The proposed Healthy Homes Regulations: An assessment

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tailrisk economics
te maha hoki o nga pihikete

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Principal, Ian Harrison (B.C.A. Hons. V.U.W., Master of Public Policy SAIS Johns Hopkins) has worked with the Reserve Bank of New Zealand, the World Bank, the International Monetary Fund and the Bank for International Settlements.

Contact: Ian Harrison – Principal Tailrisk economics

harrisonian52@gmail.com

Phone: 022175366

043848570

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Part one: Introduction

In September 2018 the Ministry of Business, Innovation and Employment (MBIE) released a discussion paper on various proposal to improve the insulation, heating capacity, ventilation, moisture egress and draft proofing properties of rental dwellings. This discussion paper is a response to many of the issues raised in that document. The paper primarily discusses the New Zealand Institute of Economic Research's (NZIER) cost benefit analysis, which provides the quantitative analytical support for the proposals. However, the proposals, and the supporting evidence and discussion have broader implications than just for rental housing, so we first discuss some of the claims made about home heating and health which relate to all home occupants.

It is claimed in many papers and documents that many New Zealand houses, not just rental houses, are 'cold and damp' and that this has material health implications. A key touch point for this assessment is that our homes do not meet the World Health Organisation (WHO) recommendation that indoor spaces be heated to at least 18 degrees Celsius.

It is not altogether clear what the WHO means by a house having an average temperature of 18 degrees. Do they mean that all rooms should be at 18 degrees, 24 hours a day? Or do they mean rooms should be over 18 degrees just when people are in them? On the latter interpretation the temperature in bedrooms should be over 18 degrees through the night, and that livings rooms should be 18 degrees right through the day.

A study by the Building Research Association of New Zealand (BRANZ) found that, during the winter months, average living room and bedroom temperatures were 15.8°C and 14.2°C, respectively, during the day and 13.5°C and 12.6°C, overnight. This looks like there is a 'problem' if the WHO 18 degree standard is a meaningful indicator of health risk. But the living room averages are not very useful because they include significant periods when the room is either not occupied, or when the occupant is active and does not need, or want, a higher temperature. In the evenings the typical average temperature is around 18 degrees. The bedroom nighttime temperatures are indicative of the temperatures people sleep in.

Many New Zealanders would see the idea that they should be targeting 18 degrees right through the day in living rooms as wrong-headed. The idea that rooms should be heated when no one is in them is simply silly. Mostly, New Zealanders do not (excluding the elderly, the sick and children’s' bedrooms) heat their bedrooms right through the night, preferring a lower temperature, and see bedroom heating as mostly wasteful. They know from experience and their approach is not a health risk.

So the first issue we deal with is who is right. Is the typical New Zealand approach of spot heating, and putting on more clothes and bedclothes in winter a sensible, frugal and energy efficient approach, or have New Zealanders been unwittingly running health risks?

To answer this question, in part three we look at the evidence in the WHO report[1] that support an 18 degree target, and a later report by Public Health England, which reviewed all of the relevant literature on the health risk of indoor temperatures

The bulk of this paper reviews the NZIER’s cost benefit analyses of the proposals. In part three we look at their theoretical arguments for intervention. Part four looks at the additional insulation requirement. Part five reviews the heating requirement cost benefit analyses. Where appropriate we adjust the methodology and/or inputs and then present our own cost benefit results. Parts six seven and eight look at the ventilation, moisture egress and draft stopping standards. The final section discusses rent increases and the impact of the Government’s payments to assist the elderly with winter heating expenses.

What is the evidence of a systemic problem?

As noted, it is almost taken as self-evident that if that average indoor temperatures are not at the WHO ‘recommendation’ that there is a problem. No attention has been paid to what tenants actually think. A 2017 BRANZ report on the New Zealand rental sector found that 82 percent of tenants were happy with their accommodation. Of the eighteen percent who were dissatisfied, the largest problem was that the house was too small for their needs. 15 percent said the property was cold and damp. That is, cold and dampness was a problem for 2.7 percent of tenants (18 percent times 15 percent). Of that 2.7 percent it is not clear if the problem was due to the intrinsic

1 WHO, (1987), Health Impact of Low Indoor Temperatures: Report on a WHO meeting Copenhagen 11-14

properties of the house or to tenant behavior. Most houses will be cold and damp if the tenant does not adequately heat and ventilate the property.

Part two: Key Conclusions

World Health Organisation did not recommend a minimum indoor temperature of 18 degrees

The World Health Organisation did **not,** as claimed by MBIE, the NZIER **and** many academics, **r**ecommend a minimum indoor temperature of 18 degrees for the general population. What they did say is that ***No conclusions could be reached on the average indoor ambient temperature below which the health of the general population may be considered endangered.*** There was no evidence at all to support an 18 degree threshold.

New Zealand bedroom heating practices do not present a health risk

There is research evidence that the common New Zealand practice of lightly heating bedrooms is safe for the general population. Winter-weight bedclothes keep people warm. There is no evidence at all that it not safe.

Cold and damp dwellings is not a widespread problem for renters

A comprehensive survey by Building Research Association New Zealand found that only 2.7 percent of tenants thought that their rental was cold and damp. Of that percentage it was not clear what proportion was due to inadequate use of heating and a failure to ventilate by tenants.

Cost benefit outcomes are negative not positive

The NZIER's cost benefit analyses of the proposals were generally 'client friendly'. Key 'unhelpful' documents were sometimes ignored, costs were systematically understated, and unrealistic methodologies were adopted that overstated the net benefits. Our assessments of the net benefits is that they are strongly negative.

- On the most intrusive insulation top-up proposal the benefit cost ratio is 0.39, and the net cost is $270 million. The NZIER's estimates were 1.51 and a net benefit of $130 million. The NZIER assumed that insulation would reduce deaths from the cold, even if renters did not increase the temperature, taking all the benefits through lower heating costs. The NZIER ignored the cost of underfloor insulation altogether.

- Our assessment of the heating requirement for living rooms shows a benefit to cost ratio of 0.38 and a net cost of $418 million The NZIER's estimates were 1.34 and a net gain of $169 million.
- Our estimate of the benefit cost ratio for requiring plug-in electric heaters in bedrooms is 0.12 compared to the NZIER's 0.26. If heat pumps are required in some bedrooms the benefit to cost ratio falls to .04
- There was no field-testing of the draught stopping proposals so the NZIER did not know how they would work in practice. However, they produced a wildly optimistic 'indicative' cost benefit analysis that showed a benefit to cost ratio of 3.36. Our indicative analysis produced a ratio of .02.
- The research evidence shows that underfloor ventilation of just 20 percent of code provides adequate ventilation. Expenditures to upgrade ventilation and to install ground sheeting will be almost entirely a waste of money.

Table one: Summary of capital costs and benefits

	Capital cost $'m	**Net impact $'m**
Insulation topup	410	Loss 269
Living room heating	757	Loss c. 500
Bedroom heatpumps	500	loss c. 480
Draft proofing	c. 300	Limited benefits
Ventilation	c. 200	Very limited benefits
Moisture ingress	c. 300	Benefits not material
Total	C 2400	c. 1900 loss

The above table assumes a 'worst case' scenarios where owners are required to install heat pumps capable achieving a 20 degree target in living-rooms and some bedrooms, ground sheeting is required, and more realistic assumptions about the cost of meeting the various requirements.

Part three: Literature on health effects of low indoor temperatures

The WHO report

The WHO document[2] was a report on a 1985 meeting by the European office of WHOM.

The background was a concern that respiratory diseases were still a problem, despite significant progress on air quality in preceding years, and that the indoor environment could be a driver of bad respiratory health. Thus it was considered useful to review the health impact of low indoor temperatures and recommend some lower limits to protect human health, especially of the very young and the elderly.

However, the review came up with almost no direct evidence that housing temperatures were linked to poor health outcomes for the general population, and certainly nothing to suggest that 18 degrees was a critical threshold. Health impact was rather vaguely defined to mean normal physiological functioning in the absence of stress such as produced by thermal discomfort.

This is not very useful. Thermal discomfort, of course will depend on how much clothing a person is wearing. A person may be uncomfortable wearing a T-shirt and shorts at 16 degrees, but perfectly comfortable when wearing more suitable clothes and if they are active. It is not useful to say that a house is unhealthy because a person has neglected to dress appropriately, and can easily remedy the situation.

Evidence on impact of low temperatures

In the section 'Temperature requirements for health,' which most directly addresses the issue of what is a unhealthy indoor temperature, the only reference to a 'threatening' temperatures is as follows

With air temperature as low as ***6 degrees*** (our emphasis), *cardiovascular reflexes can be initiated by cold air on the face or hands that result in heart rate and blood pressure and consequently in increased cardiovascular strain. Similarly cold air in the respiratory tract damp down the action of cilia that help present airway contaminants from being absorbed by the respiratory mucus.*

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[2] WHO Op. cit.

In the discussion on the impact of cold indoor environments it was found that the old were more affected by very low temperatures, but the impact was minimal at 12 degrees and disappeared at 15 degrees.

And that was the extent of the direct evidence, though there were several inferences and claims in the document that cold houses were still somehow a 'risk'.

Recommendations

The paper recognizes the paucity of evidence in its conclusions and recommendations.

1. *No demonstrated risk between 18-25 degrees*

2. ***No conclusions could be reached on the average indoor ambient temperature below which the health of the general population may be considered endangered*** (our emphasis).

Thus the WHO did **not** recommend a minimum indoor temperature of 18 degrees, and it i**s** misleading for the NZIER and MBIE to say that they did.

The WHO went on to make the following statements about vulnerable groups.

3**.** *For certain groups, such as the sick, the handicapped, the very old and the very young, a minimum air temperature of 20 is recommended.*

4. There is evidence that ambient air temperature below 12 degrees C is a health risk for groups such as the elderly, the sick, the handicapped and preschool children.

Thus there was no evidence to support the 20 degree recommendation, but there was evidence that a lower threshold would suffice. 12 degrees is a lot lower than 20 degrees.

5. At air temperatures below 16 degrees relative humidity above 65% imposes additional hazards

6**.** *It should be recognized that the elderly and the very young may be at special risk when bedroom temperatures are low at night*.

This is not wrong, but it does depend on what is meant by 'low', and without that qualification is not a very meaningful statement.

So the only substantive recommendation is that the bedroom heater should be turned on for the very elderly, the sick and very young, on cold nights. Most people know this. To the extent that they don't, it is arguably, a case for public education, or a matter between doctors and their patients. It does not justify spending large amounts of money trying to heat every house beyond the level people are comfortable with.

Public Health England literature review

The second document is *Minimum home temperature thresholds for health in winter – A systematic literature review* from Public Health England (PHE), which was published in 2014.

The WHO paper was dated in terms of the literature considered, so the objective was to review all of the relevant literature on the impact of indoor temperature thresholds and their impact on human health.

The 20 papers reviewed were divided between: the general population, the elderly, the chronically ill, and children. The first category is the most relevant for this discussion. There were 8 papers, but one included the elderly, who would have dominated the results, so we have excluded it from our review.

Readers who wish to skip the technical details can accept our assessment that there was nothing in the papers to support an 18 degree threshold for the general population. One paper refuted the idea that not heating bedrooms at night poses a health risk in the New Zealand context. The reason we have set out the technical detail is so general readers can see for themselves just how flimsy the evidence on the impact of 'low' indoor temperatures in the 'literature' really is.

The papers

1. Influence of room heating on ambulatory pressure in winter 2013[3]

This was a randomized controlled trial comparing the impact of temperatures of 22 degrees and 12 degrees on 18-60 year olds. Blood pressure was found to be lower for those exposed to the higher heat in the mornings. However, there was no statistically significant difference in nighttime blood pressure between those exposed to 22 degree and 12 degree temperatures. The authors suggested that this was due to increased use of bedclothes and blankets when the temperature was low.

This is the only study relevant to the question of whether there is a health risk from

[3] *Saeki, K., Obayashi, K, Iwamoto, J., Tanaka, Y., Tanaka, N., Takata, S., Kubo, H., Okamoto, N. Tomioka, K., Nezu, S., Kurumatani, N., 2013. Influence of room heating on ambulatory pressure in winter: a randomised controlled study.*

low bedroom temperatures, and it appears to show that there is no, or very low risk, because people keep comfortably warm by using heavier bedclothes and/or nightclothes.

The conclusion that can be drawn here is that the average New Zealander is right in believing that not heating their bedroom overnight, in typical winter temperatures, is healthy and safe. The bureaucrats and academics are wrong.

2.The contribution of environmental temperature and humidity to geographical variations in blood pressure UK 1991[4]
The authors concluded that there was no relationship between room temperature and regional variations in blood pressure.

3. Contribution to obesity[5]
There is a small, inconclusive, literature on whether low indoor temperatures contribute to obesity. One theory is that cold people overeat for comfort. The other is that warmth has a positive association with obesity because less energy is used to keep warm. This paper makes the makes the latter claim.

As no one in New Zealand seems to be suggesting that obesity in New Zealand is connected to indoor temperatures this study is not relevant for this discussion.

4. Habituation to the cold[6]
This was a clinical study of 6 males that found that the subjects got used to feeling cold. They were subject to 30 minutes at 27-28 degrees and then 120 minutes at 10 degrees on 11 consecutive days. They were wearing shorts.

This is consistent with everyday experience. People returning from a tropical holiday will feel colder than usual when they get back, but they soon re-acclimatise. The relevance of this result is that it is difficult to make general recommendations about appropriate indoor temperatures. Different people have different responses to the cold, depending on what they have become use to.

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[4] *Bruce, N., Elford, J. Wannameth ee, G. Shaper, A. G., 1991*

[5] Contributors to the obesity and hyperglycaemia epidemics. A prospective study in a population based cohort.

[6] *Leppäluoto, J Korhonen, I Hassi, J., 2001: Habituation of thermal sensations, skin temperatures and norepinephrine in men exposed to cold air.*

5. The effect of short-term cold exposure on risk factors for cardiovascular disease[7]
This was a clinical study of 11 healthy men in their mid 20s. It found that being exposed to 11 degrees wearing while wearing shorts had physiological effects. Its relevance to the indoor temperature debate is about nil. Not many people sit in their houses in shorts at 11 degrees.

6. Cold induced increases in erythrocyte count, plasma cholesterol and plasma fibrinogen of elderly people without a comparable rise in Protein C or Factor X[8]
12 volunteers were exposed in a laboratory settings exposed to 22 degrees with blankets, and then 18 degrees with no blankets. There were physiological effects, but again the significance of artificially exposing people to rapid changes in temperatures to the temperature threshold issue is not obvious.

7. Comparisons of blood and urinary responses to cold exposures in young and older men and women[9]
This study exposed subjects to short term temperatures of 10, 15, 20 and 28 degrees in minimal clothing. There were physiological effects at the lower temperatures.

And that was it on the evidence base. There is nothing here that provides evidence that appropriately dressed people are at risk it the temperature is below 18 degrees, or at the kinds of temperatures that New Zealand homes are heated to.

Evidence on the elderly, chronic illnesses and children
With respect to the elderly, chronic illnesses and children we present the PHE paper's summary for information. Again there is only a limited amount of information here.

These findings (general population) are also likely to be applicable to older people. When the effects of cold in older people were compared with those in younger people, the studies showed in general that the changes in outcomes such as blood pressure, clotting factors, cholesterol and in core and skin temperature were more profound, with slower recovery, in older people. Several studies also demonstrated reduced thermoregulatory control and thermal perception/discrimination with ageing.

For people with chronic illnesses, there was only very limited information on the effects of specific cold indoor temperature thresholds. Among older adults with chronic obstructive pulmonary disease, better respiratory symptom score was associated with more hours of indoor warmth (at least nine hours) at and above 21°C in the living room. Nights with bedroom temperatures of at least 9 hours at 18°C showed a trend to association (P = 0.04). However the

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7 *Mercer, J.B., Osterud, B. Tveita, T., 1999*

8 Neild, P.J. Syndercomb e-Court, D. Keatinge, W.R. Donaldson, G.C. Mattock, M., Caunce, M., 1994

9 Wagner, J. A., Horvath, S. M. Kitagawa, K., Bolduan, N. W., 1987:

choice of these thresholds was based on existing temperature guidance, and it is not clear if other (lower) temperature thresholds might have also demonstrated health benefits.

For children, the literature suggests that there are small, and sometimes statistically significant effects on children's respiratory health from increased indoor temperatures due to heating and energy efficiency interventions, but there is insufficient evidence available on the impact of specific indoor temperature thresholds.

Excess winter mortality

One of the drivers behind the view that poor housing conditions are a health problem in New Zealand is the phenomenon of 'excess' winter mortality. Death rates are higher in winter than in the rest of the year. Every country has 'excess' winter mortality, but it is argued that because this is higher in New Zealand that in some overseas countries, it is possible that the poor insulation and insufficient heating explain this. Excess winter mortality in New Zealand was studied by Davis et al. [10]. They found that 'excess' mortality was slightly higher in New Zealand than in a comparator group of 19 countries (1.18 compared to 1.16), but it appeared to only a material, and statistically robust factor for aged.

However, it is a big step to conclude a significant driver of New Zealand's higher excess mortality rate is poor housing. There are other explanations. First, New Zealand does not have an 'excess summer heat' mortality problem. Many countries with continental climates do. These countries will show a lower excess mortality ratio figure than New Zealand, (even with the same incidence of winter mortality as in New Zealand) because the summer weather related 'excess mortality' effect reduces the measured winter excess mortality figure.

Second, because New Zealand has a relatively benign winter climate, New Zealanders might tend to spend more time outside in winter, than in colder climates. This could explain part of the winter effect. There is some evidence to support this. In the WHO report there is reference to a paper on mortality rates and temperature in rest homes. One explanation for the higher than expected mortality in one rest home was that the occupants were allowed to go outside in winter.

Third, there is a distinction between the house, and the behavior of the occupant. There is a culture in New Zealand of frugality in the use of heating. Nearly all houses have the capacity (access to electricity at least) to allow tenants to reach comfortable

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. [10] Davie GS, Baker MG, Hales S and Carlin JB (2007) Trends and determinants of excess winter mortality in New Zealand: 1980- 2000; *BMC Public Health* 2007, 7:263.

temperatures if they choose to. Some don't, either because they want to spend a limited budget on other things, or because they simply don't like spending money on heating. Another occupant in an identical house will heat to a 'healthy' level, so it can be a mistake to identify the house as the source of the 'problem'. In Europe a higher percentage of the vulnerable elderly live in apartments which have area or building heating, so even if they were inclined to under heat if they were they were in their own independent property, they can't in an apartment building.

Part four: The NZIER cost benefit analysis: The conceptual arguments for intervention

The NZIER was provided with an early draft of this paper. This gave them an opportunity to clarify points that we may have misunderstood and to respond to issues we had raised.

The main justification for a policy intervention was couched in terms of a market failure because there is a 'split incentive' problem. The NZIER says

There is a well-documented market failure in energy efficiency provision in rental properties caused by split incentives between landlord and tenants: for example, tenants have little incentive to invest in improvements that need to be fixed to the building (such as insulation, fixed heating and draught stopping), and landlords also have little incentive to invest in these changes that are of most apparent benefit to tenants.

The substance of the argument is that a tenant wants a warmer home (and would be prepared to pay for it), but does not have a ability to do the necessary changes (because this would require the landlords consent), nor an incentive to pay for the capital improvement (thicker insulation, more efficient and higher capacity heater, etc.) because they will not necessarily be in the property to secure the benefits. The landlord on the other hand does not benefit from the improved heating performance, so they will not invest.

The NZIER claims that the split incentive problem is "well documented". This is not supported by any references, although there is some literature on the subject. However, the NZIER ignores the alternative view that the split incentive problem, is overstated, at least in New Zealand. Providing the costs can be recovered through a higher rent a rental property owner would invest, as the improvements are attractive to potential tenants. In some countries it may not be possible to increase rents so a split incentive problem does arise. An OECD paper[11] on the issue reported that in Germany the split incentive problem was mitigated when owners were able to recover energy efficiency expenditures though rent increases.

If market rents are free to adjust then the problem becomes one of information asymmetry - the lack of tenant information; or the tenant's unwillingness or incapacity to act in their own best interests. The information asymmetry problem largely arises because the owner cannot easily convey heating efficiency information to prospective tenants, so the investment would be wasted, and the owner does not make the investment.

Whether this is a major problem is an empirical question, but in recent years as tenants' understanding and interest energy efficiency has improved, the demand for more energy efficienct housing has increased, and owners have responded to this. When the requirement to insulate tenanted dwellings was introduced, MBIE noted that the majority of rental housing already had ceiling insulation. Most did not have unfloor insulation, but there was a rational reason for this. Only about 10 percent of heat is lost through the floor and informed landlords and tenants would understand that underfloor insulation is not a cost effective way of keep a housing warm.

The spit incentive argument, if applied to the requirement for owners to provide plug-in electric heaters is, of course, a nonsense. Tenants can take their heater with them when they leave.

The fact that many tenants do not demand warmer houses, or heat their property to the WHO 'standard', does not initself indicate a problem. Rental houses have many attributes: location, aspect to the sun in winter, size, style, energy efficiency and importantly, the rent. It is well known that older houses are harder to heat, but they may be chosen anyway, because they are cheaper or better located. The tenant can then choose to spend more on heating (reducing some of the rent advanatage), or simply accept a colder house, secure in the knowledge, that they are not in a 'vulnerable' group, and that a strategy of wearing more clothes and using a winter weight duvet, presents no risk to their health.

Some tenants will find, after living in the property, that they have made a mistake and that the house is colder and more expensive to heat than they thought. They could contract with the landlord to provide thicker insulation and/or a heat pump in exchange for a higher rent. Or eventually they could move to a more suitable house, which is a viable oprion for many, because tenants tend to move relatively frequently.

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11 Determinants of Households' Investment in Energy Efficiency and Renewables
Evidence from the OECD Survey on Household Environmental Behaviour and Attitudes

That leaves us with, probably, a small minority who do not act in their own best interests. The issue is whether it is efficient to impose higher standards on every one to 'help' this group, particuarly when there is a limit to what the regualtion can do. Passive measures can only go so far, if people do not use the heater.

A further argument for intervention relates to other externalities.

This (low temperatures) result can be sub-optimal from a national perspective if there are significant externalities not accounted for in the decisions made by landlords and tenants, such as impacts on public health services or on the wider environment from insufficiently warm and dry houses. Setting basic requirements for insulation, heating, ventilation and moisture removal could address those market failures, if they can be implemented at reasonable cost. This report examines whether introducing standards would create national benefits in excess of their costs of implementation.

The NZIER's analysis shows that the global warming externalties are trivial. There are some health related extenalities, as the government pays for some of the health related costs. These are not explicitly calculated by the NZIER, being embedded in the larger health cost estimate, but it also turns out these are small and would not justify the interventions.

Part five: The Insulation standard

The NZIER considers two options beyond the status quo and two variants for each, with a high and low number of buildings affected for each option.

To simplify our discussion of the NZIER's methodology we have focused on just the option with the highest number of buildings affected - 190,000. The NZIER model works more of less the same, regardless of the scale of the intervention, so focusing on just one outcome does not miss any important points.

Discussion of assumptions

The key assumption in the analysis is that tenants maintain the temperature of their house, and take the benefits of higher insulation though a savings in energy costs.

Mortality benefits

Mortality benefits (a reduction in the number of deaths) are assumed to arise simply because the houses have been insulated, even if there is, by assumption no increase in indoor temperatures.

This is simply wrong. Insulation in itself does not in itself save lives. It is not a pill. It is the increase in temperature that generates any health benefits. If temperature is assumed not to change, then there should be no reduced mortality benefit. The NZIER assumes that there will be no other health benefits because the temperature has not increased, so there is no reason why mortality benefits should have been treated differently. The NZIER had the opportunity to respond on this key point, but did not.

We have removed the mortality benefit from our assessment.

The NZIER does not explain why they have assumed that all of the benefits of insulation are taken through lower energy costs. That is not what happened in the Warmup New Zealand (WUNZ) insulation campaign, and it would reasonable to assume that much of the benefit would be taken interms of higher temperatures. We suspect that one reason is that the NZIER understood that if temperature was assumed to increase then they would have to lower the benefits for the other interventions because, as they correctly acknowleged, the marginal benefits will fall as the temperature increases.

Cost of insulation

The cost of insulation, at $1338 per household was the Energy Efficiency and Conservation Authority's estimate of the average ceiling top up cost in the WarmUp New Zealand programme. This assessment is now old, and should have been increased, say, by the consumer price index, for subsequent price movements. We have assumed a 15 percent price increase.

Second, this is a price just for ceiling insulation. Our understanding is that an underfloor insulation top up could also be required, with an additional cost. The calculations for ceiling and underfloor insulation should have been done separately. They are clearly distinct interventions, with different payffs in terms of energy savings. The heat loss through the ceiling is typically put at three to four times the loss through the floor.

The difference between ceiling and underfloor insulation was not assessed when the current insulation requirements were being considered, though it obviously should have been. It would be also be useful to the general public to be provided with information on the savings from putting in underfloor insulation, when they already have ceiling insulation, so they can make an informed choice on the matter.

The NZIER's response was that they were directed by MBIE not to consider underfloor insulation. As energy saving benefits will be relatively slight, and the capital costs relatively high (we understand that the costs of topping up underfloor insulation is not much different from providing new uprated insulation), the costs are likely to be significantly greater that the benefits. The omission of underfloor insulation will materially overstate the net benefits of the insulation requirement.

Absent further information it is difficult to adjust for this omission. However, to illustrate a possible impact we have assumed that 100,000 properties are affected at a cost of $1500 each for a total cost of $150 million. We have assumed that the marginal energy savings would be immaterial.

Discount rate
The discount rate of four percent is lower that the Treasury's recommendation of six percent. The Treasury rate should be used, unless there is a good argument for using a four percent discount rate. A six percent rate reduces the benefits by around 17 percent. We have adjusted the benefits by that amount.

Energy savings
The present value of the estimated energy savings is $161 million. Without a detailed understanding of the Energy efficiency and Conservation Authorities model we cannot assess whether this is too high. However the only available evidence suggests that it might be. In 2018 MBIE presented with the Minister with a graph that showed the relationship between the thickness of insulation and the amount of heat loss through ceilings. It showed that the 1979 standard of R1.9 accounted for more than 80 percent of the possible reduction in heat loss through insulation compared to an uninsulated building. The effect of topping-up to the latest standard is to reduce the heat loss by less than another 10 percentage points.

As ceilings account for about 40 percent of heat loss in the typical house, the effect of the top-up would be to decrease energy consumption by only four percent. Most homeowners would notice little change in their winter heating bills. While the NZIER's energy savings could be substantially overstated we have not made an explicit adjustment for this factor in our cost benefit assessment.

Summary of changes

- Mortality benefits removed
- Insulation costs increased by 15 percent
- Underfloor top up costs of $150 million added.
- Discount rate of six percent reduces present value of benefits by 17 percent

The NZIER and our results are set out in table 2.

Table 2: insulation ceiling top-up costs and benefits

	NZIER	Tailrisk analysis
Number of properties	190,000	190,000
Benefits $'m		
Reduced costs from ill health (mortality)	213.7	0
Reduction in energy costs	161.1	151.7
Better environment	2.8	2.3
Producer surplus	8.2	7.0
Total benefits	384.8	161.0
Capital costs	254.7	410.2
Net benefit	130.3	-269.2
Benefit cost ratio	**1.51**	**0.39**

Our results are very different from the NZIER's. There is a negative present value of $269 milion compared to a positive $130 million. The benefit cost ratio falls from 1.51 to 0.39. The main reasons for the difference are that we have removed the NZIER's counting of mortality benefits, which cannot be generated if the temperature has not changed; and second have accounted for underfloor top up insulation.

Part six: The heating standards

Description of the NZIER analysis

Under Option 2 owners must provide efficient heating devices to be able to achieve an indoor temperature of at least 18 degrees in rooms covered by the heating standard, at a reasonable cost to operate. They may need to supplement or replace any existing heating devices that do not have sufficient capacity to heat the room to 18C, but owners and tenants are not required to *maintain* this indoor temperature.

Option 3 requires owners to provide efficient heating capacity to be able to achieve 20 degrees in any areas covered by the heating standard at a reasonable cost to operate.

These general requirements can be interpreted in a number of ways, so the NZIER has made the assumption that the following will be required.

Plug-in heaters will be required in bedrooms. They note that the regulations might require heat pumps in larger bedrooms, but as they didn't have information on the number of large bedrooms, it was assumed that only plug-in heaters will be required.

Although the NZIER did not have good information on the number of larger bedrooms, they could still have conducted a cost benefit analysis,for a single bedroom, which could then have been scaled by an estimate of the number of bedrooms affected to give a sense of the size of the net benefits or costs. The NZIER presumably does not have any information on the distribution of the size of livingrooms, which affects the number of properties affected, but they did not have any problem there. As the net benefits of requiring heatpumps would have been strongly negative, they probably, neglected to do the bedroom heatpump analysis on instruction from MBIE.

For this assessment we first replicate the NZIER assumption that all bedrooms heaters are plug-ins, but we also comment on a policy of requiring heat pumps in some bedrooms.

All new heaters in living rooms are assumed to be heat pumps. Some properties will already have a heat pump or other 'compliant' heater such as a wood burner, or the living room will be small enough that a heat pump is not required. The NZIER estimated that 179,000 heat pumps would be required under option two, and 285000 under option three. Under both options it is assumed that 50 percent of occupants will pursue the temperature targets once provided with the heaters. This assumption requires some interpretation. We have assumed that what they mean here is that 50 percent of occupants will maintain their current temperature and use their heat pumps to save on heating costs. There will be no health benefits, so all of the benefits will come from lower heating costs. They will not ignore the heatpump altogether.

The other 50 percent will pursue the 18 degree target thereby securing possible health benefits. On the energy side there will be a savings on the energy required to meet their current temperature level, with an offset of the additional energy required to meet the 18 degree target.

A problem in deciding whether a heat pump is 'necessary' is that the requirement that a heater be capable of heating to 18 degrees is insufficient. It does not say what the ambient temperature is or how quickly that temperature must be reached. A requirement that 18 degrees must be reached from a starting point of 0 degrees in 10 minutes, is quite different from a starting point of 10 degrees in 45 minutes. We have tested a 2.4 kilowatt heater on the latter standard, in 20 square metre room an older home with limited insulation and found that in easily met the test. But it might fail to meet a tougher test. The NZIER is not clear on what test they have applied and how this impacts on the number of affected properties. In their discussion they say that plug-in heaters are sufficent up to 20 square metres, but this appears to conflict with the MBIE discussion document which appears to set an average limit of around 13 metres based on the EECA model.

The other requirement is that the heater has a 'reasonable' cost to operate. This is a largely meaningless statement. What is a 'reasonable' cost to operate?

Health and mortality savings

The health and mortality savings are generated from the Warmup New Zealand study of the costs and benefits of that programme as follows.

To quantify the benefits we use estimates of health benefits from the WUNZ to help determine the health benefits of raising the indoor temperatures of dwellings. Although the WUNZ study did not estimate the resulting increase in indoor temperatures from installing insulation, we infer what this temperature rise might have been by using the EECA AccuRate dataset.

We obtain an annual health benefit of around $125 ($124.78) per "average" household as shown in the table below. If we assume these houses, on average, increased the indoor temperature by 1.5°C, then the benefit per degree is about $86 ($85.79) per year. This "per degree Celsius" estimate is a simple point estimate that must be used with caution, as a one degree increase from 20°C will have far less benefit than a one degree increase from 15°C. Sensitivity analysis tests the robustness of the CBA to changes in the assumed benefit values.

It was assumed that the health benefits per degree of temperature increase do **not** change as temperature increases (at least over the relevant temperature range of up to 20 degrees considered in the paper).

Cost assumptions

The cost assumptions are described as follows.

Notwithstanding heat pump warranties commonly in the range of 4-6 years, we assume 15 years as the lifespan of a heat pump, in line with BRANZ SR329 Heat Pump study (2015) which recorded some models still operating after more than 20 years, and other sources suggesting 15 years as an average We assume an annual maintenance cost for heat pumps of a minimum of $20 and maximum of $100 falling initially on the landlord. The BRANZ SR329 reports that over 70% of owners do maintenance themselves and many others do no maintenance at all or *are put off by commercial quotes of $75-$105 per heat if pumps are maintained by the occupants or owners there is an opportunity cost for their time and a longer term expected cost for repairs or maintenance to interior or exterior units, which means the economic cost of maintenance is not zero.*

Assessment of option two: Livingroom heaters

Comments on the assumptions

Plug-in heaters in living rooms

The option of using more than one plug-in heater in living rooms was not considered. It is argued that this is not an option because it would risk overloading electric circuits, which poses a safety issue. This is wrong. An electric circuit will automatically cut out if it is overloaded so there is no safety issue, although it is possible that two large heaters will not work. In any event, many larger living areas will include the lounge, dining area and kitchen, which will often have more than one circuit, so using two heaters will work.

MBIE are proposing to put plug-in heaters in every bedroom. The load on circuits will depending on the wiring configuration in the house, but often there will be a single power circuit servicing the bedrooms so here may be three plug-in heaters on the bedrooms' circuit. Three heaters won't work on the same circuit so some owners might be faced with the cost of a rewiring job, which has not been considered in the NZIER assessment.

The other argument against the use of plug-in heaters in living rooms is that they pose a 'safety' risk because people might trip over them. Apparently, there is no risk that people will trip over plug-in heater cords in dark bedrooms.

Health benefits assumed to increase linearly with temperature increases

The WUNZ based health savings estimate were generated by the impact on insulation on indoor temperatures. However, once the house was insulated (as they are presently required to be) we would expect the marginal benefit from a further temperature increase to fall. This is what the WUNZ study on the impact of installing heatpumps in insulated houses showed. There only very small health benefit. The NZIER notes this outcome and admits the falling marginal benefit effect in principle, but they ignore it. They explain

*We apply this (*the fixed benefit per degree assumption*) to houses receiving new insulation and new heating, as it appears unlikely that heating would have zero effect.*

This is not a reasonable approach. There is a difference between having a ***zero*** effect and having the **same** marginal effect as the initial increase from a lower temperature when a house is insulated.

The NZIER cited two studies that might suggest that installing heat pumps in insulated houses might have some positive effect.

When schemes have installed new heaters they are operated for longer and increase average winter-time living room and bedroom temperatures by 2.3^{O}C and 1.3^{O}C, respectively compared to houses with old heaters.[12] Replacing old heaters with clean heating devices raised average winter temperatures by 1.1^{O}C in living rooms and 0.57^{O}C in bedrooms, resulting in reduced symptoms of asthma in the children and 1.8 fewer days off school compared to other families without new heating.[13]

The first paper (Boulie et al.) is was a very small scale study (only 12 homes had heat pumps installed) that compares the treated group with a control group that mainly used unflued gas heaters (UFGH). The heatpump group did operate the heat pumps for longer and had higher temperatures, but there was no assessment of the health effects. Interestingly, the household with the longest heater use and highest temperature was a control group household that used plug-in electric heaters.

The study demonstrated that the cause of low temperatures in house where UFGHs were used was not heater capacity. Rather it was because households used these heaters very sparingly, running them for short periods and then mostly on the low to medium settings. If they were used on high for longer, higher temperatures could have been reached. [14]

The second study was much larger (over 400 households), and compared the behavior of mostly lower income households, all with children who has been diagnosed with asthma. Nearly 60 percent of the control group, had unflued gas heaters. It showed

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[12] Boulic,M, Fjallstrom P, Phipps R, Cunningham M, Cleland D, Howden-Chapman P, Chapman R & Viggers H (2007) "Cold homes in New Zealand – Low Heater Capacity or Low Heater Use?

[13] Howden-Chapman P et al (2008) Effects of improved home heating on asthma in community dwelling children: randomised controlled trial; BMJ 2008;337:a1411

[14] At first sight the use of UFGHs seems irrational. UFGHs are thought to have health issues, and typically cost 50 percent more than using a plug in electric heater. One reason they are used is that some people like them. They can get an intense heat close to the heater, and the gas flame is comforting. People like to see things burn. The second reason is that UFGHs are used as a form of budgeting. The heat is prepaid, and used sparingly to avoid running out, so the budget is controlled. A heat pump does not provide that control and there is the risk of a nasty shock when the electricity bill arrives. One of the shortcomings of the study is that it did not compare energy bills. While heatpump use was high while households were being monitored (when there is pressure to use a heatpump that was provided free) it might drop off later after a succession of high electricity bills. Caution should be used when using experimental studies to inform understand understanding of how the general renting population might behave. While people might use heat pumps when they have been given it and they are the centre of attention, the general population might be more inclined to continue with their old ways.

that there was no statistically significant improvement in the children's lung function, but an improvement in reported health and small improvements in school absences and doctors visits.

This study does not providing very compelling evidence that there are health benefits for the general rental population from using heatpumps. As noted, it was restricted to a small sector of the occupant population who had children with asthma, and then only to those who were located in the colder parts of New Zealand (Wellington and cities to the South).

If the NZIER wished to account for the benefits to this vulnerable group it could have quantified the benefits from this study, making some assumptions about the number of households affected on a New Zealand wide basis. This would not have produced a vey high figure.

To account for the declining health benefits with higher temperatures we have applied a 50 percent reduction to the NZIER benefits of heatpumps with a target of 18 degrees.

Reduced cost of ill health
As the NZIER health benefits are derived from the WUNZ estimates of the benefits of insulation it is necessary to examine the robustness of those estimates.

There are two contributing studies to the WUNZ estimates. The first considered - hospital and pharmaceutical costs. The study found that insulation had **no** effect on the number of hospital visits, but it was claimed that the average cost per visit was higher without insulation.

It is difficult to have confidence in the per visit hospital cost estimates, as they appear to generate some perverse results. The average cost savings per household for all conditions is about $5 per month, but the average costs for individual illnesses was higher than this, and the aggregate cost of the individual illnesses much higher. Logically the individual illness cost should roughly add to the all conditions costs. It appears that hospital costs per treatment were not directly obtained from patient records but had been modeled in some way. The authors of the study, noted the issue of the inconsistency in the results, but said that it was probably due to some noise in the data, which wouldn't affect the results. Our view is that there must be something wrong with the modeling and the results shouldn't be used, or used with great caution, unless the problem is fixed.

There is also a possibility that the higher health cost, if it were real, was the result of behavioral differences in the insulating and non-insulating populations that was not controlled for in the analysis. This was not a controlled randomized trial so there was a risk that behavioral biases could creep in. The insulators might be more inclined to deal with a problem early (hence they were choosing to insulate), while the non-insulators tend to let things ride. If they get sick, by the time they do get to hospital the condition is more serious and expensive. Thus there is a correlation with insulation but there is no causation. Mandatory fitting of heatpumps will not fix a procrastination problem.

A later paper (2018) calculated hospital costs for just the rental properties in the WUNZ study. It also found that insulation had no impact on the number of hospital visits but that the average health cost savings was about 10 percent lower than the full sample. The NZIER should have, but did not, use this result. We have adjusted the NZIER estimate by this amount.

The WUNZ study did find that there was a savings in pharamaceutical costs, and the numbers appear robust but the savings was small.

The second source of information on health costs was an earlier randomised trial which compared insulated and uninsulated rental houses of tenants with children with asthma. The outcomes which were quantified (doctors visits, days off school and work), were primarily derived from participant questionaires.

It is well known there is a potential for positive bias in this approach because participants, consciously ,or unconsciously, shade their answers to what they think the trial managers want. As a check on this the study did some objective tests. They found that the number of doctors visits actually went up, not down as reported by participants, and that there was an immaterial reduction in the presence of mold, not a significant reduction as reported.

At this point the researchers could have drawn the conclusion that all of the questionaire information was unreliable. If you cannot trust the responses on doctor visits, why should the days off school and work , which drove the cost savings estimte, be reliable? But they did not do that (understandibly, perhaps, given the enormous amount of work that had gone into the project). Instead the increase in doctors visits was treated as a negtive benefit and the benefits from fewer school and work days lost were counted.

The other issue is how to apply the numbers to the general tenant population. Households with asthmatic children and obviously much more vulnerable than the general renting population, but only constitute a small proportion of that population.

Many flat dwellers do not have children, let alone asthmatic children. The WUNZ analysis attempts to account for this by reducing their benefit estimate by 50 percent. As the share of asthmatic rental households is much lower than this, and there is no evidence that insulation benefits the health general population, we think that this reduction is too low.

So if the health benefit data used is so fragile, what do we make of the number used by NZIER. One approach, if you believe that insulation must have had some effect, would be to reduce the reported WUNZ numbers. We have imposed a further 50 percent reduction, which still provides a generous allowance, given the evidence.

The value of an avoided death

The NZIER took issue with the WUNZ estimate of the value of a life year saved. Their best estimate is one third of the WUNZ number. However, in the interests of 'consistency' the WUNZ estimate was used in the headline numbers. The one-third numbers only appear in the sensitivity assessment, where it is unlikely to receive much attention.

An important driver of the WUNZ value of a life saved estimate, which the NZIER didn't consider, was the assumption that five years of life would be saved. This was calculated to be half the live expectancy of a healthy person in the relevant age group. This is arguable. If a relatively small difference in the indoor temperature makes the difference between life and death, then the person's health was probably quite fragile to begin with, and the life expectancy short. We don't have a better suggestion to present here, but the issue adds another uncertainty to the value of life saved estimate.

It is important to understand that the WUNZ mortality estimate was based on life savings for just one small group: old people with an existing circulatory (heart) condition, who were less than 3 percent of the study population. This result was barely statistically significant. If there had been one less life saved then the authors would have had to conclude that there were no mortality benefit.

There is no direct evidence in this study, or anywhere else, that there is a mortality benefit for the rest of the population. Indeed the WUNZ study found, amongst the elderly with a preexisting respiratory conditions, installing insulation was associated with an **increase** in mortality (though the effect was not statistically significant).

We think that the NZIER's mortality assessment is better than the WUNZ estimate, particularly having regard for uncertainties about the robustness of the WUNZ numbers. We have used the NZIER estimate as the starting point in our calculation.

The significance of the mortality benefits being concentrated amongst a small group is that the WUNZ numbers can only be used if the demographic composition of renters is the same as the general population. That is not the case. Renters tend to be younger than owner-occupiers. We do not have numbers on the respective shares of the elderly in the private renter and owner-occupier populations but we have reduced the mortality numbers by 20 percent to account for some of the compositional difference.

Energy cost savings with heat pumps

The major benefit (with a net present value of $476 million) from the introduction of heat pumps is the net savings in electricity costs, because heat pumps are cheaper to run that plug-in electric heaters. The tenant would use more electricity to meet the 18 degree temperature target, but this would be more than offset by savings on their current spending on electricity to meet their current temperature target.

It appears that the these savings have been significantly overstated.

One of the massages from the 2015 BRANZ heat pump study[15] *was that heat pumps did* ***not*** *save most people much money.*

Compared to other electrical appliances used for space heating, heat pumps use electricity more efficiently than other domestic electricity-based heating appliances. This does not mean, however, that using heat pumps necessarily reduces the annual electricity consumption used for heating New Zealand dwellings. Nor does it necessarily mean that households using heat pumps will find their overall electricity consumption, or even their electricity for heating, has decreased or their heating expenditure lessened. Among the heat pump dwellings, the average electricity use by heat pumps alone is ***36% higher*** (our emphasis) *than all the electricity use for heating found in the HEEP study.*

Householders give mixed views around the impact of heat pumps on household energy costs. Of the 128 householders that discussed that aspect of their heat pump operation, 44 householders reported that their energy costs had increased since acquiring a heat pump. Of that same group 37 householders reported a decrease in energy costs. A considerable number reported that they simply did not know, and 26 householders said that their energy costs stayed the same.

The NZIER estimate of a $476 million saving does not square with these results.

The BRANZ study is obviously one of the 'go to' papers for any assessment of the costs and benefits of requiring heatpump installation. The NZIER did not reference the paper, still less explain the difference from its own estimates.

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15 BRANZ (2015) Heat pumps in New Zealand

One part of the energy cost savings calculation is the assumed efficiency of heat pumps. Their relative efficiency is frequently cited as three (so the cost of electricity for heat pumps is one third of that of a plug-in heater) but these estimates are based on laboratory estimates. The BRANZ report says that in real world conditions the efficiency advantage is more like two. We asked the NZIER which factor was used. The response was that they didn't know, but would get back to us with the answer. They didn't.

In a figure in the MBIE consultation paper heat pump energy costs are one third of electric heater costs so it appears that an efficiency factor of three was used in the NZIER analysis. Absent further advice on this matter we have assumed that a factor of three was used and have adjusted the NZIER's energy savings estimates using a factor of two.

The other reason why heatpumps might be more costly is that they have to do more heating to provide the same degree of comfort. A radiant heater can provide higher heat in its immediate vicinity without having to heat the entire room to the same extent. With the heatpump the whole room has to be heated. This is requires more energy which is essentially wasted. Put another way a radiant electric heater allows for more efficient spot heating.

To take account of the efficiency factor effect and the spot heating effect we have reduced the NZIER's estimate of the energy saving by 50 percent.

Cost of heat pumps

The assumed cost of heat purchasing and supplying a heat pump is $2826. However in tables 8 and 9 the average costs are $2548, and $1900 respectively for the 18 degree and 20 degree targets. The difference is not explained explicitly. The 18 degree figure reflects a staged approach to the introduction of the regime, so the average present value of the costs are lower. However, this doesn't explain the $1900 number, which appears still is too low. We considered the possibility that smaller, and cheaper heat pumps were installed in the additional properties caught by the higher temperature requirement. But that didn't work. The smaller heat pumps would have to cost between $1000 and $1100, which isn't possible In addition the higher target would sometimes require the purchase of some higher capacity heaters, in the properties captured by the 18 degree requirement, which would add to costs.

An additional issue is that no account has been taken of the time cost to owners of purchasing and arranging for the installation of the heat pumps.

We have used a figure of $2648, which allows for a staggered introduction at the 18 degree target rate and $100 of transaction costs, for both the 18 degree and 20 degree targets.

Heat pump maintenance costs
The NZIER makes a case for servicing costs similar to the cost of employing a serviceman, but then suggests a range between $20 and $100, and use the lowest figure. This assumes the owner does the servicing, with real account of the time cost. Further, the figure they use relates to just the cost of regular servicing to ensure that the heat pump operates efficiently. It does not include maintenance costs when the heat pump breaks down.

For simplicity we have assumed an annual serving costs and maintenance costs are $100 per year, five times the NZIER estimate.

Heat pump life
It is assumed that the heat pumps will last 15 years. The reference the cited in this regard said 10-20 years, with a midpoint of 15 years. The source is a US heating system supplier[16]. It is not clear how relevant this information is to the New Zealand situation, or if the supplier has taken an optimistic view of the performance of their products.

We think a more conservative view should have been taken of the average life of a heat pump, which would have increased the capital cost figure, but we have not explicitly allowed for this.

Environmental impacts
For simplicity we have not adjusted the NZIER estimate.

Summary of adjustments for the 18 degree target

- Heat pump costs have been increased to $2658.
- NZIER servicing and maintenance costs have been increased by a factor of 5.
- Ill-health cost savings are reduced by 50 percent
- Mortality benefits are the NZIER preferred estimate, reduced by a further 20 to account for population composition.
- Energy savings reduced by 50 percent
- The discount rate is 6 percent.

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16 Conditioned Air, Macon Georgia U.S.

Table 3: Living room 18 degree target

	NZIER	Tailrisk estimate
Number of properties ’000	179	179
Benefits		
Reduced costs of illhealth $’m	130	57
Mortality benefits $’m	100	13
Tenants’ reduction in energy costs $’m	476	198
Better environment $’m	9	9
Producer surplus $’m	-45	-23
Costs		
Capital cost $’m	456	476
Owner opertional costs $’m	45	196
NPV $‘m	169	-418
Benefit cost ratio	1.34	0.38

Key differences in outcomes

Our negative present value assessment of $419 million and benefit cost ratio is driven by a range of factors, which as argued above, are more realistic and comprehensive that the NZIER’s.

Living rooms: 20 degree target

The NZIER’s assessment of the costs and benefits of the 20 degree target was not very useful because it conflates estimates of changes in two different assumptions and does not provide a reaslistic assessment of marginal costs and benefits of the option compared to the 18 degree option.

The first impact of the 20 degree target is to increase the number of properties affected by 106,000. It appears that most rental properties that do not already have a ‘compliant’ livingroom heater will be required to have one.

The second impact is on the assumption on the temperature target. It is implcitly assumed that just because the the requirement is more stringent, that occupants will increase their target temperatures. They obviously won't, the 20 degree target is unrealistic. It would have been more useful to assume that the temperature target. remained unchanged to more clearly focus on the impact of policy due to the larger number of properties affected.

Further the marginal health and mortality benefits of any increase from 18 to 20 degrees would be very low. Even the WHO says that there is no risk to the general population when the indoor temperature is over 18 degrees.

A focus on just the 106,000 additional properties would need to consider the likelihood that the heat pumps would not be used at all. In a small living room a plug in heater will be perfectly adequate to meet the tenants needs, and many tenants won't like heat pumps. They might be perceived as noisy, draughty, difficult to operate easily and end up costing more money.

There is insufficient information in the NZIER report for us to make a detailed assessment of the marginal costs and benefits, but the benefit cost ratio would be material lower than our estimate reported in table 2.

Bedroom heating

The NZIER assumes that 71000 and 125000 properties are affected under the 18 and 20 degree scenarios respectively. How these numbers were calculated is not explained.

We had difficulty in understanding the NZIER's figures. In part this may be due to how the option requirements are interpreted.

***Landlords** (our emphasis**)** must provide efficient heating devices to be able to achieve an indoor temperature of at least 18 degrees in rooms covered by the heating standard, at a reasonable cost to operate. They may need to supplement or replace any existing heating devices that do not have sufficient capacity to heat the room to 18C.*

On one interpretation an owner must provide a plug-in heater, whether or not a tenant already has a heater. On the other, the owner only provides a heater if there is not already one in the room. Assuming the NZIER has taken the latter approach the estimate of 71,000 affected properties is difficult to understand. It is implied that over 500,000 properties already have plug-in heaters in all their bedrooms. The assumption that 125,000 properties are affected it the target is increased to 20 degrees also doesn't seem to make sense. If there is already a heater in the room, as required under the 18 degree option, then should be no impact on the number of heaters required when the heating target is increased.

We have assumed that many tenants do not currently have their own bedroom heaters in every bedroom and most landlords are not currently providing them. 250,000 properties are assumed to be affected with the 18 degree target and the total number of bedrooms affected is 250,000 properties x 2.75 bedrooms per property = 688,000

Cost of plug in heaters
It is assumed that cheap $35 heaters will be purchased and will be replaced every five years. What is missing here is the owner's management costs. Owners will have to spend time purchasing and delivering the initial stock of heaters, and then respond to tenant requests to replace failed heaters. Calculating these costs is complicated, as it will depend on a number of assumptions about heater use and whether the tenant will bother to contact the owner. We have assumed that transaction costs doubles the cost of providing heaters.

Estimates of number of tenants pursuing targets
We think the NZIER's assumption that 50 percent of tenants will pursue the 18 degree target is far too high. Most tenants who have felt a need to have bedroom heater will already have one and they won't change their heating behavior.

Most of those in the affected households could readily have obtained the heater themselves, but they didn't. Those who are not heating their bedroom through the night (in common with most owner occupiers) will mostly be doing so for perfectly rational reasons. They are perfectly comfortable with using winter bedding, and like a cooler room to sleep in. They have no interest in pursing a summer lifestyle through the winter, at the cost that this would entail.

As the literature survey demonstrated, there is no evidence that unheated bedrooms, with the temperatures most New Zealanders experience, poses a health risk. The only relevant study showed that it didn't. Having the owner's heater in the room won't change too many minds.

Maybe there will be a few tenants would like to have purchased a cheap bedroom heater, but never quite got around to it. So these tenants could potentially benefit from the health savings. The MBIE Consultation document suggested that some tenants might not be able to afford a plug-in heater, implying that the policy would address this ‘problem’. However if tenants can’t afford to buy a $40 heater then they won’t be able to run them.

In our cost benefit analysis we assume that five percent of households pursue the 18 degree target because a landlord heater has been provided.

Cost of heating
In the 18 degree scenario the present value of the cost of heating the bedrooms in the 71400 houses to 18 degrees is $116 million, or around $10 million a year. This looks to be too low. As half of the houses will not pursue the target this is the cost for 35700 with, say, 80,000 bedrooms. The per bedroom heating cost is about $125 per year. If the heating season is 6 months[17] this works out to a cost of $5 a week, using less than 20 kilowatt hours of electricity. It would appear that this is inadequate to heat a room that might otherwise be at, say, 14 degrees to 18 degrees. A significant increase in the heating cost could be appropriate here. For illustrative purposes we have assessed a 50 percent increase in bedroom heating costs.

Summary of adjustments

- Number of plug-in heaters provided is 688,000million.
- Cost of heaters increased to $70 to account for transactions costs.
- 5 percent of owner provided heaters will be used to meet the 18 degree target
- The mortality and ill health benefits are the same as those applied in the living room cost benefit analysis
- The discount rate is left at 4 percent because the 6 percent rate would apply to both benefits and some costs and the higher rate would not make a substantial difference.
- Energy costs have been increased by 50 percent

We have not assessed the 20 degree target because we believe that very few tenants would actually adopt that target. Note however that in the NZIER analysis the benefit cost ratio improves from 0.28 to

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17 The 18 degree target will extend the heating season as temperatures are still cool overnight in spring and autumn

Table four: Bedroom temperatures 18 degree target

	NZIER	Tailrisk calculations
Number of properties targeting 18 degrees	71.400	250,000
Reduced health costs $’m	53	9
Reduction in mortality costs $’m	40	2
Tenants energy costs	-116	-61
Environment	-1	-1
Producer surplus	28	14
Capital costs	16	48
Present value NPV $’m	-12	-84
Benefit cost ratio	0.26	0.12

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Heat pumps in bedrooms

The MBIE Consultation document suggests that bedrooms that are bigger than 13 square metres, at least from Wellington and localities to the south, will be required to have a heat pump. Put bluntly this is a silly idea.

We know that owner-occupiers seldom put heat pumps in bedrooms, and that New Zealanders seldom heat their bedrooms through the night. We know that winter bedclothes are an effective substitute for bedroom heating. To the extent that renters want to heat the room then a plug-in electric heater would be adequate.

A bedroom heat pump requirement would markedly increase owners’ capital costs. At our assumption of $2658 per heat pump the aggregate capital cost of $266 million if we assumed that 100,000 bedroom heatpumps were required. If we assumed again that only 5 percent would actually be used to reach the 18 degree target, but that the energy cost of meeting the heating target would be halved by the use of heat humps then the benefit to cost ratio would be around .04. This would be an extraordinarily inefficient policy intervention.

Part seven: Mositure and ventilation standards

Rationale for intervention

The rationale for the ventilation standards is that poor ventilation can be associated with the growth of mildew and mould, leading to damper clothes, which can increase cleaning costs, and increase heating costs. While there are discussions in the literature of possible associations between mildew and mould and health, there is little actual analysis that provides guidance on what difference the proposed standards would make.

It is acknowledged by the NZIER that the ventilation problem can be readily be reduced by opening windows for 10-15 minutes, but it is argued that this raises security concerns. This might be a concern for some people if they are in the shower, but hardly for every window in every inhabited room. If that were the case tenants would be too scared to open windows in summer. Other tenant mitigants, such as cleaning and opening closets or putting in a low output heater, would also take care of the problem.

What is acknowleged, but not addressed because there no estimate of the benefits, is that even if security locks are put in place, they may not be used. If they are open the house will lose heat and be draughty, so a person who, either does not know that they should open windows or doesn't remember to do so, is likely to leave them closed.

There is no solid evidence that mould is a serious issue in rental properties. The 2015 BRANZ House condition survey[18] found mould in 44 percent of owner-occupied houses and 56 percent of rentals. 30 percent had visible mould in living rooms, compared to 18 percent for owner-occupiers, but this included specks of mould that could be readily removed by cleaning. The difference in observed mould may, in part, reflect differences in cleaning and ventilation habits between tenants and owner-occupiers. Of the rental houses with mould this was described as 'serious' in 8 percent of cases.

Interestingly, there was no relationship between the presence of mould in bedrooms and the heating of bedrooms.

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[18] *Study Report SR372 Warm, dry, healthy? Insights from the 2015 House Condition Survey on insulation, ventilation, heating and mould in New Zealand houses*

Mould was less frequent when there was heating and extractor fans in bathrooms, and kitchens, but this in initself does not provide strong evidence that providing extractor fans to renters would make much difference to health or othe problems. As people do not spend much time in kitchen's and bathrooms it is doubtful that the presence of mould there presents a serious health risk.

The options

Option one has a suboption that requires the installation of security fittings on one window in every inhabited room. Option two requires the installation of extractor fans in bathrooms and in the kitchen as well as fitting security stays.

The capital costs are calculated by estimating hardware and appliance costs and the direct labour cost.

Comments on the methodolgy

Security latches

Only 25 percent of properties were assumed to require security latches. There was no basis for this low estimate. If they are required then presumably all houses would have to have them and it is unlikely that 75 percent of properties already have security latches in one window in every room.

Costings

These do not appear to be based on realistic (preferable 'blind' quotes, - quotes to officials may be shaded down) quotations. An installation cost of $138 to install a bathroom fan looks low.

No explicit allowance is made for extractor fans where the bathroom or range is not on an outside wall, although the issue is noted. This would substantially increase the cost of installation. Anecdotally, we are familiar with a quote for an extractor fan for an interior fitting of $2200.

Maintenance and running costs

There is no allowance for maintenance, and replacement of the fans, or for electricity costs.

Owners' management costs

No alliance is made for landlord management costs. This would be material.

Overall the costs could be a multiple higher than the NZIER estimates.
Benefits are not quantified, but it is acknowledged that the health and environment benefits are unlikely to be large (we would suggest minimal). However, it is suggested that savings from maintenance and cleaning costs could covered the costs. This is obviously wrong once a proper assessment of costs is made.
What this suggests is that there is not really a case for regulatory intervention. It is really up to the owner to make a business decision on whether his maintenance benefits would exceed his costs. Regulation is almost certain to be suboptimal, when landlords are forced to provide mechanical extraction, and security fittings are unlikely to change tenant behavior.

Part eight: Moisture ingress standard

The options

Three options were considerd.
Option 1 (status quo) is for owners to continue to meet their existing legal obligations under the Building code, Residential Tenancies Act and Building Code H1 Regulations.

Option 2 would target the 'identified issue' of substantial subfloor moisture in New Zealand rental properties by requiring all owners to either provide adequate ventilation or install a moisture barrier over the soil under the home

Option three is to provide a moisture barrier under all rental homes regardless of whether they meet the ventilation requirement

The claim that there is an 'identified issue' of a substantial problem with of subfloor moisture with New Zealand rental properties is overstated. Just because there is substantial under floor evaporation under some New Zealand houses (up to 40 litres a day, which seems impressive), this does not mean that there is necessarily a problem, as the NZIER seems to imply. This can be readily dealt with by adequate ventilation.

Here the relevant document is a 2016 BRANZ report[19]. This report documented a series of tests on a research building. First, the under floor was first sealed and it was

. [19] McNeil S, Li Z, Cox-Smith I, Marston N. (2016): Managing subfloor moisture, corrosion and insulation performance. BRANZ study report SR354. BRANZ Ltd.

found the wood in the sub-structure, starting from a relatively dry state (about 12 percent moisture content) became moisture saturated after four months. Ventilation, of just 20 percent of the Building code ventilation standard was then installed. After four months the wood had substantially reduced its moisture content (to 13.5 percent). Ventilation was then installed to the code standard. It didn't seem to make much difference. The ventilation rates with the 20 per and 100 percent of code ventilation openings were 25.9 and 32.6 ach respectively (ach is the measure of air turnover rates per hour).

A third experiment was to seal the building again, and install a polythene moisture barrier. It was found that the moisture content reduced from a starting point of 20 percent to 13.5 percent after 4-5 months.

They did not experiment with ventilation and the ground barrier together to see if the moisture barrier had any marginal benefit. Probably there was little point as the ventilation, even at the 20 percent of code level, was doing a good job.

While it is suggested that the results could have been more positive than for homes in a denser urban environment, they concluded that there was a wide margin for safety in the building code. For our purposes the implications are that:

- There should be limited concern if homes do not fully meet the current building code. The historically installed ventilation should be adequate in most cases.
- There is no evidence that installing a ground barrier will provide a material benefit for a house that complies with the building code.

The cost of complying with the option two variants are estimated at $112 million, and $202 million. These costs are probably understated. An average cost of $700 for ground cover seems optimistic; particularly when account is taken of the owner's transaction costs.

The marginal cost of option three is almost certainly a waste of money. The NZIER seems to have come to the view that ground cover would not provide much of a marginal benefit on the basis that ventilation was already adequate.

Much of the spending under option 2 is also likely to generate very little benefit. A sensible requirement would be that rental properties would have to meet 50 percent of the building code. This would identify properties with the greatest risk of having a ventilation problem.

Part nine: Draught stopping standard

The options

Option 1: continue with the status quo in which owners are required to maintain their properties in a good or reasonable state of repair

Option 2: require owners to stop any unnecessary gaps or holes that cause noticeable draughts and a colder home and:

- are 3 mm or greater around windows and doors

-are 3 mm or greater around walls, floors, ceilings and internal access hatches

- block decommissioned chimneys or fireplaces.

Cost benefit outcome of option two
The cost benefit analysis of option two generates the highest benefit to cost ratio, 3.37, of all the proposals, but in our view is largely a contrivance. The numbers were mostly just made up. The cost benefit numbers were intended to be only illustrative, but no doubt will be used to promote and justify option two. It would have been just as valid to generate a very low benefit cost ratio if that was the client's requirement.

Issues with the analysis

No assessment of whether a systemic problem exists
No consideration was given was given to whether a systemic problem really exists, and whether it can be managed under option one. At the least the NZIER should have reviewed the BRANZ report on the New Zealand rental sector[20] to see if tenants are reporting owner failure to address serious draught problems as a widespread issue. The only evidence mentioned is the study of the draught stopping of five Wellington apartments on the south wall of a Wellington apartment block. The NZIER admits that this is 'far from representative' of the rental housing stock. This is an understatement. Basing the assessment on a study of south facing apartments in a tall Wellington apartment building is like assessing the health of the general population by visiting the critical care ward of a hospital.

[20] Branz 2017 Op. cit.

No field testing
Option 2 has not been field tested on a sample of representative properties. This is essential to

- assess the practicality and effect of 3 mm gap test,
- provide remediation cost estimates,
- critically, to more precisely define what key terms mean. In particular, what does 'unnecessary gap' mean?

On the last point take the case of sash windows. Many older dwellings have these windows and, probably, nearly all would fail the 3 mm test. So what does unnecessary mean in this context. One interpretation is that older sash windows need a good gap to operate and the gap is necessary. The other is that sash windows can operate with a 3mm gap, so the older windows should be replaced. The owner could be then faced with a $30,000-50,000 bill for a larger house. There will be many other examples of potentially expensive remediation for older buildings with wooden windows and doors

Cost assessment
The NZIER's cost assessment is hugely understated. They
assume that draught stopping can be complied with by applying sealant to fill gaps around windows and doorframes, also by removing ceiling coving and sealing the junction of walls and ceiling plus the addition of draught excluders for external doors.

All of this can be done at a cost of $107 to $217 with the use of a sealant. Ripping off ceiling coving and then reinstating it is an expensive proposition. Gaps around noncompliant internal doors cannot be fixed just with a sealant. Draught excluders for external doors cost money to buy and to install. Replacing windows that cannot be made complaint can be very expensive.

The NZIER's response was that the repairs were only meant to be illustrative of the kinds of repairs that could be affected at a low cost and that they relied on BRANZ who suggested that most remediation could be done with a couple of sealant tubes.

Ventilation
Drafts provide a ventilation benefit when the occupant fails to ventilate the house properly. This benefit was ignored.

Benefits
The average temperature gain was assumed to be 1 degree based primary on the results of the gains, of the five apartments on a southerly wall Wellington study. This cannot be taken seriously.

Marginal benefits of intervention
The possibility that the intervention could come on the top of the insulation and heating requirements, which would suggest that the marginal benefits would be low was not considered.

Positive impacts under status quo
Under the status quo a tenant can ask the owner to fix the problem if drafts causing a serious problem. As owners will generally address these issues this will reduce the marginal benefits under option two. This possibility was not considered.

There was insufficient information on both costs and benefits to conduct a serious cost benefit analysis, but in the spirit of the approach the NZIER has taken we present an alternative 'illustrative' analysis. We have reduced the assumed health benefits to 10 percent of the MBIE benefits to reflect the range of issues identified in the heating discussion and to take account of the lower marginal benefits for this intervention

Table four: Indicative cost benefit analysis for draught stopping

	Cost and benefit $'m PV
Cost of initial assessment 500,000 properties at $100	50.0
Cost of less ventilation in under ventilated homes 100,000 properties at $200 PV	20.0
Capital cost low intervention 200,000 properties @ $1000 PV	200.0
Capital costs of high intervention, sash window etc properties 10,000 @ $20000	200.0
Health benefits 172000 homes at 10 percent of NZIER assessment or about $60 per rental.	10.3

Net present value	-449.7
Benefit cost ratio	**.02**

Part eleven: Other issues

Effect on rents

The NZIER does engage with the issue of the impact on rents. They suggest that the costs will not be passed on in full. However, the expectation should be that they will, at least in the medium term. This is a competitive market and the standard assumption is that cost increases will substntially fall on tenants. Even in the short run most owners, in a very tight rental market, could impose an immediate increase if they chose to. Some, irked by what they see as unnecessary costs, imposed mostly for political reasons, will tell their tenants, that their costs have gone up and they 'have to' recover those costs with a rent increase. If the costs are $7500-10000, as the NZIER suggests, then a rent increase of, say, $25-30 dollars a week could easily be justified. A tenant could be paying $8-10 a week for a bedroom heatpump that they don't want and will seldom if ever use.

Rent increases will fall disproportionatly on the poorest tenants, who rent the oldest houses, because they are cheaper. These increases will have a feedback effect on expenditure on heating. Renters on a tight budget will have to find the money from somewhere, and heating is an obvious candidate. A fall in heating expenditure will unwind some of the heating benefits identified in the NZIER cost benefit analysis. We have not allowed for this feedback effect in our assessments, although conceptually we should have.

Government heating payments

Both MBIE and the NZIER have ignored the winter heating benefit paid to over 65 year olds. While the payment is not tied to actual heating expenditure, the expectation is that it will have some impact on the heating behavior of the recipients. If older tenants are already heating their homes more, then the marginal benefits of further interventions will be lower. Again we have not attempted to assess this effect.

Appendix A

Public Health England's conclusions and recommendations

The discussion section states

*Whilst there is **strong evidence** that cold homes have a harmful effect on health, and there are good arguments for making recommendations for minimum home temperature thresholds in winter, the findings of this literature review demonstrate that **there is very limited robust evidence** on which to base these recommendations*.

The discussion goes on

A population wide approach to minimum indoor temperature thresholds in winter is warranted for a variety of reasons. The currently available evidence base, alongside expert discussion, suggests indoor temperatures of at least 18°C poses minimal risk to the health of a sedentary person, wearing suitable clothing. Below 18°C, negative health effects may occur, such as increases in blood pressure and the risk of blood clots which can lead to strokes and heart attacks.

*However, given the **weak evidence (**our emphasis**)** to support this threshold, it would not be appropriate to frame this as a 'strong' recommendation. Furthermore the fact that certain groups are particularly vulnerable to cold, and that younger healthy adults may find it easier to increase activity levels and adjust their clothing, we consider that some nuancing of the message is needed to allow flexibility above and below the threshold to allow individuals to tailor their own actions*

Despite the thin evidence base they still propose a set of thresholds.

Daytime recommendations

- *The 18°C (65F) threshold is particularly important for people over 65yrs or with pre-existing medical conditions. Having temperatures slightly above this threshold may be beneficial for health.*

- *The 18°C (65F) threshold also applies to healthy people (1 – 64)*. If they are wearing appropriate clothing and are active, they may wish to heat their homes to slightly less than 18°C (65F)*

Overnight recommendations

- *Maintaining the 18°C (65F) threshold overnight may be beneficial to protect the health of those over 65yrs or with pre-existing medical conditions. They should continue to use sufficient bedding, clothing and thermal blankets or heating aids as appropriate.*
- *Overnight, the 18°C (65F) threshold may be less important for healthy people (1 – 64) if they have sufficient bedding, clothing and use thermal blankets or heating aids as*

appropriate.

- *It has been documented that over time people acclimatize to different outdoor temperatures. It is Important to consider whether the same applies to indoor temperatures (although evidence on the issue is lacking)*
- *The evidence identified supports previous guidance that cold temperatures have physiological and health effects and that these effects start to occur at indoor temperatures of 18oC*

Our view is that the recommendations, though not very strong, tend to be overstated given the almost complete lack of relevant evidence for the general population. Clinical studies on people wearing shorts have no real relevance to the issue of household temperature thresholds. The PHE's recommendations reflects their predisposition to show an abundance of caution, and a reluctance to pull back from their previous recommendations when they found that there is really nothing to support them. At no point did they consider that there might be a cost if people followed their recommendations. The other point is that these are just recommendations, people are not being compelled to spend money to comply with them. In New Zealand owners might be, and tenants will largely bear these costs.