Minor Residential Unit Uptake Analysis

Report on estimated policy impact

Ministry for the Environment
6 September 2024

Acknowledgements

This report was prepared by Chris Crow, Jia Liu, and William Warren in collaboration with Ministry for the Environment colleagues Jym Clark, Megan Rickerby, Lucy Knowles, Sarah McCarthy, and Nathan Stocker. We are grateful for review comments as well as valuable advice on the relevant data sources from Richard Deakin and Paul Johnstone at the Ministry of Housing and Urban Development. We also owe thanks to the data teams at Auckland Council and Masterton District Council for their assistance in providing building consent records for analysis.

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Context

In response to housing supply shortages, the Government has committed to amend the Building Act and the resource consent system to make it easier to build minor residential units on existing residential properties. To achieve this, the Government via The Ministry of Business, Innovation and Employment and the Ministry for the Environment are seeking feedback on policy options ("the policy") to make it easier to build small, self-contained, and detached houses, commonly known as 'granny flats' on properties with existing dwellings on them. Policy options apply to the Building Act 2004 (Building Act) and the Resource Management Act 1991 (RMA). The policy options would remove the requirement to obtain a building consent and a resource consent before constructing a minor residential unit of up to 60 square metres in floor area, under certain conditions.

The Ministry for the Environment requires empirical analysis of the likely effect of such a policy on the supply of new dwellings over time. This report presents an estimate of the effect of the proposed policy based on data from Auckland, Dunedin, Timaru, and Masterton.

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6 September 2024

Minor residential unit uptake analysis

Dear Mr. Clark,

You have requested that Crow Advisory assist you in conducting an estimate of the potential impact of proposed changes to the Resource Management Act and the Building Act to reduce barriers to constructing minor residential units. We are pleased to share this revised report of our analysis, which has been developed by Crow Advisory in collaboration with counterparts at the Ministry for the Environment and Housing and Urban Development. In this document we provide estimates of the uptake effects of the proposed policies. Included in the analysis is a description of the methodologies we used to derive our estimates, as well as of the limitations of those methods. The minor revisions in this version are provided for clarity in response to questions and feedback during stakeholder discussions of our final report. They do not include any changes to the estimates of policy impact. This revised report is provided as a courtesy, as the final deliverable in accordance with the terms of our LVLR GMC Contract for services #27045 dated 17 June 2024 was submitted on 31 July as agreed. This report is subject to the restrictions set out at the end of the report and supersedes all previous drafts. Please do not hesitate to contact me if you have any questions.

Yours sincerely,

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Executive Summary

The Government has proposed removing the consenting process for minor residential units

The government has committed to make it easier for landowners to build minor dwellings, also known as “granny flats”, “family flats”, secondary dwellings, auxiliary dwellings, or minor residential units (MRUs). The purpose of this is to reduce the cost and non-monetary barriers to increasing the supply of dwellings and improve choice and affordability.

Through two proposed amendments, one to the Building Act 2004 and the other via national direction to the Resource Management Act 1991, the proposed policy options (“the policy”) would remove the requirements for obtaining both resource consents and building consents when building an MRU up to 60 square metres in floor area, subject to meeting other proposed criteria.

The purpose of this report is to present estimates of the likely effect of this change on the dwelling supply over the medium term (8 years).

We have no data on part of the effect we want to measure

There is a significant challenge in estimating the likely effect of removing both resource and building consent processes in an evidence-based way. The critical issue is that building consents themselves provide the best available source of data for what has been built and where. Without them, we do not have an accessible record of past MRU construction. This is because in cases where no building consent is required, no record is created in the building consent data. Because we use consent records to observe past residential development events, our dataset has no variation in whether a building consent was required for a new MRU, and thus we cannot directly measure the influence of this requirement on likelihood to build.

However, we do have variation in the dataset on whether a resource consent is required. Some new MRUs were built in zones where this was a “permitted activity” meaning no resource consent is required so long as the activity complies with any relevant requirements and conditions.[1] Others were built in zones or circumstances where this was a “controlled”, “restricted-discretionary”, “discretionary”, or “non-complying” activity. These categories mean that an MRU can still be built but requires a resource consent process of varying difficulty and cost to proceed. Occasionally these consents are denied, meaning for any resource consent application there is a chance the MRU cannot be built at all.

Because we have variation in the data on the level of difficulty involved in the resource consenting process, including observations where no resource consent is needed at all, we can empirically estimate the effect of removing this requirement on the likelihood of building an

[1] RMA section 87A (1) states that a resource consent is not required for a permitted activity if it complies with the requirements, conditions, and permissions, if any, specified in the RMA, regulations, plan, or proposed plan.

MRU, and with some additional assumptions, derive an estimate of the effects of also removing the remaining building consent process.

We estimate the likely effect of the policy in four territories

We gained access to building consent records from 2016 to 2023 for Auckland, Dunedin, Timaru, and Masterton,[2] selected because they have currently MRUs permitted in part but not all of their district plan and for their relatively complete text descriptions for most consents, which we use to identify whether a consent involved an MRU. We matched the addresses of these consents to latitude and longitude coordinates and used the resulting spatial points to match them with district valuation roll data[3] containing information about land values, zoning, parcel size, and other features of the properties. We then use a discrete choice model—estimated using both logit regression and machine learning methods—to estimate the effects of reduction in the "regulatory burden costs" associated with the two consenting processes. Note that we implicitly capture not only fees and time costs but also behavioural effects of perceived non-monetary barriers to development that influence the decisions of individual landowners.

We find that the policy as proposed is likely to increase residential development, but not everywhere

Our results must be understood in the context of the blind spots in our dataset, and thus come with a wide range of uncertainty. Table 1 below summarises our low, medium, and high estimates for the likely medium-term policy impact across the four territories in our dataset. Here "medium-term" means the effect we expect over about the same period as that covered by our sample data, so about 8 years.

Table 1: Estimated policy impact

	Low	*Mid*	*High*
Auckland	+224.29%	+320.42%	+416.54%
Dunedin	+53.24%	+76.06%	+98.88%
Timaru	+18.14%	+25.91%	+33.69%
Masterton	+0.00%	+0.00%	+0.00%

Source: Authors' analysis. Figures are percentage increases over the observed rate of MRU development.

The results vary significantly between territories, as we would expect. A change in restrictions on residential development can only influence construction activity if the existing rules before the change are constraining compared to demand. This balance of demand relative to existing constraints is the key factor determining potential response to a relaxation of regulatory constraints on development. In Auckland, we expect about 3 to 5 times more MRUs in the eight years following the policy change than we see in the eight years covered by our data. In Dunedin, this drops to 1.5-2 times, in Timaru we expect a marginal increase of about 18-34%, and in Masterton we see no evidence that the change will influence the rate of MRU development.

[2] Provided by Pacifecon Building Intelligence (Dunedin and Timaru) and by local government data teams (Auckland and Masterton).
[3] Provided by Land Information New Zealand.

In interpreting these results, it is important to note that there are many factors that influence individual decisions about building that we cannot observe. The broad assumption implied by this approach is that the future will be similar to the past, which it may not be in practice. For example, we have not considered demographic changes or net migration trends for these territories. These and other limitations are discussed in our limitations section below.

Introduction

The Government is committed to increasing the availability of affordable housing for New Zealanders. To support this initiative, it is proposing measures to simplify the construction of minor residential units (MRU) which are small, self-contained, detached units, commonly referred to as 'granny flats,' on properties that already have an existing home.

To simplify the construction of MRUs and boost the supply of affordable housing for all New Zealanders, the policy proposes amendments to two key pieces of legislation that govern residential building: the Building Act 2004 and the Resource Management Act 1991 (RMA).

The Building Act

The Building Act sets out the rules for the construction, alteration, and demolition of buildings. Regardless of whether building work is exempt from a building consent or not, all building work must comply with the New Zealand Building Code. The policy proposes to establish a new schedule in the Building Act providing a building consent exemption for simple standalone houses up to 60 square metres in size, subject to criteria being met.

The Resource Management Act

Many district plans currently permit MRUs without the need for resource consent, but the permitted activity standards vary nationwide (e.g., building coverage of the net site area, setbacks from property boundaries etc). The policy as proposed would create a national environmental standard (NES) to permit MRUs on sites in rural and residential zones without resource consent with consistent permitted activity standards.

The policy

The proposed changes to the Building Act and the Resource Management Act will remove the requirements to obtain a building consent and a resource consent before constructing an MRU of up to 60 square metres in floor area, under certain conditions.

From the individual landowners' perspective, removal of building consents and resource consents reduces the costs of constructing an MRU, as well as removing any risk that a consent application may be declined. These cost reductions come in various forms: there is a reduction in financial costs for not having to pay application fees for the consents, there is also a reduction in time costs for not having to go through the consent process (which may compound the costs associated with project delays), and finally there is a reduction in the mental burden of going through the consenting process. These cost reductions increase the likelihood that individual landowners will choose to develop an MRU. This report presents an estimate of the likely impact of the proposed policy on the rate at which MRUs are constructed in the future.

Our assessment of likely impact follows the individual landowners' decision-making process for deciding whether to construct an MRU, and how changing consent costs affect this decision. The following section covers our methodology and modelling process.

Methodology

This section provides an explanation of the processes and techniques used in this study. We begin with a discussion of the modelling methods considered for this analysis, including alternative methods that were not selected, accompanied by justifications for their exclusion based on criteria such as suitability, accuracy, and computational efficiency. The subsequent section offers an overview of the chosen methods, outlining their fundamental principles and the rationale for their selection. The final section describes the technical aspects of the methods, explaining each model's specifications, and the employed estimation procedures.

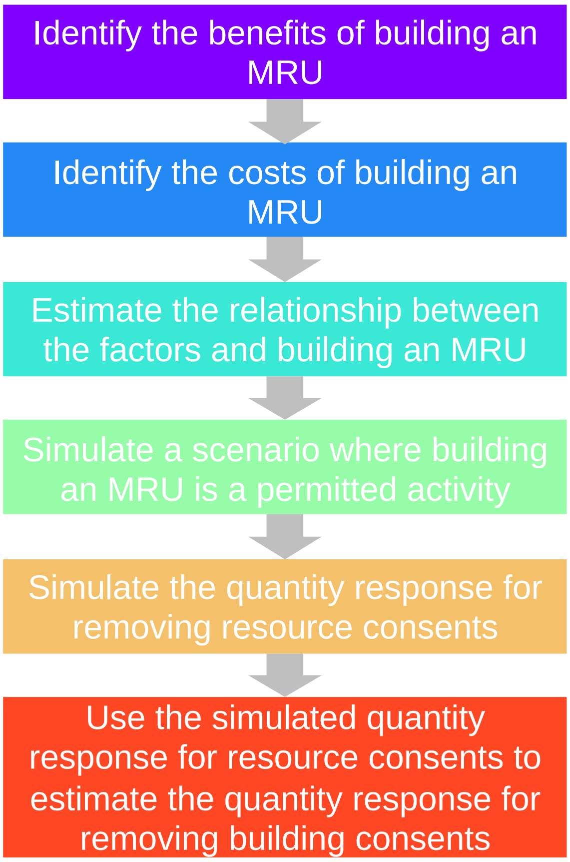
Model overview

Our goal is to estimate the likely number of MRUs added as a result of the policy. Since the policy would remove the building consent and resource consent requirements for building an MRU, an ideal estimate would have the benefit of a natural experiment in the existing data to draw upon. For example, if a set of typical cities in New Zealand had already removed building consenting requirements for minor dwellings, and another similar city had not, we could use the difference in how many minor dwellings were built after that change to estimate how much effect this policy might have if implemented elsewhere throughout New Zealand, assuming many of the driving factors are similar across subnational territories. This would allow for robust causal inference of the effects of the policy itself (as distinct from general changes in building trends over time).

However, in our case, this approach is not feasible for two reasons. First, there is no comparable natural experiment for removing building consents. Second, the building consent process itself is what provides us with data on whether an MRU has been built on a parcel of land during a certain period. That means that any cases involving the removal of building consent requirements have also removed the primary source of data on what then gets built as a result. This is the core challenge our study seeks to overcome, as we have no data on what happens when building consents are removed.

Instead of a natural experiment, our approach uses microeconomic theory and revealed preferences in the data to model the underlying decision-making process for landowners choosing to build an MRU, so that we can then simulate the interaction of the proposed policy with that process. In other words, we capture the apparent preferences and trade-offs made by landowners in our data set and apply these to a simulated change in the permissibility of building an MRU. Since we have no data on building consent removal, this approach requires a proxy variable to represent how the population might respond to the removal of the building consent process. We use the difference across residential zones in resource (not building) consent requirements as our proxy. We consider this the best available proxy as both consent processes introduce similar elements of uncertainty, fees, administrative process, timing complexity, and stress for the applicant. The high-level modelling process is outlined in Figure 1.

Figure 1: Modelling Process – Both logit and machine learning approaches



Source: Authors

We start by identifying features in the dataset that might correlate to the benefits and costs of building an MRU for a landowner. We then identify and classify properties according to whether they required a resource consent to build an MRU during our study period. We model the relationship between these features and the choice to develop an MRU. The following sections describe this modelling process. To arrive at a final estimate for the number of MRUs added, we consider a scenario where the measured effect of needing a resource consent on the likelihood to add an MRU is subtracted from all properties that could add an MRU, since the barrier that would be removed by the proposed policy is an extension of removing the resource consent requirement. We compare the total number of MRUs in this hypothetical scenario to the current baseline number of MRUs. We then use assumptions based on past developments to estimate the rate at which these MRU developments would take place during the years following the policy change.

Modelling approach – narrative description

Policy interaction with drivers of homeowner behavior

To construct an appropriate model estimating the impact of the policy, we need a clear understanding of what mechanisms the policy will change. Territorial authorities across New Zealand feature a variety of planning rules about where an MRU can be built, but all of those for which we have data require a building consent to do so. This lack of variation in the data makes it impossible to directly measure the effect of removing building consents. However, the data does hold substantial variation in where resource consents are required. The proposed policy would remove both the resource consent requirements (where they exist) and the building consent requirements for all residential properties, so long as the construction still complies with the proposed standards. This includes proposed standards for maximum building coverage, permeable surface, and setbacks requirements in the resource management system as well as height in relation to boundary, building height, protection from fire and building design and build requirements under the Building Act. Where an MRU does not comply with these proposed conditions a building and/or resource consent may still be required.

In other words, the primary effect of the policy is to reduce the amount of consenting time, costs, uncertainty, unpredictability, and general hassle ("regulatory burden costs") involved in building an MRU. In some cases, the policy may also make building an MRU possible in an absolute sense, for parcels where building or resource consents might have been declined. Collectively, these regulatory burden costs form a barrier to building an MRU that is both monetary and non-monetary. While we can explicitly measure the monetary costs, they are a small portion of the overall expenditure on construction, and we expect that they form a small portion of the effect of the overall barrier to development behaviour. Other components such as the time cost could also be estimated, although we cannot predict with spatial accuracy how these vary in practice, and for a homeowner deciding to apply for a consent, what likely matters is their perception of the time costs as a hassle ahead of time rather than the actual measurable costs after the decision is made.

Finally, not everyone will view the reduced hassle of consent compliance equally—for some, it might have no bearing on their decision at all, for others it may be a significant factor and for others it may have a marginal effect. We can measure part of this effect—whether a resource consent is required—but not all of it, and we do not know what portion of the perceived regulatory burden costs it represents nor how that varies across properties and owners. In the section below we present a theoretical approach to deriving the unknown portion of these costs based on the observed effects of the known portion.

There are other drivers of the underlying likelihood of the population to build MRUs as well. For example, some drivers may be linked to demographic features of populations that are expected to change over time in predictable ways. These and other influences that are beyond the scope of this study are discussed in the limitations section. Our approach assesses the utility of MRUs to landowners based on whether and where they've been built in the past, connecting build behaviour to features of the property itself, without consideration of who is living in the property.

Model specification

Landowners who own a parcel of land that can feasibly accommodate an MRU face a set of mutually exclusive decisions: Build an MRU within a given period, or do not build an MRU. Each option comes with its own set of driving influences. Choosing to build an MRU increases the value and utility of their property, but incurs a cost of construction, consenting, maintenance, and personal stress.

Economists typically model these scenarios using discrete choice models (DCM) (Greene, 2003). A DCM is a tool used to understand and predict how people make decisions when they have a limited number of distinct options to choose from. A DCM examines the factors that influence peoples' choices, such as costs and personal preferences.

A DCM examines these factors using the concept of utility. Utility, in economic terms, is a concept similar to value, but distinct in that it concerns personal value according to individual preference rather than concepts of value mediated by markets. This concept helps explain how individuals make decisions based on their own preferences. The term "utility" refers to the personal satisfaction or happiness they derive from the results of those decisions.

When a landowner decides whether to build an MRU, they compare their expected level of utility if they were to build the MRU (considering the associated costs) to their expected level of utility if they do not build the MRU. The levels of utility can be influenced by many factors, such as the possibility of renting out the MRU or the possibility of using the MRU as an additional living space for their own household.

The landowner chooses to build an MRU if the utility of building the MRU is greater than the utility of not building it, and vice versa. If we observe that a current landowner has built an MRU on their parcel of land, we can infer that the utility of having an MRU was greater than the utility of not having an MRU at the time of that decision.

In this scenario, landowners face two distinct choices. This is a special case of the DCM called the binary choice model (BCM). In a BCM, the utility of each of the two outcome options is related to each observed combination of contributing factors that may influence decision making.

We use two approaches to estimate this relationship. The first is a traditional logit model, the second is a random forest machine learning model. Both models aim to estimate the policy-induced change in probability of building an MRU versus not building an MRU. The key difference between them is that the logit model allows for estimating the marginal effect on the difference in utility associated with each factor. This allows high interpretability but requires assumptions about the underlying functional form of the relationships between factors and outcomes. By contrast, the random forest approach focuses on predictive accuracy, without needing these assumptions, but sacrifices the ability to interpret the influence of individual factors.

By estimating these effects for observed combinations of factors, we can predict how changes in factors such as regulatory burden costs might influence future decisions.

Our logit model is similar to Nakosteen and Zimmer (1980) but with an additional term included in one option to accommodate the regulatory burden cost incurred by the choice to build an MRU. The policy reduces the cost of building an MRU by removing the cost of a building or resource consent, including perceived and non-monetary costs. A reduction in this cost is equivalent to an increase in the net utility of building an MRU. With this change in utility, some landowners will now choose to build an MRU when they would have not built one previously. This is the effect that our modelling captures—the past relationship between the factors that influence the decision to build an MRU and the actual construction of an MRU.

However, we can only empirically estimate the effect of removing a resource consent and not a building consent. As discussed above, this is because there is no data available on the relationship between not requiring a building consent and developing an MRU. Therefore, we have a portion of regulatory costs with a clear estimate, as well as an unknown remainder. To estimate this remainder, we ask the question "what *portion* of total regulatory costs and associated burden is reduced when we remove the resource consent requirement?" This might depend on many things and certainly varies across the population and different property circumstances. One simplistic way to estimate it might be to assume that the two consent processes are equally deterrent in the behavioral sense, and therefore we can double the average resource consent effect to estimate the full effect. However, we can improve on this. Intuitively, we understand that going from a lot of regulatory costs to half as much is good, but going all the way to near zero is probably more than twice as good. In economic theory, this notion is described as "diminishing marginal utility of consumption," except here we apply it not to a "good" as is usually the case, but to a "bad" – the regulatory costs. The theory states that the added value or utility of each *additional* unit of consumption *declines* as consumption *increases*. In our case, the added value or utility of each *subtracted* unit of cost *increases* as costs *decrease*. We can model this using an exponential decay function, although we still need assumptions for both the starting relative burden of the two types of consents and for the rate of exponential decay. We provide sensitivity testing for these parameters.

An exponential decay model is a mathematical approach used to describe how a quantity changes at a rate proportional to its current value. A key concept in these models is the ξ-life (the more specific "half-life" is better known), which is the change in an independent variable required for the original value of the dependent variable to change to a fraction ξ of its initial value. In our case, the independent variable is regulatory burden costs, and the dependent variable is utility. Using this approach, our discrete choice modelling estimates how many MRUs are likely added following the removal first of a resource consent. We set ξ equal to an assumed ratio of the resource consent to all regulatory burden costs. We then calibrate an exponential decay model with the first ξ-life equal to the estimated added MRUs. We use this calibrated model to estimate the number of likely MRUs added for removing both resource consents and building consents. The following section formalizes our model.

The model – technical description

Let J denote the set of landowners. Each $j \in J$ has an observed set of K characteristics. Each landowner faces a binary choice set $\{B, N\}$ where B denotes the decision to build an MRU and N denotes the decision to not build an MRU. The decision to build an MRU incurs a cost, $C = C(E(Z), R(p))$. The cost is decomposed into two components:

$$C(E(Z), R(p)) = E(Z) + R(p)$$

Where:

- *E(Z),* a function of exogenous construction and maintenance costs, *Z*
- *R(p),* a function of existing permissibility policies, *p.*

Let x denote the *(J x K)* design matrix, β denote the *(K x 1)* vector of coefficients, and γ denote the coefficient for costs. The utility for a landowner choosing to build an MRU is given as

$$U^B = x\beta_B - \gamma C(Z,p) + \epsilon_B$$

And the utility for not building an MRU is given as

$$U^N = x\beta_N + \epsilon_N$$

If we denote *Y = 1* to be the landowners' choice to build an MRU. We observe that

$$Y = \begin{cases} 1 & if \quad U^B > U^N \\ 0 & if \quad U^B \leq U^N \end{cases}$$

We can characterize this in terms of probabilities as

$$Prob[Y = 1|x] = Prob[U^B > U^N]$$

$$= Prob[x\beta_B - \gamma C(E(Z), R(p)) + \epsilon_B - x\beta_N - \epsilon_N > 0|x]$$

$$= Prob[x(\beta_B - \beta_N) + (\epsilon_B - \epsilon_N) - \gamma C(E(Z), R(p)) > 0|x]$$

$$= Prob[x\beta + \epsilon - \gamma C(E(Z), R(p)) > 0|x]$$

Where

$$\beta = \beta_B - \beta_N \ and \ \epsilon = \epsilon_B - \epsilon_N$$

Binary choice logit model

For the traditional logit model, we assume that ϵ_B and ϵ_N are independently and identically distributed (iid) and follow a logistic distribution, thus we have

$$Prob[x\beta + \epsilon - C(Z,p) > 0|x] = \frac{1}{1 + e^{-(x\beta - \gamma(E(Z) + R(p)))}}$$

The coefficients β, γ are estimated by maximizing the following likelihood function

$$L(\beta) = \prod_{i=1}^{n} \left(\frac{1}{1 + e^{-(x\beta - \gamma(E(Z) + R(p)))}}\right)^{y_i} \left(\frac{1}{1 + e^{-(x\beta - \gamma(E(Z) + R(p)))}}\right)^{1-y_i}$$

Or the equivalent log-likelihood function

$$\ln L(\beta) = \sum_{i=1}^{n} y_i \ln\left(\frac{1}{1 + e^{-(x\beta - \gamma(E(Z) + R(p)))}}\right) + (1 - y_i) \ ln\left(\frac{1}{1 + e^{-(x\beta - \gamma(E(Z) + R(p)))}}\right)$$

After obtaining estimates $\hat{\beta}$, $\hat{\gamma}$, we consider the updated cost scenario with building and resource consents removed. That is,

$$C(E(Z), R(p')) = E(Z) + R(p')$$

We estimate the total number of MRUs that will likely be added due to removing resource consents by looking at how many landowners' switch their decision from not building an MRU to building an MRU given a reduction in costs through a change in permissibility.

We convert probabilities to dwelling quantities by taking the sum of all probability estimates for all properties. For example, out of ten properties, if each has a predicted probability of 20 percent, the expected value will be the sum of the ten probabilities, or 2 MRUs added. This can be calculated as

$$\sum_{j=1}^{J}\left(\frac{1}{1+e^{-\left(x\hat{\beta}-\hat{\gamma}(E(Z)+R(p'))\right)}}-\frac{1}{1+e^{-\left(x\hat{\beta}-\hat{\gamma}(E(Z)+R(p))\right)}}\right)$$

The result of this becomes an input to a further module described in the Deriving building consent effects section below.

Random forest machine learning model

Our logistic regression approach above requires a strong assumption that the underlying relationships we model are linear in log-odds, however the true underlying relationships may be non-linear. For example, the likelihood to build an MRU might increase within a certain range of LVsqm, but then begin to decrease once LVsqm reaches a different range of values.

Machine learning methods enable flexible, non-parametric modelling, allowing the data to determine the model structure without needing to assume a specific functional form, such as a logit model. Another benefit of machine learning models is that we do not need to make an assumption about the distribution of error terms. This means that we can reformulate the discrete choice model above to estimate the likelihood of having an MRU rather than comparing the utility between having an MRU and not having an MRU. It is worth noting that in this variation, we can still infer that if a parcel has an MRU, then the utility of having an MRU is higher than the utility of not having an MRU. In the discrete choice framework developed above, a machine learning estimator can be formulated as

$$Prob[B=1|x]=\psi_{\theta}(x)$$

Where:

- B represents building an MRU
- x is a set of features for the land parcel
- Ψ is a machine learning model
- θ is a set of hyperparameters.

Like our logit specification, we estimate the total number of MRUs that will likely be added due to removing resource consents by looking at how many landowners' switch their decision from not building an MRU to building an MRU given a reduction in costs through a change in permissibility. This total estimate is given as

$$\sum_{j=1}^{J}\left(\psi_{\theta}(x_j')-\psi_{\theta}(x_j)\right)$$

Where x_j' is the set of explanatory variables for the jth landowner when building an MRU is permissible and x_j is the existing set of explanatory variables for the jth landowner. We then get the total effect of the policy by following the same exponential decay process above.

Deriving building consent effects

Taking the outputs of either of the above models, we then calibrate an exponential decay model with $\xi=\frac{BC_{cost}}{RC_{cost}+BC_{cost}}$, where RC_{cost} represents the estimated cost of a resource consent, and

BC_{cost} represents the estimated cost of a building consent. ξ is defined to be the fraction of the initial value remaining after removing ρ_ξ amount of regulatory burden costs. That is $\xi N_0 = N_0 e^{-\lambda \rho_\xi}$. We let r be the amount of regulatory burden costs removed.

The exponential decay function in this context is given as

$$N(r) = N_0 e^{-\lambda r}$$

The first reduction in regulatory burden costs from removing resource consents satisfies

$$N_{rc} = \int_0^{\rho_\xi} N_0 e^{-\lambda r} dr$$

We use the estimate N_{rc} to calibrate the value of N_0. We use this calibrated value of N_0 to calculate the number of MRUs added when all regulatory burden costs are removed or 'decayed'. We denote this as N_{policy}. The value for the M[th] regulatory burden cost removal is given as

$$N_M = \int_0^{\rho_\xi} N_0 e^{-\lambda r} dr + \int_{\rho_\xi}^{2\rho_\xi} N_0 e^{-\lambda r} dr + \int_{2\rho_\xi}^{3\rho_\xi} N_0 e^{-\lambda r} dr \quad + \cdots + \int_{(M-1)\rho_\xi}^{M\rho_\xi} N_0 e^{-\lambda r} dr = \sum_{i=1}^{M} \int_{(i-1)\rho_\xi}^{i\rho_\xi} N_0 e^{-\lambda r} dr$$

The i[th] regulatory burden cost removed can be evaluated as

$$\int_{(i-1)\rho_\xi}^{i\rho_\xi} N_0 e^{-\lambda r} dr = N_0 \left[\frac{-1}{\lambda}\ e^{-\lambda r}\right]_{(i-1)\rho_K}^{i\rho_\xi} = N_0 \left[\frac{-1}{\lambda}\ e^{-\lambda i \rho_\xi} - \frac{-1}{\lambda}\ e^{-\lambda (i-1)\rho_\xi}\right] = N_0 \left[\frac{-1}{\lambda}\xi^i - \frac{-1}{\lambda}\xi^{i-1}\right]$$

$$= N_0 \left[\frac{\xi^{i-1} - \xi^i}{\lambda}\right]$$

Now rewriting the M[th] regulatory burden cost removal gives

$$N_M = \sum_{i=1}^{M} N_0 \left[\frac{\xi^{i-1} - \xi^i}{\lambda}\right] = \frac{N_0}{\lambda} \sum_{i=1}^{M} (\xi^{i-1} - \xi^i)$$

This is a telescoping series leaving

$$N_M = \frac{N_0}{\lambda}(1 - \xi^M)$$

We estimate the total effect of the policy when there is a complete decay of costs, which is

$$N_{policy} = \lim_{M \to \infty} N_M = \frac{N_0}{\lambda}$$

Data

This section outlines the data sources used in our analysis. We received datasets from multiple sources. These include:

- The national District Valuation Roll provided by LINZ
- LINZ primary parcels
- LINZ building outlines

- 15 years of consent history data for Auckland, Dunedin, and Timaru provided by Pacifecon Building Intelligence
- Supplementary consent history data from 2016 to 2023 provided for Auckland and Masterton by their respective district councils.

The following sections provide an overview of each data set and how they are used in our analysis.

District Valuation Roll

The District Valuation Roll (DVR) in New Zealand is an official record maintained by local councils that provides detailed information about the value of properties within their jurisdiction. The DVR contains information such as the land value, improvement value, capital value, zoning, and property use for each rateable unit.

We use the DVR to get land value, improvement value, capital value, and zoning information for each rateable unit. Note that this dataset is collected by councils for tax revenue purposes rather than research purposes. It comes with certain limitations and challenges in applying it to estimations of land use change. Relevant limitations are described in our limitations section.

LINZ Primary Parcels

Since our analysis focuses on the decisions made by landowners, it is essential that our unit of analysis is at the parcel level. We aggregate rateable unit data in the DVR onto LINZ parcels. This process involves summing the land, improvements, and capital values of all ratings units that are on a parcel. We consider the zone for a parcel to be the most common zone of all ratings units on that parcel i.e. if a parcel has 11 rateable units where 10 are residential and 1 is commercial, we assume the zone for this parcel is residential.

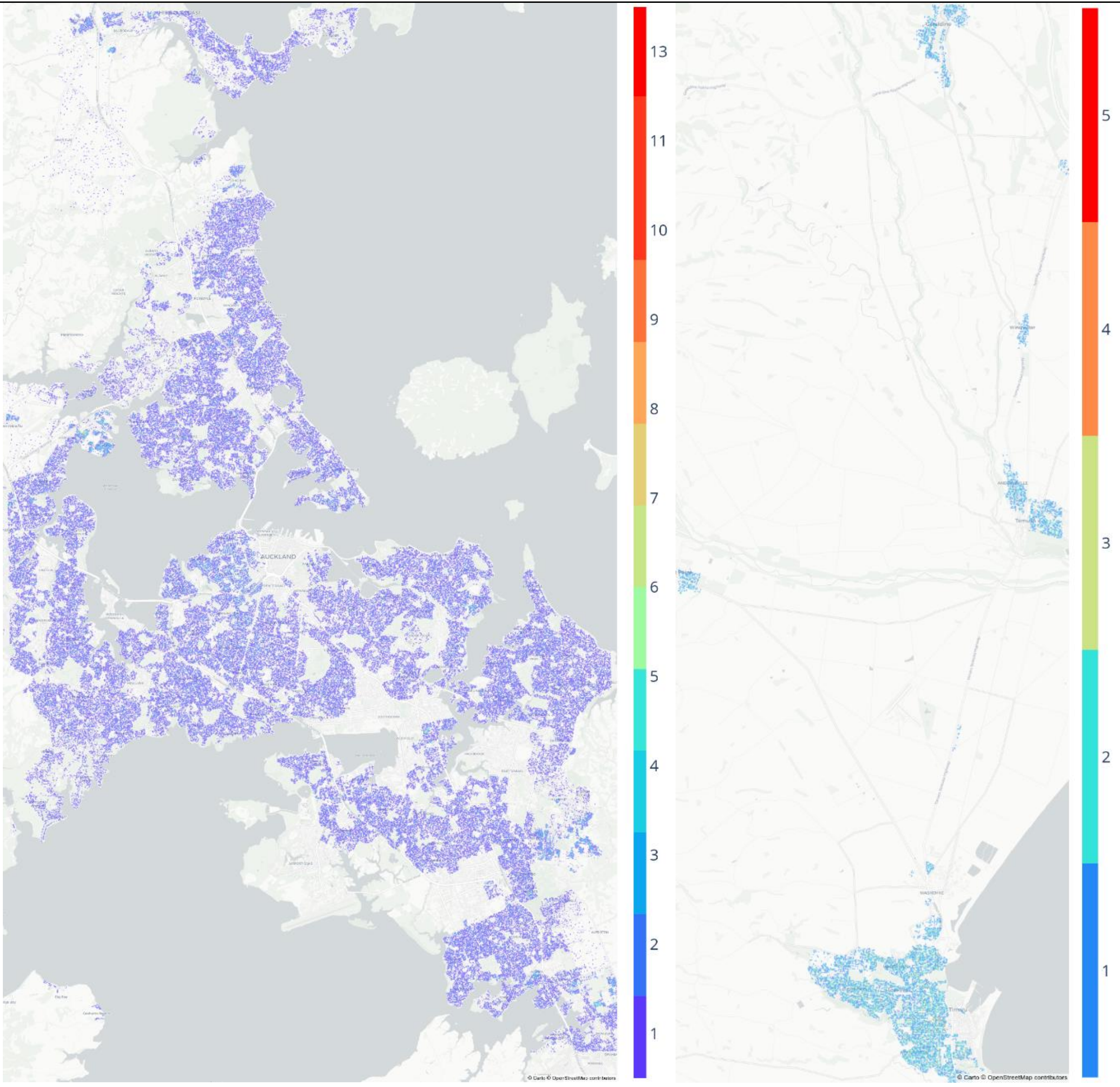
After filtering by the zoning field from the DVR dataset, across the three regions we have 440k residential parcels and about 516k total parcels.

LINZ Building Outlines

The LINZ buildings outlines data set contains current outlines of buildings captured from the latest aerial imagery. We use this data set to determine what buildings already exist on land parcels. This allows us to determine the total available land for developing an MRU.

Two factors were considered for assessing whether a given parcel could feasibly accommodate an MRU. The first is regulatory limitations outside of specific MRU consent requirement changes, namely the permitted maximum building coverage for the given parcel. The second is the physical parcel size and area without existing buildings. This was calculated using the LINZ building outlines data, subtracted from the parcel shape. Only parcels were considered whose unbuilt area, within the bounds of maximum building coverage, had a remaining permitted buildable area greater than 60sqm. From there, a stochastic geometric algorithm was fit to assess whether the remaining unbuilt area could fit a square building of 60sqm within the bounds of the parcel polygon. Figure 2 and Figure 3 below show the distribution of parcels meeting this test in each of the four case study territories.

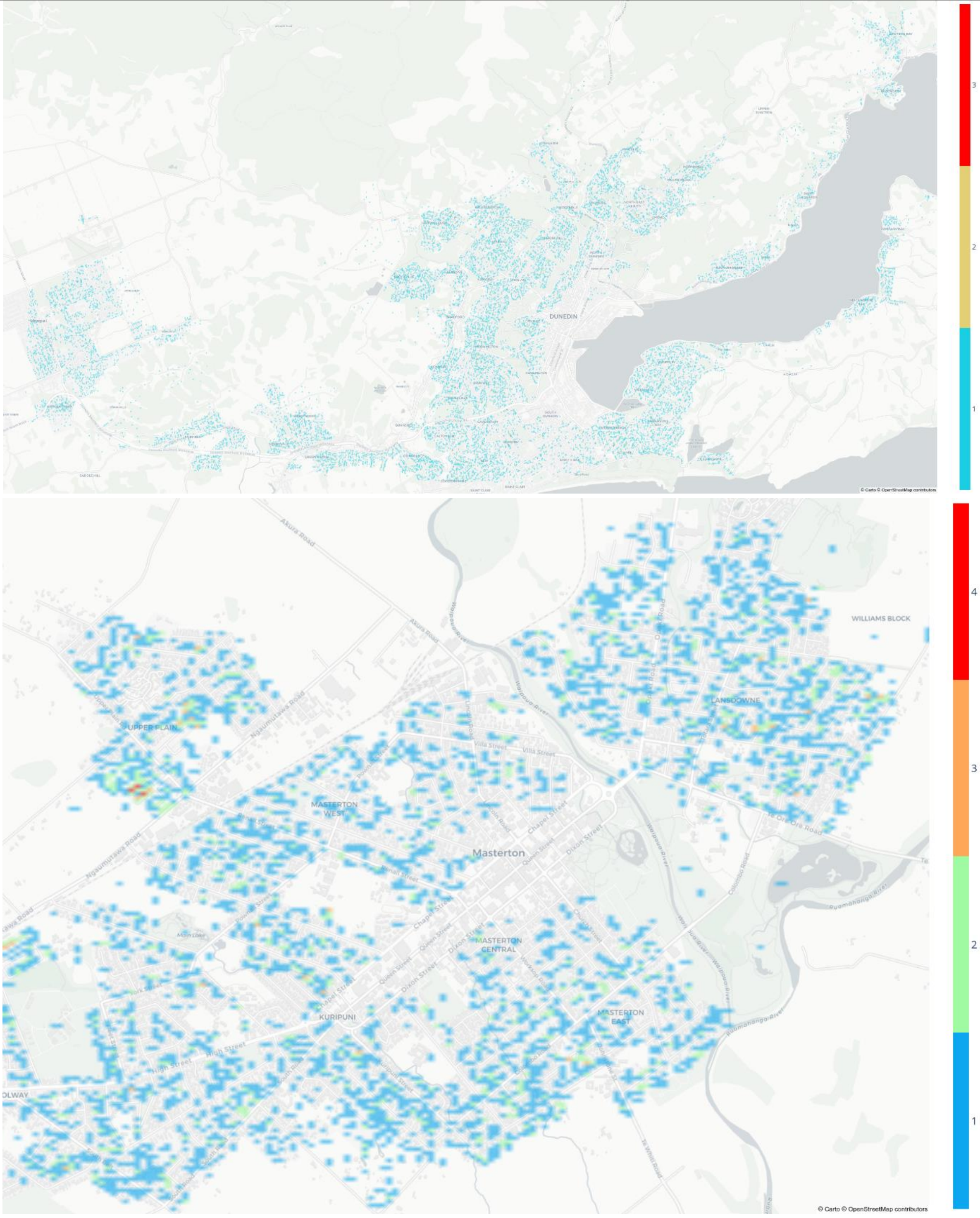
Figure 2: Parcels able to fit a Minor Residential Unit – Auckland (left), Timaru (right)



Source: Authors' analysis. Legend colours represent the count of parcels per pixel that can fit an MRU.

We also restrict our set of potential MRU sites to land parcels where the ownership type is a freehold title, as cross-lease and other special titles carry additional restrictions on new development. This allows us to restrict our set of potential MRUs to a realistic subset of residential parcels for our forecast. We consider this approach conservative in restricting potential parcels for MRUs, since in practice MRUs can be smaller than 60sqm to accommodate parcels with limited available space. This is somewhat offset by the presence in practice of boundary setbacks and other placement rules and topographic factors that constrict the final developable area.

Figure 3: Parcels able to fit a Minor Residential Unit – Dunedin (top), Masterton (bottom)



Source: Authors' analysis. Legend colours represent the count of parcels per pixel that can fit an MRU.

Consent data

We used consent history data compiled by Pacifecon Building Intelligence to identify which parcels have an existing MRU. A parcel is likely to have an existing MRU if there was a building consent for the parcel that added exactly 1 dwelling that has a floor area of less than 100sqm. Based on this definition, there were at least 627 potential MRUs across Auckland, Dunedin, and Timaru built between 2014 and 2023. Each consent in this dataset also contains a description field, which is written by the applicant and details the purpose of the consent. To supplement our classification of MRUs, we search the description field for keywords related to MRUs. We classify a consent as adding an MRU if it either contains a word in Table 3 or adds at least 1 dwelling that is less than or equal to 100sqm. Table 2 provides a summary of the consent data.

Table 2: Summary of Consents

	Auckland	*Dunedin*	*Timaru*	*Masterton*	*Total*
Total consents	32,469	14,723	8,125	N/A	55,290
Total consents that add at least 1 dwelling	4,923	1,931	989	N/A	7,843
Total consents adding exactly 1 dwelling	3,499	1,774	938	N/A	6,211
Total consents adding 1 dwelling and less than or equal to 100sqm	371	195	61	N/A	627
Total MRUs including text filtering results[4]	1,853	236	109	12	2,210

Source: Authors' analysis. Data provided by Pacifecon Building Intelligence, Auckland Council, and Masterton District Council

Table 3: List of MRU keywords

family flat
minor unit
minor dwelling
granny
auxiliary unit
auxiliary dwelling
minor residential unit

Source: Authors. Note this was a case-insensitive search for descriptions containing one or more of the above terms.

The consent history data supplied by Pacifecon Building Intelligence had a 255-character limit on the description field. This meant that in many cases, the description field was incomplete, limiting the effectiveness of our text-based classification method. To supplement our consent data, we also received consent data for Auckland directly from Auckland Council.

Estimation and results

This section covers our estimation process and results. We start by discussing our choices for explanatory variables and why they are important in DCM. We then present our regression model, estimated coefficients, and results. Finally, we present a robustness test based on an alternative modelling approach.

Spatial autocorrelation

Spatial autocorrelation refers to the correlation of a variable with itself through space. In simpler terms, it measures how similar or dissimilar values are based on their geographic locations. When spatial autocorrelation is present, the value of a variable at one location is influenced by the values of that variable at nearby locations. In the context of MRUs, spatial autocorrelation

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[4] These totals include consents that add 1 dwelling and floor area less than or area to 100sqm.

means that if a landowners' neighbour has an MRU, then that landowner will be more likely to have an MRU.

Spatial autocorrelation can significantly weaken the performance and validity of regression models by violating the assumption of independence. This can result in biased estimates. It also has a lesser weakening effect on non-parametric models such as our random forest model described in the Machine Learning Model section below.

We test for spatial autocorrelation using Moran's I test, a statistical measure used to evaluate whether the pattern of a variable observed in a spatial distribution is clustered, dispersed, or random. Moran's I is given as

$$I = \frac{N}{W} \frac{\sum_i \sum_j w_{ij}(x_i - \bar{x})(x_j - \bar{x})}{\sum_i (x_i - \bar{x})^2}$$

Where:

- N is the number of spatial units (in this case parcels)
- W is the sum of all spatial weights, w_{ij}
- w_{ij} is the spatial weight between observation i, and observation j
- x_i and x_j are the values of the variable (MRU) at locations i and j
- $\bar{x}$ is the mean of the variable (MRU) across all locations.

A value of I > 0 indicates positive spatial autocorrelation, a value of I < 0 indicates negative spatial autocorrelation, and a value of I = 0 indicates no spatial autocorrelation. For Moran's I test, we run a hypothesis test and test the null hypothesis that I = 0, and the alternative hypothesis of $I \neq 0$.

Running Moran's I on our data gives $I = 0.065$, and a p-value of 0.001. This indicates a very weak but statistically significant spatial autocorrelation. While the effect is small, it is also significant. To address this, we make an adjustment to our model using spatial lags to better account for the observed spatial dependencies. Mathematically, for each MRU, the spatially lagged variable W_{MRU} is defined as

$$(W_{MRU})_i = \sum_j w_{ij} MRU_j$$

Where:

- w_{ij} represents the spatial weight between observations i and j
- The spatial weights matrix W captures the spatial structure of the data, with each element w_{ij} indicating the influence of location j on location i.

The spatial lag is a weighted average of the neighbouring MRUs based on the weights defined in the spatial weights matrix. We choose to use spatial lags instead of other adjustments for spatial autocorrelation because our main goal is prediction rather than inference. By including these spatial lags, the analysis adjusts for spatial dependencies, improving the robustness and accuracy of our results.

To create these spatial lags, we create block spatial weight matrices separated by territory. This is so that the spatial influence of an MRU in say Dunedin does not affect likelihoods in Auckland and vice versa.

Explanatory variables

A landowner might choose to build an MRU for several practical reasons. It can generate rental income or potentially enhance the property's overall value. For families with adult or teenage children, an MRU provides independent living space. It can also serve as a dedicated home office or workspace. Furthermore, an MRU offers comfortable guest accommodation. These reasons can be broadly split into two categories: financial and personal.

We use land value per square metre (LVsqm) as a proxy for the financial benefits of land. LVsqm correlates with the market value of rent on a property. This metric captures the intrinsic worth of land based on its location, accessibility, and access to amenities, which are key factors influencing rental income. We expect LVsqm to have a positive influence landowners' decisions to choose to build an MRU.

We measure the personal benefits using household density based on 2013 census data.[5] We estimate the number of people living on a land parcel by taking the 2013 census population at the meshblock level and dividing this by the total number of ratings units that fall within that meshblock. We hypothesize that the effect of household density on landowners' decisions to choose to build an MRU is negative when household density is small, positive when it is moderate, and negative when it is large. This is because if there are a few people in a household, the benefit of building an MRU solely for housing is small. If there are a lot of people in a household, then considering a larger dwelling might be more appropriate, but choosing an MRU might be more appropriate for households that might want to house an additional person.

Another key factor in the decision to build an MRU is the amount of land available for development. But the relationship between this and the likelihood of building an MRU may not be linear. When there is a lot of land available for development, the opportunity cost to building an MRU as opposed to something larger increases, so building an MRU is less desirable. Building an MRU is more desirable when the amount of land available is within a range close to but still exceeding the amount of floor area needed for an MRU. We measure the relevant land availability using the remaining allowable buildable area of each parcel, which we calculate as the total developable area on the parcel permitted by zoning regulations, minus the estimated area of any existing developments. Put differently, we use the maximum land area available for development without violating existing zoning regulations. We then include non-linear derivatives of this variable in our model estimates.

For the costs of an MRU, we primarily consider the regulatory costs of building an MRU and their associated barriers. The regulatory costs are split into two categories: building consent costs,

[5] We use the 2013 census because this is the latest available that includes an estimate of population at the meshblock (the smallest administrative area) level. The 2018 census did not record population at this level, and the 2023 census results have not yet been released at this level.

and resource consent costs. The difference between these and the data available for each plays an important role in our modelling.

We choose not to explicitly model the construction cost of building the MRU as it is not influenced by the policy. It is also likely that an MRU will increase the value of a property in an amount similar to the cost of construction (Edmunds, 2024), so it is not a pure cost to the landowner. For simplicity, we assume that the build cost is offset by an equal increase in the improvement value for a parcel.

Instead of modelling the costs of MRU development in dollar terms, we model the total process barriers and regulatory costs based on differing levels of permissibility in the existing zoning rules. If building an MRU is a permitted activity according to local zoning rules, then a resource consent is not required.[6] That this is the case in some zones and not others gives us an important source of variation in the data that we use to estimate the total costs (monetary and non-monetary) associated with this part of the regulatory process. We choose to model permissibility rather than costs in dollar terms because there are relevant behavioural factors influencing the decision-making process that are related to the consent process, but which are not captured through the financial costs. These behavioural factors include the risk of potential time delays, the effort of putting together an application, and the mental burden of going through the application process.

Our modelling uses a dummy variable for permissibility. This variable is equal to 1 if building an MRU is a permitted activity, and 0 otherwise. This permissibility variable is the key source of variation that allows us to estimate the effect of not requiring a resource consent on individual landowners' decision-making process for choosing to construct an MRU. We determine permissibility by examining local councils' district plans around permissibility in residential zones. Table 7 in the Appendix shows which zones allow MRUs as permitted activities.

Our final explanatory variables are dummy variables for each region. We also allow for the effects of LVsqm, household density, and permissibility to vary across regions. To get our final regression data set, we consider all residential land parcels in Auckland, Dunedin, and Timaru that can accommodate an MRU that is 60sqm without violating their existing zoning regulations and all residential land parcels that have an existing MRU using our classification criteria. There are 196,509 parcels that satisfy these criteria.

Binary choice logit model

Having an MRU is rare in our data. We have classified 2,118 MRUs across Auckland, Dunedin, and Timaru out of 196,509 parcels, or 1.078%. This means that our data is severely imbalanced. Imbalanced data can cause serious issues in estimating a logistic regression, such as biased estimates, poor predictive performance, and misleading statistics. To address this issue, we use methods from the rare events literature. We use methods in King and Zeng (2001) such as re-weighting the data to reduce the imbalance.

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[6] A building consent is still required.

For estimation purposes, we standardize each variable in our regression.[7] We do this because logistic regression models tend to perform better with standardized data.[8] We estimate the following regression equation:

$$Prob[MRU = 1|x]$$
$$= \beta_0 + \beta_1 LVsqm + \beta_2 HouseholdDensity + \beta_3 HouseholdDensity^2 + \beta_4 HouseholdDensity^3 + \beta_5 \text{RemainingBuildArea} + \beta_6 Permissibile + \beta_7 SpatialLag + \gamma \text{Regions} + \phi \text{RegionInteractions} + \epsilon$$

Where:

- *MRU* is a dummy variable equal to 1 if a parcel has an MRU on it
- *LVsqm* is the land value of a parcel divided by the total area of the parcel
- *HouseholdDensity* is the estimated number of people that live on a land parcel
- *RemainingBuildArea* is the estimated land area on a parcel that can be developed on without violating existing zoning regulations
- *Permissible* is a dummy variable equal to 1 if building an MRU is a permitted activity
- *SpatialLag* is the spatial lag for a land parcel
- *Regions* is a *n x 2* matrix of region dummies with Auckland as the base category
- *RegionInteractions* is a *n x 6* matrix of interactions of regions with LVsqm, HouseholdDensity, and Permissible respectively.

Table 4: Regression results

	MRU	STD. ERROR
constant	-5.002***	(0.035)
LVsqm	0.150***	(0.015)
HouseholdDensity	-0.347***	(0.049)
DouseholdDensity^2	0.011***	(0.002)
HouseholdDensity^3	-0.000***	(0.000)
RemainingBuildArea	-0.030	(0.044)
Permissible	1.528***	(0.048)
SPATIALLAG	-0.0595	(0.296)
Dunedin	0.083	(0.581)
Timaru	0.968**	(0.339)
Masterton	0.017	(0.581)
Permissible x Dunedin	-1.311***	(0.174)
Permissible x Timaru	-2.113***	(0.354)
Permissible x Masterton	-2.434***	(0.670)
Observations	203,770	
Adjusted r2	0.047	
	Note: *p<0.1, **p<0.05, ***p<0.01	

Source: Authors' analysis

The standardized coefficients shown in Table 4 indicate the strength and direction of the relationship between each predictor and the excess utility from building an MRU. A positive

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[7] Except dummy variables such as permissible.
[8] Standardizing variables increases the speed of convergence, improving performance.

coefficient means that as the predictor increases, the utility of having an MRU is higher—in other words, more of these factors means a landowner is more likely to find it worthwhile to build an MRU—while a negative coefficient means the utility is lower.

- The coefficient on LVsqm is positive. This means that the utility a landowner receives from building an MRU is higher if their land value per square metre is higher.
- The coefficient on HouseholdDensity is negative, $HouseholdDensity^2$ is positive, and $HouseholdDensity^3$ is negative. This means that the effect of household density on landowners' decisions to choose to build an MRU is negative when household density is small, positive when it is moderate, and negative when it is large as we hypothesised earlier.
- The coefficient on Permissible is positive. This means that being in a permissible zone increases the utility of building an MRU. This is consistent with our theoretical model.
- The coefficient on Permissible x Dunedin and Permissible x Timaru is negative. This means that the effect of permissibility on utility is lower in Dunedin and Timaru compared to Auckland. Put differently, permissibility increases utility more for landowners in Auckland than in Dunedin and Timaru. This likely implies that Auckland faces greater regulatory constraint relative to demand for MRUs. Note also that Dunedin plan change Variation 2, effective as of February 2023 may have influenced some instances of MRUs at the tail end of our study period.[9]

To get an estimate of the uptake in MRUs, we start by applying the proposed policy by setting permissibility equal to 1 for all parcels that could potentially accommodate an MRU. We then use the coefficients above and re-estimate likelihoods and compare this to our baseline likelihoods before altering permissibility. Using the sum of probabilities gives us the expected increase in MRUs following a removal of resource consents. We estimate that removing resource consents will increase MRU uptake by approximately 170.72% in Auckland, 4.45% in Dunedin, 0.00% in Timaru, and 0.00% in Masterton.

We then use the estimated effect of removing all resource consents to estimate the effect of removing resource consents and building consents. For our exponential decay function, we choose a value of ξ based on a building consent cost estimate between $2,000 and $5,000 (Ministry of Business, Innovation and Employment 2024; New Zealand Infrastructure Commission 2022) and a resource consent cost of $1,500 (National Monitoring System, 2022). Our mid-point estimate uses a building consent cost of $3,500. And our sensitivity tests, we use $2,000 for the low estimate, and $5,000 for the high estimate. For the relative red-tape costs of resource versus building consents, we use administrative fees as a proxy (note this only influences the starting effect relative to each other, it does not use dollar amounts to quantify those effects).

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[9] We have not made specific allowance for this. Our estimates are intended as indicative for the policy effect in territories across New Zealand, so the precise estimation of specific recent or pending changes in the counterfactual for our case study territories is out of scope.

Using this, we set

$$\xi_{mid} = \frac{3{,}500}{1{,}500 + 3{,}500}$$

$$\xi_{low} = \frac{2{,}000}{1{,}500 + 2{,}000}$$

$$\xi_{high} = \frac{5{,}000}{1{,}500 + 5{,}000}$$

And normalise $\rho_{\xi} = 1$. And solve

$$N_{policy} = \lim_{M \to \infty} \sum_{i=1}^{M} \left[\frac{\xi^{i-1} - \xi^{i}}{\lambda} \right] = \frac{N_0}{\lambda} \sum_{i=1}^{M} (\xi^{i-1} - \xi^{i})$$

For each region, and each scenario to get the estimated policy effect.

Table 5 shows the estimated percentage increase in MRUs from removing all regulatory burden costs by region. We estimate a notable increase in MRU uptake of 569.06% in Auckland, 14.82% in Dunedin, 0.00% in Timaru, and 0.00% in Masterton.

Table 5: Estimated policy impact

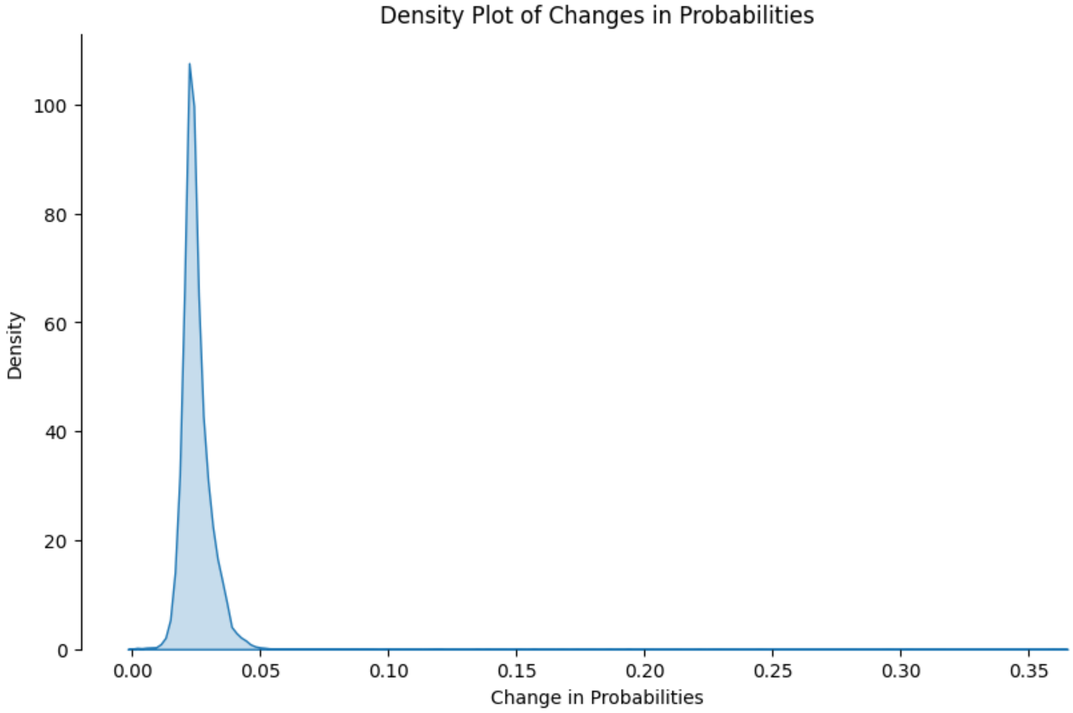
	Low	*Mid*	*High*
Auckland	+398.57%	+569.38%	+740.20%
Dunedin	+10.38%	+14.82%	+19.27%
Timaru	+0.00%	+0.00%	+0.00%
Masterton	+0.00%	+0.00%	+0.00%

Source: Authors' analysis. Impact figures represent the estimated increase in the rate of MRU development versus the study period.

Figure 4 shows how these increases are distributed in Auckland. There are two notable features in Figure 4.

- There is a peak around 0.03. This indicates that for the vast majority of landowners, the policy increases convenience and reduces regulatory burden costs, but has a very small impact on the likelihood of adding an MRU.
- There is a long tail going up to 0.37 (barely visible against the axis line). This indicates that there are some landowners for whom the reduction in regulatory burden costs are substantial and thus increase their likelihood of building an MRU significantly.

Figure 4: Density plot of probability changes in Auckland

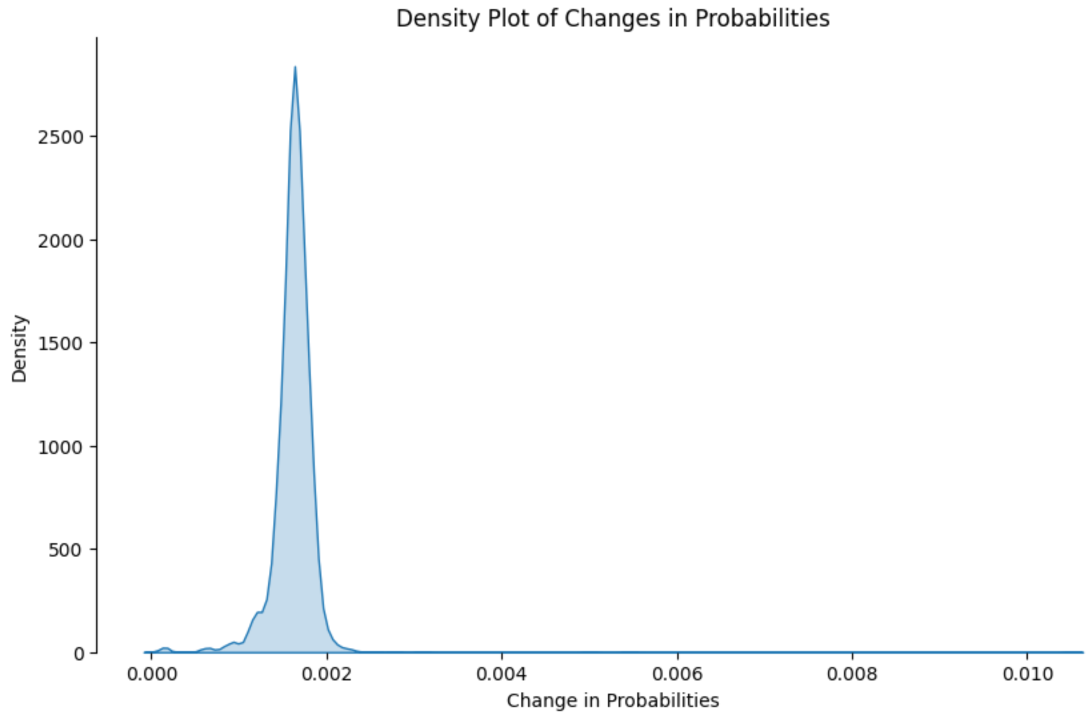


Source: Authors' analysis. Note density here refers not to population density but density of observations around given ranges of probability.

Figure 5 shows how these increases are distributed in Dunedin. There are two notable features in Figure 5.

- There is a peak between 0.001 and 0.002. This indicates that for most landowners, the policy increases convenience and reduces regulatory burden costs, but has a very small impact on the likelihood of adding an MRU.
- There is a long tail going up to 0.01. This indicates that there are some landowners for whom the reduction in regulatory burden costs is greater and thus the change results in a greater increase their likelihood of building an MRU. It is worth noting that this tail in Dunedin is smaller than the tail in Auckland, which indicates that the estimated effect will be greater in Auckland than Dunedin.

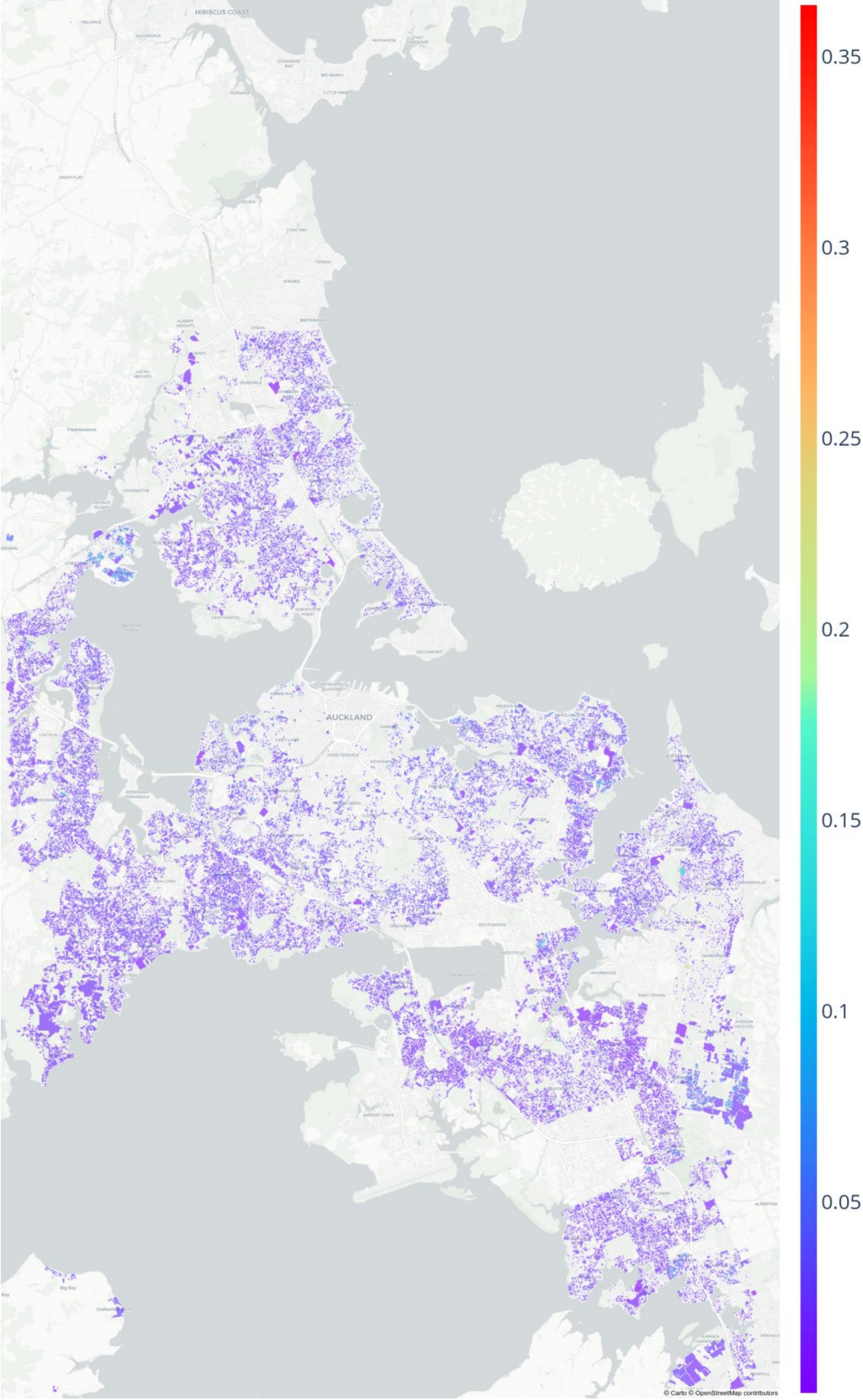
Figure 5: Density plot of probability changes in Dunedin



Source: Authors' analysis. Note density here refers not to population density but density of observations around given ranges of probability.

Figure 6 shows how these changes in probability are distributed across Auckland using the logit model. Note the clusters of higher probability around Flat Bush and Hobsonville. Figures 6-14 can be compared against maps of the possible locations of MRUs in the data section above.

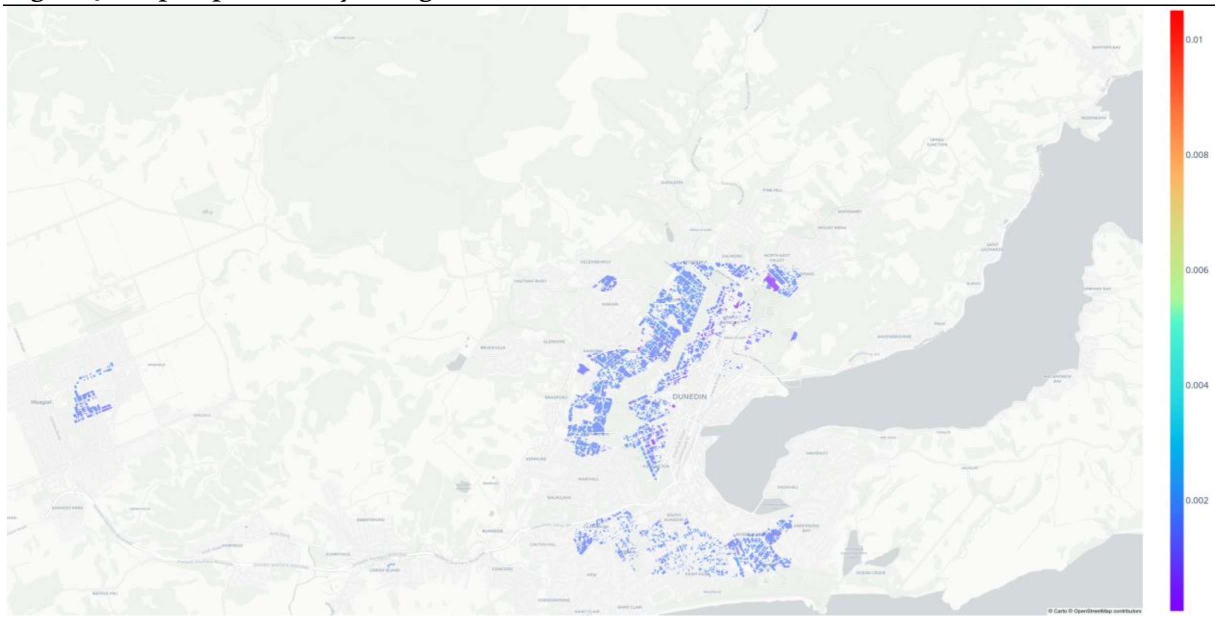
Figure 6: Map of changes in probability in Auckland



Source: Authors' analysis

Figure 7 shows how these changes in probability are distributed across Dunedin using the logit model. Note that the colour scale is different to the Auckland map.

Figure 7: Map of probability changes in Dunedin



Source: Authors' analysis

The change in probability plots, and maps for Timaru and Masterton have been omitted as the estimated effect from the logit model is zero.

Random forest machine learning model

To obtain an alternate set of estimates, we trained a random forest machine learning model on the same variables as in the logit regression model. A random forest is an ensemble learning method that builds multiple decision trees from different bootstrap samples of the training data. Each tree makes predictions based on a random subset of features at each split. For classification tasks, the random forest predicts the probability of an outcome by aggregating the votes from all trees, estimating $Prob[B = 1|x]$. This probability is denoted as $Prob[B = 1|x] = \mathrm{RF}_\theta(x)$, where RF_θ is the aggregated prediction with hyperparameters θ. By taking votes from an ensemble of shallow decision trees, random forests can learn complex non-linear relationships (Breiman, 2001).

The model hyperparameters were tuned with performance assessment by 10-fold cross-validation. The training data in each fold was oversampled, but the model was tested for accuracy on the original proportioned data.

The best-performing model hyperparameters were used to train a final random forest on all data. This was used for predicting the probabilities of MRUs being created on parcels where none currently exist if those parcels were marked as permissible. The probabilities of these parcels to add MRUs was predicted both before and after changing the permissibility as a result of the policy. The difference in predicted probabilities provides our estimate of the proportion of the policy effect associated with resource consents.

For a random forest model, the effect of individual variables cannot be interpreted as they can in the regression model, so this has not been included here. Table 6 shows likely percentage increase in MRUs from removing all regulatory burden costs using our trained random forest model. Using this model, we estimate a significant increase in MRU uptake with 320.42% in Auckland, 76.06% in Dunedin, 25.91% in Timaru, and 0.00% in Masterton.

Table 6: Random forest estimated policy impact

	Low	*Mid*	*High*
Auckland	+224.29%	+320.42%	+416.54%
Dunedin	+53.24%	+76.06%	+98.88%
Timaru	+18.14%	+25.91%	+33.69%
Masterton	+0.00%	+0.00%	+0.00%

Source: Authors' analysis. Figures are percentage increases over the observed rate of MRU development.

The most important features for prediction[10] are:

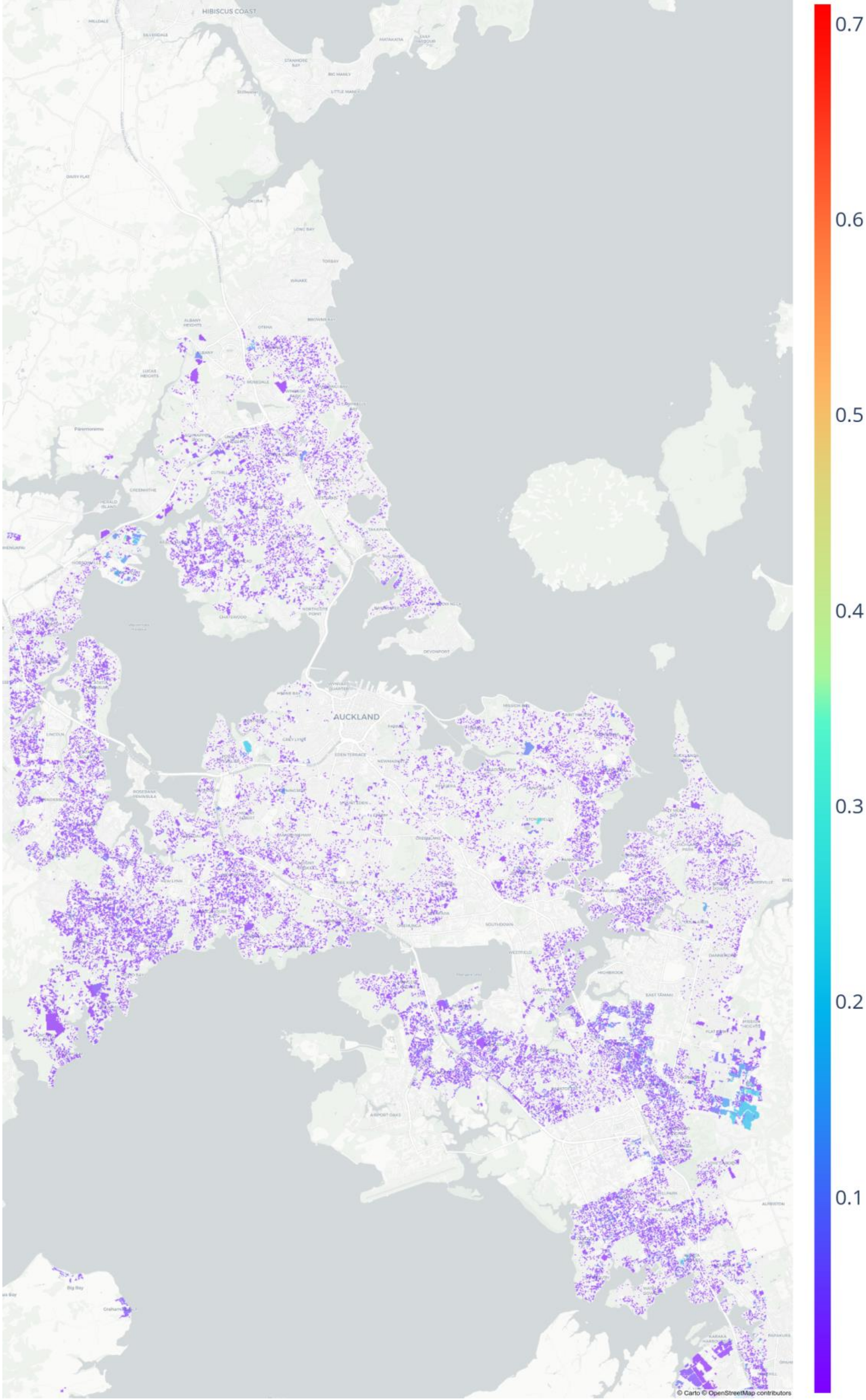
1. *RemainingBuildArea*
2. *LVsqm*
3. *HouseholdDensity*
4. *Permissible*
5. *SpatialLag*

We believe that the estimates from our random forest model are more robust than the estimates in our logit model. This is because the random forest model automatically picks up non-linearities, automatically includes feature interactions, and is trained to be robust to overfitting.

Figure 8 shows how these changes in probability are distributed across Auckland using the random forest model. Similarly to the logit model, there are clusters of increased probability in Hobsonville and Flat Bush.

[10] Using Gini impurity.

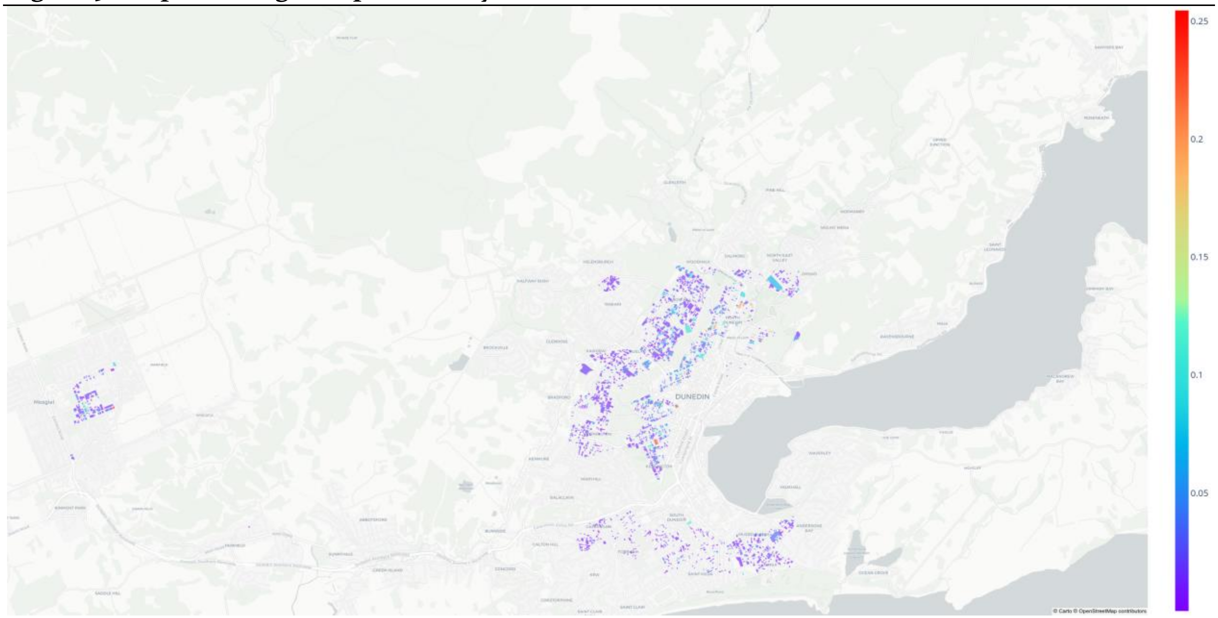
Figure 8: Map of changes in probability in Auckland - Random forest



Source: Authors' analysis

Figure 9 shows how these changes in probability are distributed across Dunedin using the random forest model.

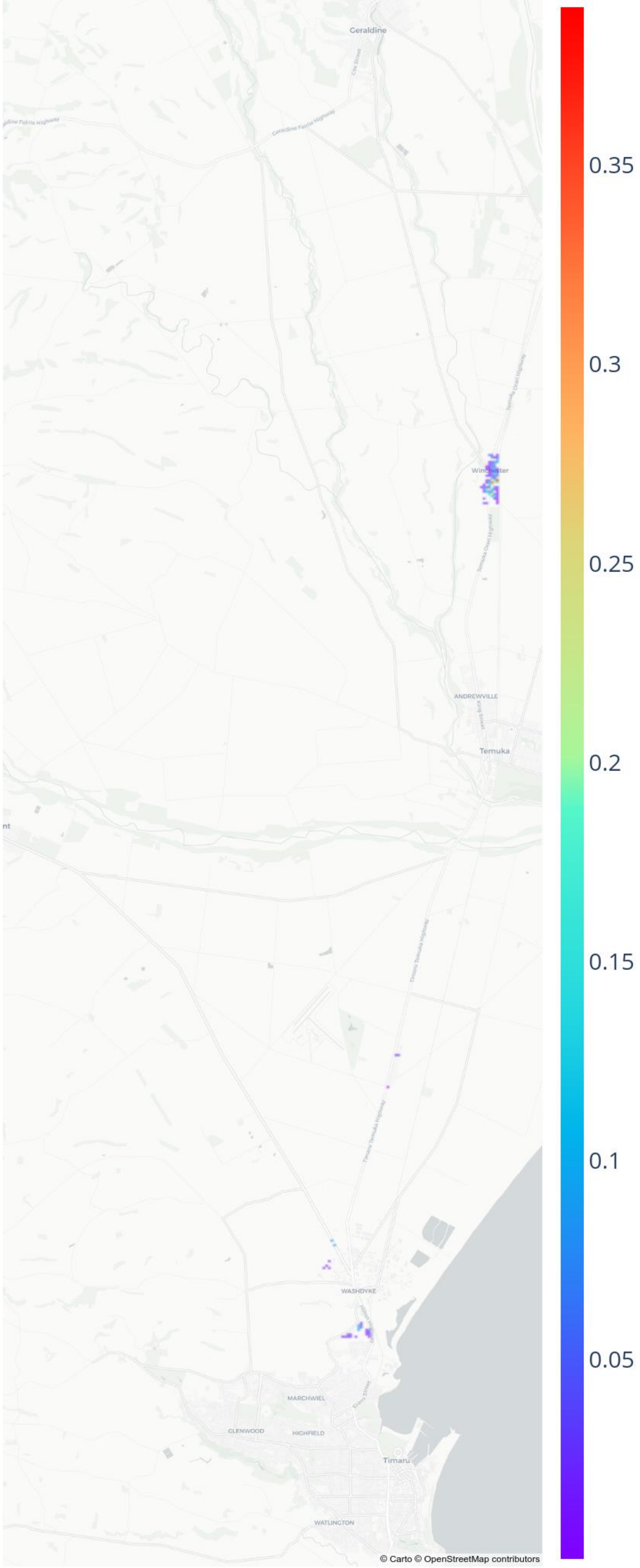
Figure 9: Map of changes in probability in Dunedin - Random forest



Source: Authors' analysis

Figure 10 shows how these changes in probability are distributed across Timaru using the random forest model.

Figure 10: Map of changes in probability in Timaru - Random forest



Source: Authors' analysis

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Limitations

Data limitations

Our analysis raises a few quality issues with the consents data used in our modelling. In consent data received from Pacifecon Building Intelligence, there were many missing values for number of dwellings added and floor area. Moreover, these fields only had data between 2016 and 2023. We did not do a full completeness check to assess the causes of this missing data, or whether the missing data was systematic at all.

The consent data includes consents for 'transportable units'. These are units that are constructed at a depot and then shipped to a final destination. Our analysis of the data showed that there were many consents registered under industrial locations that have similar descriptions and were likely this type of consent. However, while some building consent records include descriptions of relocated transportable dwellings to the site, we do not have consistent data on where the final destinations of these transportable units are. This means that there may be MRUs on land parcels that our data cannot capture, which can in turn affect the accuracy of our results.

Modelling limitations

There may be other viable alternative modelling methods, including models that rely on different assumptions, such as a probit model or other machine learning models. These other methods may yield different estimates for the likely impact of the policy.

Our modelling is based on existing zoning regulations during the period covered by our data. This means that our modelling does not include the effects of future regulations or proposed plan changes.

We have not considered the effects of future demographic or demand changes in our estimates (e.g. aging, ethnic makeup, domestic and international migration trends, etc. We expect that if we were to assess and forecast these influences, migration patterns would be dominant. Areas with strong future net migration would show a greater impact of the policy than estimated here, whereas areas with little or negative net migration would see little change from the current estimates.

We have not modelled parcel slope dynamics in either modelling approach, as a project scoping decision. We do not know without modelling it whether the effect on the estimates would be an increase or a decrease.

We have not distinguished between the several levels of "non-permissible" zoning rules in our dataset, for example, the difference between a "controlled activity" and a "restricted discretionary activity". Instead, we have favoured the simplification of grouping any level of permissibility other than a "permitted activity" into a single category. This is a design choice, partly to minimise fragmentation of our already very rare observations of MRUs compared to observations of no MRU. Splitting our non-permissible group would likely have little effect on the overall estimates (aggregating probabilities to the city level means the variation within non-permissible zones is averaged out in the results) but may influence the spatial distribution of modelled changes in probabilities.

The announcement of a policy like this may itself raise awareness in the population that they could build an MRU, which could influence their decisions. We do not model this but expect if we did the effect would be to increase the estimated impact of the policy.

Conclusion

This report presents our estimation of a DCM to model the decision to build an MRU following proposed changes to The Resource Management Act, and The Building Act. The proposed changes would remove the requirement to obtain a building consent and a resource consent before constructing a minor residential unit of up to 60 square metres in floor area, under certain conditions. We employed two different estimation methodologies: the traditional logit model, and the more contemporary random forest model. The logit model provided clear insights into the relationship between permissibility and MRU construction. However, the random forest model, with its ability to capture complex, non-linear relationships, demonstrated superior predictive performance and flexibility. For this reason, we believe the estimates from our random forest model are more robust than the traditional logit model.

Our findings suggest that while the freedom from regulatory burden costs is not the most important factor in the decision to build an MRU, it can still significantly affect the decision to build an MRU through removing monetary and non-monetary barriers associated with going through the consent process. Our findings also suggest that the potential impact of the policy depends on constraints given by existing zoning regulations as well as demand. Specifically, we estimate that the policy will increase MRU uptake by between 224.29% to 416.54% in Auckland, 53.24% to 98.88% in Dunedin, and 18.14% to 33.69% in Timaru. Our findings suggest there may be minimal to no impact in Masterton. Our wide range of estimates reflect uncertainties and potential incompleteness in consent data, but we are confident that the policy will increase MRU uptake overall across New Zealand, with significant spatial variation in the strength of development responses.

We suggest that in applying these estimates to other territories, analysts align the territory in question to the test case presented here that is most similar in terms of demand and existing constraints and test a range of potential impact levels at least as wide as the range of results we present.

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Restrictions

This report is prepared for the Ministry for the Environment by Crow Advisory. The purpose of this report is to present the results of our estimation of the potential effects of a change in policy on building minor dwellings on residential parcels, and to do this for the sake of supporting the regulatory process, including providing inputs into a Regulatory Impact Statement, Section 32 assessment, or other reports and assessments as needed. The methods and data used in this report have been determined in collaboration with the Ministry and every effort has been made to ensure that they are applied robustly and accurately. However, as with any forecast, the results of this analysis are an estimate of potential impact and may differ from what actually occurs. Crow Advisory will not accept liability for any use of this report other than its intended purpose. The Ministry for the Environment has permission to share this report with other stakeholders and the public as needed to serve that purpose.

Appendix

Permissibility by zone

The way district planning zones are coded in the DVR dataset follows a nationwide standard established in the Ratings Valuation Rules 2008 (LINZ 2010). Within this standard, each territorial authority has discretion to assign their specific zone classifications to the set of available codes. For example, residential codes always begin with the digit 9, but the zone assigned to a specific residential code, such as "9H" may differ by territory. Table 7 below summarises these codes and their permissibility status for building MRUs in our model.

Table 7: Zones and permissibility

	DVR zone code	Local zone name	Permissible
Auckland	9A	Single House	Yes
	9B	Mixed Housing Suburban	No
	9C	Mixed Housing Urban	No
	9D	Terraced Housing & Apartment Buildings	No
	9F	Rural & Coastal Settlement	No
	9H	Large Lot	No
Dunedin	9A	General Residential 1	Yes
	9B	General Residential 2	No
	9C	Low Density Residential	Yes
	9D	Large Lot Residential 1	Yes
	9E	General Residential 1	Yes
	9F	Inner City Residential	No
	9G	Large Lot Residential 1 / Coastal	Yes
	9J	Township and Settlement	Yes
Timaru	9A	Residential 1 / Suburban Residential	Yes
	9B	Residential 2 / High Density Residential	Yes
	9C	Residential 3 / Township	No
	9D	Residential 4 / Low Density Residential	No
	9E	Residential 5 / Future Residential	No
	9F	Residential 6 / Medium Density Residential	Yes
Masterton	9A	General Residential	Area-dependent[11]

Source: Authors' analysis

[11] Parcels were considered permissible if they had sufficient area (>350 sqm) for a second dwelling to be permissible under the current plan rules.