Timely Rental Price Indices for thin markets: Revisiting a chained property fixed-effects estimator

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Abstract

The ‘rentals for housing’ class of New Zealand’s CPI is estimated using a non-revisable property fixed-effects estimator – the FEMS(8y): Fixed-Effects, Mean-Splice, 8 year rolling window – on stock-imputed administrative microdata. The term fixed effects index was introduced by Krsinich (2016), the approach is also known as the Time Product Dummy (TPD) method. Applying the same estimator to raw flow-based administrative data, creates a statistic to track changes in the market price of new tenancies. Monthly series are published around 9 working days after the end of the reference period, using administrative data processed within the reference period. This represents a preference for timeliness over precision given less than half the final data will be available in time for inclusion. The indices are used for near real-time monitoring of the rental market.

In this paper we investigate a potential enhancement that uses more of the data by revisiting the FEMC (Fixed-Effects, Mean-Chain) estimator introduced by Bentley (2018) (2022). The flow series are not a direct input into the CPI, so a publication revisions policy that accommodates revisions to historical estimates is proposed. For revisable timeseries, window chained series may be preferable to spliced series since any revisions, resulting from new data or improved parameter estimates, will be allocated to the correct time period. Benefits are observed empirically during New Zealand’s COVID-19 pandemic recession of 2020, which concurrently disrupted administrative data collection and reduced rental price inflation. In retrospect, a shorter, sharper, impact is observed during the first national lockdown, compared with the more gradual deceleration in inflation recorded in real-time. More generally, chained series were found to be less volatile than spliced series. This property is especially useful for estimating rental price indices for small geographic regions.

This paper uses the FEMC estimator and proposes a coherent practical approach to publication of timely rental price indices for national and broad regions, alongside small regions with thin rental markets. The strategy includes using a ‘flash data subset’ for provisional estimates to minimise potential revisions bias, whilst maximising the use of data once this becomes available. Differential reporting lags and rolling up monthly data are also proposed for some regions, dependent on the size of the rental market.

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1 Introduction

Publication revision policies for Consumer Price Indices (CPIs) typically constrain the first published estimates to be final.[1] The constraint ensures that first published period-on-period change can be used for indexation of monetary payments with the confidence that the official estimate will not change. However, the convention has a cost in terms of statistical quality. The *CPI Manual: Concepts and Methods* (ILO et al, 2020) notes *"the lack of revisions may create a somewhat spurious impression of certainty, but it also seems to enhance the credibility and acceptability of the index"*. In practice, the 'no revisions' constraint has been given such importance that it is often incorporated into the design of multilateral price index methodology. For example, the Fixed Effects Window Splice (FEWS) estimator uses a window splice to simultaneously resolve the dual issues of extending multilateral estimates beyond a single data window and dealing with revisions to model parameter estimates without changing historical timeseries (Krsinich, 2016).

However, for many statistics an 'open revisions' policy - which accommodates additional data as this becomes available, and revisions to parameter estimates as timeseries grow - is both possible and desirable. De Haan and Van De Laar (2021) discuss the desirability of statistical revisions in the context of multilateral price indexes, noting: *'Revisions can be a nuisance to users but are not necessarily a "bad" feature; the use of more data can improve the efficiency of the estimators'*. The dissemination of many official statistics, including some non-CPI price indices, is accommodating of revisions. Users regularly accept revisions in other economic statistics (ONS, 2016; Carson et al, 2004), including House Price Indices (Silver, 2016). Eurostat et al, 2013, suggest that *'it will generally be desirable to allow stock RPPIs [Residential Property Price Indices] to be revised'*. Even when official CPIs are not revised, many countries produce analytical series from time to time to provide users with an indication of the potential bias of not using alternative price index formulae and revising the index (Stats NZ, 2020; Clews et al, 2014; Shoemaker, 2013).

1.1 Rental price indices

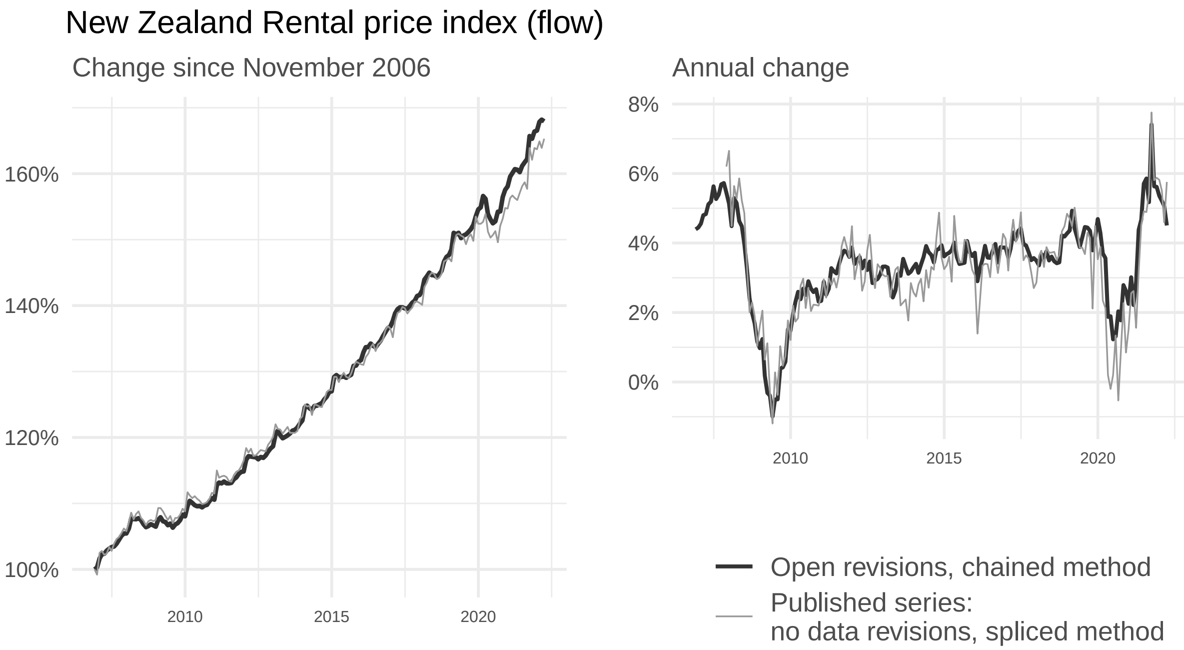
In this paper we will use New Zealand rental price data to better understand and quantify some of the costs of a 'no revision' policy, in the context of a multilateral property fixed-effects (or Time Product Dummy) price index. Since the second quarter of 2019, the 'rentals for housing' class of New Zealand's CPI has been estimated using a non-revisable model-based estimator – the FEMS(8y): Fixed-Effects, Mean-Splice[2], 8 year rolling window – on stock-imputed administrative microdata, Stock-i-FEMS(8y). The stock-imputation estimates the currently paid rent for the entire rental stock. Applying the same estimator to raw flow-based administrative data (without stock imputation), Flow-FEMS(8y) has created a new official statistic to track changes in the market price of new tenancies. The latter series, a *flow Rental Price Index (RPI)*, is used as a leading indicator of rental price inflation and is used for near real-time monitoring of the rental market.

The *flow RPI* is currently published using the CPI convention of no revisions to historical timeseries. This constraint is due to the statistic being created as part of research into CPI rent, but since the *flow RPI* is not itself an input into the CPI it is a candidate to be published with a relaxed policy of 'open revisions' across the entire timeseries. The consideration is pertinent for the *flow RPI* since timeliness is a key dimension of quality which lead to a publication schedule where less than half the final data will be available in time for inclusion. Fig. 1 shows the cost of a no revisions policy, in terms of reduction in statistical reliability, for the New Zealand RPI. Long run accuracy doesn't appear too affected by the timely publication schedule (series are published about 9 working days after the reference period), yet the precision of the historical timeseries would be noticeably improved by incorporating data and model parameter revisions.

[1]OECD (2022a) reports that a few OECD countries (e.g. Austria) have an explicit revision policy to publish a preliminary CPI and then revise the index after some fixed periods (usually one to three months). National CPIs also tend to update the index reference period from time to time, which changes the numerical index numbers but not the information content in terms of estimates of price change between periods.

[2]We use the terms *Mean-Splice* and *Mean-Chain* to refer to the *geometric mean* splice and chain methods defined in equations 3 & 4 (see Section 2).

Figure 1: More precise RPI with an open revision policy



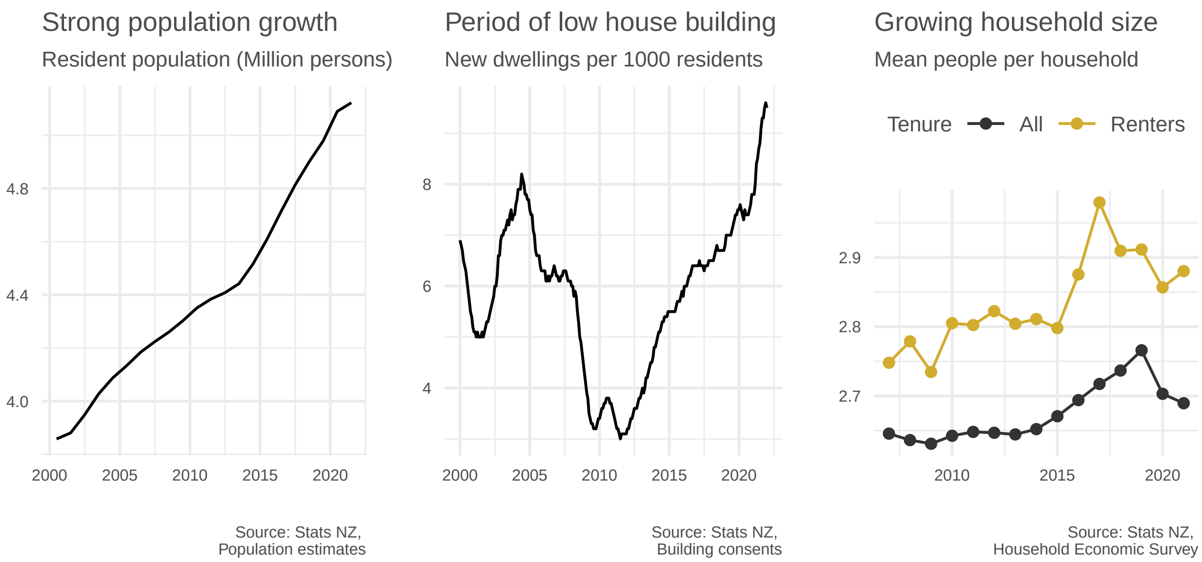
Rental price statistics are of considerable public interest. In New Zealand, housing costs and inflation are two top issues of concern today (Ipsos, 2022). New Zealand house prices increased an eye watering 29.9% in the year to October 2021 (REINZ, 2021) which has implications for wealth inequality (Symes, 2021) and financial stability risks (Brunton, 2021). Yet, arguably, from a wellbeing perspective, rental prices may matter more, because low-income renter households have little discretion over their level of housing expenditure, since "housing costs generally make the first claim on disposable income" (Stone, 2006), or, as Matt Desmond put it, "the rent eats first" (Desmond, 2016, as cited in Herbert et. al., 2018). In New Zealand, rental prices are receiving growing attention as the proportion of people and households who pay rent has been increasing since the early 1990s; homeownership rates have fallen. Renters typically have lower incomes than owner-occupiers, spend a greater share of their income on housing, and have lower material wealth (Bentley, 2021). New Zealand rental properties are typically of lower physical quality compared with owner-occupied properties. On average, rentals are smaller and more likely to be crowded, in a poorer state of repair, less healthy and less conducive to stable tenure (NZ Treasury, 2022). OECD rental affordability statistics show that in 2019 New Zealand had the highest rate of housing costs overburden among low-income private-sector tenants in the OECD (OECD, 2022b)[3]

Rent (actual rentals for housing) is one of the most important components of consumer price indices. In New Zealand, rent is about 10 percent of the Consumers Price Index (CPI) by expenditure weight. For households who pay rent, the proportion of their expenditure on rent is typically 30-40 percent. In many other countries, the contributions of rent price indexes in CPIs are amplified through their use as a proxy for owner-occupied housing costs (a 'rental equivalent' approach), as well as representing actual rent prices.

New Zealand experienced rapid population growth over the past two decades that hasn't yet been matched by an increase in the construction of new dwellings of a similar magnitude (shown in Fig. 2). People per household increased from a mean of 2.65 to 2.77 between the years to June 2014 and 2019. For renters, who on average have more people per household, the comparable increase was from 2.81 to 2.91. These statistics are evidence of an imbalance between supply and demand, during the period 2014–19, which has contributed towards upward pressure on rents (Brunton, 2021). These pressures may have eased somewhat in the past couple of years (2020–21), as population growth has slowed and dwelling construction has increased.

[3]Share of population in the bottom quintile of the income distribution spending more than 40% of disposable income to pay for rent at market price on the private rental market. Data for 2019 reports a rate of 56% for New Zealand compared with a rate of 33.4% for the OECD as a whole.

Figure 2: Rental price pressures in New Zealand

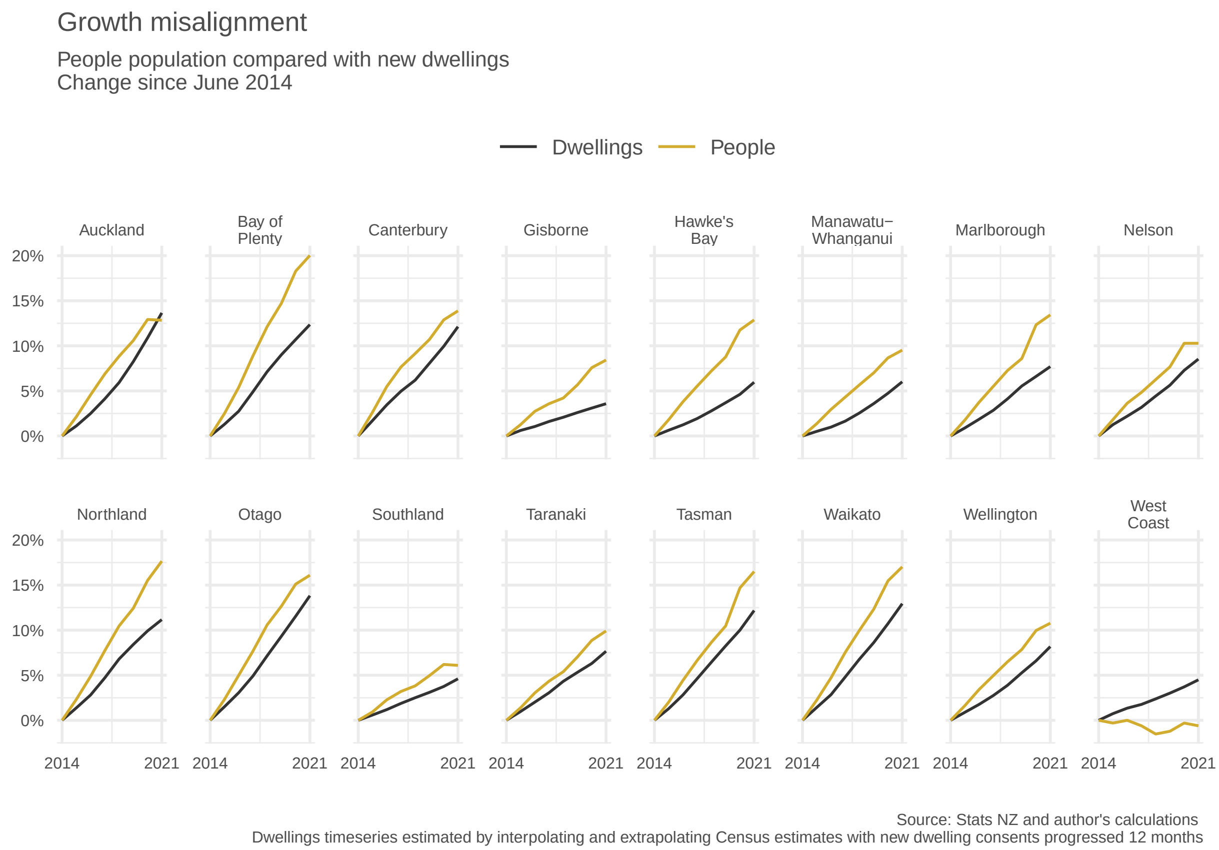


1.2 Need for subnational RPIs

Regional rental price indexes are important for timely monitoring, and potential policy responses, by central or local government. The National Policy Statement on Urban Development (New Zealand Government, 2020) aims to ensure that New Zealand's towns and cities are well-functioning and liveable urban environments that meet the changing needs of diverse communities. As part of the statement's requirements, local authorities are directed to monitor quarterly, and report annually, on rental prices. The Government Policy Statement on Housing and Urban Development (New Zealand Government, 2021) further advocates for taking a 'place-based approach' which requires understanding the different challenges and opportunities facing each place, and what is driving housing and urban outcomes in places. Fig. 3 shows the misalignment in regional council areas of New Zealand between the growth in people population and new dwellings between June 2014 and June 2021.[4] In lieu of subnational RPIs, changes in median or geometric mean weekly rental costs, as published by the New Zealand Ministry of Business, Innovation and Employment, (MBIE, 2022), are often used to track changes in rental prices. However, these series are not ideal as they are not quality-adjusted price indices (i.e. there is no method to account for changes in the quality of rental properties). We show comparisons between our proposed regional RPIs and geometric mean rental amounts in Section 4.3 'Validation of results'.

[4]Dwellings timeseries estimated by interpolating and extrapolating Census estimates with new dwelling consents, progressed 12 months to allow for the time lag between consent to completion. Extrapolated consents have been multiplied by a factor of 0.97, to account for consented dwellings that are not build. These factors were informed by Stats NZ (2017).

Figure 3: Regional misalignment between growth in people population and new dwellings



To support these Government priorities, relating to housing and urban development, Stats NZ has been exploring the feasibility of constructing regional RPIs for 16 Regional Councils, and 67 Territorial Authorities. Current publication of subnational RPIs is limited to 5 broad regions (Auckland, Wellington, Rest of North Island, Canterbury, Rest of South Island). Researching ways to reduce the volatility of estimates that can be created using all available data, under an accommodating open revisions policy, is particularly important for smaller geographic regions with thin rental markets (those with a small number of rental properties).

The remainder of this paper is as follows. Section 2 describes the rolling window property fixed-effect estimators used: a *mean-splice*, when a revision constraint (of no revisions) is adopted; and a *mean-chain*, when revisions are permissible. Section 3 describes the New Zealand administrative data used, including describing real-time availability and known biases. Section 4 presents empirical results which demonstrate the precision gain using the chain estimator, both nationally and subnationally, and addresses ways to minimise revisions. The plausibility of our novel subnational indexes are checked with reference to correlates of rent. Section 5 concludes.

2 Rolling Window Property Fixed-Effect Estimators

We explore rolling window property fixed effects estimators. The term fixed effects index was introduced by Krsinich (2016)[5], the approach is also known as the Time Product Dummy (TPD) method.

Two window extension methods are considered:

- a *mean-splice*, when a revision constraint (of no revisions) is adopted;
- and a *mean-chain*, when revisions are permissible.

Within a given data window, the estimating equation is:

$$\ln p_i^t = \alpha + \sum_{t=1}^{T} \delta^t D_i^t + \sum_{i=1}^{N-1} \gamma_i D_i + \varepsilon_i^t \tag{1}$$

where: p_i^t is the price p of property i at time t; $D_i^t = 1$ if a price for property i is observed at time t and $= 0$ otherwise; $D_i = 1$ if the observation relates to property i and $= 0$ otherwise; α, δ_t and γ_i are regression estimates and ε_i^t is an error term; dummies for item N and period 0 are excluded to identify the model.

The index is derived from the estimated parameters on time; price change between period 0 and period t can be expressed as:

$$P_{fixed-effects}^{0,t} = \exp(\hat{\delta}^t) \tag{2}$$

2.1 Joining multilateral price estimates

To extend timeseries beyond a single data window, including to append additional windows of data as these become available in real-time, it is necessary to choose a method to join multilateral price indices. Bentley (2022) introduced new terminology to distinguish two aspects of joining multilateral price estimates using rolling windows of data. We adopt this terminology and consider a **mean-spliced** estimator if a revision constraint *is* required; and a **mean-chain estimator** if a revision constraint *is not* required.

2.2 Mean-splice estimator

Without revising historical timeseries we use a mean-splice. Defined as:

$$P_{MeanSplice}^{w,w+1} = \frac{P_{NEW}^{w+1}}{P_{NEW}^{w}} \times \left(\prod_{t=2}^{w-1} \frac{P_{NEW}^{w}/P_{NEW}^{t}}{P_{OLD}^{w}/P_{OLD}^{t}} \right)^{\frac{1}{w-2}} \tag{3}$$

where P_{OLD} is the index computed over periods 1 to w (the window length), and P_{NEW} is the index computed over the window rolled forward one period, from periods 2 to $w+1$.

The first term is the movement splice estimate and the second term is the revision factor. Using a revision factor in the latest time period helps to ensure that the long-run index is not biased should the model tend to be revised in a common direction (up or down) as additional data becomes available (see Krsinich, 2016). The downside to adopting this approach, is that the period-on-period change now reflects both the observed change between the periods at hand, and a bias correction (revision) factor.

[5] As a component of the 'fixed effects window splice' (FEWS) index, which argued for the importance of the splicing aspect to ensure that the FE (or TPD) indices are not systematically biased by consistently omitting the effect of new products each period.

2.3 Mean-chain estimator

Relaxing the revision constraint, we can use a mean-chained estimator. The mean chain aligned index between periods $t-1$ and $t+1$ can be expressed as:

$$P_{MeanChain}^{t-1,t+1} = \prod_{v=1}^{V} \left(\frac{P_v^t}{P_v^{t-1}} \right)^{\frac{1}{V}} \times \prod_{v=1}^{V} \left(\frac{P_v^{t+1}}{P_v^t} \right)^{\frac{1}{V}} \tag{4}$$

where P_v^t is the index value at time t computed using data of vintage v, over the periods $1+r$ to $w+r$, where the period rolled forward r increases by 1 for each successive vintage (a generalisation of P_{OLD}, where $r=0$, and P_{NEW}, where $r=1$, to consider 3 or more vintages of data).

Revisions, resulting from new data or improved parameter estimates, will be allocated to the correct time period.

In keeping with the pragmatic choices of Bentley (2022), and as implemented in the New Zealand CPI, we use data windows of 8 years.[6]

3 Data

Landlords in New Zealand can ask tenants to pay a monetary bond as security when they move into a property. Landlords who charge a bond must lodge it with the Ministry of Business, Innovation, and Employment's (MBIE's) Tenancy Services within 23 working days. The Bond lodgement form (which can be completed online or by post) includes a requirement to state the weekly rent payment. Other data captured includes the dwelling address, dwelling type (such as room, flat, house), and the number of bedrooms. A unique property identifier is created as part of the administrative process.

The dataset used for this analysis covers private sector bonds lodged during the, 25 year, period 1 Jan 1997 – 31 Mar 2022. It contains 3.6 million price observations, for 930,000 unique properties. Bentley (2021) explains the dataset further.

3.1 Availability of data in real time

A feature of this data is that there is a time lag between tenancies starting and being included in the available data. To create real-time summary statistics, there is a quality trade-off between reliability (accuracy and precision) and timeliness.

The Residential Tenancies Act 1986 allows up to 23 working days for bonds to be lodged. Processing times can typically add another 5-10 days before inclusion in the dataset. Over the past 10-years, the median lag between tenancy start date and bond lodgement date is 21 days (mean: 30 days). Critically, as noted by Olsen (2021), there appears to be a bias for higher value rentals to be processed sooner so early estimates of average weekly rental amounts tend to get revised down once additional data becomes available. On average, during the period September 2011 - September 2021 (the most recent 10 years of finalised data) the initial estimate of geometric mean weekly rent is 2.6% higher than final estimate (using all available data) (0.7% higher using data 28 days after the reference period; 0.2% higher after 56 days). Shown in Fig. 4 (right panel), since 2005 there appears to be an increasing trend in the bias of initial estimates of geometric mean weekly rent. With this knowledge it is reassuring the that current price index estimation procedure (FEMS estimator and no revisions policy) controls for nearly all this bias (as shown in Fig. 1).

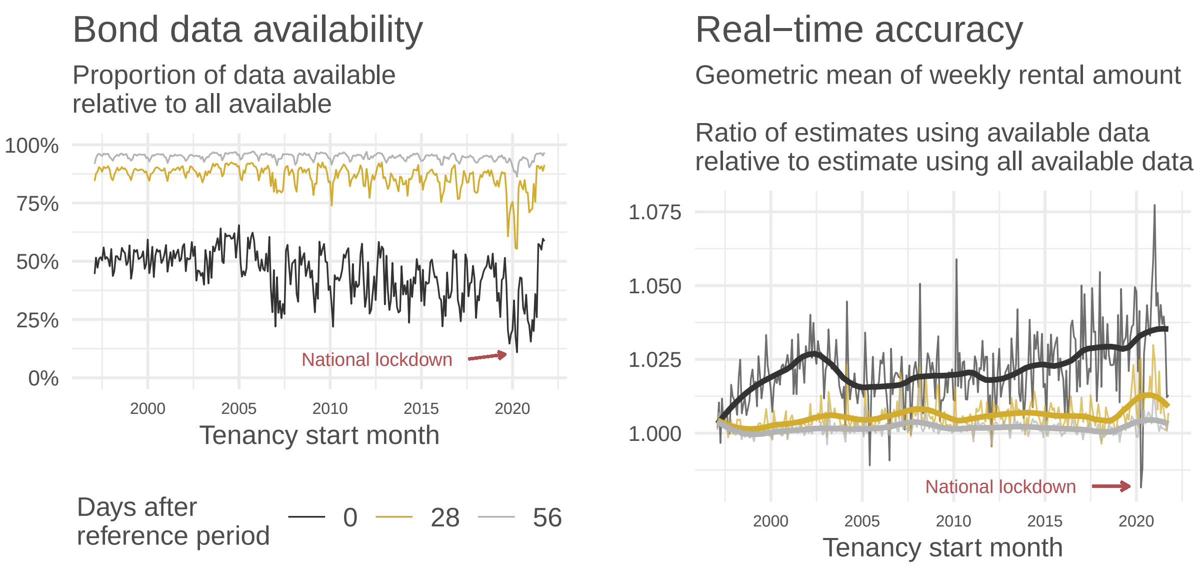
On average, about 40% of bonds are processed within the reference period (Fig. 4 left panel), which is the current cut-off for data to be delivered to Stats NZ for inclusion in the RPI calculation (labelled as 0 days

[6] The 'rentals for housing' class of New Zealand's CPI is estimated using a non-revisable property fixed-effects estimator – the FEMS(8y): Fixed-Effects, Mean-Splice, 8 year rolling window – on stock-imputed administrative microdata.

after the reference period). Many tenancies that commenced in the most recent month will not have been lodged and processed in time to be included in the initial data.

Fig. 4 also shows the impact of New Zealand's first national lockdown in response to the COVID-19 pandemic during March and April 2020. A smaller than usual number of bonds were processed within the reference period, and, in a change to the usual pattern, more lower-value rentals appear to have been newly lodged at this time.[7]

Figure 4: Real-time availability of data



Regional patterns of data availability and real-time accuracy of geometric mean weekly rental amounts are shown in Appendix Fig. A1.

4 Results

4.1 New Zealand

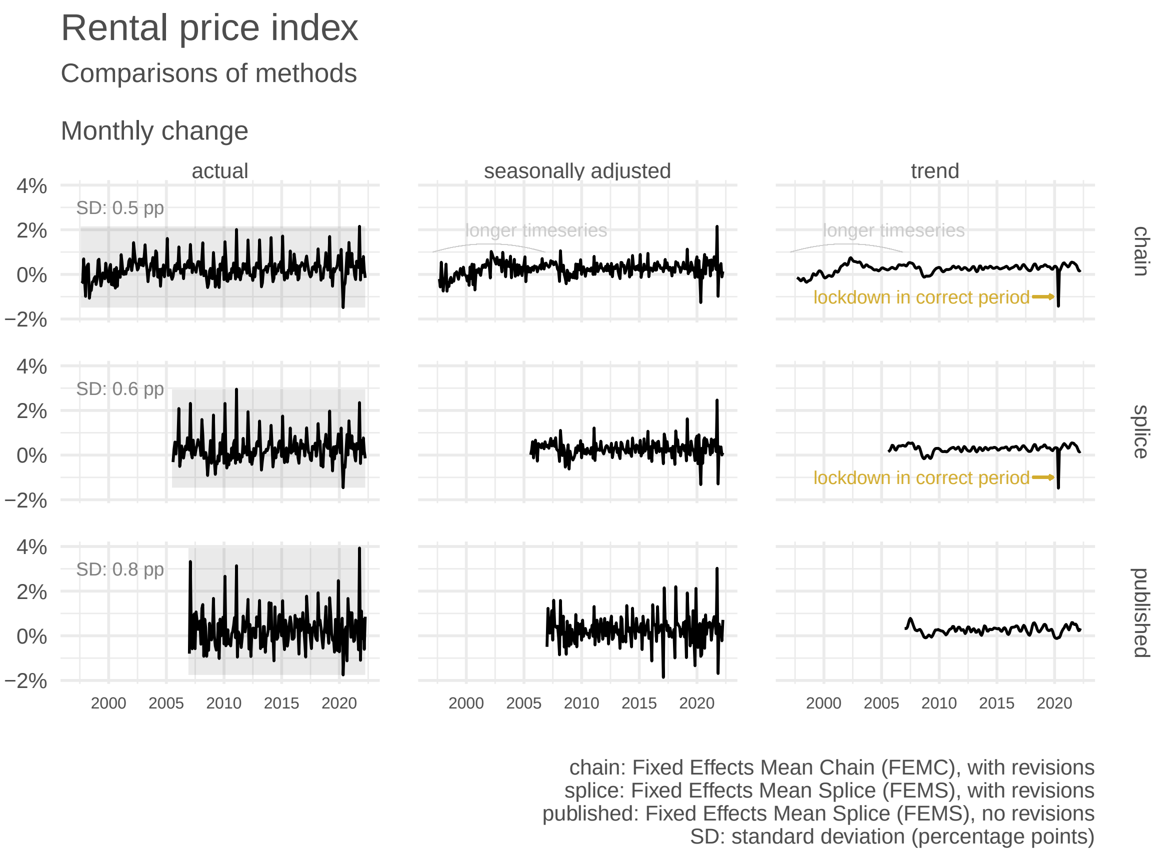
Shown in Fig 5. (left panel: 'actual'), the volatility of month-on-month changes in the New Zealand RPI was found to reduce by incorporating revised data, once this becomes available (the standard deviation in monthly change decreased from 0.8 percentage points to 0.6 percentage points). A further gain is precision was obtained by using the mean-chain (FEMC), rather than mean-splice (FEMS) estimator (the standard deviation in monthly change was 0.5 percentage points with the FEMC).

We also found ways to extend the historical timeseries. Two years can be gained simply by decoupling the design of the *flow RPI* from the *stock RPI* (used for the CPI). The stock-imputation requires two years of back data before the start of the index timeseries. Like the current adoption of a consistent 'no revisions' policy across stock and flow series (described in Section 1), the timeseries both commence in 2006. More significantly, as noted by Bentley (2022), an advantage of the mean-chain methodology is that an estimate is generated for all time periods, contained in any window. This extends the timeseries a further 8 years (the length of the 1st window).

[7]In response to the COVID-19 pandemic New Zealand moved to 'Alert Level 4 - Lockdown' of the COVID-19 Alert System at midnight 25 March 2020 until midnight 27 April 2020 (New Zealand Government, 2022). This is the most restrictive level which put the entire country into self-isolation with significant restrictions on gatherings, work, and travel.

It is noted that on a seasonally adjusted basis similar gains in precision were found incorporating data revisions and moving from the FEMS to FEMC estimators. Looking at the trend series (obtained as part of the seasonal adjustments), a shorter, sharper, impact is observed during the first national lockdown in April 2020, compared with the more gradual deceleration in inflation observed in real-time (as reported in the published series, using the non-revisable FEMS).

Figure 5: Comparison of rental price index estimates



4.1.1 Method to reduce systematic revisions

The current application of a no revisions policy limits the amount of data used. However, a benefit to this approach is that a *consistent* early subset of the data is used. This helps to mitigate bias arising from systematic processes which affect what type of properties (and average weekly rental amount) are processed before the cut-off date (as discussed in Section 3).[8]

To provide early estimates for top level RPI regions, on the existing publication schedule, it will be necessary to continue this process of using a consistent subset to provide initial monthly *flash estimates* of rental price change. Fig. 6 shows that full data initial estimates are biased downwards (the red dots, which indicate the initial estimates using data available at month end, are almost always lower than subsequent estimates shown in black or grey). That is, they almost always get revised upwards once additional data becomes available. In contrast, Fig. 7 shows that using a *'flash data subset'* minimises potential revisions bias.

It is therefore proposed that a *'flash data subset'* is used to estimate the initial monthly estimates for top level regions. These can be spliced onto the full data estimates which can be use for all but the initial monthly

[8]There is a risk that the early subset of data may lose this consistency in the event that the administrative data generation processes change.

estimates for top level regions.

Figure 6: Systematic revisions to initial estimates using full data

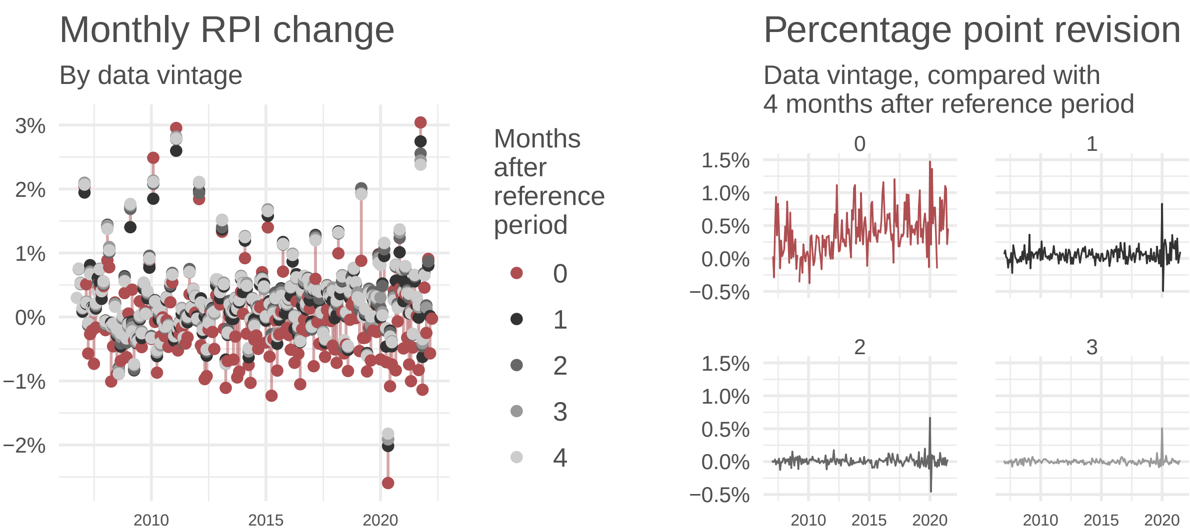
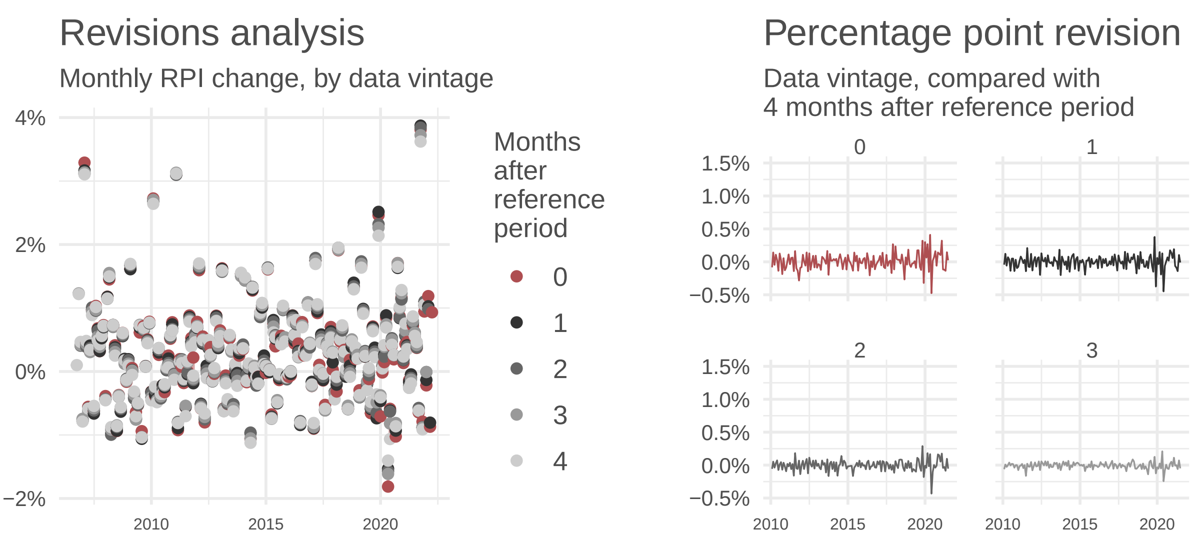


Figure 7: Random revisions to initial estimates using consistent 'flash data' subset



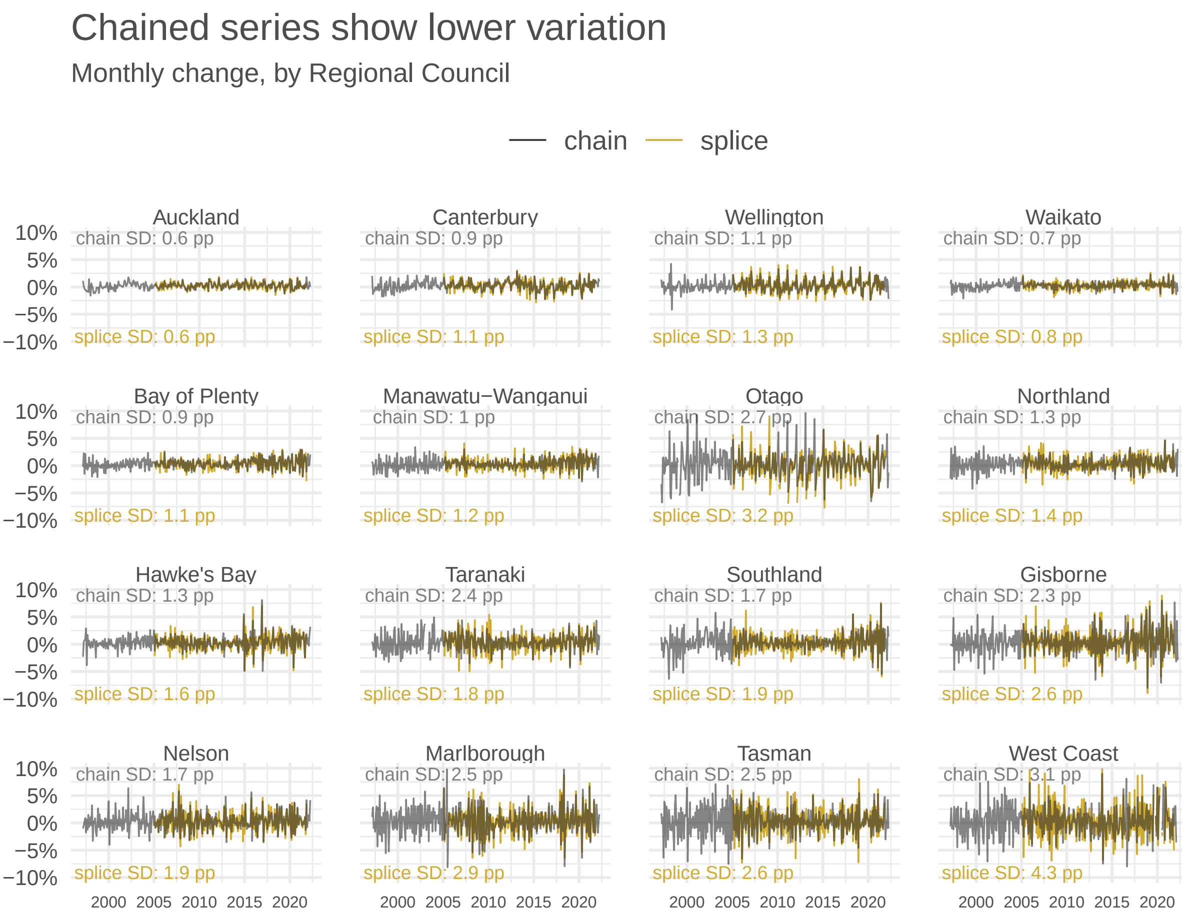
4.2 Sub-national indices

New Zealand has two levels of local government: 16 Regional Councils and 67 Territorial Authorities. There is a large variation in size between these regions: Auckland is the largest region (it is both a regional council and territorial authority) with about 1.7 million people and 200,000 rental properties; the West Coast is the smallest regional council with about 33,000 inhabitants and 4,000 rental properties; Kaikoura District, the smallest Territorial Authority considered in this study,[9] has a population of about 4,000 people and 500 rental properties.

[9]Chatham Islands Territory was deemed too small for inclusion with less than 1,000 inhabitants and little over 100 rental properties.

Fig. 8 compares the RPIs for Regional Councils using chain and splice methodologies. The precision gain from using a chain, rather than splice, method is apparent in the regional RPI series.

Figure 8: More precise regional RPI with chain methodology (which an open revision policy allows)



4.2.1 Treatment for thin markets

Given the very thin rental market for small regions of New Zealand we have devised a practical approach to allow timely publication. The following is proposed:

- National and broad region RPIs will continue to be published on the existing timescale (about 9 working days after the reference period), with an open revisions policy.
- RPI for additional sub-national breakdowns will be published with an additional one-month lag (publication about 1 month and 9 working days after the reference period), to allow sufficient data to have been processed.
- Carry-forward rental amounts for 3-months in small geographic areas, regions with less than 15,000 rental properties, to create sufficient monthly sample sizes.

These proposals build on each other to create a design strategy to maximise the value of the statistics. RPIs for each region are disseminated as soon as sufficient data is available, with quality improving as additional data becomes available.

Each of the nine largest Regional Councils have more than 15,000 rental properties so will use actual monthly data. Together these nine regions contain about 91% of all rental properties. The six largest Territorial

Authorities, representing about 58% of rental properties, will use actual monthly data.

4.2.1.1 First publish regional breakdowns about 6 weeks after reference period

Using the data available after one month allows for publication about 6 weeks after the reference period. The existing publication schedule would remain, with additional regional information available with a one month lag. The approach, with differential timeliness at different levels of regional aggregation, is necessary to achieve timely publication of data, as soon as sufficient data is available.

For a reliable index estimate a minimum sample size is required. At the current level of publication (national and 5 broad regions) the minimum sample size is about 170 properties per month. Disaggregation to smaller regions will naturally result in small samples of properties. One way to increase the available sample size is to wait for more data to become available.

Shown in Table 1, using the data available at the end of the reference period (zero days from the end of the reference period; the current approach) only about 37 (out of 67) Territorial Authorities would have a minimum sample size of 3 properties. It would not be possible to calculate reliable indexes for many regions. Only 14 Territorial Authorities would have a minimum of 10 properties. Waiting an additional month (28 days) would boost samples sizes to enable 53 and 39 Territorial Authorities to have minimum sample counts of 3 and 10 properties, respectively.

Table 1: Number of Territorial Authorities meeting minimum sample criteria

Days from reference period	Minimum 10 monthly observations	Minimum 5 monthly observations	Minimum 3 monthly observations
0	14	27	37
7	24	35	43
14	29	41	47
28	**39**	**46**	**53**
56	41	49	59
84	41	50	59

Further to the minimum sample size criteria (Table 1), we can consider an indicator of typical quality using the average minimum sample size per period, over the past 10-years. This is an indicator of typical quality given the standard relationship between sample size and variability. Shown in Table 2, the largest gains in quality occur over the first 28 days after a reference period as the sample builds (due to addition bonds being lodged and processed immediately after the reference period).

Table 2: Number of Territorial Authorities meeting average sample criteria

Days from reference period	Minimum average 50 monthly observations	Minimum average 30 monthly observations	Minimum average 15 monthly observations
0	15	26	42
7	18	35	44
14	26	37	50
28	**34**	**42**	**53**
56	37	42	54
84	37	43	54

4.2.1.2 Carry-forward rental amounts for 3-months in small Territorial Authorities

Waiting 28 days after the reference period helps address the smaller regional sample sizes. However, the rental market is so thin in some districts that even after a one-month lag reliable estimates can not be obtained on a monthly frequency. The sparse data problem is a critical limitation in 14 Territorial Authorities, where the index methodology fails to compute.

It is proposed that smaller regions carry forward observed rental amounts for 3 months (this 'rolls up' three months of data for each monthly time period). This boosts samples sizes (decreasing variance) at the expense of temporal accuracy. Shown in Table 3, using rolling 3-monthly data, one month (28 days) after the reference period, it is possible to calculate indices for all Territorial Authorities, except Chatham Islands Territory). These 66 Territorial Authorities will have a minimum average sample size of at least 15 observations.

Table 3: Rolling 3-monthly data - Number of Territorial Authorities meeting minimum sample criteria

Days from reference period	Minimum average 15 rolling 3-month observations	Minimum average 30 rolling 3-month observations	Minimum average 50 rolling 3-month observations	Minimum 3 rolling 3-month observations	Minimum 5 rolling 3-month observations	Minimum 10 rolling 3-month observations
0	57	45	37	67	51	41
7	62	51	42	67	59	49
14	64	55	45	67	61	51
28	**66**	**59**	**51**	**67**	**65**	**60**
56	66	63	53	67	66	63
84	66	63	53	67	66	63

4.2.1.3 Defining small regions

A practical challenge is determining which regions it is necessary and desirable to use 3-monthly data; 'small' regions. Some regions can not be calculated using only actual monthly data. For others, the volatility is very high which may affect credibility of the series (and regional RPIs more broadly). Ultimately, the maximum acceptable volatility is a judgement call. The following principles were used to guide decision making:

- Only rolling the data if necessary
- Avoid publishing highly volatile series, as they may be misleading
- Aiming for an enduring solution (not needing to revisit the size designation often)

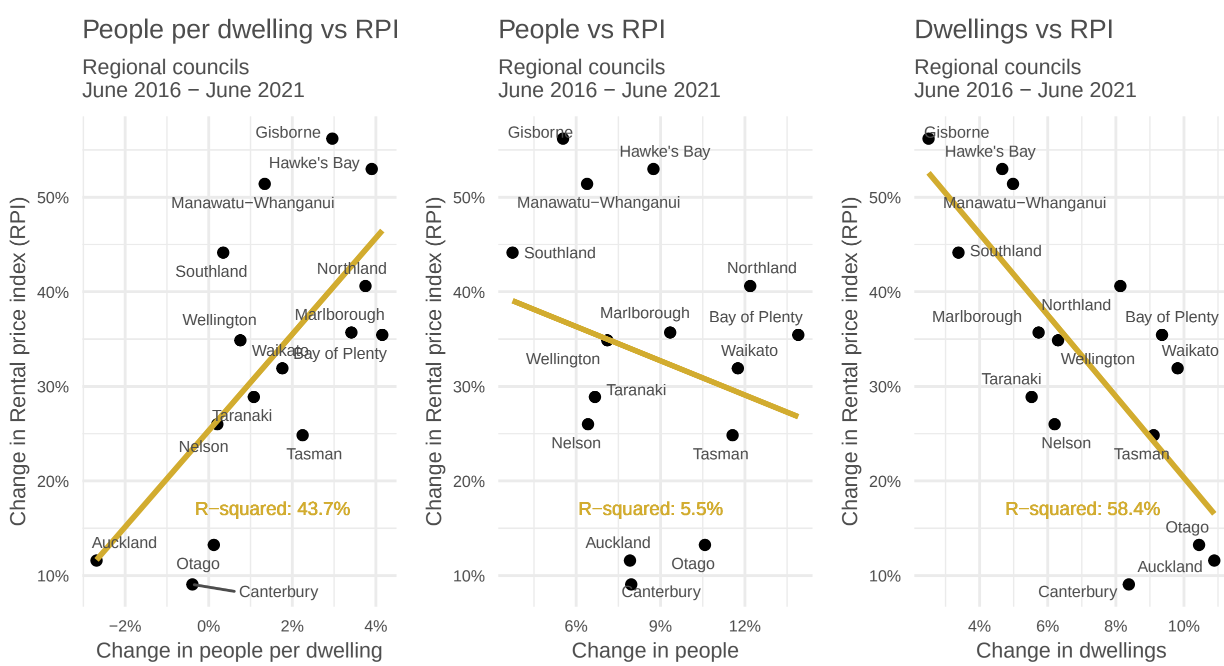
It is proposed that regions with 15,000 rental properties or more be designated as 'large', and regions with less than 15,000 rental properties will be designated as 'small'. 'Large' regions will use actual monthly data, 'small' regions will use a rolling 3-months of data. About 91% of rental properties will be in a 'large' region and therefore be reported using actual monthly data.

The choice of 15,000 rental properties as the criteria is pragmatic, balancing the specified decision principals. Furthermore, the threshold is based on analysis of sample volatility using calculated standard deviations of monthly change and visual inspection of timeseries graphs. Appendix Figs. A2 & A3 and Table A1 show the design choices at the regional council level.

4.3 Validation of results

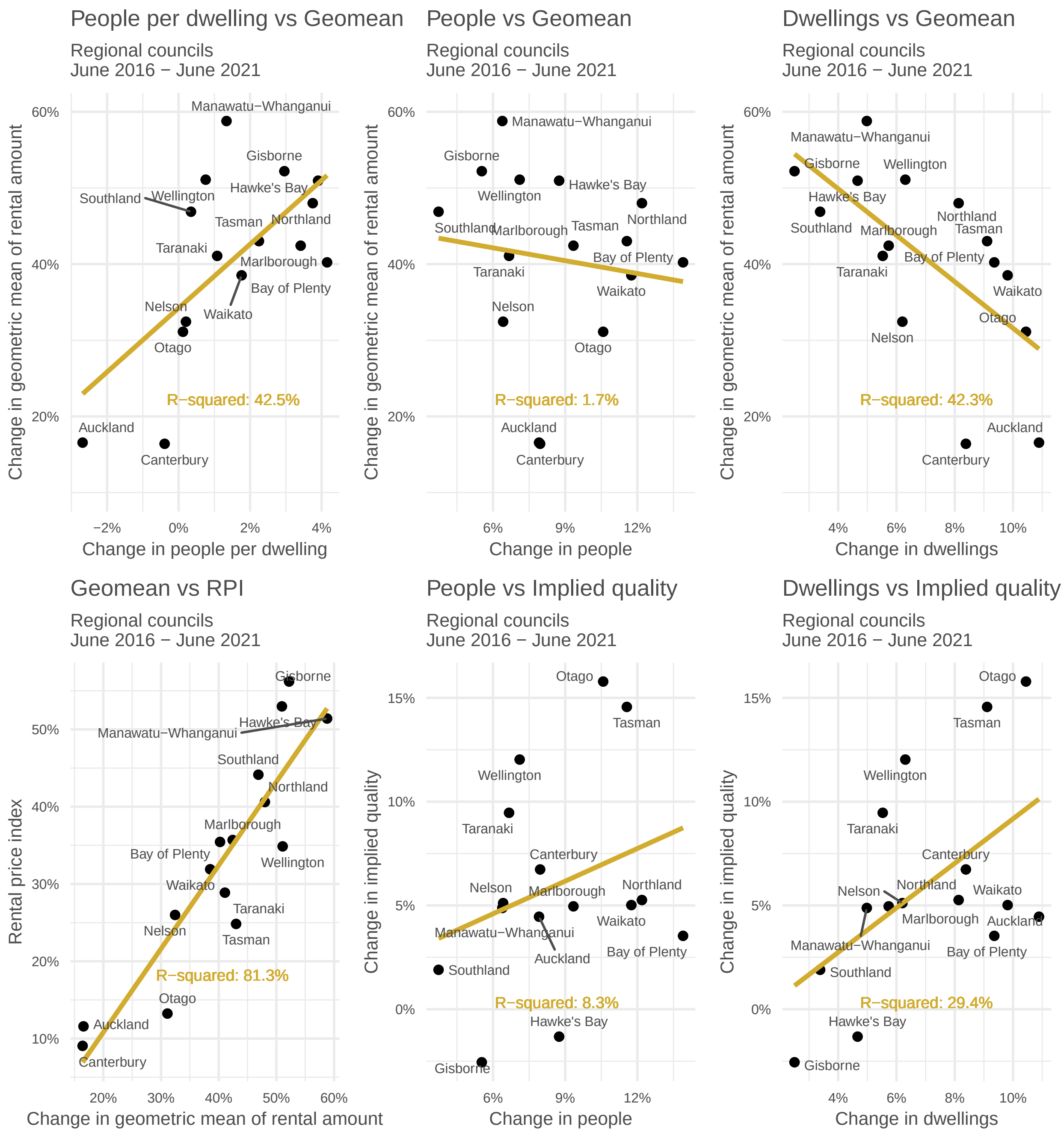
Several authors have suggested an imbalance between housing supply and demand may be indicated by changes in the number of people per dwelling/household, among other things (e.g. Brunton, 2021; Saunders and Tulip, 2019). All else equal, this will contribute upwards pressure on rental prices. As a plausibility check on the validity of our new regional rental price indices, Fig. 9 top panel-row, compares, over the 5 year period June 2016 - June 2021, the proposed RPIs with several potential correlates of rent (people per dwelling; people; and dwellings).[10] A strong correlation is observed between dwellings and RPI (R-squared: 58.4%), a smaller correlation with people per dwelling (R-squared: 43.7%). Little correlation was found between people population change and RPI (R-squared: 5.5%). Fig. 9 middle panel-row, shows the same comparisons using a smoothed geometric mean of weekly rental amounts.[11] The findings are similar, but RPI correlations are stronger. Notably so for dwellings; the R-squared is 16.1 percentage points lower using the non-quality adjusted geometric mean compared with the quality adjusted RPI. The expected strong correlation between the change in geometric mean of rental amounts and change in RPI is shown in the last panel-row of Fig. 9. alongside comparisons of changes in implied quality, calculated as the (multiplicative) difference between RPI and changes in smoothed geometric means, compared with people and dwelling changes. Appendix Fig. A4 compares temporal trends in regional RPIs with people per dwelling. A *'relative rental price index'* is used, calculated by dividing the regional RPI by the national RPI, to show the region specific variation in rental prices over time. Broadly similar patterns are observed for most regions. An exception to the pattern is the Canterbury region, which suffered significant damage to the dwelling stock following earthquakes in 2010 and 2011.

Figure 9: Plausibility checks



[10]People per dwelling calculated using data shown in Fig. 3. West Coast region is excluded as an outlier, the only region to have a population decrease, but is included in Appendix Fig. A4.

[11]Smoothed geometric mean of weekly rental amounts was calculated using Locally Weighted Scatterplot Smoothing: span parameter set to 0.33



5 Conclusions

Publication revision policies for Consumer Price Indices (CPIs) typically constrain the first published estimates to be final. This is important to ensure that first published period-on-period change can be used for indexation of monetary payments with the confidence that the official estimate will not change.

However, many economic statistics, including some price indices, have open revisions policies. For revisable timeseries, window chained series may be preferable to spliced series, since any revisions, resulting from new data or improved parameter estimates, will be allocated to the correct time period.

We used New Zealand rental price data to explore some of the costs of a revision constraint, in the context of a multilateral property fixed-effects (or Time Product Dummy) price index. New Zealand's flow Rental Price Index (RPI), which tracks price change for new tenancies, is a candidate for an open revision policy as it is not a direct input into the CPI.

Revisable timeseries were found to be important to maximise the use of available data, and therefore maximise precision of estimates. This is especially important for small regions with thin rental markets.

To provide initial monthly *flash estimates* for top level RPI regions, on the existing publication schedule, we found that it will be necessary to use a consistent subset of data (only data processed within the reference period) to provide initial estimates of rental price change. This complication helps to mitigate bias arising from systematic processes which affect what type of properties (and average weekly rental amount) are processed before the cut-off date. All subsequent estimates use all available data. The revisions will be small and non-systematic if historical data generation processes continue, or at least self-correcting if new patterns of revision emerge.

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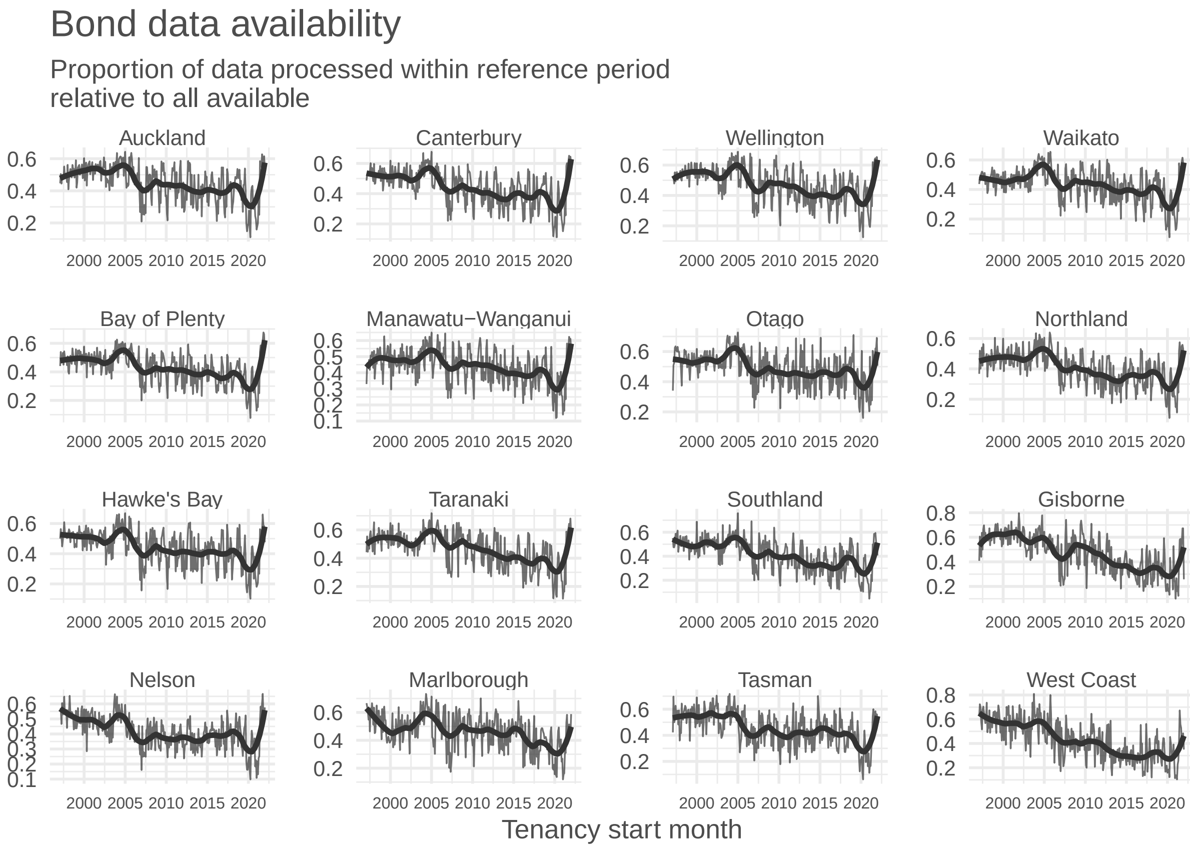
7 Appendix

Figure A1: Real-time availability of data by regional council



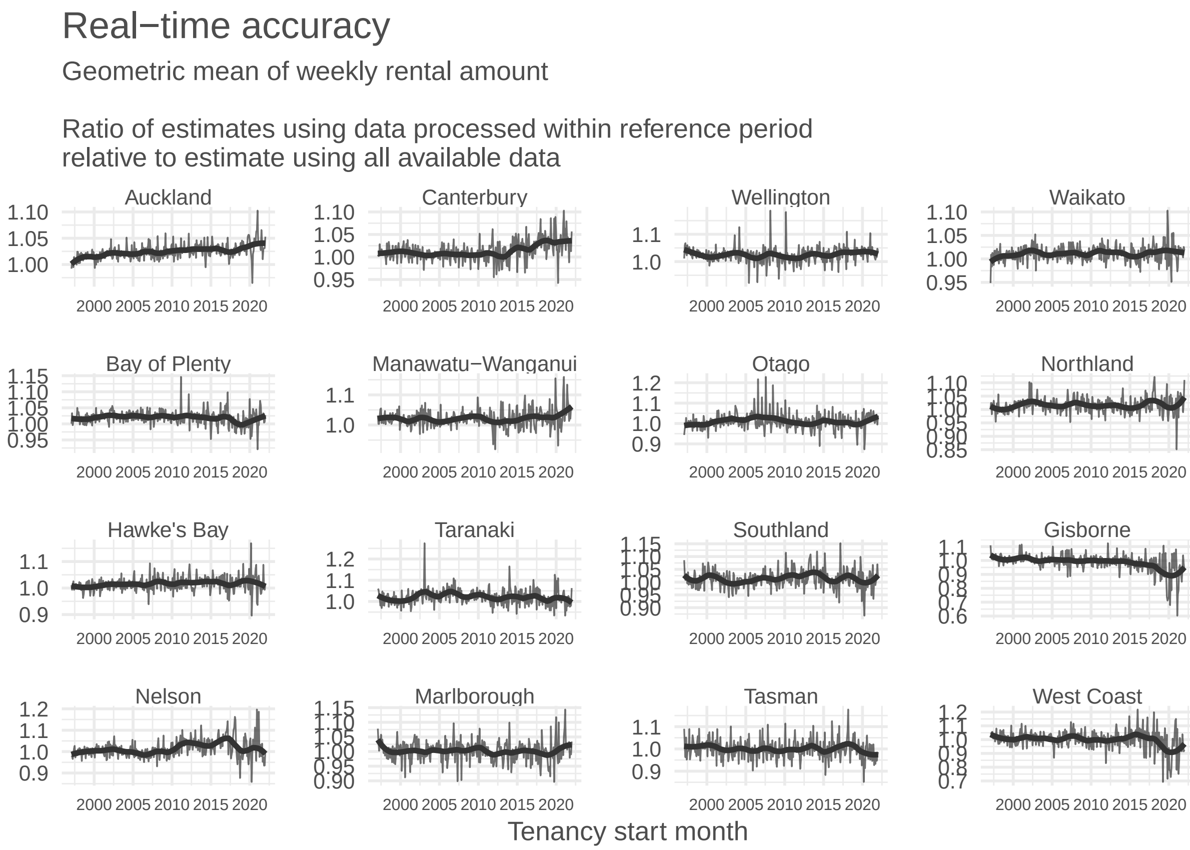


Figure A2: Number of rental properties by region, with proposed monthly data use

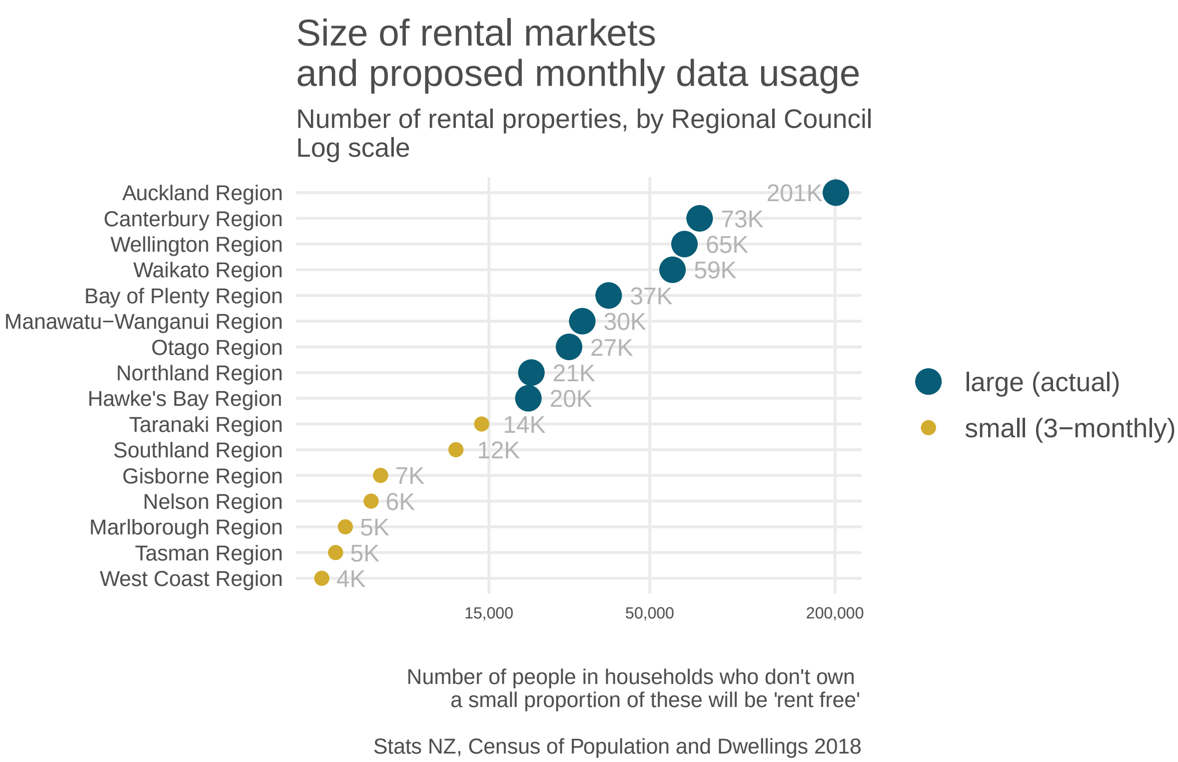


Figure A3: Precision of regional RPIs improves over time (as more data becomes available)

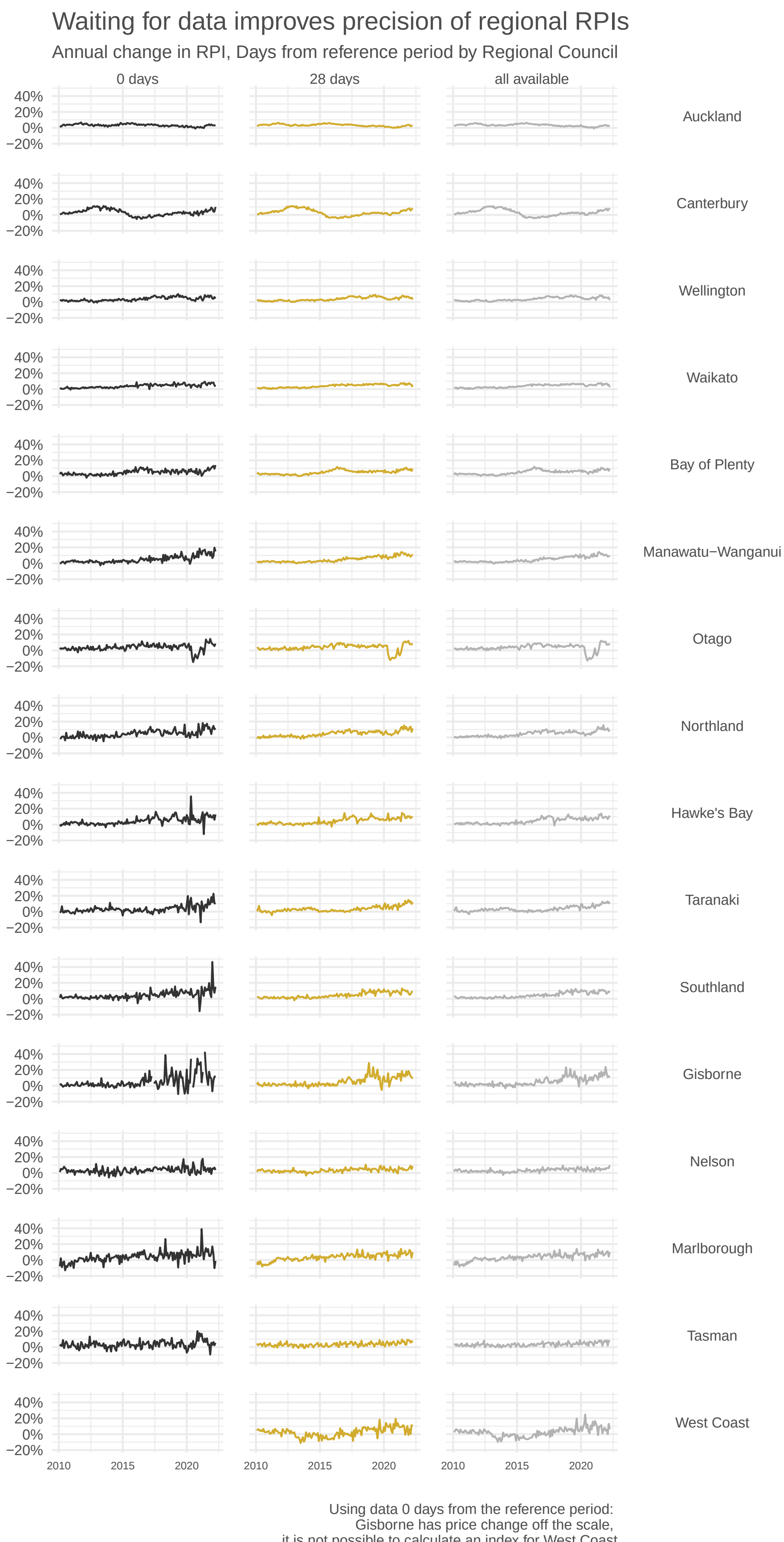


Table A1: Regional Council sample sizes, 28 days after reference period

region	Average sample size	Minimum sample size	Average sample size, 3-month roll	Minimum sample size, 3-month roll	Proportion of final data available	Proposed monthly data usage
West Coast	48	8	144	64	81	small (3-monthly)
Tasman	67	28	200	111	85	small (3-monthly)
Gisborne	76	23	227	82	84	small (3-monthly)
Marlborough	82	29	243	123	88	small (3-monthly)
Nelson	139	49	416	186	86	small (3-monthly)
Southland	163	44	488	310	83	small (3-monthly)
Taranaki	213	56	634	270	85	small (3-monthly)
Northland	258	82	766	449	81	large (actual)
Hawke's Bay	262	53	782	435	84	large (actual)
Manawatu-Wanganui	470	115	1398	817	85	large (actual)
Bay of Plenty	611	182	1827	773	82	large (actual)
Otago	619	168	1836	905	85	large (actual)
Waikato	953	270	2840	1548	84	large (actual)
Wellington	1208	317	3616	2074	82	large (actual)
Canterbury	1307	400	3924	2549	85	large (actual)
Auckland	3349	1017	10001	6003	84	large (actual)

A4: Trends in regional rental prices and mean people per dwelling