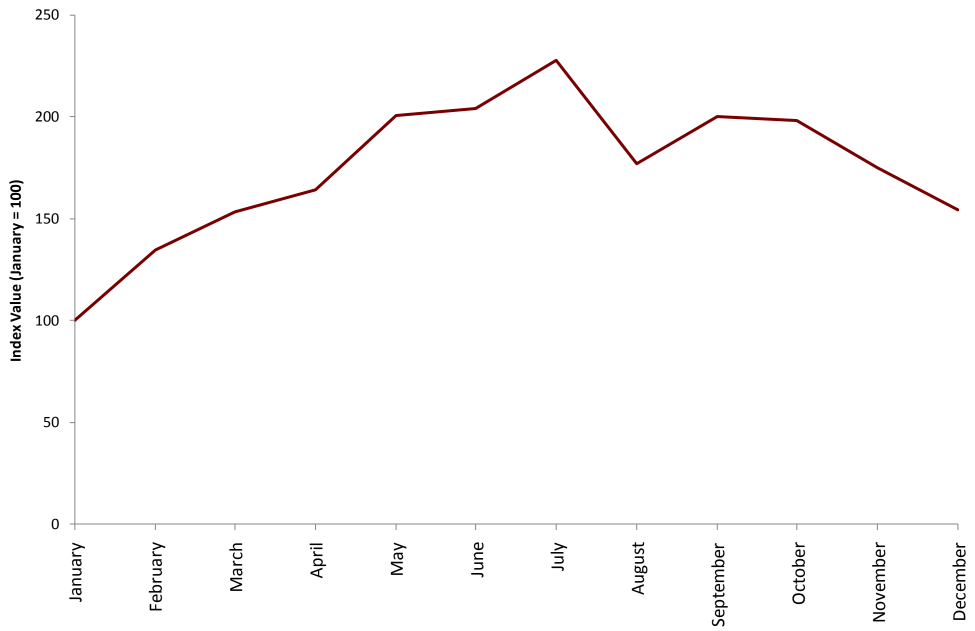
4.2.2 Employment

A small number of producers provided employment data and some installers provided estimates of the number of people required to install insulation on a square metre basis. The data provided suggest that:

- employment in production averages approximately 1 per 100,000m^2;
- employment in installation generally involves small teams with installation of 50-100m^2 per person per day; and
- administrative costs associated with the programme have been significant, including auditing of sites and office administration. Estimates are of additional labour ranging from 12.5-25% of that in installation.

There is a strong seasonality to sales and installations (Figure 9), whereas production occurs throughout the year. This means that for a given amount produced on an annual basis, installation employment levels will vary over time.

Figure 9 Seasonality of Installation



Source: average of industry data from interviews

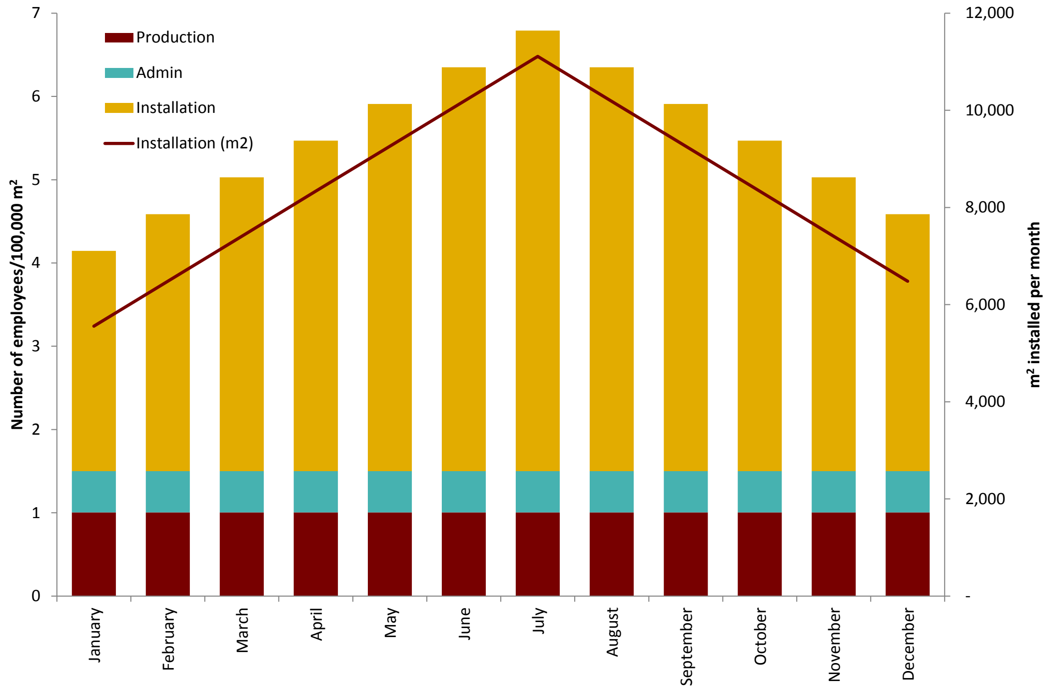
EECA provided alternative estimates of the seasonality of installations under the programme, suggesting that levels of activity in the least busy months are 50% below that in the busiest months. These data are used in estimating seasonal peak and off-peak employment levels for a given amount of insulation installed. We start with industry estimates of the areas that can be installed by teams of installers (50-100m^2 per person per day). This is combined with estimates of levels of installation per month, based on a stylised version of the seasonality data which is used to spread 100,000m^2 of insulation installed per year across twelve months (Figure 10); this is combined with the employment rate estimates above to estimate seasonal peak and off-peak employment levels for 100,000m^2 installed per year (Figure 10 and Table 6). We also include an estimate of full time equivalents, calculated as the number of people required, if working full-time, to install the same amount over 1 year.

Table 6 Average employment per 100,000m^2 per annum of production/installation

	Production	Installation	Admin	Total
Peak	1.0	5.3	0.5	6.8
Off peak	1.0	2.6	0.5	4.2
Full Time Equivalent (FTE)	1.0	4.0	0.5	5.5

Source: industry interviews; Covec analysis – see text for explanation

Figure 10 Assumed Monthly Installation and Required Monthly Employment



4.2.3 Costs, Revenues and Profits

The analysis of costs, revenues and profits is split between production and installation below.

Production

Manufacturers have not provided data on either the costs of production or on revenues. To estimate the surplus from additional manufacture, we have used a generic dataset in the form of the Annual Enterprise Survey (AES) published by Statistics NZ. This is an annual survey of businesses across different industries and sectors to obtain financial performance data. A selection of results for the Manufacturing Sector is provided in Table 7. We use this to estimate the likely surpluses available from additional manufacture of insulation.

Table 7 Annual Enterprise Survey Results for Manufacturing Sector

Item	Value as % of Revenue from Sale of Goods
Salaries & wages	13%
Depreciation	3%
Surplus before tax	6%

Source: Estimated from Stats NZ Annual Enterprise Survey 2009 (provisional tables)

We have two data points that can be used as inputs to the calculation: an estimate of the number of employees per m^2 of insulation manufactured (approximately 1 per 100,000 m^2) and the wholesale sales price of insulation materials ($4.50 – 7.50/$m^2$). This range reflects different data provided by manufacturers and installers paying a wholesale price. The lower end of this estimate ($4.50/$m^2$) would suggest $450,000 of revenue per employee from sales of goods, which is higher than the average for the Manufacturing

Sector as a whole ($396,233)[14], reflecting the particular product mix in insulation production. However, it is close enough to suggest that the AES data could be used as a useful data source. It means that there is some mix of costs and surplus between the $4.50 cost of production and the price paid by installers of approximately $7.50/m² equivalent. However, in the absence of data we have not assumed any surplus here.

From the AES data the average wage/salary in the manufacturing sector is estimated to be $51,000.[15] The surplus from production can be estimated at the margin as equal to the "surplus before tax" plus depreciation in Table 7. Depreciation is included because it represents a fixed cost item and will not represent a cost at the margin; thus in total, our estimated surplus is 9% of sales revenue.[16] Our estimate of the surplus and payment in wages and salaries per m² produced is included in Table 8.

Table 8 Estimated Surplus and Payments to Workers in Insulation Manufacture

Item	Assumption[(1)]	per 100,000 m²	per m²
Surplus	9% of sales revenue	$40,500[(2)]	$0.41
Salaries & wages	$51,000/person	$51,000[(3)]	$0.51

[(1)] Taken from AES data; [(2)] assumes sales value of $4.50/m²; [(3)] based on 100,000m²/person/year

These are used as an estimate of the marginal addition to producer surplus from production of additional insulation.

Installation

In comparison with manufacture of insulation, installation is a simpler process. Thus we have used estimates of actual costs to calculate surpluses rather than using generic data. Table 9 gives a range of estimates of costs, revenues and profits of installation resulting in high and low margin estimates.

The cost of material is based on the wholesale price of insulation material, including discounts to large consumers. The range of numbers is based on those provided by installers.[17] As discussed above, these costs are higher than the estimated production costs.

Labour requirements for installation and administration are estimated from insulation industry estimates (Table 6); the range, reflecting difficulties in installation, is of 50-100m² per person per day. Many installers are paid by the installation company on a per m² basis and wage rates are estimated at approximately $20/hr based on these. Wage rates for administration are estimated to be 50% above these, again based on advice from installers.

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[14] Total income per employee count in the Manufacturing sector is estimated at $404,200, but this includes revenue from other sources (interest, non-operating sources).

[15] This is estimated from 13% of sales revenue being wages & salaries (Table 7) and sales revenue being $396,233 per employee

[16] Depreciation (3%) + surplus before tax (6%)

[17] As some reality check on this, R1.5 polystyrene insulation panels are for sale for DIY installations for $7.90/m² (including GST) or $6.87/m² (excluding GST) and polyester blanket insulation from $8.26/m² (Insulation Warehouse - www.homeinsulation.co.nz/products-page/). Wholesale prices would be less than these prices.

Table 9 Estimated Costs and Revenues for Insulation Installers

Item	High Margin $/m^2$	High Margin $/installation[1]	Low Margin $/m^2$	Low Margin $/installation[1]
Cost of material	6.00	720	8.00	960
Labour (installation)	1.60	192	3.20	384
Labour (admin)	0.30	36	0.60	72.00
Vehicle ($)[2]	0.23	27	0.56	67.48
Other	3.84	461	3.84	461
Total Cost	8.13	975	12.36	1,483
Installed Price	15.00	1,800	18.00	2,160
Margin	3.03	364	1.80	216
Margin including GST	5.28	634	4.50	540

[1] Costs are for a $120m^2$ installation; [2] see Table 10

Vehicle costs are estimated using the assumptions and calculations listed in Table 10. The number of vans required is taken from industry estimates. We base our cost estimates on the number required at peak. This might over-estimate costs if these vans could be used elsewhere in the off-peak periods for insulation installation.

Table 10 Vehicle Cost Assumptions

Item	Low Value	High Value
Vehicle		
Vans per 100,000 m^2 installed per annum	2[1]	4
Purchase Price ($)	40,000	40,000
Life (years)	7	7
Cost of capital	8%	8%
Annual cost	$7,682.90	$7,682.90
Annual Maintenance cost etc ($)	2000	2001
Total ($ pa)	$9,682.90	$9,683.90
$/m^2$	$0.19	$0.39
Fuel		
Distance per job (km)	15	50
m^2/job	120	120
Fuel consumption (l/100km)	14	14
Litres	2.1	7
Price ($/l)	2	3
$/m^2$	0.035	0.175
Total ($/m^2$)	0.23	0.56

[1] Assumes teams of 3 people. The number is estimated from the number of employees required at peak to install $100,000m^2$ given seasonality as discussed above

The costs includes an "other" category based on the estimate provided by one installation franchiser that margins "could be as low as 10%" of the installed price. We have specified the "other" cost to achieve a 10% margin ($1.80/m^2) in the low margin option; we have included this same cost in the high margin calculation. This "other" category may include additional transport or administration costs associated with the installation. GST is included in the margin calculation because it contributes to the total surplus at the national level.

The value of the subsidy has not been included in the analysis above as it is a transfer rather than a cost.[18] Approaches used by installers differ and include an "included

[18] There is a cost associated with the collection of the revenue for the subsidy via taxation. This deadweight cost of taxation is discussed in a separate paper.

price" in which the quote takes account of the subsidy, versus an approach that calculates the cost of the job and allows house-owners to choose the subsidy or not (acknowledging that the subsidy brings additional obligations such as to insulate both the ceiling and underfloor spaces).

As a check on these numbers we examined company valuations for a number of insulation businesses for sale. Using a number of assumptions we estimate the surplus (including GST) to range between $3.97 and $7.89 per m² installed (Table 11); these values are higher than those estimated above, and this might be because the Table 11 data are from asking prices as opposed to final agreed sales prices.

Table 11 Margin Estimates based on Company Valuations

Value/Sale Price ($'000)	Assumed profit (NPAT) ($'000)[1]	Other information	Estimates	Margin estimate ($/m²)[4]	Margin including GST[5]
895	298 – 597	12 staff	170,000m² pa [2]	2.6 – 5.2	4.9 – 7.9
75	25 – 50	$320,000 turnover	21,667 m² pa [3]	1.7 – 3.4	4.0 – 6.1

Note: [1] Assume value = net profit after tax (NPAT) x factor of 1.5 – 3 These are relatively low values reflecting the riskiness of the business for any individual firm; [2] Assumes 7 staff per 100,000m² (see Table 6 installation and admin staff numbers); [4] Assumes $15/m² sales price and assumes tax rate of 33% given time period of calculations (ie pre-tax profit is NPAT / 0.67); [5] The range reflects assumed sales price of $15-18/m²

Source: Valuation data from www.nzbizbuysell.co.nz

We note that the estimates of surplus from installation (Table 9) are higher than for production, ie before GST surpluses range from 10 – 20% of the sales revenue, compared to 9% for production (Table 8). The margin or surplus estimated for installation is a return to the business owner and, for existing owners that are selling more insulation as a result of the subsidy, this is pure surplus. For new companies that have established as a result of the programme, part of this surplus is a return to managerial labour and to business ownership. For those companies, this is not a pure surplus as, without it, these firms would not have established.

These data and assumptions are used in the calculations of impacts of the programme below.

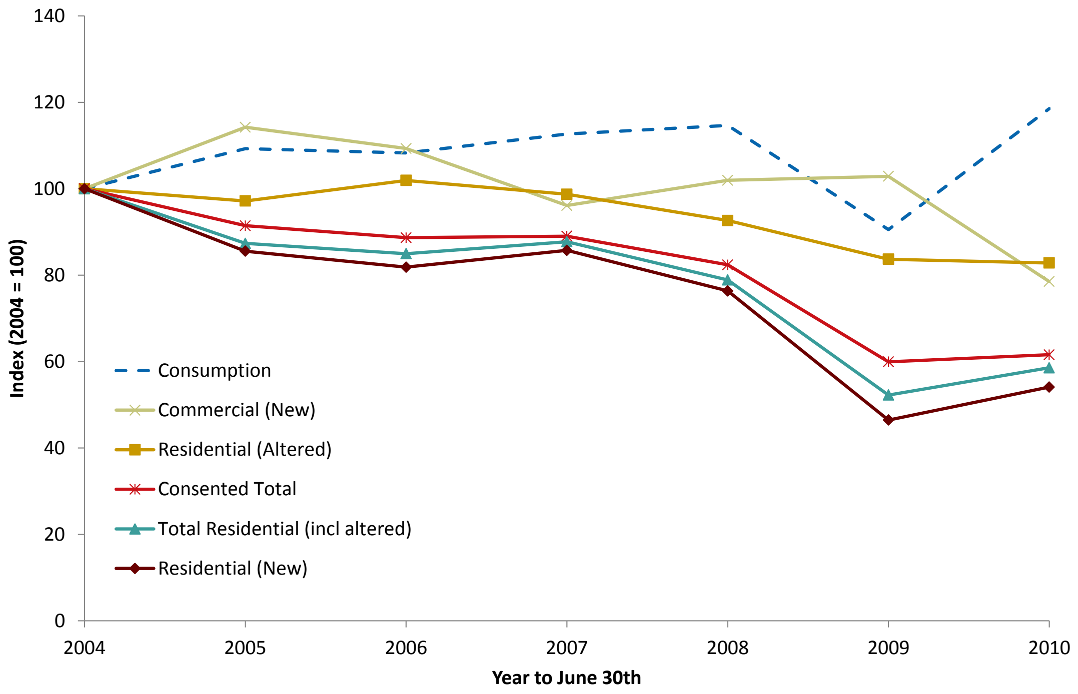
4.3 Effects of the Subsidy on Insulation Consumption

4.3.1 Predictors of Insulation Consumption

Subsidies for insulation available under the programme will result in some payments being made for houses that would be insulated in the absence of the programme. Because there is no test of additionality in approving houses for treatment (and it is difficult to see how there could be), isolating those installations that are directly attributable to the subsidy is not straightforward. In this section, in order to isolate these effects, we set out an analysis of historical production levels, including those before and after the start of the programme.

To separate out the effects of the programme from other factors influencing levels of production and installation, we compare historical production levels with building consents data. Not all insulation historically will be associated with a building consent, as there will be some retrofitting that is occurring independently of any building work, but it is likely that the majority is linked to a building consent. In Figure 11 we show indexes of consumption (production plus imports) (dashed line) based on estimates in Figure 8 and consents data (solid lines) (see Section 3.3). The consents are for residential new build and for commercial buildings measured as m^2 of floor space. The analysis also uses estimates of floor space for consents for altered buildings; this is done by using the same annual ratio of value to floor space as for new build.[19]

Figure 11 Comparison of Consumption Estimates and Consents Data (index, 2004 = 100)



4.3.2 Implications of Data Limitations

We consider how well the floor area of building consents from 2004-2010 and the insulation subsidy explain the consumption of insulation.

It is important to note up front that we have few data points (7 years) with which to analyse the impacts of the programme. Therefore any regressions will have a limited ability to model insulation consumption. In addition, the estimates of insulation consumption are built up from a limited data set (four companies provided data). We have used the available data as they provide an indication of the impact of the insulation subsidy, however the analysis below shows there is a wide range about the estimated coefficients due to the limited number of observations.

Furthermore, with few observations, we are limited in how many variables we can use as the basis for our predictive model, because adding additional variables reduces the degrees of freedom. Degrees of freedom describe how much information could be

[19] In reality, costs (value is the term used by Statistics NZ) for alterations will vary widely, compared with new build, and note these are the costs of the alteration project as a whole, not the costs of the insulation element of the project.

extracted from a set of data before reaching its limit. Each time more information is extracted from the data (by including more explanatory variables in the regression) estimating the coefficients of these variables becomes less accurate. While adding more explanatory variables improves the fit of the regression, fewer degrees of freedom reduces the confidence we have in the estimated values. To limit the number of variables we combine new residential, altered residential and commercial consented floor areas into one, so that we have the highest level of confidence around the included predictors. This is particularly important once we include the variable for the number of houses receiving the insulation subsidy.

There are different ways in which a model predicting insulation consumption could be specified. We have tested a number of options and present a model below that regresses insulation consumption against building consents data and the number of houses provided with a subsidy. A review by Richard Arnold (Victoria University) of this and other models is included in an Annex. We have not included a time trend in the regression because of the possible collinearity problem, ie that there may be a time trend associated with insulation consumption and the level of subsidy (both increasing over time) and the regression analysis will not be able to isolate these effects. Including a time trend is likely to underestimate the effects of the subsidy. We note that in excluding the time trend we may overestimate the effects of the subsidy. If there is a trend of increasing insulation consumption due to factors not included in the model, for example, more awareness of the benefits of insulation over time, the regression will estimate this trend using the included parameters. As a result it will assign additional weight to the parameters that reflect the trend, that is, the increasing size of homes and the increasing insulation subsidy. Thus the coefficients of these variables will be greater than their actual effect on insulation consumption.

There has been increased use of information with the expansion of the programme, such that some of the effect that we have attributed to the subsidy will be attributable to the information. However, as we are using the subsidy as a proxy for the programme as a whole this does not matter to the extent that the level of information has increased to the same extent as the quantity of subsidy payment; we have no quantitative measure of the awareness raising programme.

4.3.3 Linear Regression Model

Firstly, we assume that normal consumption "$Consumption_N$" (ie in the absence of insulation subsidies) is given by:

$$ln\ (Consumption_N) = ln(\alpha) + \beta ln(Floor)$$

Or,

$$Consumption_N = \alpha(Floor)^\beta$$

Where Floor is the floor area of building consents. We assume total consumption "$Consumption_T$" including the insulation subsidy is given by

$$Consumption_T = Consumption_N + Consumption_S$$

Where $Consumption_S$ is additional insulation consumption that is a result of offering the insulation subsidy. We assume this relationship is proportional to the number of subsidised homes, (*Subsidised*).

$$Consumption_S = \gamma(Subsidised)$$

We rewrite the total consumption relationship as:

$$Consumption_T = \alpha(Floor)^{\beta} + \gamma(Subsidised)$$

In estimating the equation we first test if $\beta = 1$ and cannot reject that hypothesis at conventional significance levels.[20] With this restriction added ($\beta = 1$), we test if insulation consumption is zero when both the floor area of building consents is zero and there is no subsidy. We cannot reject the hypothesis that insulation consumption is zero[21] under these circumstances. The resulting equation is

$$Consumption_T = \alpha(Floor) + \gamma(Subsidised)$$

Table 11 shows the results for a regression of floor area and the number of homes receiving the insulation subsidy (n=7). Insulation subsidies started in 2008 with a large increase in 2009-10 when the current programme started. While the rules for the 2009-2010 programme are significantly different from earlier programmes, the purpose of including the variable is to gauge additional demand for insulation based on the number of houses provided with a subsidy; the rules around how the subsidy are provided do not affect the results.[22] Including the number of subsidised houses as a variable provides an estimate of the impact on insulation consumption as a result of each additional house receiving a subsidy.

Table 12 Regression results for insulation consumption[(1)]

Parameter[1]	Consented Floor Area	Number of Subsidised homes
Coefficient (m^2)	1.91	127.2
Standard Error (m^2)	0.0782	25.7
P-Value	0.000	0.004

[(1)] As the constant is fixed at zero, R Squared cannot be interpreted in the usual way and so is not reported.

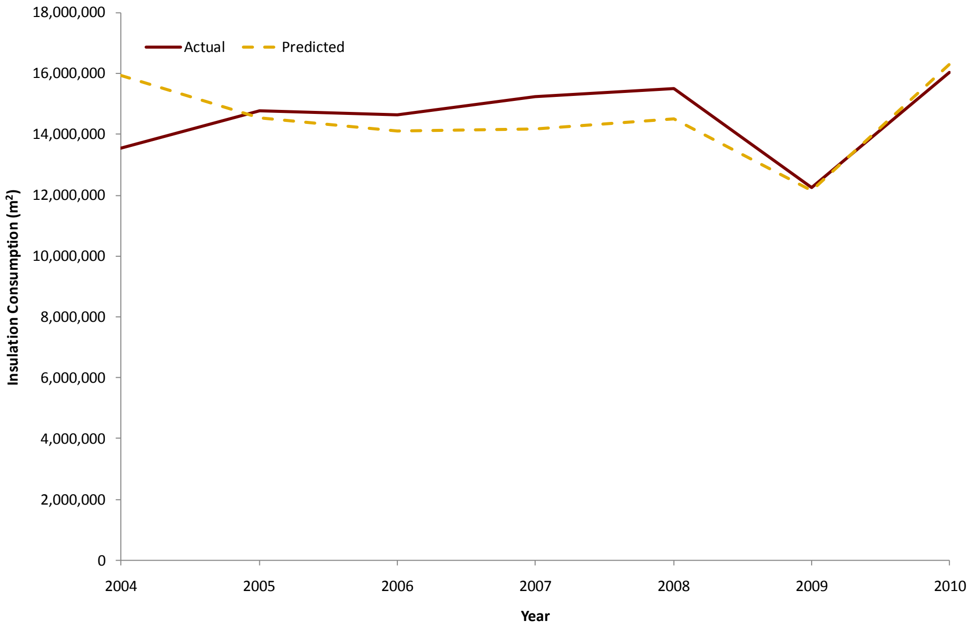
Using this formula, the coefficients are statistically significant, meaning with the available data we can determine to a 95% confidence level that the insulation subsidy is a statistically significant factor in predicting insulation consumption. The regression suggests that, for every subsidised home, there is additional insulation consumption of 127 m^2 with a 95% confidence interval of 61.1 m^2 to 193.4 m^2. Figure 12 shows insulation consumption and the "Predicted" values.

[20] We cannot reject $\beta = 1$ (p value = 0.963).

[21] We cannot reject $constant = 0$ (p value = 0.315)

[22] We have not differentiated between the current and previous programmes as this would reduce the number of data points to one.

Figure 12 Installed and Predicted Insulation



Using the central estimate of 127 m^2 of insulation consumption per subsidised home suggests that, for a total of 51,663 homes insulated as a result of the programme over the period to end of June 2010 (Table 5), 6.6 million m^2 of additional insulation would have been installed (Table 13). Using a 95% confidence interval, there is a range of possible consumption levels around this central estimate: at the top end of the range, approximately 10 million m^2 (or 193 m^2 per house) and, at the bottom end, 3.2 million m^2 (61 m^2 per house). It is feasible that total insulation could be higher than the quantity installed in subsidised houses because the publicity surrounding the programme has increased general awareness of house insulation and may have encouraged people to insulate outside of the programme. They may have an incentive to do so because of the constraints of the programme, eg the need to insulate both underfloor and ceiling areas and to use a professional installer. Some people are likely to have been encouraged to undertake DIY installations, for example.

The subsidised sample total in Table 13 is estimated from the EECA data, ie a total of 6,448,869 of insulation (Table 2) across 42,850 houses (Table 3),[23] or 150.5m^2 per house. Below we show our low, central and high estimate, based on the range of the confidence interval and the level of the subsidy.

Table 13 Projected Increases in Insulation Consumption as a Result of the Programme (2009-10)

Estimate	Quantity installed per house (m^2)	Total quantity installed (million m^2)[(1)]	% of Subsidised
Subsidised Sample	150.5	7.8	100.0%
Low	61.1	3.2	40.6%
Central	127.2	6.6	84.5%
High	193.4	10.0	128.5%

[(1)] Based on 51,663 houses

[23] This is based on the totals for underfloor insulation only (6,266) + ceiling insulation only (12,558) + underfloor and ceiling insulation (24,026) = 42,850 (Table 3)

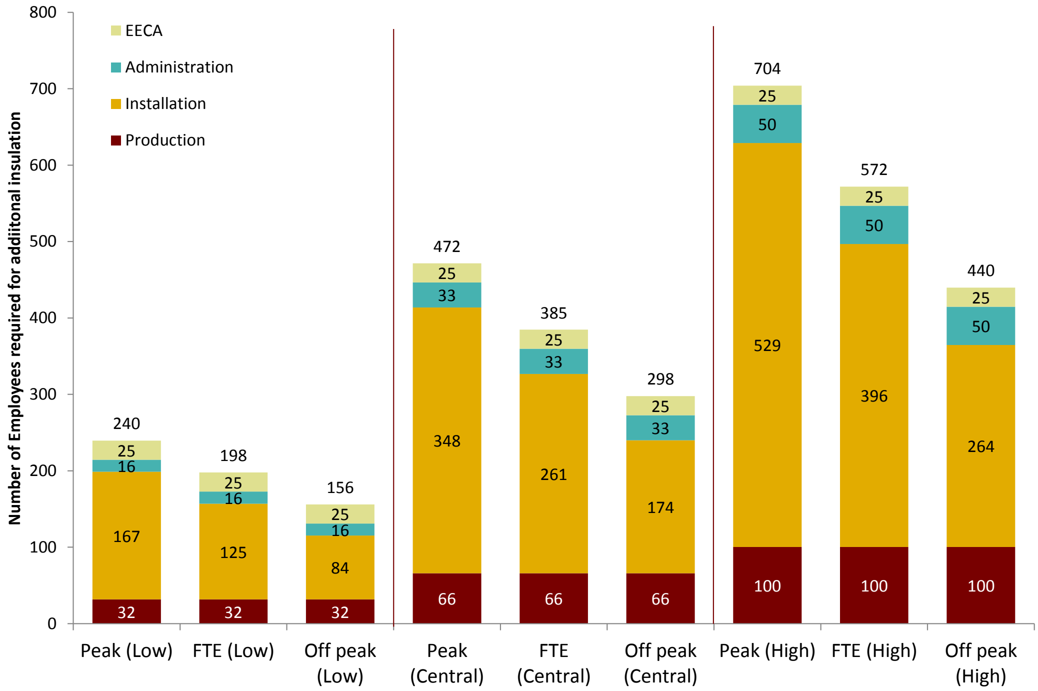
We use the regression results as the basis for our estimates of the effects of the programme. It suggests, as a central estimate, that 85% of the quantity of insulation installed in subsidised houses is additional to that which would have been installed under business as usual. However, there is a reasonably large range of uncertainty around this central estimate, from 41% to 129%.

4.4 Employment Impacts

4.4.1 Direct Effects

We start by examining the employment required to produce and install the additional insulation that is associated with the programme. The additional insulation is that derived econometrically and summarised in Table 13 (central estimate of 127 m^2/house insulated); this is combined with the number of houses insulated (51,663 insulated under the programme in 2009-10) and the employment requirement estimates in Table 6 which show how many people are required per 100,000m^2 of insulation. In addition, EECA advises that approximately 25 FTEs have been required to administer the programme. The results are summarised in Figure 13.

Figure 13 Estimated Impacts of the Programme on Employment in Insulation Production and Installation (2009-10 year)



4.4.2 Indirect Effects

In addition to these direct effects there are expected to be indirect effects on employment. When new jobs are created as a result of new industrial activity there will be additional jobs associated with supplies to these firms (indirect effects) and as a result of the increased expenditure of the households of workers that are employed (induced effects). Standard employment multipliers can be used to estimate these indirect and induced effects. In doing this care is needed not to double count the effects.

For example, some of the indirect effects from installation activity will be associated with the production of additional insulation. Given this, we have used multipliers for installation and subtracted the production employment from the estimates of indirect employment. The multipliers used are shown in Table 14; the multipliers are estimated from ratios of FTEs to output, but are presented as ratios of indirect & induced employment FTEs to direct employment FTEs. We multiply these ratios in Table 14 by the direct employment numbers in Figure 13 to estimate the indirect and induced effects in addition to the direct effects (Table 15).

Table 14 Multipliers for Indirect and Induced Effects (FTEs:direct employment FTEs)

Activity	Sectoral assumption	Indirect	Induced	Total
Production	Glass and glass product and ceramic manufacturing	0.84	0.72	1.55
Installation	Ancillary Services to Construction	0.52	0.42	0.94
Administration	Business administrative and management services	0.57	0.44	1.01
EECA staff	Central government administration	0.66	0.52	1.19

Source: Geoff Butcher (Butcher Partners Ltd)

Table 15 Direct, Indirect and Induced Employment Effects

		Low	Central	High
Production	Direct	32	66	100
	Indirect & Induced	49	103	156
	Total	81	169	256
Installation	Direct	125	261	396
	Indirect & Induced	37	76	116
	Total	162	337	513
Administration	Direct	16	33	50
	Indirect & Induced	16	33	51
	Total	32	66	101
Government	Direct	25	25	25
	Indirect & Induced	30	30	30
	Total	55	55	55
Total	Direct	198	385	572
	Indirect & Induced	132	242	352
	Total	329	627	924

4.4.3 Additional Employment

These estimates comprise the total employment associated with the additional production and installation that is a result of the programme. However, not all of this employment will itself be additional. The employment might result from some combination of transfers of people from other industries and a shift of people from unemployment to employment. And within these categories there will be people that have shifted from other industries where their jobs are replaced and some where they are not, and the replacements may come from currently unemployed people or from other industries. Given this series of possible effects, the estimation of net employment impacts is fraught with difficulties.

Where workers shift from other industries, it could be assumed that wage rates would need to increase in order to replace those workers in those other industries, or that the productivity of replacement staff was lower. In both cases the effect is higher costs of production and a resulting decrease in total employment in those other industries that partially offsets the employment gains in insulation production. This means that the additional employment in insulation production and installation will not all be additional at the national level.

This issue has been addressed in analyses elsewhere. David Maré, for example, analyses the impacts of Active Labour Market Policies,[24] ie wage subsidies.[25] Maré uses the results of a large number of studies (in a range of economic conditions) to draw some broad conclusions:

- typically 60% of gross effects would have happened in the absence of the wage subsidy policy, ie these people would have been employed without the subsidy (thus 40% is additional). Some of this is taken into account in our analysis by the estimate of the proportion of the total insulation that is additional, ie 74%;

- taking account of employment displacement[26] elsewhere and substitution[27] effects, net employment effects (total additional employment over what would have happened in the absence of the policy) are about 5-10% of gross outcomes.

The other piece of information that we have on employment effects is that related to the shift from unemployment. Information provided by a large installer suggested that approximately 60% of the additional installers that have been employed were previously unemployed. Using the 60% figure ignores the likelihood that some might have found employment in the absence of the insulation subsidy, however it also ignores that fact that some people displaced from jobs elsewhere to take up insulation installation, might lead to unemployed people being employed in these other industries.

In the absence of more detailed data, we use these to provide our range for analysis, ie:

- a low estimate of 7.5% of gross employment, which is the mid-point of Maré's net effect estimate. However, as noted, some of his analysis includes the effects that we are measuring directly, so we take 7.5% of the total employment associated with all insulation that receives a subsidy; and

- a high estimate of 60% of gross employment as estimated in Table 15.

The results are shown in Table 16 for the central estimate of additional insulation.

As with all of the estimates of employment effects, these are associated with the additional production and installation of insulation that is incentivised by the programme; these are not long-term additions to total employment. They are regarded by the government as a contribution to increasing employment during the recession.

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[24] Maré DC (2005) Indirect Effects of Active Labour Market Policies. Motu Working Paper 05-01

[25] The insulation programme can be conceived of as a wage subsidy; it has the same net impact on installers, ie costs are reduced.

[26] Firms with subsidised workers can out-compete other firms, causing those firms to reduce employment

[27] Employers substitute cheaper (subsidised) workers for other workers

Table 16 Additional Employment for central estimate of additional insulation

	Low			High		
	Direct	Indirect & Induced	Total	Direct	Indirect & Induced	Total
Production	6	9	15	40	62	101
Installation	23	7	30	156	46	202
Administration	3	3	6	20	20	40
EECA	2	3	5	15	18	33
Total	34	21	56	231	145	376

4.5 Producer Surplus

The additional producer surplus is made up of:

- the additional surplus earned by manufacturers and installers of insulation estimated as the product of the quantity of additional production and installation and the production and installation surpluses noted in Table 8 and Table 9 above; plus

- the value of the wages to employees that are additional at the national level, ie that have displaced previously unemployed people (as discussed in Section 4.4). This amount adds to producer surplus from a national perspective in which the producer is the nation, and where producer surplus is defined as the total revenue obtained from using a productive resource minus all opportunity costs of production. As discussed in the previous section, it is assumed that 60% of the workers in insulation installation have shifted from unemployment to employment. While recognising that there may be additional displaced unemployment to other industries, we have limited our estimate of contribution to surplus to this 60%. We assume that these are part of the total surplus rather than being part of the costs of supply. For the low scenario we assume that all of the additional 7.5% of gross labour has a zero opportunity cost.

The inputs to the analysis are shown in Table 17 and the estimates of total surplus are given in Table 18 based on multiplying the estimates of additional insulation produced as a result of the subsidy programme by the estimates of surplus per m^2 in Table 17. The transfer wages are those regarded as a transfer payment within the economy rather than representing a cost.[28]

Table 17 Inputs to Assessment of Surplus ($/m²)

	Producer Margin	Transfer Wages	Total
Production	0.41[(1)]	0.13 - 0.78[(2)]	0.54 - 1.19
Installation	4.5 - 5.28[(3)]	0.24 - 1.42[(4)]	4.74 - 6.7
Total	4.91 - 5.69	0.37 - 2.2	5.27 - 7.89

[(1)] Surplus value from Table 8; [(2)] based on the wages from Table 8 and the ratio between total direct employment and additional employment (Table 16) ; [(3)] Table 9; [4] based on wage rates for installers and admin staff plus estimates of additional employment (Table 16)

[28] A cost would apply where the payment to workers was equal to the opportunity cost of lost production elsewhere in the economy.

In addition we add a surplus associated with payments to EECA staff on the assumption that some percentage of this employment is additional at the national level also; the same assumptions are used as for the other employment.

Table 18 Producer Surplus to Insulation Producers and Installers (2009-10)

	Total additional insulation (million m^2)[1]	Production Surplus ($ million)	Installation Surplus ($ million)	EECA staff ($million)	Total Surplus ($ million)
Low	3.2	1.6 - 3.7	14.5 - 18.4	0.1 - 1.1	16.2 - 23.3
Central	6.6	3.4 - 7.8	30.9 – 44.0	0.1 - 1.1	34.5 – 53.0
High	10.0	5.2 - 11.9	47.1 - 66.9	0.1 - 1.1	52.4 - 79.9

[1] Source: Table 13

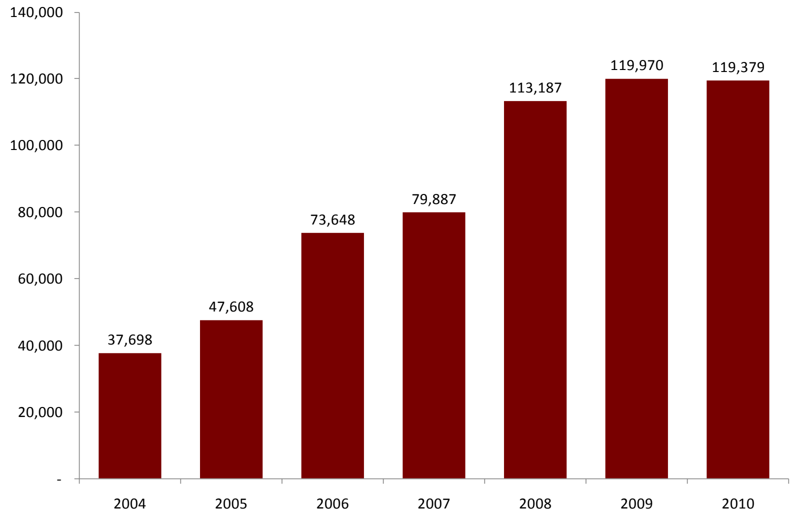
The total additional producer surplus is estimated at $35–53 million in our central estimate.

5 Clean Heating Analysis

5.1 Historical Data

Clean heating includes heat pumps, efficient woodburners, wood pellet stoves and flued gas heating. The majority of installations have been of heat pumps, all of which are imported to New Zealand. Sales data (Figure 14) show a period of escalating total sales which has levelled off during the period of the programme.

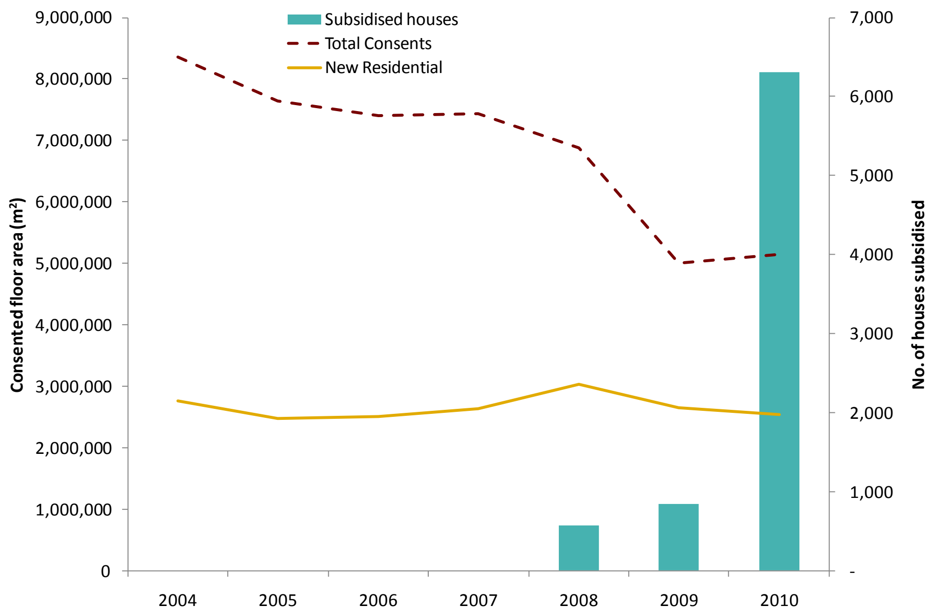
Figure 14 Heat pump sales



Source: EECA

Possible explanatory variables as used for insulation are shown in Figure 15.

Figure 15 Possible explanatory variables for heat pump sales



However, as explained below, we found no statistically significant relationship between these variables and heat pump sales, ie sales are not related, in a simple way, to consents.

5.2 Impacts of the Programme

In this section we estimate the producer surplus per additional clean heater installed as a result of the programme.[29] The programme includes heat pumps and other heating types, eg pellet burners, efficient wood and gas burners. However, for analysis we have assumed all are heat pumps. Given the uncertainties in the data this is unlikely to affect the results significantly.

5.2.1 Installations

There is little scope for an analysis of a factual versus counter-factual for clean heat installations to calculate additionality as we have not identified any explanatory variables, as we did for insulation. The data in Figure 14 show a large and recent increase in the number of installations of heat pumps that is not related to any change in the number of new house builds or total alterations, and there is a time trend that pre-dates the subsidy programme. Regressing heat pump sales against data on the subsidy programme and these other variables does not reveal a statistically significant relationship, particularly as sales fell between 2009 and 2010, the year in which the number of heaters that were subsidised increased significantly. Including a parameter for the recession in the analysis results in a statistically insignificant (and positive) effect on sales.

We therefore have no robust way to estimate the effect of the programme on total sales and installations of heat pumps and other clean energy forms. Given this uncertainty, we make a simple assumption that the impact is the same as that for insulation, ie a central estimate of 85% of subsidised clean heating being additional to that which would have happened in business as usual, a low of 41% and a high of 129% (see Table 13). Under the programme 12,658 clean heaters were purchased and installed; these assumptions on additionality would suggest a central estimate of 10,698 being installed as a result of the programme and in addition to what would have been installed with no subsidy.

Table 19 Estimates of number of clean heaters installed as a result of the programme

Estimate	% of total subsidised	Number of clean heaters installed
Total subsidised	100	12,658
Low scenario	40.6	5,139
Central estimate	84.5	10,698
High estimate	128.5	16,266

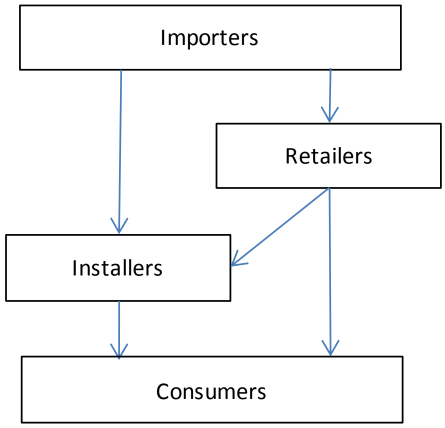
5.2.2 Importers

The supply chain of heat pumps in New Zealand has the stages illustrated in Figure 16. Most are imported to New Zealand by manufacturers (eg Daikin, Fujitsu, Mitsubishi, Panasonic, Toshiba). These are distributed either through retailers or installers. Consumers in turn purchase heat pumps either from retailers or through the installation

[29] The number of additional heat pumps installed is not necessarily the total number of heat pumps funded by the programme. Some of the funded heat pumps may have been installed without the subsidy. The additional heat pumps installed referred to here is heat pumps that were only installed because the subsidy is offered and would not have been installed in absence of the subsidy.

companies; generally retailers sell heat pumps with an installation service using accredited installers.

Figure 16 Heat Pump Supply Chain



Heat pumps are imported to New Zealand by the manufacturers and sold to retailers generating a surplus for the importer over the import price. We estimate the producer surplus per unit sold. As these importers are typically the New Zealand office of a foreign manufacturer, and profits are likely to be repatriated overseas, we also estimate the portion of surplus that remains in New Zealand.

We estimate import price based on the average import value. This is calculated from Statistics New Zealand import data. The wholesale price received by the importers is estimated using prices provided by heat pump distributors, weighted by the models[30] and number of units in the Heat Smart programme. Lastly we estimate importers costs using the results of the Annual Enterprise Survey (AES) 2009.[31] We estimate these costs as a range of the average percentage of revenue and the average percentage of gross margin for the Wholesale Trade sector.

From Statistics New Zealand data we find an average import price for heat pumps of $923. Based on a weighted average of sale prices we find an average wholesale price of $2,011. Including other costs of the importer this gives a surplus of between $371 and $681 per heater sold. We assume all costs incurred by the importer are marginal such that they are incurred for every unit sold, ie the marginal surplus is equal to the average surplus. This is the same assumption as used for the insulation analysis and it partly reflects the absence of data at a company level, but might be explained by economies of scale, as for insulation installation and competition with other heating systems, rather than inter-heat pump competition eroding margins. Fundamentally it is the absence of data that is the major reason for the assumption.

Since the importers and manufacturers are foreign owned, it is assumed that surplus is repatriated overseas. The portion of the surplus which stays in New Zealand is the

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[30] This does not cover all units included in the programme, only those where we have a price and model number available.

[31] Available from Statistics NZ http://www.stats.govt.nz/browse_for_stats/businesses/business_finance/annual-enterprise-survey_hotp09.aspx

portion paid in tax. Using the corporate tax rate of 33%[32], the producer surplus per unit retained in New Zealand is estimated at between $122 and $225.

5.2.3 Retailers

The surplus generated by heat pump retailers is the difference between the retail price received and their costs. In this case the costs are the cost per unit estimated above at $2,011 on average and retail costs estimated from the Annual Enterprise Survey. We again use the Wholesale Trade category (ANZSIC06 division F) rather than a retail category as this is probably a better reflection of the actual costs for a heat pump retailer. The revenue received is estimated as a weighted average of the heat pumps sold at $2,924. Including other costs the producer surplus is between $321 and $447.

Similarly to importers, we assume all costs are marginal, ie the marginal producer surplus is equal to the average producer surplus. Of this surplus, $325 is paid in GST[33], $0 - $40 is paid in corporate tax and $394 is retained by the retailer. We assume that approximately half of retailers are New Zealand-owned and half of the after-tax profits are retained in New Zealand. The producer surplus retained in New Zealand is estimated to be between $322 and $406.

5.2.4 Installation

The heat pump installer generates a surplus from providing the installation service. The price for installation services ranges from $750 to $1,350[34] depending on the difficulty of installation. While a "back to back" installation requires 3-4 hours work and parts, more expensive installations require more labour and materials. We therefore estimate a range for producer surplus. A simple "back to back" installation generates $249 of surplus with $88 paid in GST and $53 paid in tax with $108 retained by the installation company. For a more complicated installation we estimate the surplus generated to be $378 with $144 paid in GST $77 paid in tax and $157 retained by the firm. These calculations assume a wage for installation of $80/hour, reflecting the requirement for installations to be undertaken by electricians.

Since each additional heat pump sold requires installation, the costs for the average heat pump will be the same for each additional heat pump. Therefore the marginal producer surplus is the same as the average producer surplus. We assume that all installers are New Zealand-owned and the whole surplus is retained in New Zealand.

5.3 Employment

The majority of clean heaters are imported rather than manufactured in New Zealand and it is estimated that there is likely to be minimal if any requirement for additional workers in importing. The main requirement for new labour is in installation. We estimate the requirement for additional labour on the basis of 4.25 hours per installation,

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32 From 1 of October, 2010, the corporate tax rate has dropped to 30% but this analysis was for the year to June 2010.

33 We use a rate of 12.5% for GST. From 1 October 2010 GST has increased to 15%.

34 Consumer Magazine (2010) Heat Pumps; The Importance of Installation, published on 2 November 2010, available at http://www.consumer.org.nz/reports/heat-pumps/the-importance-of-installation

as an average of simple and complex installations, that installers spend half their time on installations and that there are 1920 working hours per year.[35] This means that an installer can install 226 heat pumps per annum.[36] We estimate the direct and indirect employment as a result of the heating that is installed under the programme; multipliers used are the same as for insulation installers. We then estimate, of this employment, how much is additional at the national level, ie diverted from unemployment. The estimate of impacts on total employment is given in Table 20.

Table 20 Additional Employment from Heat Pump Installation (2009-10)

Installation additionality	Direct	Indirect	Total	Employment additionality
Low	23	21	44	4 – 26
Central	47	45	92	8 – 55
High	72	68	140	12 – 84

To provide inputs to the cost benefit analysis that summarises the results of this study, we show the estimated employment effects in Table 21 per 10,000 installations per annum; it includes the gross employment required to install this number plus low and high values for the quantity estimated to be additional.

Table 21 Additional Annual Employment from Heat Pump Installation per 10,000 installations

Impact	Direct	Indirect	Total
Gross Employment	44.3	41.6	85.9
Additional Employment (low)	3.3	3.1	6.4
Additional Employment (high)	26.6	25.0	51.5

5.4 Total Surplus

There is potential for a surplus at each step. Our estimate of average producer surplus per unit sold is summarised in Table 22. It includes the individual data noted above. The transfer to wages is the amount paid to workers that is regarded as part of the national surplus because these workers would have been unemployed in the absence of the programme. The calculations are based on the same assumptions as used for insulation, ie 7.5% of the amount paid at the low end[37] 60% of the amount paid at the high end.

Table 22 Producer Surplus ($/unit)

	Margin	Transfer to wages	Total Surplus	Surplus Retained in NZ
Wholesale	371 – 681		371 – 681	122 – 225
Retail	321 – 447		321 – 447	322 – 406
Simple Installation	249	28 – 168	277 – 417	277 – 417
Complex Installation	378	40 – 240	419 – 618	277 – 417

[35] 48 weeks x 40 hours

[36] In practice this work may be undertaken by electricians who do many other types of electrical work also

[37] This is calculated for the central estimate by assuming that it is 7.5% of the staff required to install all 12,658 heaters rather than 9,410. Estimates for the low and high scenarios are estimated relative to the central scenario.

The approach is somewhat different from that for insulation for a number of reasons.

- The source of surplus at the wholesale/retail level with heat pumps is from the difference between import and retail prices. The surplus is this difference, less costs multiplied by the tax rate. For insulation there is a difference between estimates of production cost and wholesale value but we are unable to explain the source of this difference, ie we have different estimates of value from producers compared to that from installers. In the absence of data we have not included this as a surplus, although it might underestimate the total surplus for insulation producers.

- We attribute GST on the heat pump itself to retailers, whereas for insulation we have calculated GST on an installation service that includes the insulation and the installation.

For these reasons there is a significant difference between the ratios of surplus between producers and installers across the two products.

The surplus estimates are combined with estimates of the quantity of clean heater units that are additional as a result of the subsidy.

Numbers installed under the subsidy programme are counted as 9,975 in the period July 2009 to May 2010 (Table 2) and 9,974 houses (Table 3). The total number provided with subsidies in the year to June 2010 was 12,658.

Using this, and taking the average of the range of figures above, we estimate the total producer surplus in Table 23.

Table 23 Producer Surplus from Clean Heating (2009-10 year)

	Percentage of total	Additional installations	Wholesale Surplus ($million)	Retail Surplus ($million)	Installation Surplus ($million)	Total Surplus ($million)
Low	40.6%	5,139	0.9	1.9	2.2	5.0
Central	84.5%	10,698	1.9	3.9	4.6	10.4
High	128.5%	16,266	2.8	5.9	7.0	15.8

6 Summary and Conclusions

Isolating the effects of the programme is complicated by the other factors that have influenced sales of insulation and clean heating over the same period. This includes changes in the number of new build houses and house alterations, the effects of the recession and the fact that heat pumps are a new technology that has shown considerable growth in sales following its introduction to the market and significant market advertising effort.

We have tried a number of different regression analyses and selected an approach that predicts insulation consumption on the basis of building consents data and the number of houses subsidised. The analysis shows a statistically significant relationship between insulation consumption and the subsidy at the 95% confidence level.

The results suggest that, of the houses insulated under the subsidy, 85% are additional to those which would have been insulated in the absence of the subsidy. However, there is a reasonably large uncertainty range, from 41% to 129% at the 95% confidence level.

An estimate of additionality in the sales and installation of clean heating has not been possible because of the way in which the market for heat pumps has been developing. Sales have increased in the years prior to the programme and have since been levelling off, but we have been unable to produce a reasonable counter-factual. We have therefore adopted the same estimate of additionality as used for insulation.

Using these calculated effects, we have estimated the additional employment and national producer surplus resulting from the programme. Producer surplus is estimated as the total revenue obtained from using a resource minus all opportunity costs of production; some proportion of the labour costs is valued at zero because unemployed labour is being used. The overall results are given in Table 24 as impacts on additional consumption and employment, and in Table 25 as the increase in producer surplus, which represents part of the national benefit arising from the subsidy programme. It does not include any benefits attributable to health benefits or energy savings; these benefits are being evaluated separately.

Table 24 Additional Consumption and Employment from the Programme (2009-10 year)[1]

	Insulation		Clean Heat	
Scenarios	**Additional consumption (million m^2)**	**Additional FTE Jobs[2]**	**Additional Consumption ('000 units)**	**Additional jobs**
Low	3.2	29 – 198	5.1	4 – 26
Central	6.6	56 – 376	10.7	8 – 55
High	10.0	82 – 555	16.3	12 – 84

[1] Analysis is for 51,600 houses for insulation and 12,658 for clean heating; [2] FTE = Full-time Equivalents; employment impacts include direct and indirect effects.

Table 25 Total Additional Producer Surplus in 2009-10 ($ million)

Scenario Estimate	Insulation	Clean Heating	Total
Low	16 - 23	5	21 – 28
Central	35 - 53	10	44 – 62
High	52 - 80	16	66 – 94

Annex Review of Regression Analysis

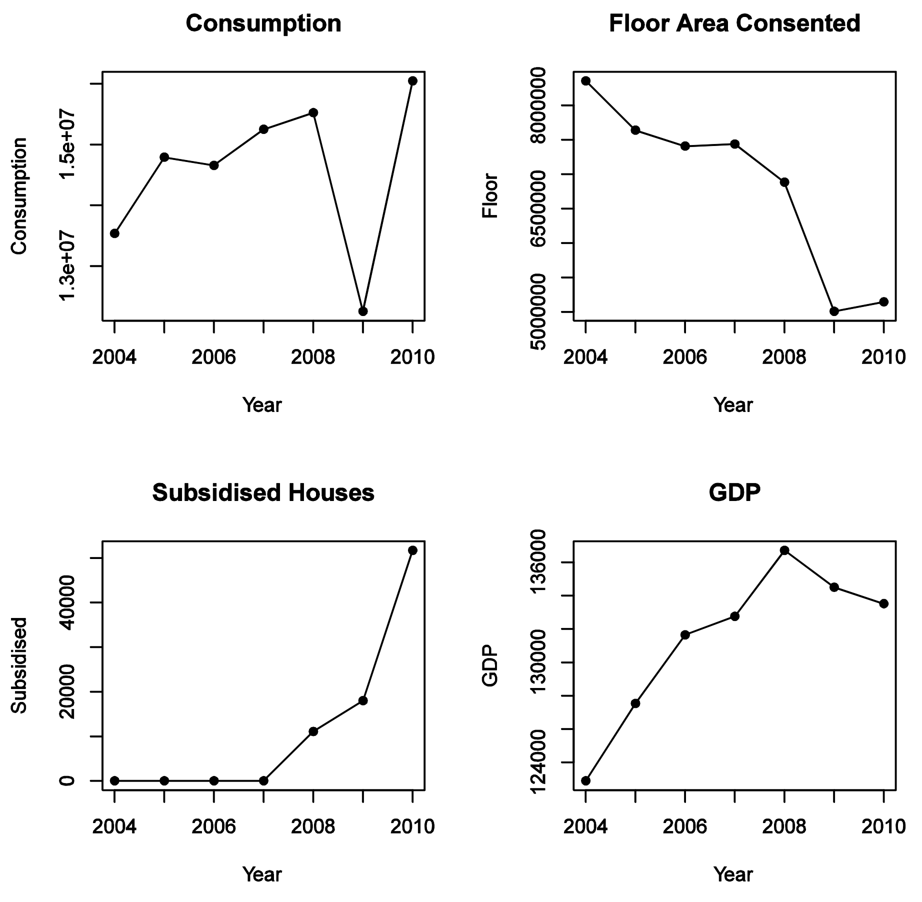
The following review of alternative regression analyses has been undertaken by Richard Arnold.[38].

The raw data are shown in Figure 17. The data are, for the set of times *t* = 2004,…,2010:

- C_t, consumption of insulation;
- F_t, floor area consented;
- S_t, number of subsidised homes;
- G_t, GDP

where GDP is another measure of the health of the economy.

Figure 17 The Raw Data



Most notable in the raw data are (1) the onset of the recession in 2009 (visible in Consumption, Floor Area Consented and GDP), and (2) the introduction of insulation subsidies from 2008.

[38] Senior Lecturer in Statistics, School of Mathematics, Statistics and Operations Research, Victoria University of Wellington

Model 1 – Maximal Model

We seek to explain as much variation as possible in the data using these covariates.

The most complex linear model, excluding interactions, including all of these covariates, including time t, is

$$C_t = \mu + \alpha F_t + \beta t + \gamma S_t + \delta G_t + \varepsilon_t \quad (1)$$

We initially assume that the errors ε_t are independent and identically distributed:

$$\varepsilon_t \sim Normal(0, \sigma^2) \quad (2)$$

If this model is fitted we find the following table of F statistics

	DF	F-value	p-value
Intercept	1	597.8273	0.0017
Floor	1	0.0293	0.8799
Year	1	2.2531	0.2722
Subsidised	1	0.8515	0.4535
GDP	1	0.3245	0.6264

The corrected Akaike Information Criterion is defined

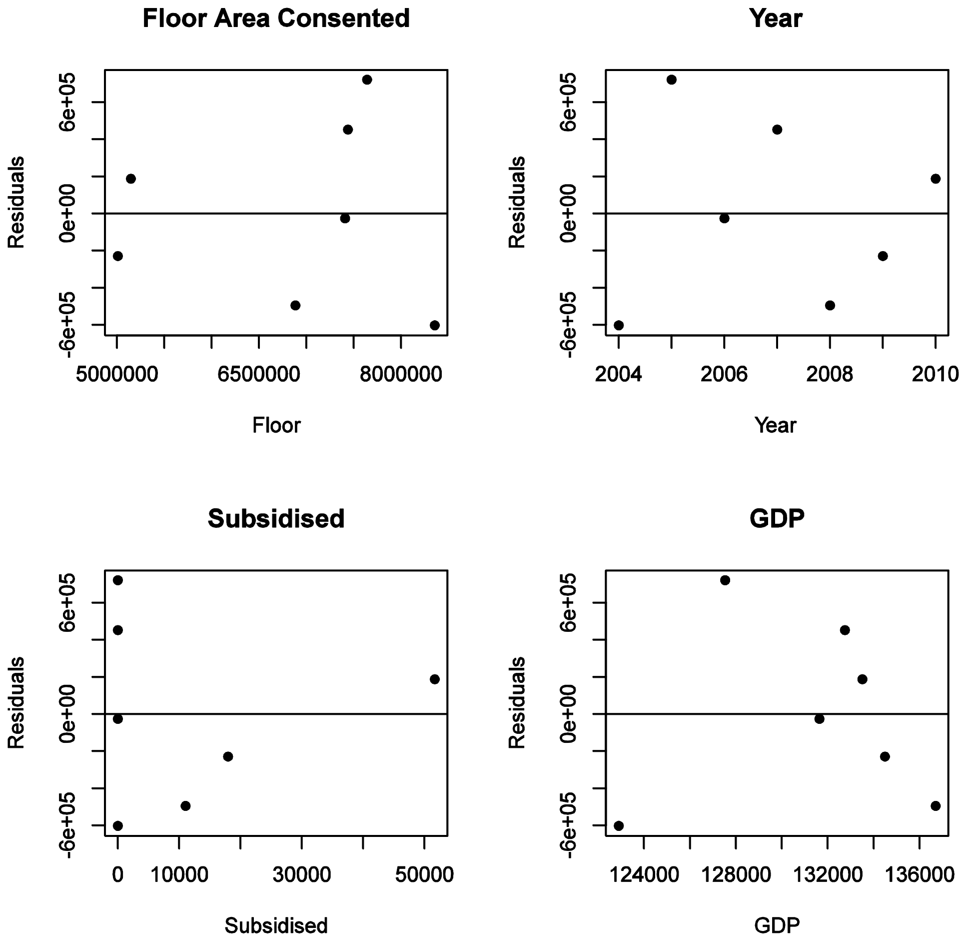
$$AICc = -2\log L(\theta) + 2k + \frac{2k(k+1)}{n-k-1} \quad (3)$$

where $L(\theta)$ is the likelihood of the data given a set of k parameters θ and n observations. We have $n = 7$ years of observations and in Model 1 $k = 5$, leading to an AICc of 274.1263. The table of estimates is:

	Value	Std.Error	t-value	p-value
Intercept	5.446103e+08	2.559258e+09	0.2128001	0.8512027
Floor	1.761563e+00	9.274740e-01	1.8993121	0.1979229
Year	-2.916447e+05	1.291429e+06	-0.2258310	0.8423113
Subsidised	1.109297e+02	6.080395e+01	1.8243837	0.2096513
GDP	3.195242e+02	2.998431e+02	1.0656380	0.3982024

The residuals of the fit are shown in Figure 18.

Figure 18 Residuals from Model 1 (All covariates, 2004-2010)



Note that the data point for 2004, which has the most negative residual, is an apparent outlier in the Year and GDP residual plots.

Modifying the specification of the error term in Model 1 to include AR(1) errors:

$$\varepsilon_t = \rho\varepsilon_t + u_t \quad \text{where } u_t \sim Normal(0, \sigma^2) \tag{4}$$

we have **Model 1a** with analysis of variance table

	DF	F-value	p-value
Intercept	1	4689.513	0.0002
Floor	1	1.048	0.4137
Year	1	3.339	0.2092
Subsidised	1	0.579	0.5263
GDP	1	0.926	0.4374

and parameter estimates:

	Value	Std.Error	t-value	p-value
Intercept	2.386928e+09	2.267619e+09	1.052614	0.40292489
Floor	1.911155e+00	6.100835e-01	3.132612	0.08857326
Year	-1.227195e+06	1.150244e+06	-1.066899	0.39774833
Subsidised	1.849445e+02	8.422520e+01	2.195833	0.15927577
GDP	5.747292e+02	3.192052e+02	1.800500	0.21358294

with an estimated value for the AR(1) correlation $\hat{\rho} = -0.881$.
This model has so many parameters however that the AICc value is not defined.

Model 2 – Stepwise Regression

A backwards stepwise regression on Model 1 (using AICc as the selection criterion) eliminates all of the covariates except Floor Area F_t and Subsidised Homes S_t. The last elimination is between GDP and Subsidised Homes, and is equivocal. When the outlier 2004 is eliminated (Model 3 below) the elimination of GDP is preferred. For this reason we also eliminate GDP from this model. This yields:

$$C_t = \mu + \alpha F_t + \gamma S_t + \varepsilon_t \quad (5)$$

and the following analysis of variance table:

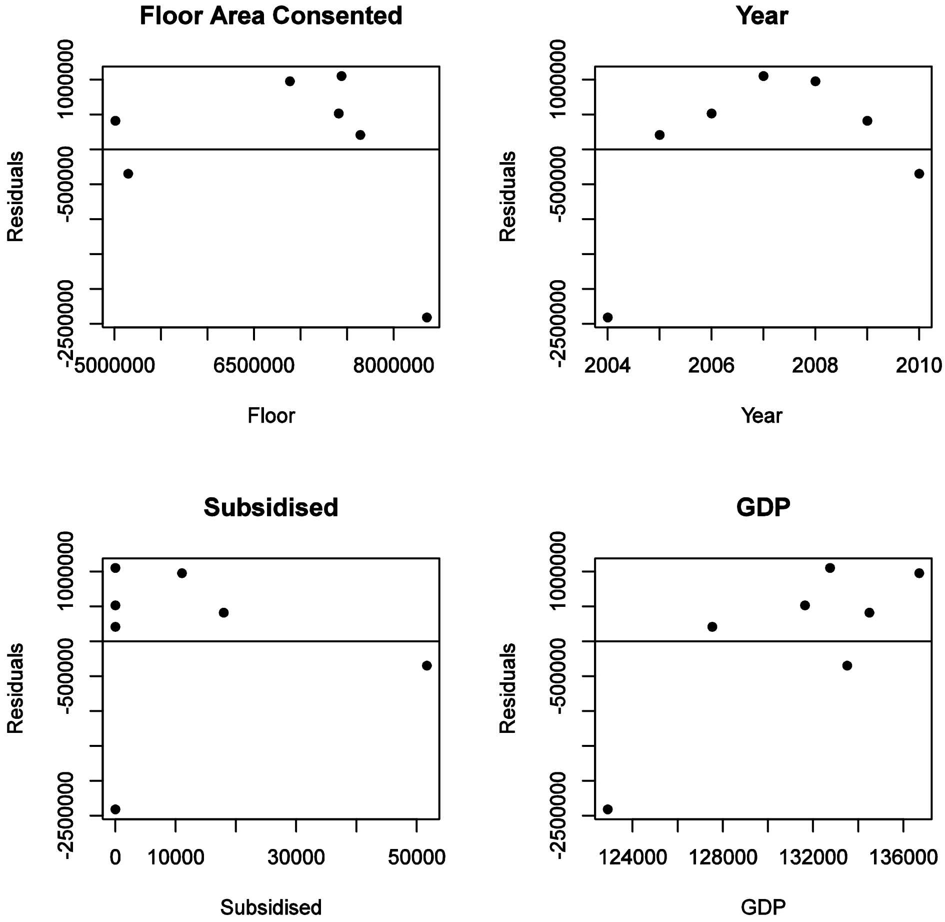
	DF	F-value	p-value
Floor	1	609.9402	<.0001
Subsidised	1	17.4662	0.0087

with an AICc of 223.6237 - an improvement over Model 1 (274.1263). The table of estimates is:

	Value	Std.Error	t-value	p-value
Floor	1.908968	0.07818165	24.417088	<.0001
Subsidised	127.241905	25.73163884	4.944959	0.0043

and residuals as shown in Figure 19.

Figure 19 Residuals from Model 2 (Best Model, 2004-2010)



Model 2a is the same as Model 2, but with AR(1) errors included. The analysis of variance table is

	DF	F-value	p-value
Floor	1	199.51825	<.0001
Subsidised	1	12.90535	0.0157

with an AICc value of 229.8549. Thus **Model 2** is preferred (AICc = 223.6237). The parameter estimates are

	Value	Std.Error	t-value	p-value
Floor	1.857551	0.1297255	14.319094	<.0001
Subsidised	120.643750	28.3828472	4.250587	0.0081

with $\hat{\rho} = -0.543$.

Notes:

- In both Model 1 and 2, 2004 is apparently an outlier - as can be seen in the GDP residual plots in both models.
- Models 2 and 2a are simply interpretable - the outcome (Consumption C_t) is linearly related to the two predictors (Floor Area F_t and Subsidised Homes S_t) without an intercept so that the coefficients of these two terms (α and γ) are the increase in consumption per unit increase in the relevant covariate, with zero consumption for zero values of the covariate.
- Time and the number of subsidised houses both increase through the dataset. If time were to have been retained in the model this collinearity would have reduced the interpretability of the coefficient of S_t.

Model 3 – Sensitivity Analysis

Removing the 2004 observation from the model, stepwise regression again selects Models 2 and 2a as above.

Model 3, with independent errors, has the following analysis of variance table:

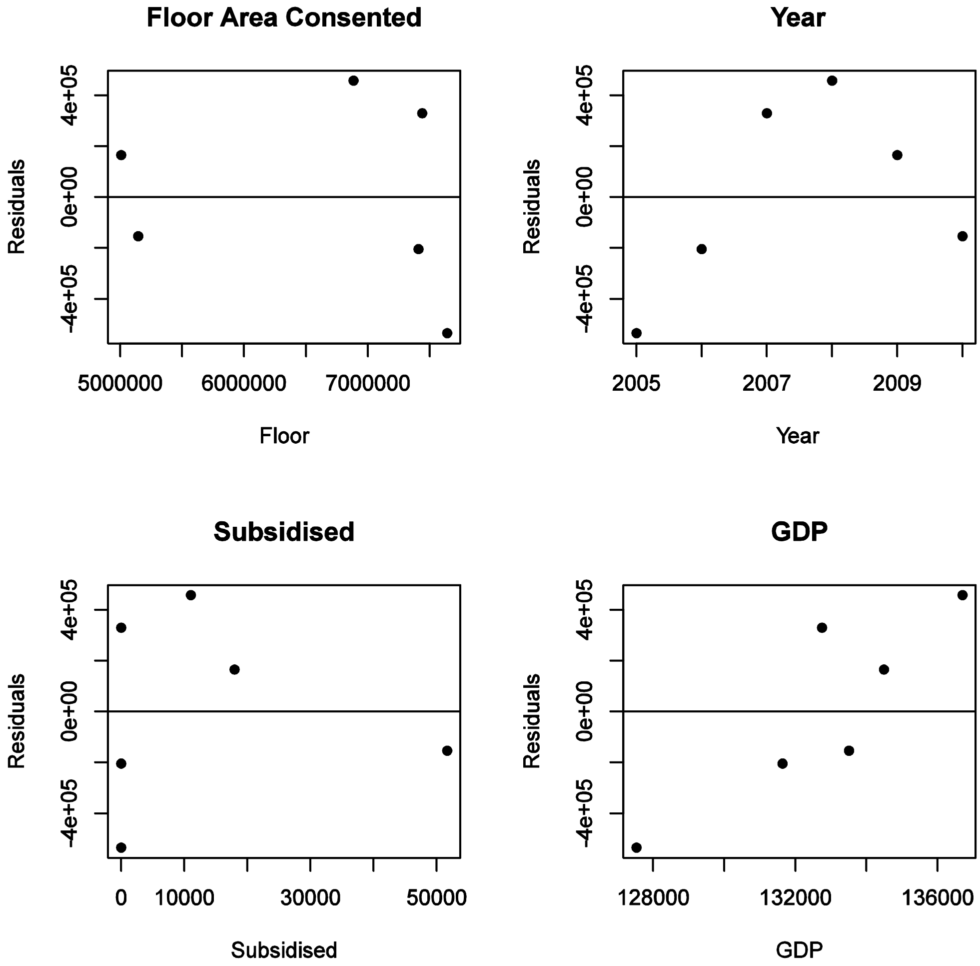
	DF	F-value	p-value
Floor	1	4910.411	<.0001
Subsidised	1	119.755	0.0004

with an AICc of 179.8935. The table of estimates is:

	Value	Std.Error	t-value	p-value
Floor	2.006086	0.0289623	69.26541	<.0001
Subsidised	113.772877	8.4887885	13.40272	0.0002

and residuals as shown in Figure 20.

Figure 20 Residuals from Model 3 (Best Model, 2005-2010, independent errors)



Model 3a, with AR(1) errors, has the following analysis of variance table:

	DF	F-value	p-value
Floor	1	1746.5016	<.0001
Subsidised	1	108.0837	0.0005

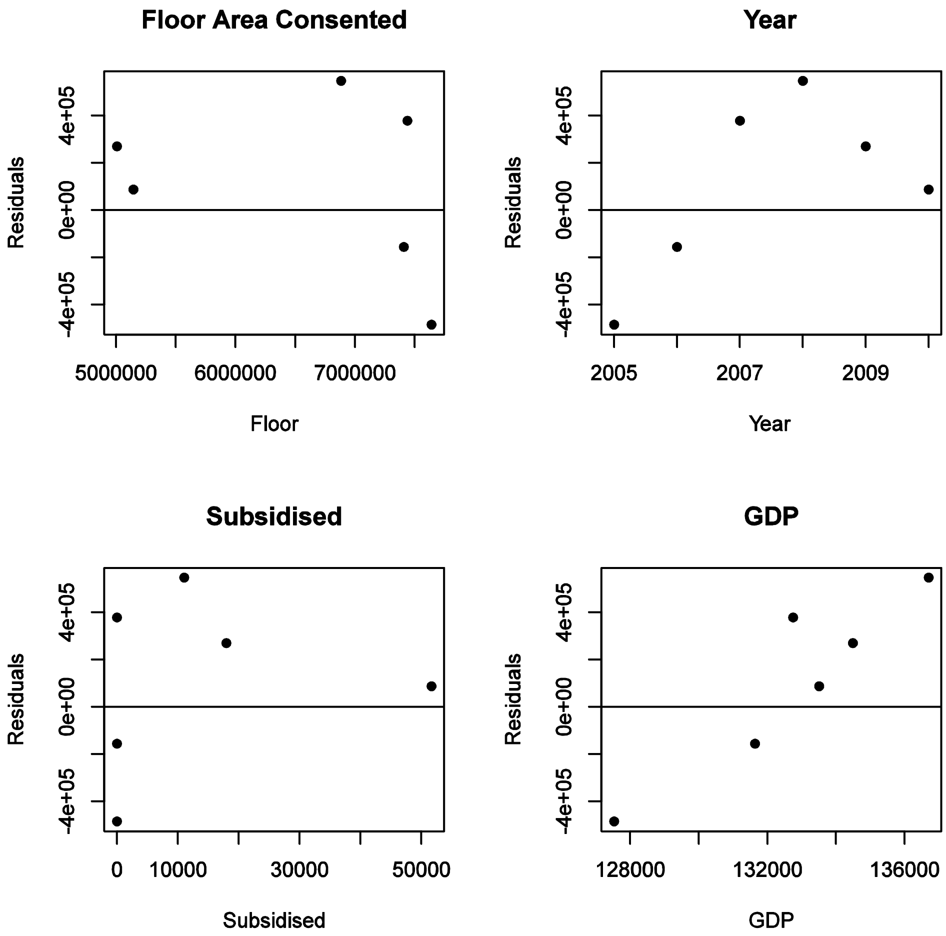
with an AICc of 188.3809. The table of estimates is:

	Value	Std.Error	t-value	p-value
Floor	1.999489	0.04611142	43.36213	<.0001
Subsidised	109.756948	8.61998068	12.73285	0.0002

and $\hat{\rho} = -0.590$.

The residuals are shown in Figure 21.

Figure 21 Residuals from Model 3a (Model 3 with AR(1) errors)



Discussion

This analysis selects the best model from among the available predictors by using the Corrected Akaike Information Criterion.

The best model is Model 2 - independent errors, and only Floor Area and Subsidised Homes as predictors:

$$C_t = \mu + \alpha F_t + \gamma S_t + \varepsilon_t \tag{6}$$

We have tested for correlated errors, but rejected an AR(1) structure using AICc: independent errors give a better fit.

Best estimates for the parameters of the final model are:

Model 2 (Best Model, 2004-2010)					
		Value	Std.Error	p-value	95% CI
α	(Floor Area)	1.909	0.078	<0.0001	(1.708,2.110)
γ	(Subsidised Homes)	127.24	25.73	0.0004	(61.10,193.39)

As part of a sensitivity analysis, we removed the 2004 data point, and found the following estimates:

Model 3 (Best Model, 2005-2010)					
		Value	Std.Error	p-value	95% CI
α	(Floor Area)	2.006	0.029	<0.0001	(1.926,2.086)
γ	(Subsidised Homes)	113.77	8.49	0.0002	(90.20,137.34)